Filed 6/10/11; pub. order 7/8/11 (see end of opn.)

COURT OF APPEAL, FOURTH APPELLATE DISTRICT

DIVISION ONE

STATE OF CALIFORNIA

CITIZENS FOR RESPONSIBLE EQUITABLE ENVIRONMENTAL DEVELOPMENT, Petitioner and Appellant, v. CITY OF CHULA VISTA, Respondent;	D057779 (Super. Ct. No. 37-2009-00095947-CU-TT-CTL)
TARGET CORPORATION, Real Party in Interest.	

APPEAL from a judgment of the Superior Court of San Diego County, Ronald S. Prager, Judge. Affirmed in part, reversed in part, and remanded with directions.

Following preparation of an initial study under the California Environmental Quality Act (Pub. Resources Code, §§ 21000-21178.1; undesignated statutory references are to this code), the City of Chula Vista (City) adopted a mitigated negative declaration (MND) with respect to a project to replace a store operated by Target Corporation (Target), a smog check facility, and a small market (the existing

facilities) with a new larger Target store (the Project). Citizens for Responsible Equitable Environmental Development (Citizens) filed a petition for writ of mandate in the trial court against the City. Citizens appeals from the denial of the petition.

Citizens contends the trial court erred because there is substantial evidence of a fair argument that the Project may have a significant environmental impact on: hazards or hazardous materials; air quality for sensitive receptors; particulate matter and ozone; and greenhouse gas emissions and global climate change.

We conclude that the judgment denying Citizens's petition for a writ of mandate must be reversed to the extent it concluded that Citizens had not presented a fair argument that hazards and hazardous materials from the Project may create a potentially significant adverse environmental impact. In all other respects, the judgment is affirmed.

FACTUAL AND PROCEDURAL BACKGROUND

The Project site is a 9.9-acre shopping center parcel at the northwestern corner of North Fourth Avenue and C Street in Chula Vista, California. The Project proposes to demolish the existing facilities and replace them with a new Target store, resulting in a net size increase of 9,844 square feet of commercial development. The Project would increase the site's green space from 3.17 percent to 10.6 percent, and provide drainage facility improvements.

In November 2008, Target applied for the Project's preliminary environmental review. In January 2009, the City circulated its initial study which determined that the Project may cause potentially significant impacts and required Target to comply with a

series of mitigation measures set forth in the MND and an associated mitigation monitoring and reporting program (monitoring program). The City received no comments during the public review period. The MND concluded that the Project could have significant environmental impacts in the areas of air quality, geology and soils, hazards and hazardous material, hydrology and water quality, and traffic/transportation, but that those impacts could be mitigated. In June 2009, the City's planning commission recommended that the City Council approve the Project.

On July 13, 2009, the day before the City Council meeting, Citizens submitted a letter along with a CD-ROM containing thousands of pages of materials, asking that the council deny the Project. The following day, the City responded to each of the concerns raised by Citizens. After receiving no oral comments at the meeting, the City Council voted to approve the MND, monitoring program, and amend the zoning map. Citizens filed this action challenging the City's approval of the Project without preparing an environmental impact report (EIR).

The trial court issued a tentative ruling denying the petition for writ of mandate, and the parties submitted to the ruling. The court filed a judgment, and Citizens timely appealed.

DISCUSSION

I. *Standard of Review*

An EIR must be prepared "whenever it can be fairly argued on the basis of substantial evidence that the project may have significant environmental impact." (*No Oil, Inc. v. City of Los Angeles* (1974) 13 Cal.3d 68, 75 (*No Oil*).) Under the fair

argument standard, we determine whether there is substantial evidence in the record to support a fair argument that the project may have a significant effect on the environment. (Cal. Code Regs., tit. 14, § 15064, subd. (f)(1).) (References to the "Guidelines" refer to title 14 of the California Code of Regulations.) Whether a fair argument exists is a question of law that we review de novo, with a preference for resolving doubts in favor of environmental review. (*Pocket Protectors v. City of Sacramento* (2004) 124 Cal.App.4th 903, 928.) Although our review is de novo and nondeferential, we must give the lead agency the benefit of the doubt on any legitimate, disputed issues of credibility. (*Ibid*.)

Under the fair argument standard, a project "may" have a significant effect whenever there is a "reasonable possibility" that a significant effect will occur. (*No Oil*, *supra*, 13 Cal.3d at pp. 83-84.) Substantial evidence, for purposes of the fair argument standard, includes "fact, a reasonable assumption predicated upon fact, or expert opinion supported by fact." (§ 21080, subd. (e)(1).) Substantial evidence is not argument, speculation, unsubstantiated opinion or narrative, evidence that is clearly inaccurate or erroneous, or evidence of social or economic impacts unrelated to physical impacts on the environment. (§ 21080, subd. (e)(2).)

II. *Hazards and Hazardous Materials*

Citizens asserts the record contains substantial evidence of a fair argument that the Project may have a significant environmental impact due to contaminated soil, and the evidence does not show that the potential impact will be mitigated to a level of insignificance. We agree.

The MND notes that a gas station, formerly operating on a portion of the Project site, created environmental contamination "beneath the site" from leaking underground storage tanks and product lines. Since 1990, the groundwater at the site has been monitored. In 1996, "[c]onfirmatory soil sampling" was conducted. In 2008, a corrective action plan was created to reduce the remaining methyl tertiary butyl ether on the property. The Project's monitoring program indicates that the mitigation measures outlined in the corrective action plan must be complied with before building permits are issued. The MND anticipated that the required remediation would be completed before grading started, and if not completed, would continue during the grading activities.

The City asserts that the building permit stage is an acceptable deadline for completion of the remediation activities because it is groundwater that is contaminated and not soils; and existing groundwater contamination will not be affected by grading activities. The record, however, suggests otherwise.

The Guidelines define "substantial evidence" as "enough relevant information and reasonable inferences from this information that a fair argument can be made to support a conclusion, even though other conclusions might also be reached." (Guidelines, § 15384, subd. (a).) Here, the MND suggests that pollutants leaking from underground storage tanks contaminated the soil underneath the Project site before reaching the groundwater. Although the building permits are conditioned on compliance with the corrective action plan, it is unknown what, if any, mitigation measures in this plan address contaminated soils as the corrective action plan is not

part of the record. Thus, it can be fairly argued that the Project may have a significant environmental impact by disturbing contaminated soils.

Accordingly, the matter must be remanded to the trial court to determine whether the corrective action plan addresses contaminated soil. In the event the trial court determines that the corrective plan does not address contaminated soil, it is to order an EIR.

III. *Air Pollution Impact on Sensitive Receptors*

"Sensitive receptors" include children. Citizens contends that there are at least four schools and pre-schools within a mile of the Project, and that the nearest residence is within 500 feet of the Project; however, the MND does not mention sensitive receptors and merely identifies mitigation measures designed to reduce dust and exhaust emissions. It asserts that the Project will emit hazardous air pollutants, particularly diesel exhaust, during construction and normal operations, and that the emission of these pollutants warranted a health-risk assessment or, at a minimum, a health-risk screening. Because there is no analysis of the environmental impact of these pollutants, Citizens claims it is impossible to tell if the mitigation measures identified in the MND will be effective at reducing the sensitive-receptor impact to a level of insignificance. Thus, it concludes there is substantial evidence of a fair argument that the Project may have a significant impact by exposing sensitive receptors to increased air pollution. We disagree.

An "Air Quality Assessment" prepared for the Project analyzed potential air quality impacts caused by construction and operation of the Project. The Air Quality

Assessment states that a project would have a significant environmental impact if it would expose sensitive receptors, such as children or the elderly, to substantial pollutant concentrations. As required by the Guidelines, the Air Quality Assessment evaluated, among other things, whether the Project would expose sensitive receptors to substantial pollutant concentrations.

To determine whether the Project would produce emissions that could violate any air quality standard or contribute substantially to an existing or projected air quality violation, the City was guided by the CEQA Air Quality Handbook created by the South Coast Air Quality Management District (the District). The District is the agency responsible for regulating nonvehicular air pollution in certain counties in southern California. (*Communities for a Better Environment v. South Coast Air Quality Management Dist.* (2010) 48 Cal.4th 310, 317.) The District typically requires a health risk assessment of diesel particulate matter for projects that: (1) generate substantial truck traffic (such as a warehouse distribution center or a truck stop), or (2) substantially increase truck traffic over existing levels.

The Air Quality Assessment concluded that the Project would not significantly impact traffic, and determined that emissions associated with construction and operation of the Project did not exceed any air quality significance thresholds. Thus, there was no need for the City to conduct a health-risk assessment or screening. Citizens has not cited any evidence in the record to dispute these conclusions.

Finally, although a box in the initial study was marked to show that the impact of the Project with regard to exposing sensitive receptors to substantial pollutant

concentrations would be "less than significant *with mitigation incorporated*" (italics added), it appears this box was marked in error as the Air Quality Assessment established that the Project would not exceed any air quality significance thresholds. Additionally, the mitigation measures specified in the MND do not relate to mitigating pollution for sensitive receptors; rather, they relate to best management practices to control dust and reduce air emissions during construction activities, and design features in the Project to reduce greenhouse gas emissions.

Accordingly, we conclude there is no substantial evidence of a fair argument that the Project may have a significant impact by exposing sensitive receptors to increased air pollution.

IV. *Cumulative Impact on Particulate Matter and Ozone*

The federal Clean Air Act (42 U.S.C. § 7401 et seq.) requires that the United States Environmental Protection Agency establish national air quality standards. (42 U.S.C. § 7409(a), (b).) Additionally, the California Air Resources Board established its own standards for California. (Health & Saf. Code, § 39606, subd. (a)(2).) Areas that do not meet national or state standards for a particular pollutant are considered to be nonattainment areas for that pollutant. (42 U.S.C. § 7407(d).)

Citizens notes that the Air Quality Assessment indicated that the region where the Project is located is in nonattainment of federal standards for 8-hour ozone and in nonattainment of state standards for ozone and particulate matter. Citizens concludes that the Project may have a significant cumulative air-quality impact due to its

contribution of particulate matter and NOx (an ozone precursor) in a nonattainment area. The record does not support Citizens's assertion.

The Air Quality Assessment evaluated whether the Project would result in a cumulatively considerable increase of particulate matter, or exceed quantitative thresholds for ozone precursors. To determine whether the Project would cumulatively increase net particulate matter or exceed quantitative thresholds for ozone precursors for which the San Diego air basin is in nonattainment, the City evaluated Project emissions against the significance thresholds established by the District. (Guidelines, § 15064.7 [The lead agency may rely on a threshold of significance standard to determine whether a project will cause a significant environmental effect.].) For nonattainment pollutants, the Air Quality Assessment concluded that the Project could potentially result in "a cumulatively considerable net increase in these pollutants and thus could have a significant impact on the ambient air quality" if the emissions exceeded the screening level thresholds.

A table in the Air Quality Assessment shows the screening level criteria for impacting air quality. Other tables list the screening level criteria for various emissions during construction and operation of the Project, along with estimated emissions during construction and operation of the Project. These tables show that the net emissions *increases* over the existing amounts are below the significance level for all pollutants.

Although the Project will contribute additional air pollutants to an existing nonattainment area, these increases are below the significance criteria and are thus

considered to have no significant impact on ambient air quality based on the standard articulated in the Air Quality Assessment. Citizens has not presented any evidence to contradict the conclusion in the Air Quality Assessment that these increases are below the significance criteria, nor does it assert that the Air Quality Assessment articulated an erroneous standard for determining whether the increases in nonattainment pollutants have a significant impact on ambient air quality. Thus, we conclude no fair argument exists that the Project will cause a significant unavoidable cumulative contribution to an air quality impact.

V. *Cumulative Impact on Greenhouse Gas Emissions and Climate Change*

The Air Quality Assessment shows that greenhouse gas emissions come from a variety of sources, including waste, and that waste generates two percent of total greenhouse gas emissions. Citizens argues that the Air Quality Assessment underestimated the Project's contribution to greenhouse gases because it failed to include waste as a greenhouse gas producer in its inventory. Citizens contends that because the store will be larger, it is reasonable to assume that it will generate more waste.

While the proposed Target store will be larger, Citizens's assumption that it will generate more waste is erroneous as the proposed store will maintain the existing dumpster, which will be emptied at the same frequency as the existing Target store. Thus, the increased store size is not projected to increase waste, or greenhouse gas emissions generated from waste. Moreover, Citizens's argument ignores that the Project eliminated two existing facilities that generated waste, a market and a smog

check facility. Taking into account the elimination of these waste producers, it is more reasonable to assume that the Project will result in a net decrease of waste and resultant greenhouse gas emissions. Thus, under these facts, the City did not err when it failed to include waste as a source of greenhouse gas emissions.

Citizens observes that the Air Quality Assessment indicated that the first part of the threshold of significance for the Project's greenhouse gas emissions and climate change impacts was whether the Project would "[c]onflict with or obstruct the goals or strategies of the California Global Warming Solutions Act of 2006 (AB 32) or its governing regulation." As a preliminary matter, Citizens takes issue with the City's use of AB 32 as the significance threshold. It asserts that the Project exceeds the significance thresholds under three other well-recognized potential thresholds of significance. As such, it contends that a fair argument exists that the Project will significantly impact greenhouse gas emissions and climate change.

Citizens does not contend, however, that there is one universally accepted significance threshold, and that the City erred by utilizing AB 32. Rather, the Air Quality Assessment made clear that, while guidelines were being proposed, none existed at that time for determining the impact of a project on greenhouse gas emissions or climate change. Accordingly, the Air Quality Assessment noted that lead agencies may exercise their discretion on what criteria to use. (Guidelines, § 15064(b) ["The determination of whether a project may have a significant effect on the environment calls for careful judgment on the part of the public agency involved, based to the extent possible on scientific and factual data."].)

Effective March 18, 2010, the Guidelines were amended to address greenhouse gas emissions. (Guidelines, § 15064.4.) The amendment confirms that lead agencies retain the discretion to determine the significance of greenhouse gas emissions and should "make a good-faith effort, based to the extent possible on scientific and factual data, to describe, calculate or estimate the amount of greenhouse gas emissions resulting from a project." (Guidelines, § 15064.4(a).) When assessing the significance of impacts from greenhouse gas emissions on the environment the lead agency should consider: the extent the project may increase or reduce greenhouse gas emissions; whether the project emissions exceed a threshold of significance that the lead agency determines applies to the project; and the extent the project complies with regulations or requirements adopted to implement a statewide, regional, or local plan for the reduction or mitigation of greenhouse gas emissions. (Guidelines, § 15064.4(b).) Thus, under the new guidelines, lead agencies are allowed to decide what threshold of significance it will apply to a project.

Here, the City properly exercised its discretion to utilize compliance with AB 32 as the threshold. Accordingly, we reject Citizens's argument that the City erred by not applying a different threshold.

We also reject Citizens's argument that the standard and analysis used by the City were arbitrary and unsubstantiated. AB 32 sets a target of reducing greenhouse gas emissions to 2000 levels by 2010 and 1990 levels by 2020. The Air Quality Assessment estimated that to reach 2000 levels by 2010 required 11 percent below business as usual emissions; and to reach 1990 levels by 2020 required 25 percent

below business as usual emissions. The Air Quality Assessment then established a target of 20 percent below business as usual as the appropriate standard, and not the 25 percent below business as usual that would be needed to be consistent with the estimate for reaching 1990 levels by 2020, stating that this is "an appropriate midpoint between the 2010 and 2020 targets set forth in AB 32 considering the timeframe for Project operations is within these dates."

Citizens contends that the City arbitrarily picked a number falling somewhere between the 2010 and 2020 targets, and that the standard selected was not supported by substantial evidence. Citizens is correct that the Air Quality Assessment established a target of 20 percent below business as usual as the appropriate standard, and not the 25 percent below business as usual that would be needed to be consistent with AB 32. However, the Air Quality Assessment ultimately concluded that, with implementation of emission reduction programs, the Project would reduce greenhouse gas emissions by 29 percent by 2020. This is four percent more than the AB 32 goal of 25 percent. Thus, it is irrelevant whether the Air Quality Assessment utilized a 20 percent reduction or a 25 percent reduction as the target, because the 29 percent reduction exceeded both goals.

The record supports the 29 percent reduction. The Air Quality Assessment listed the operational emissions for "business as usual" for the existing Target store and the proposed store at 8,280 metric tons per year and 10,337 metric tons per year, respectively. Thus, under "business as usual" the proposed Target store would increase greenhouse gas emissions by 2,057 metric tons. However, through the

implementation of energy saving measures, the operational greenhouse gas emissions for the proposed store is reduced to 7,381 metric tons per year, or 2,956 metric tons *less than* "business as usual." This amounts to a 29 percent reduction from business as usual.

Finally, Citizens argues that even assuming consistency with the goals of AB 32 was the proper significance threshold and that the 29 percent reduction cited in the Air Quality Assessment is accurate, the Project does not achieve a 33 percent reduction below the business as usual threshold required for San Diego County as set forth in an "On-Road Transportation Report" (the Report) which is a component of the San Diego County Greenhouse Gas Inventory. As we explained above, the City had the discretion to not adopt this different threshold. Thus, we do not respond to Citizens's arguments premised on this different inventory. In any event, the Report acknowledged that AB 32 does *not* require cities or counties to reduce emissions by a certain amount, and noted that the required reductions listed were "theoretical."

In summary, we conclude no fair argument exists that the Project will have a significant greenhouse gas emissions and climate change impact.

DISPOSITION

The judgment denying appellant's petition for writ of mandate is reversed to the extent it concluded that appellant had not presented a fair argument that hazards and hazardous materials from the Project may create a potentially significant adverse environmental impact. In all other respects, the judgment is affirmed. On remand, the trial court shall determine whether the corrective action plan addresses contaminated

soil. In the event the trial court determines that the corrective plan does not address contaminated soil, it is to order an EIR. The parties are to bear their own appellate costs.

MCINTYRE, J.

WE CONCUR:

MCDONALD, Acting P. J.

AARON, J.

Filed 7/8/11

CERTIFIED FOR PUBLICATION

COURT OF APPEAL, FOURTH APPELLATE DISTRICT

DIVISION ONE

STATE OF CALIFORNIA

CITIZENS FOR RESPONSIBLE EQUITABLE ENVIRONMENTAL DEVELOPMENT, Petitioner and Appellant, v. CITY OF CHULA VISTA, Respondent;	D057779 (Super. Ct. No. 37-2009-00095947-CU-TT-CTL) ORDER CERTIFYING OPINION FOR PUBLICATION
TARGET CORPORATION, Real Party in Interest.	

THE COURT:

The opinion filed June 10, 2011, is ordered certified for publication.

The attorneys of record are:

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California Environmental Protection Agency
Air Resources Board

Air Pollution - Particulate Matter Brochure

This page last reviewed May 6, 2009

What is Particulate Matter (PM10)?

Particulate matter (PM10) pollution consists of very small liquid and solid particles floating in the air. Of greatest concern to public health are the particles small enough to be inhaled into the deepest parts of the lung. These particles are less than 10 microns in diameter - about 1/7th the thickness of the a human hair - and are known as PM10. This includes fine particulate matter known as PM2.5.

PM10 is a major component of air pollution that threatens both our health and our environment.

Where does PM10 come from?

In the western United States, there are sources of PM10 in both urban and rural are as, major sources include:

1. Motor vehicles.
2. Wood burning stoves and fireplaces.
3. Dust from construction, landfills, and agriculture.
4. Wildfires and brush/waste burning.
5. Industrial sources.
6. Windblown dust from open lands.

PM10 is a mixture of materials that can include smoke, soot, dust, salt, acids, and metals. Particulate matter also forms when gases emitted from motor vehicles and industry undergo chemical reactions in the atmosphere.

How does PM10 affect our health?

PM10 is among the most harmful of all air pollutants. When inhaled these particles evade the respiratory system's natural defenses and lodge deep in the lungs.

Health problems begin as the body reacts to these foreign particles. PM10 can increase the number and severity of asthma attacks, cause or aggravate bronchitis and other lung diseases, and reduce the body's ability to fight infections.

Although particulate matter can cause health problems for everyone, certain people are especially vulnerable to PM10's adverse health effects. These "sensitive populations" include children, the elderly, exercising adults, and those suffering from asthma or bronchitis.

Of greatest concern are recent studies that link PM10 exposure to the premature death of people who already have heart and lung disease, especially the elderly.

Does PM10 affect our view?

PM10 is often responsible for much of the haze that we think of as smog. This is a problem in our cities, rural areas and pristine areas - such as national parks and forests.

What is being done to reduce PM10 pollution?

The United States Environmental Protection Agency has set air quality standards for PM10. Based on health research, these identify acceptable levels of PM10. Currently, these standards are violated in many parts of the western United States.

Air quality agencies in several states have developed, or are now developing, air quality plans to bring PM10 concentrations down to healthful levels. These plans include a variety of programs to reduce emissions, including:

1. Dust control for roads, construction, and landfills.
2. Landscaping, barrier, and fencing to reduce windblown dust.
3. Programs to reduce emission from wood stoves and fireplaces.
4. Cleaner - burning gasoline and diesel fuels.
5. Emission control devices for motor vehicles.
6. Controls for industrial facilities.

What can you do?

Here are a few things individuals, business, and other organizations can do immediately to reduce the threat of PM10:

1. Reduce travel on days with poor air quality.
2. Avoid vigorous physical activity on days that have poor air quality.
3. Avoid using your wood stove and fireplace on days that have poor air quality.
4. Avoid using leaf blowers and other dust - producing equipment.
5. Drive slowly on unpaved roads and other dirt surfaces.
6. Get involved with air quality improvement programs in your community.
7. If you own or operate an industrial source of PM10, comply with local rules that apply to your operation. Work with local agencies to develop strategies that will further reduce PM10 emissions.

AIR QUALITY AND LAND USE HANDBOOK: A COMMUNITY HEALTH PERSPECTIVE



April 2005

California Environmental Protection Agency
California Air Resources Board

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To My Local Government Colleagues....

I am pleased to introduce this informational guide to air quality and land use issues focused on community health. As a former county supervisor, I know from experience the complexity of local land use decisions. There are multiple factors to consider and balance. This document provides important public health information that we hope will be considered along with housing needs, economic development priorities, and other quality of life issues.

An important focus of this document is prevention. We hope the air quality information provided will help inform decision-makers about the benefits of avoiding certain siting situations. The overarching goal is to avoid placing people in harm's way. Recent studies have shown that public exposure to air pollution can be substantially elevated near freeways and certain other facilities. What is encouraging is that the health risk is greatly reduced with distance. For that reason, we have provided some general recommendations aimed at keeping appropriate distances between sources of air pollution and land uses such as residences.

Land use decisions are a local government responsibility. The Air Resources Board's role is advisory and these recommendations do not establish regulatory standards of any kind. However, we hope that the information in this document will be seriously considered by local elected officials and land use agencies. We also hope that this document will promote enhanced communication between land use agencies and local air pollution control agencies. We developed this document in close coordination with the California Air Pollution Control Officers Association with that goal in mind.

I hope you find this document both informative and useful.

Barbara Riordan

Mrs. Barbara Riordan
Interim Chairman
California Air Resources Board

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Acknowledgments

The ARB staff would like to acknowledge the exceptional contributions made to this document by members of the ARB Environmental Justice Stakeholders Group. Since 2001, ARB staff has consistently relied on this group to provide critical and constructive input on implementing the specifics of ARB's environmental justice policies and actions. The Stakeholders Group is convened by the ARB, and comprised of representatives from local land use and air agencies, community interest groups, environmental justice organizations, academia, and business. Their assistance and suggestions throughout the development of this Handbook have been invaluable.

Executive Summary

The Air Resources Board's (ARB) primary goal in developing this document is to provide information that will help keep California's children and other vulnerable populations out of harm's way with respect to nearby sources of air pollution. Recent air pollution studies have shown an association between respiratory and other non-cancer health effects and proximity to high traffic roadways. Other studies have shown that diesel exhaust and other cancer-causing chemicals emitted from cars and trucks are responsible for much of the overall cancer risk from airborne toxics in California. Also, ARB community health risk assessments and regulatory programs have produced important air quality information about certain types of facilities that should be considered when siting new residences, schools, day care centers, playgrounds, and medical facilities (i.e., sensitive land uses). Sensitive land uses deserve special attention because children, pregnant women, the elderly, and those with existing health problems are especially vulnerable to the non-cancer effects of air pollution. There is also substantial evidence that children are more sensitive to cancer-causing chemicals.

Focusing attention on these siting situations is an important preventative action. ARB and local air districts have comprehensive efforts underway to address new and existing air pollution sources under their respective jurisdictions. The issue of siting is a local government function. As more data on the connection between proximity and health risk from air pollution become available, it is essential that air agencies share what we know with land use agencies. We hope this document will serve that purpose.

The first section provides ARB recommendations regarding the siting of new sensitive land uses near freeways, distribution centers, rail yards, ports, refineries, chrome plating facilities, dry cleaners, and gasoline dispensing facilities. This list consists of the air pollution sources that we have evaluated from the standpoint of the proximity issue. It is based on available information and reflects ARB's primary areas of jurisdiction – mobile sources and toxic air contaminants. A key air pollutant common to many of these sources is particulate matter from diesel engines. Diesel particulate matter (diesel PM) is a carcinogen identified by ARB as a toxic air contaminant and contributes to particulate pollution statewide.

Reducing diesel particulate emissions is one of ARB's highest public health priorities and the focus of a comprehensive statewide control program that is reducing diesel PM emissions each year. ARB's long-term goal is to reduce diesel PM emissions 85% by 2020. However, cleaning up diesel engines will take time as new engine standards phase in and programs to accelerate fleet turnover or retrofit existing engines are implemented. Also, these efforts are reducing diesel particulate emissions on a statewide basis, but do not yet capture every site where diesel vehicles and engines may congregate. Because living or going to school too close to such air pollution sources may increase both cancer and non-cancer health risks, we are recommending that proximity be considered in the siting of new sensitive land uses.

There are also other key toxic air contaminants associated with specific types of facilities. Most of these are subject to stringent state and local air district regulations. However, what we know today indicates that keeping new homes and other sensitive land uses from siting too close to such facilities would provide additional health protection. Chrome platers are a prime example of facilities that should not be located near vulnerable communities because of the cancer health risks from exposure to the toxic material used during their operations.

In addition to source specific recommendations, we also encourage land use agencies to use their planning processes to ensure the appropriate separation of industrial facilities and sensitive land uses. While we provide some suggestions, how to best achieve that goal is a local issue. In the development of these guidelines, we received valuable input from local government about the spectrum of issues that must be considered in the land use planning process. This includes addressing housing and transportation needs, the benefits of urban infill, community economic development priorities, and other quality of life issues. All of these factors are important considerations. The recommendations in the Handbook need to be balanced with other State and local policies.

Our purpose with this document is to highlight the potential health impacts associated with proximity to air pollution sources so planners explicitly consider this issue in planning processes. We believe that with careful evaluation, infill development, mixed use, higher density, transit-oriented development, and other concepts that benefit regional air quality can be compatible with protecting the health of individuals at the neighborhood level. One suggestion for achieving this goal is more communication between air agencies and land use planners. Local air districts are an important resource that should be consulted regarding sources of air pollution in their jurisdictions. ARB staff will also continue to provide updated technical information as it becomes available.

Our recommendations are as specific as possible given the nature of the available data. In some cases, like refineries, we suggest that the siting of new sensitive land uses should be avoided immediately downwind. However, we leave definition of the size of this area to local agencies based on facility specific considerations. Also, project design that would reduce air pollution exposure may be part of the picture and we encourage consultation with air agencies on this subject.

In developing the recommendations, our first consideration was the adequacy of the data available for an air pollution source category. Using that data, we assessed whether we could reasonably characterize the relative exposure and health risk from a proximity standpoint. That screening provided the list of air pollution sources that we were able to address with specific recommendations. We also considered the practical implications of making hard and fast recommendations where the potential impact area is large, emissions will be reduced with time, and air agencies are in the process of looking at options for additional emission control. In the end, we tailored our recommendations to minimize the highest exposures for each source category independently. Due to the large variability in relative risk in the source categories, we chose not to apply

a uniform, quantified risk threshold as is typically done in air quality permitting programs. Instead, because these guidelines are not regulatory or binding on local agencies, we took a more qualitative approach in developing the distance-based recommendations.

Where possible, we recommend a minimum separation between a new sensitive land use and known air pollution risks. In other cases, we acknowledge that the existing health risk is too high in a relatively large area, that air agencies are working to reduce that risk, and that in the meantime, we recommend keeping new sensitive land uses out of the highest exposure areas. However, it is critical to note that our implied identification of the high exposure areas for these sources does not mean that the risk in the remaining impact area is insignificant. Rather, we hope this document will bring further attention to the potential health risk throughout the impact area and help garner support for our ongoing efforts to reduce health risk associated with air pollution sources. Areas downwind of major ports, rail yards, and other inter-modal transportation facilities are prime examples.

We developed these recommendations as a means to share important public health information. The underlying data are publicly available and referenced in this document. We also describe our rationale and the factors considered in developing each recommendation, including data limitations and uncertainties. These recommendations are advisory and should not be interpreted as defined "buffer zones." We recognize the opportunity for more detailed site-specific analyses always exists, and that there is no "one size fits all" solution to land use planning.

As California continues to grow, we collectively have the opportunity to use all the information at hand to avoid siting scenarios that may pose a health risk. As part of ARB's focus on communities and children's health, we encourage land use agencies to apply these recommendations and work more closely with air agencies. We also hope that this document will help educate a wider audience about the value of preventative action to reduce environmental exposures to air pollution.

1. ARB Recommendations on Siting New Sensitive Land Uses

Protecting California's communities and our children from the health effects of air pollution is one of the most fundamental goals of state and local air pollution control programs. Our focus on children reflects their special vulnerability to the health impacts of air pollution. Other vulnerable populations include the elderly, pregnant women, and those with serious health problems affected by air pollution. With this document, we hope to more effectively engage local land use agencies as partners in our efforts to reduce health risk from air pollution in all California communities.

Later sections emphasize the need to strengthen the connection between air quality and land use in both planning and permitting processes. Because the siting process for many, but not all air pollution sources involves permitting by local air districts, there is an opportunity for interagency coordination where the proposed location might pose a problem. To enhance the evaluation process from a land use perspective, section 4 includes recommended project related questions to help screen for potential proximity related issues.

Unlike industrial and other stationary sources of air pollution, the siting of new homes or day care centers does not require an air quality permit. Because these situations fall outside the air quality permitting process, it is especially important that land use agencies be aware of potential air pollution impacts.

The following recommendations address the issue of siting "sensitive land uses" near specific sources of air pollution; namely:

- High traffic freeways and roads
- Distribution centers
- Rail yards
- Ports
- Refineries
- Chrome plating facilities
- Dry cleaners
- Large gas dispensing facilities

The recommendations for each category include a summary of key information and guidance on what to avoid from a public health perspective.

Sensitive individuals refer to those segments of the population most susceptible to poor air quality (i.e., children, the elderly, and those with pre-existing serious health problems affected by air quality). Land uses where sensitive individuals are most likely to spend time include schools and schoolyards, parks and playgrounds, daycare centers, nursing homes, hospitals, and residential communities (sensitive sites or sensitive land uses).

We are characterizing sensitive land uses as simply as we can by using the example of residences, schools, day care centers, playgrounds, and medical facilities. However, a variety of facilities are encompassed. For example, residences can include houses, apartments, and senior living complexes. Medical facilities can include hospitals, convalescent homes, and health clinics. Playgrounds could be play areas associated with parks or community centers.

In developing these recommendations, ARB first considered the adequacy of the data available for each air pollution source category. We assessed whether we could generally characterize the relative exposure and health risk from a proximity standpoint. The documented non-cancer health risks include triggering of asthma attacks, heart attacks, and increases in daily mortality and hospitalization for heart and respiratory diseases. These health impacts are well documented in epidemiological studies, but less easy to quantify from a particular air pollution source. Therefore, the cancer health impacts are used in this document to provide a picture of relative risk. This screening process provided the list of source categories we were able to address with specific recommendations. In evaluating the available information, we also considered the practical implications of making hard and fast recommendations where the potential impact area is large, emissions will be reduced with time, and air agencies are in the process of looking at options for additional emission control. Due to the large variability in relative risk between the source categories, we chose not to apply a uniform, quantified risk threshold as is typically done in regulatory programs. Therefore, in the end, we tailored our recommendations to minimize the highest exposures for each source category independently. Additionally, because this guidance is not regulatory or binding on local agencies, we took a more qualitative approach to developing distance based recommendations.

Where possible, we recommend a minimum separation between new sensitive land uses and existing sources. However, this is not always possible, particularly where there is an elevated health risk over large geographical areas. Areas downwind of ports and rail yards are prime examples. In such cases, we recommend doing everything possible to avoid locating sensitive receptors within the highest risk zones. Concurrently, air agencies and others will be working to reduce the overall risk through controls and measures within their scope of authority.

The recommendations were developed from the standpoint of siting new sensitive land uses. Project-specific data for new and existing air pollution sources are available as part of the air quality permitting process. Where such information is available, it should be used. Our recommendations are designed to fill a gap where information about existing facilities may not be readily available. These recommendations are only guidelines and are not designed to substitute for more specific information if it exists.

A summary of our recommendations is shown in Table 1-1. The basis and references[1] supporting each of these recommendations, including health studies, air quality modeling and monitoring studies is discussed below beginning with freeways and summarized in Table 1-2. As new information becomes available, it will be included on ARB's community health web page.

[1]Detailed information on these references are available on ARB's website at: http://www.ARB.ca.gov/ch/landuse.htm.

Table 1-1

Recommendations on Siting New Sensitive Land Uses Such As Residences, Schools, Daycare Centers, Playgrounds, or Medical Facilities*

Source Category	Advisory Recommendations
Freeways and High-Traffic Roads	• Avoid siting new sensitive land uses within 500 feet of a freeway, urban roads with 100,000 vehicles/day, or rural roads with 50,000 vehicles/day.
Distribution Centers	• Avoid siting new sensitive land uses within 1,000 feet of a distribution center (that accommodates more than 100 trucks per day, more than 40 trucks with operating transport refrigeration units (TRUs) per day, or where TRU unit operations exceed 300 hours per week). • Take into account the configuration of existing distribution centers and avoid locating residences and other new sensitive land uses near entry and exit points.
Rail Yards	• Avoid siting new sensitive land uses within 1,000 feet of a major service and maintenance rail yard. • Within one mile of a rail yard, consider possible siting limitations and mitigation approaches.
Ports	• Avoid siting of new sensitive land uses immediately downwind of ports in the most heavily impacted zones. Consult local air districts or the ARB on the status of pending analyses of health risks.
Refineries	• Avoid siting new sensitive land uses immediately downwind of petroleum refineries. Consult with local air districts and other local agencies to determine an appropriate separation.
Chrome Platers	• Avoid siting new sensitive land uses within 1,000 feet of a chrome plater.
Dry Cleaners Using Perchloro-ethylene	• Avoid siting new sensitive land uses within 300 feet of any dry cleaning operation. For operations with two or more machines, provide 500 feet. For operations with 3 or more machines, consult with the local air district. • Do not site new sensitive land uses in the same building with perc dry cleaning operations.
Gasoline Dispensing Facilities	• Avoid siting new sensitive land uses within 300 feet of a large gas station (defined as a facility with a throughput of 3.6 million gallons per year or greater). A 50 foot separation is recommended for typical gas dispensing facilities.

*Notes:

- These recommendations are advisory. Land use agencies have to balance other considerations, including housing and transportation needs, economic development priorities, and other quality of life issues.

- Recommendations are based primarily on data showing that the air pollution exposures addressed here (i.e., localized) can be reduced as much as 80% with the recommended separation.
- The relative risk for these categories varies greatly (see Table 1-2). To determine the actual risk near a particular facility, a site-specific analysis would be required. Risk from diesel PM will decrease over time as cleaner technology phases in.
- These recommendations are designed to fill a gap where information about existing facilities may not be readily available and are not designed to substitute for more specific information if it exists. The recommended distances take into account other factors in addition to available health risk data (see individual category descriptions).
- Site-specific project design improvements may help reduce air pollution exposures and should also be considered when siting new sensitive land uses.
- This table does not imply that mixed residential and commercial development in general is incompatible. Rather it focuses on known problems like dry cleaners using perchloroethylene that can be addressed with reasonable preventative actions.
- A summary of the basis for the distance recommendations can be found in Table 1-2.

Table 1-2

Summary of Basis for Advisory Recommendations

Source Category	Range of Relative Cancer Risk[1,2]	Summary of Basis for Advisory Recommendations
Freeways and High-Traffic Roads	300 – 1,700	• In traffic-related studies, the additional non-cancer health risk attributable to proximity was seen within 1,000 feet and was strongest within 300 feet. California freeway studies show about a 70% drop off in particulate pollution levels at 500 feet.
Distribution Centers[3]	Up to 500	• Because ARB regulations will restrict truck idling at distribution centers, transport refrigeration unit (TRU) operations are the largest onsite diesel PM emission source followed by truck travel in and out of distribution centers. • Based on ARB and South Coast District emissions and modeling analyses, we estimate an 80 percent drop-off in pollutant concentrations at approximately 1,000 feet from a distribution center.
Rail Yards	Up to 500	• The air quality modeling conducted for the Roseville Rail Yard Study predicted the highest impact is within 1,000 feet of the Yard, and is associated with service and maintenance activities. The next highest impact is between a half to one mile of the Yard, depending on wind direction and intensity.
Ports	Studies underway	• ARB will evaluate the impacts of ports and develop a new comprehensive plan that will describe the steps needed to reduce public health impacts from port and rail activities in California. In the interim, a general advisory is appropriate based on the magnitude of diesel PM emissions associated with ports.
Refineries	Under 10	• Risk assessments conducted at California refineries show risks from air toxics to be under 10 chances of cancer per million.[4] • Distance recommendations were based on the amount and potentially hazardous nature of many of the pollutants released as part of the refinery process, particularly during non-routine emissions releases.
Chrome Platers	10-100	• ARB modeling and monitoring studies show localized risk of hexavalent chromium diminishing significantly at 300 feet. There are data limitations in both the modeling and monitoring studies. These include variability of plating activities and uncertainty of emissions such as fugitive dust. Hexavalent chromium is one of the most potent toxic air contaminants. Considering these factors, a distance of 1,000 feet was used as a precautionary measure.
Dry Cleaners Using Perchloro-ethylene (perc)	15-150	• Local air district studies indicate that individual cancer risk can be reduced by as much as 75 percent by establishing a 300 foot separation between a sensitive land use and a one-machine perc dry cleaning operation. For larger operations (2 machines or more), a separation of 500 feet can reduce risk by over 85 percent.

Source Category	Range of Relative Cancer Risk[1,2]	Summary of Basis for Advisory Recommendations
Gasoline Dispensing Facilities (GDF)[5]	Typical GDF: Less than 10 Large GDF: Between Less than 10 and 120	• Based on the CAPCOA Gasoline Service Station Industry-wide Risk Assessment Guidelines, most typical GDFs (less than 3.6 million gallons per year) have a risk of less than 10 at 50 feet under urban air dispersion conditions. Over the last few years, there has been a growing number of extremely large GDFs with sales over 3.6 and as high as 19 million gallons per year. Under rural air dispersion conditions, these large GDFs can pose a larger risk at a greater distance.

[1]For cancer health effects, risk is expressed as an estimate of the increased chances of getting cancer due to facility emissions over a 70-year lifetime. This increase in risk is expressed as chances in a million (e.g., 10 chances in a million).

[2]The estimated cancer risks are a function of the proximity to the specific category and were calculated independent of the regional health risk from air pollution. For example, the estimated regional cancer risk from air toxics in the Los Angeles region (South Coast Air Basin) is approximately 1,000 in a million.

[3]Analysis based on refrigerator trucks.

[4]Although risk assessments performed by refineries indicate they represent a low cancer risk, there is limited data on non-cancer effects of pollutants that are emitted from these facilities. Refineries are also a source of non-routine emissions and odors.

[5]A typical GDF in California dispenses under 3.6 million gallons of gasoline per year. The cancer risk for this size facility is likely to be less than 10 in a million at the fence line under urban air dispersion conditions.

A large GDF has fuel throughputs that can range from 3.6 to 19 million gallons of gasoline per year. The upper end of the risk range (i.e., 120 in a million) represents a hypothetical worst case scenario for an extremely large GDF under rural air dispersion conditions.

Freeways and High Traffic Roads

Air pollution studies indicate that living close to high traffic and the associated emissions may lead to adverse health effects beyond those associated with regional air pollution in urban areas. Many of these epidemiological studies have focused on children. A number of studies identify an association between adverse non-cancer health effects and living or attending school near heavily traveled roadways (see findings below). These studies have reported associations between residential proximity to high traffic roadways and a variety of respiratory symptoms, asthma exacerbations, and decreases in lung function in children.

One such study that found an association between traffic and respiratory symptoms in children was conducted in the San Francisco Bay Area. Measurements of traffic-related pollutants showed concentrations within 300 meters (approximately 1,000 feet) downwind of freeways were higher than regional values. Most other studies have assessed exposure based on proximity factors such as distance to freeways or traffic density.

These studies linking traffic emissions with health impacts build on a wealth of data on the adverse health effects of ambient air pollution. The data on the effects of proximity to traffic-related emissions provides additional information that can be used in land use siting and regulatory actions by air agencies. The key observation in these studies is that close proximity increases both exposure and the potential for adverse health effects. Other effects associated with traffic emissions include premature death in elderly individuals with heart disease.

Key Health Findings

- Reduced lung function in children was associated with traffic density, especially trucks, within 1,000 feet and the association was strongest within 300 feet. (Brunekreef, 1997)
- Increased asthma hospitalizations were associated with living within 650 feet of heavy traffic and heavy truck volume. (Lin, 2000)
- Asthma symptoms increased with proximity to roadways and the risk was greatest within 300 feet. (Venn, 2001)
- Asthma and bronchitis symptoms in children were associated with proximity to high traffic in a San Francisco Bay Area community with good overall regional air quality. (Kim, 2004)
- A San Diego study found increased medical visits in children living within 550 feet of heavy traffic. (English, 1999)

In these and other proximity studies, the distance from the roadway and truck traffic densities were key factors affecting the strength of the association with adverse health effects. In the above health studies, the association of traffic-related emissions with adverse health effects was seen within 1,000 feet and was

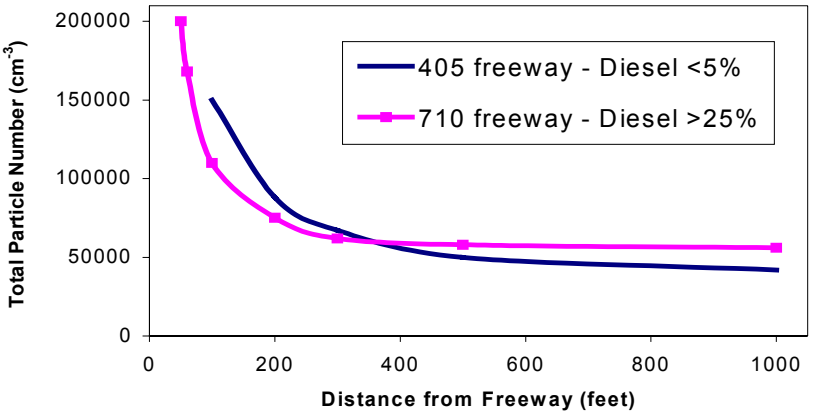
strongest within 300 feet. This demonstrates that the adverse effects diminished with distance.

In addition to the respiratory health effects in children, proximity to freeways increases potential cancer risk and contributes to total particulate matter exposure. There are three carcinogenic toxic air contaminants that constitute the majority of the known health risk from motor vehicle traffic – diesel particulate matter (diesel PM) from trucks, and benzene and 1,3-butadiene from passenger vehicles. On a typical urban freeway (truck traffic of 10,000-20,000/day), diesel PM represents about 70 percent of the potential cancer risk from the vehicle traffic. Diesel particulate emissions are also of special concern because health studies show an association between particulate matter and premature mortality in those with existing cardiovascular disease.

Distance Related Findings

A southern California study (Zhu, 2002) showed measured concentrations of vehicle-related pollutants, including ultra-fine particles, decreased dramatically within approximately 300 feet of the 710 and 405 freeways. Another study looked at the validity of using distance from a roadway as a measure of exposure

Figure 1-1
Decrease In Concentration of Freeway Diesel PM Emissions With Distance



to traffic related air pollution (Knape, 1999). This study showed that concentrations of traffic related pollutants declined with distance from the road, primarily in the first 500 feet.

These findings are consistent with air quality modeling and risk analyses done by ARB staff that show an estimated range of potential cancer risk that decreases with distance from freeways. The estimated risk varies with the local meteorology, including wind pattern. As an example, at 300 feet downwind from a freeway (Interstate 80) with truck traffic of 10,000 trucks per day, the potential cancer risk was as high as 100 in one million (ARB Roseville Rail Yard Study). The cancer health risk at 300 feet on the upwind side of the freeway was much

less. The risk at that distance for other freeways will vary based on local conditions – it may be higher or lower. However, in all these analyses the relative exposure and health risk dropped substantially within the first 300 feet. This phenomenon is illustrated in Figure 1-1.

State law restricts the siting of new schools within 500 feet of a freeway, urban roadways with 100,000 vehicles/day, or rural roadways with 50,000 vehicles with some exceptions.[2] However, no such requirements apply to the siting of residences, day care centers, playgrounds, or medical facilities. The available data show that exposure is greatly reduced at approximately 300 feet. In the traffic-related studies the additional health risk attributable to the proximity effect was strongest within 1,000 feet.

The combination of the children's health studies and the distance related findings suggests that it is important to avoid exposing children to elevated air pollution levels immediately downwind of freeways and high traffic roadways. These studies suggest a substantial benefit to a 500-foot separation.

The impact of traffic emissions is on a gradient that at some point becomes indistinguishable from the regional air pollution problem. As air agencies work to reduce the underlying regional health risk from diesel PM and other pollutants, the impact of proximity will also be reduced. In the meantime, as a preventative measure, we hope to avoid exposing more children and other vulnerable individuals to the highest concentrations of traffic-related emissions.

Recommendation

- Avoid siting new sensitive land uses within 500 feet of a freeway, urban roads with 100,000 vehicles/day, or rural roads with 50,000 vehicles/day.

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[2] Section 17213 of the California Education Code and section 21151.8 of the California Public Resources Code. See also Appendix E for a description of special processes that apply to school siting.

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Distribution Centers

Distribution centers or warehouses are facilities that serve as a distribution point for the transfer of goods. Such facilities include cold storage warehouses, goods transfer facilities, and inter-modal facilities such as ports. These operations involve trucks, trailers, shipping containers, and other equipment with diesel engines. A distribution center can be comprised of multiple centers or warehouses within an area. The size can range from several to hundreds of acres, involving a number of different transfer operations and long waiting periods. A distribution center can accommodate hundreds of diesel trucks a day that deliver, load, and/or unload goods up to seven days a week. To the extent that these trucks are transporting perishable goods, they are equipped with diesel-powered transport refrigeration units (TRUs) or TRU generator sets.

The activities associated with delivering, storing, and loading freight produces diesel PM emissions. Although TRUs have relatively small diesel-powered engines, in the normal course of business, their emissions can pose a significant health risk to those nearby. In addition to onsite emissions, truck travel in and out of distribution centers contributes to the local pollution impact.

ARB is working to reduce diesel PM emissions through regulations, financial incentives, and enforcement programs. In 2004, ARB adopted two airborne toxic control measures that will reduce diesel PM emissions associated with distribution centers. The first will limit nonessential (or unnecessary) idling of diesel-fueled commercial vehicles, including those entering from other states or countries. This statewide measure, effective in 2005, prohibits idling of a vehicle more than five minutes at any one location.[3] The elimination of unnecessary idling will reduce the localized impacts caused by diesel PM and other air toxics

[3] For further information on the Anti-Idling ATCM, please click on: http://www.arb.ca.gov/toxics/idling/outreach/factsheet.pdf

in diesel vehicle exhaust. This should be a very effective new strategy for reducing diesel PM emissions at distribution centers as well as other locations.

The second measure requires that TRUs operating in California become cleaner over time. The measure establishes in-use performance standards for existing TRU engines that operate in California, including out-of-state TRUs. The requirements are phased-in beginning in 2008, and extend to 2019.[4]

ARB also operates a smoke inspection program for heavy-duty diesel trucks that focuses on reducing truck emissions in California communities. Areas with large numbers of distribution centers are a high priority.

Key Health Findings

Diesel PM has been identified by ARB as a toxic air contaminant and represents 70 percent of the known potential cancer risk from air toxics in California. Diesel PM is an important contributor to particulate matter air pollution. Particulate matter exposure is associated with premature mortality and health effects such as asthma exacerbation and hospitalization due to aggravating heart and lung disease.

Distance Related Findings

Although distribution centers are located throughout the state, they are usually clustered near transportation corridors, and are often located in or near population centers. Diesel PM emissions from associated delivery truck traffic and TRUs at these facilities may result in elevated diesel PM concentrations in neighborhoods surrounding those sites. Because ARB regulations will restrict truck idling at distribution centers, the largest continuing onsite diesel PM emission source is the operation of TRUs. Truck travel in and out of distribution centers also contributes to localized exposures, but specific travel patterns and truck volumes would be needed to identify the exact locations of the highest concentrations.

As part of the development of ARB's regulation for TRUs, ARB staff performed air quality modeling to estimate exposure and the associated potential cancer risk of onsite TRUs for a typical distribution center. For an individual person, cancer risk estimates for air pollution are commonly expressed as a probability of developing cancer from a lifetime (i.e., 70 years) of exposure. These risks were calculated independent of regional risk. For example, the estimated regional cancer risk from air toxics in the Los Angeles region (South Coast Air Basin) is approximately 1,000 additional cancer cases per one million population.

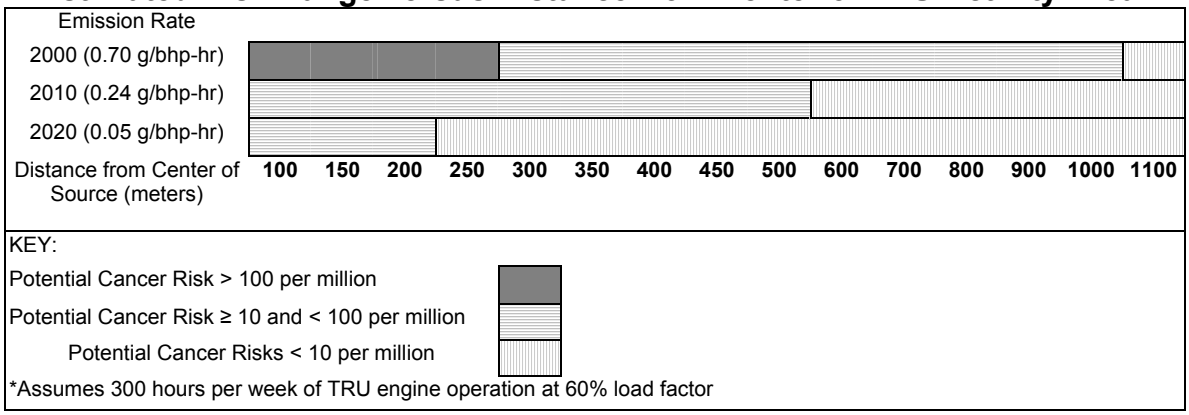
[4] For further information on the Transport Refrigeration Unit ATCM, please click on: http://www.arb.ca.gov/diesel/documents/trufaq.pdf

The diesel PM emissions from a facility are dependent on the size (horsepower), age, and number of engines, emission rates, the number of hours the truck engines and/or TRUs operate, distance, and meteorological conditions at the site. This assessment assumes a total on-site operating time for all TRUs of 300 hours per week. This would be the equivalent of 40 TRU-equipped trucks a day, each loading or unloading on-site for one hour, 12 hours a day and seven days a week.

As shown in Figure 1-2 below, at this estimated level of activity and assuming a current fleet diesel PM emission rate, the potential cancer risk would be over 100 in a million at 800 feet from the center of the TRU activity. The estimated potential cancer risk would be in the 10 to 100 per million range between 800 to 3,300 feet and fall off to less than 10 per million at approximately 3,600 feet. However with the implementation of ARB's regulation on TRUs, the risk will be significantly reduced.[5] We have not conducted a risk assessment for distribution centers based on truck traffic alone, but on an emissions basis, we would expect similar risks for a facility with truck volumes in the range of 100 per day.

Figure 1-2

Estimated Risk Range versus Distance from Center of TRU Activity Area*

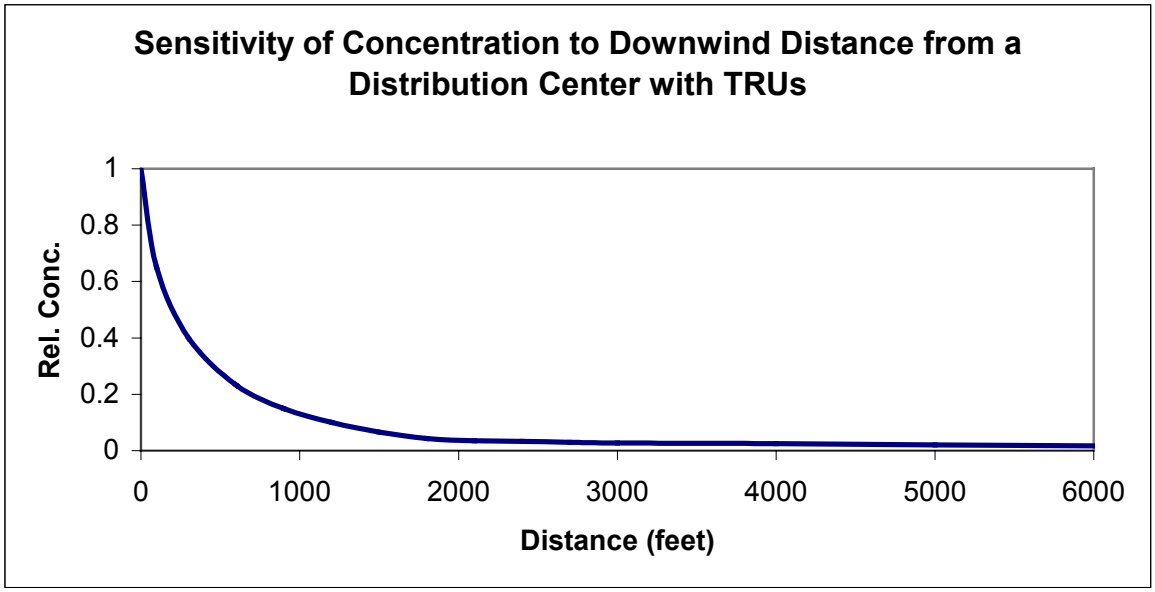


The estimated potential cancer risk level in Figure 1-2 is based on a number of assumptions that may not reflect actual conditions for a specific site. For example, increasing or decreasing the hours of diesel engine operations would change the potential risk levels. Meteorological and other facility specific parameters can also impact the results. Therefore, the results presented here are not directly applicable to any particular facility or operation. Rather, this information is intended to provide an indication as to the potential relative levels of risk that may be observed from operations at distribution centers. As shown in Figure 1-2, the estimated risk levels will decrease over time as lower-emitting diesel engines are used.

[5] These risk values assume an exposure duration of 70 years for a nearby resident and uses the methodology specified in the 2003 OEHHA health risk assessment guidelines.

Another air modeling analysis, performed by the South Coast Air Quality Management District (South Coast AQMD), evaluated the impact of diesel PM emissions from distribution center operations in the community of Mira Loma in southern California. Based on dispersion of diesel PM emissions from a large distribution center, Figure 1-3 shows the relative pollution concentrations at varying distances downwind. As Figure 1-3 shows, there is about an 80 percent drop off in concentration at approximately 1,000 feet.

Figure 1-3
Decrease In Relative Concentration of Risk
With Distance



Both the ARB and the South Coast AQMD analyses indicate that providing a separation of 1,000 feet would substantially reduce diesel PM concentrations and public exposure downwind of a distribution center. While these analyses do not provide specific risk estimates for distribution centers, they provide an indication of the range of risk and the benefits of providing a separation. ARB recommends a separation of 1,000 feet based on the combination of risk analysis done for TRUs and the decrease in exposure predicted with the South Coast AQMD modeling. However, ARB staff plans to provide further information on distribution centers as we collect more data and implement the TRU control measure.

Taking into account the configuration of distribution centers can also reduce population exposure and risk. For example, locating new sensitive land uses away from the main entry and exit points helps to reduce cancer risk and other health impacts.

Recommendations

- Avoid siting new sensitive land uses within 1,000 feet of a distribution center (that accommodates more than 100 trucks per day, more than 40 trucks with operating TRUs per day, or where TRU unit operations exceed 300 hours per week).

- Take into account the configuration of existing distribution centers and avoid locating residences and other new sensitive land uses near entry and exit points.

References

- *Airborne Toxic Control Measure To Limit Diesel-Fueled Commercial Motor Vehicle Idling.* ARB (August 20, 2004). Rule effectiveness date awaiting submittal of regulation to the Office of Administration Law. http://www.arb.ca.gov/regact/idling/idling.htm

- *Revised Staff Report: Initial Statement of Reasons for Proposed Rulemaking. Airborne Toxic Control Measure for In-Use Diesel-Fueled Transport Refrigeration Units (TRU) and TRU Generator Sets, and Facilities Where TRUs Operate.* ARB (October 28, 2003). http://www.arb.ca.gov/regact/trude03/revisor.doc

- *Health Risk Assessment Guidance for Analyzing Cancer Risks from Mobile Source Diesel Idling Emissions for CEQA Air Quality Analysis.* SCAQMD (August 2003) http://www.aqmd.gov/ceqa/handbook/diesel_analysis.doc

- *"Mira Loma Study: Analysis of the Impact of Diesel Particulate Emissions from Warehouse/Distribution Center Operations",* PowerPoint presentation. SCAQMD (July 31, 2002)

Rail Yards

Rail yards are a major source of diesel particulate air pollution. They are usually located near inter-modal facilities, which attract heavy truck traffic, and are often sited in mixed industrial and residential areas. ARB, working with the Placer County air district and Union Pacific Railroad, recently completed a study[6] of the Roseville Rail Yard (Yard) in northern California that focused on the health risk from diesel particulate. A comprehensive emissions analysis and air quality modeling were conducted to characterize the estimated potential cancer risk associated with the facility.

[6] To review the study, please click on: http://www.arb.ca.gov/diesel/documents/rrstudy.htm

The Yard encompasses about 950 acres on a one-quarter mile wide by four-mile long strip of land that parallels Interstate 80. It is surrounded by commercial, industrial, and residential properties. The Yard is one of the largest service and maintenance rail yards in the West with over 30,000 locomotives visiting annually.

Using data provided by Union Pacific Railroad, the ARB determined the number and type of locomotives visiting the Yard annually and what those locomotives were doing - moving, idling, or undergoing maintenance testing. Union Pacific provided the annual, monthly, daily, and hourly locomotive activity in the yard including locomotive movements; routes for arrival, departure, and through trains; and locomotive service and testing. This information was used to estimate the emissions of particulate matter from the locomotives, which was then used to model the potential impacts on the surrounding community.

The key findings of the study are:

- Diesel PM emissions in 2000 from locomotive operations at the Roseville Yard were estimated at about 25 tons per year.

- Of the total diesel PM in the Yard, moving locomotives accounted for about 50 percent, idling locomotives about 45 percent, and locomotive testing about five percent.

- Air quality modeling predicts potential cancer risks greater than 500 in a million (based on 70 years of exposure) in a 10-40 acre area immediately adjacent to the Yard's maintenance operations.

- The risk assessment also showed elevated cancer risk impacting a larger area covering about a 10 by 10 mile area around the Yard.

The elevated concentrations of diesel PM found in the study contribute to an increased risk of cancer and premature death due to cardiovascular disease, and non-cancer health effects such as asthma and other respiratory illnesses. The magnitude of the risk, the general location, and the size of the impacted area depended on the meteorological data used to characterize conditions at the Yard, the dispersion characteristics, and exposure assumptions. In addition to these variables, the nature of locomotive activity will influence a risk characterization at a particular rail yard. For these reasons, the quantified risk estimates in the Roseville Rail Yard Study cannot be directly applied to other rail yards. However, the study does indicate the health risk due to diesel PM from rail yards needs to be addressed. ARB, in conjunction with the U.S. Environmental Protection Agency (U.S. EPA), and local air districts, is working with the rail industry to identify and implement short term, mid-term and long-term mitigation strategies. ARB also intends to conduct a second rail study in southern California to increase its understanding of rail yard operations and the associated public health impacts.

Key Health Findings

Diesel PM has been identified by ARB as a toxic air contaminant and represents 70 percent of the known potential cancer risk from air toxics in California. Diesel PM is an important contributor to particulate matter air pollution. Particulate matter exposure is associated with premature mortality and health effects such as asthma exacerbation and hospitalization due to aggravating heart and lung disease.

Distance Related Findings

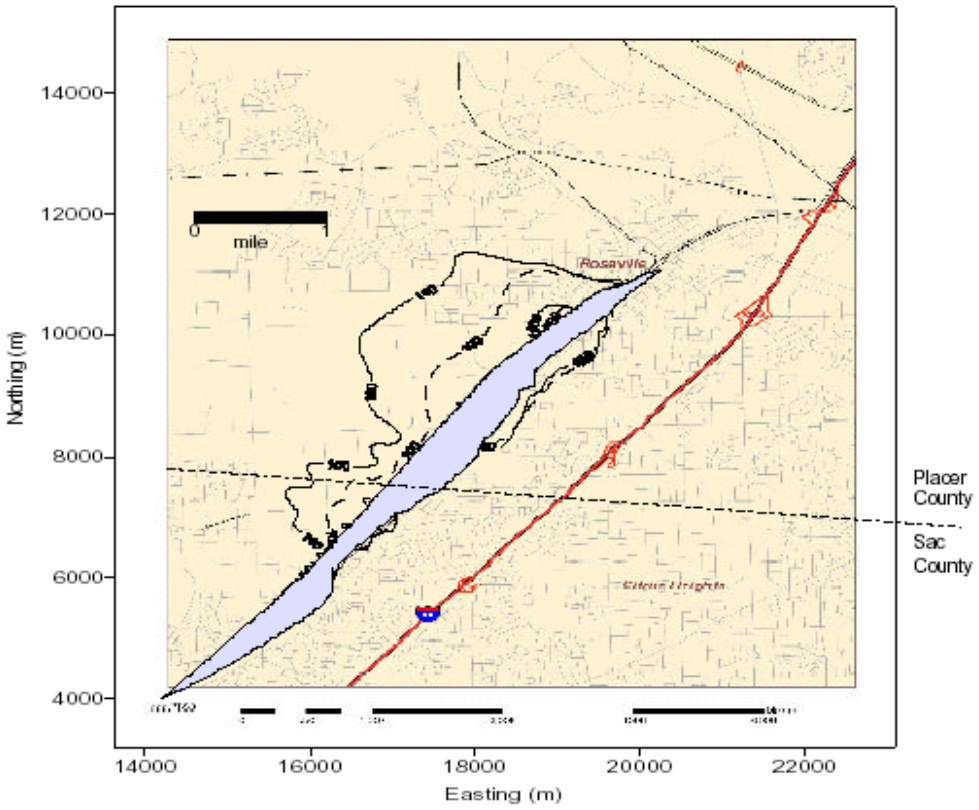
Two sets of meteorological data were used in the Roseville study because of technical limitations in the data. The size of the impact area was highly dependent on the meteorological data set used. The predicted highest impact area ranged from 10 - 40 acres with the two different meteorological data sets. This area, with risks estimated above 500 in a million, is adjacent to an area that includes a maintenance shop (see Figure 1-4). The high concentration of diesel PM emissions is due to the number of locomotives and nature of activities in this area, particularly idling locomotives.

The area of highest impact is within 1,000 feet of the Yard. The next highest impact zone as defined in the report had a predicted risk between 500 and 100 in one million and extends out between a half to one mile in some spots, depending on which meteorological conditions were assumed. The impact areas are irregular in shape making it difficult to generalize about the impact of distance at a particular location. However, the Roseville Rail Yard Study clearly indicates that the localized health risk is high, the impact area is large, and mitigation of the locomotive diesel PM emissions is needed.

For facilities like rail yards and ports, the potential impact area is so large that the real solution is to substantially reduce facility emissions. However, land use planners can avoid encroaching upon existing rail facilities and those scheduled for expansion. We also recommend that while air agencies tackle this problem, land use planners try not to add new sensitive individuals into the highest exposure areas. Finally, we recommend that land use agencies consider the potential health impacts of rail yards in their planning and permitting processes. Additional limitations and mitigation may be feasible to further reduce exposure on a site-specific basis.

Figure 1-4

Estimated Cancer Risk from the Yard
(100 and 500 in a million risk isopleths)



Notes: 100/Million Contours: Solid Line – Roseville Met Data; Dashed Line-McClellan Met Data, Urban Dispersion Coefficients, 80th Percentile Breathing Rate, All Locomotives' Activities (23 TPY), 70-Year Exposure

Recommendation

- Avoid siting new sensitive land uses within 1,000 feet of a major service and maintenance rail yard[7].
- Within one mile of a rail yard, consider possible siting limitations and mitigation approaches.

References

- *Roseville Rail Yard Study.* ARB (2004)

[7] The rail yard risk analysis was conducted for the Union Pacific rail yard in Roseville, California. This rail yard is one of the largest in the state. There are other rail yards in California with comparable levels of activity that should be considered "major" for purposes of this Handbook.

Ports

Air pollution from maritime port activities is a growing concern for regional air quality as well as air quality in nearby communities. The primary air pollutant associated with port operations is directly emitted diesel particulate. Port-related activities also result in emissions that form ozone and secondary particulate in the atmosphere. The emission sources associated with ports include diesel engine-powered ocean-going ships, harbor craft, cargo handling equipment, trucks, and locomotives. The size and concentration of these diesel engines makes ports one of the biggest sources of diesel PM in the state. For that reason, ARB has made it a top priority to reduce diesel PM emissions at the ports, in surrounding communities, and throughout California.

International, national, state, and local government collaboration is critical to reducing port emissions based on both legal and practical considerations. For example, the International Maritime Organization (IMO) and the U.S. EPA establish emission standards for ocean-going vessels and U.S.-flagged harbor craft, respectively. ARB is pursuing further federal actions to tighten these standards. In addition, ARB and local air districts are reducing emissions from ports through a variety of approaches. These include: incentive programs to fund cleaner engines, enhanced enforcement of smoke emissions from ships and trucks, use of dockside electricity instead of diesel engines, cleaner fuels for ships, harbor craft, locomotives, and reduced engine idling. The two ATCMs that limit truck idling and reduce emissions from TRUs (discussed under “Distribution Centers”) also apply to ports.

ARB is also developing several other regulations that will reduce port-related emissions. One rule would require ocean-going ships to use a cleaner marine diesel fuel to power auxiliary engines while in California coastal waters and at dock. Ships that frequently visit California ports would also be required to further reduce their emissions. ARB has adopted a rule that would require harbor craft to use the same cleaner diesel fuel used by on-road trucks in California. In 2005, ARB will consider a rule that would require additional controls for in-use harbor craft, such as the use of add-on emission controls and accelerated turnover of older engines.

Key Health Findings

Port activities are a major source of diesel PM. Diesel PM has been identified by ARB as a toxic air contaminant and represents 70 percent of the known potential cancer risk from air toxics in California. Diesel PM is an important contributor to particulate matter air pollution. Particulate matter exposure is associated with premature mortality and health effects such as asthma exacerbation and hospitalization due to aggravating heart and lung disease.

Distance Related Findings

The Ports of Los Angeles and Long Beach provide an example of the emissions impact of port operations. A comprehensive emissions inventory was completed in June 2004. These ports combined are one of the world's largest and busiest seaports. Located in San Pedro Bay, about 20 miles south of downtown Los Angeles, the port complex occupies approximately 16 square miles of land and water. Port activities include five source categories that produce diesel emissions. These are ocean-going vessels, harbor craft, cargo handling equipment, railroad locomotives, and heavy-duty trucks.

The baseline emission inventory provides emission estimates for all major air pollutants. This analysis focuses on diesel PM from in-port activity because these emissions have the most potential health impact on the areas adjacent to the port. Ocean vessels are the largest overall source of diesel PM related to the ports, but these emissions occur primarily outside of the port in coastal waters, making the impact more regional in nature.

The overall in-port emission inventory for diesel particulate for the ports of Los Angeles and Long Beach is estimated to be 550 tons per year. The emissions fall in the following major categories: ocean-going vessels (17%), harbor craft (25%), cargo handling (47%), railroad locomotive (3%), and heavy duty vehicles (8%). In addition to in-port emissions, ship, rail, and trucking activities also contribute to regional emissions and increase emissions in nearby neighborhoods. Off-port emissions associated with related ship, rail, and trucking activities contribute an additional 680 tons per year of diesel particulate at the Port of Los Angeles alone.

To put this in perspective, the diesel PM emissions estimated for the Roseville Yard in ARB's 2004 study are 25 tons per year. The potential cancer risk associated with these emissions is 100 in one million at a distance of one mile, or one half mile, depending on the data set used. This rail yard covers one and a half square miles. The Los Angeles and Long Beach ports have combined diesel PM emissions of 550 tons per year emitted from a facility that covers a much larger area - 16 miles. The ports have about twice the emission density of the rail yard - 34 tons per year per square mile compared to 16 tons per year per square mile. However, while this general comparison is illustrative of the overall size of the complex, a detailed air quality modeling analysis would be needed to assess the potential health impact on specific downwind areas near the ports.

ARB is in the process of evaluating the various port-related emission sources from the standpoint of existing emissions, growth forecasts, new control options, regional air quality impacts, and localized health risk. A number of public processes - both state and local - are underway to address various aspects of these issues. Until more of these analyses are complete, there is little basis for recommending a specific separation between new sensitive land uses and ports.

For example, the type of data we have showing the relationship between air pollutant concentrations and distance from freeways is not yet available.

Also, the complexity of the port facilities makes a site-specific analysis critical. Ports are a concentration of multiple emission sources with differing dispersion and other characteristics. In the case of the Roseville rail yard, we found a high, very localized impact associated with a particular activity, service and maintenance. By contrast, the location, size, and nature of impact areas can be expected to vary substantially for different port activities. For instance, ground level emissions from dockside activities would behave differently from ship stack level emissions.

Nonetheless, on an emissions basis alone, we expect locations downwind of ports to be substantially impacted. For that reason, we recommend that land use agencies track the current assessment efforts, and consider limitations on the siting of new sensitive land uses in areas immediately downwind of ports.

Recommendations

Avoid siting new sensitive land uses immediately downwind of ports in the most heavily impacted zones. Consult local air districts or the ARB on the status of pending analyses of health risks.

References

- *Roseville Rail Yard Study.* ARB (2004)
- Final Draft, "*Port-Wide Baseline Air Emissions Inventory."* Port of Los Angeles (June 2004)
- Final Draft, "*2002 Baseline Air Emissions Inventory."* Port of Long Beach (February 2004)

Petroleum Refineries

A petroleum refinery is a complex facility where crude oil is converted into petroleum products (primarily gasoline, diesel fuel, and jet fuel), which are then transported through a system of pipelines and storage tanks for final distribution by delivery truck to fueling facilities throughout the state. In California, most crude oil is delivered either by ship from Alaska or foreign sources, or is delivered via pipeline from oil production fields within the state. The crude oil then undergoes many complex chemical and physical reactions, which include distillation, catalytic cracking, reforming, and finishing. These refining processes have the potential to emit air contaminants, and are subject to extensive emission controls by district regulations.

As a result of these regulations covering the production, marketing, and use of gasoline and other oil by-products, California has seen significant regional air quality benefits both in terms of cleaner fuels and cleaner operating facilities. In

the 1990s, California refineries underwent significant modifications and modernization to produce cleaner fuels in response to changes in state law. Nevertheless, while residual emissions are small when compared to the total emissions controlled from these major sources, refineries are so large that even small amounts of fugitive, uncontrollable emissions and associated odors from the operations, can be significant. This is particularly the case for communities that may be directly downwind of the refinery. Odors can cause health symptoms such as nausea and headache. Also, because of the size, complexity, and vast numbers of refinery processes onsite, the occasional refinery upset or malfunction can potentially result in acute or short-term health effects to exposed individuals.

Key Health Findings

Petroleum refineries are large single sources of emissions. For volatile organic compounds (VOCs), eight of the ten largest stationary sources in California are petroleum refineries. For oxides of nitrogen (NOx), four of the ten largest stationary sources in California are petroleum refineries. Both of these compounds react in the presence of sunlight to form ozone. Ozone impacts lung function by irritating and damaging the respiratory system. Petroleum refineries are also large stationary sources of both particulate matter under 10 microns in size (PM_{10}) and particulate matter under 2.5 microns in size ($PM_{2.5}$). Exposure to particulate matter aggravates a number of respiratory illnesses, including asthma, and is associated with premature mortality in people with existing cardiac and respiratory disease. Both long-term and short-term exposure can have adverse health impacts. Finer particles pose an increased health risk because they can deposit deep in the lung and contain substances that are particularly harmful to human health. NOx are also significant contributors to the secondary formation of $PM_{2.5}$.

Petroleum refineries also emit a variety of toxic air pollutants. These air toxics vary by facility and process operation but may include: acetaldehyde, arsenic, antimony, benzene, beryllium, 1,3-butadiene, cadmium compounds, carbonyl sulfide, carbon disulfide, chlorine, dibenzofurans, diesel particulate matter, formaldehyde, hexane, hydrogen chloride, lead compounds, mercury compounds, nickel compounds, phenol, 2,3,7,8 tetrachlorodibenzo-p-dioxin, toluene, and xylenes (mixed) among others. The potential health effects associated with these air toxics can include cancer, respiratory irritation, and damage to the central nervous system, depending on exposure levels.

Distance Related Findings

Health risk assessments for petroleum refineries have shown risks from toxic air pollutants that have quantifiable health risk values to be around 10 potential cancer cases per million. Routine air monitoring and several air monitoring studies conducted in the San Francisco Bay Area (Crockett) and the South Coast Air Basin (Wilmington) have not identified significant health risks specifically

associated with refineries. However, these studies did not measure diesel PM as no accepted method currently exists, and there are many toxic air pollutants that do not have quantifiable health risk values.

In 2002, ARB published a report on the results of the state and local air district air monitoring done near oil refineries. The purpose of this evaluation was to try to determine how refinery-related emissions might impact nearby communities. This inventory of air monitoring activities included 10 ambient air monitoring stations located near refineries in Crockett and four stations near refineries in Wilmington. These monitoring results did not identify significant increased health risks associated with the petroleum refineries. In 2002-2003, ARB conducted additional monitoring studies in communities downwind of refineries in Crockett and Wilmington. These monitoring results also did not indicate significant increased health risks from the petroleum refineries.

Consequently, there are no air quality modeling or air monitoring data that provides a quantifiable basis for recommending a specific separation between refineries and new sensitive land uses. However, in view of the amount and potentially hazardous nature of many of the pollutants released as part of the refinery process, we believe the siting of new sensitive land uses immediately downwind should be avoided. Land use agencies should consult with the local air district when considering how to define an appropriate separation for refineries within their jurisdiction.

Recommendations

- Avoid siting new sensitive land uses immediately downwind of petroleum refineries. Consult with local air districts and other local agencies to determine an appropriate separation.

References

- *Review of Current Ambient Air Monitoring Activities Related to California Bay Area and South Coast Refineries. ARB (March 2002)* http://www.arb.ca.gov/aaqm/qmosqual/special/mldrefinery.pdf
- *Community Air Quality Monitoring: Special Studies – Crockett. ARB (September 2004)* http://www.arb.ca.gov/ch/communities/studies/crockett/crockett.htm
- *Wilmington Study - Air Monitoring Results. ARB (2003)* http://www.arb.ca.gov/ch/communities/studies/wilmington/wilmington.htm

Chrome Plating Operations

Chrome plating operations rely on the use of the toxic metal hexavalent chromium, and have been subject to ARB and local air district control programs for many years. Regulation of chrome plating operations has reduced statewide emissions substantially. However, due to the nature of chrome plating

operations and the highly toxic nature of hexavalent chromium, the remaining health risk to nearby residents is a continuing concern.

Chrome plating operations convert hexavalent chromium in solution to a chromium metal layer by electroplating, and are categorized based upon the thickness of the chromium metal layer applied. In “decorative plating”, a layer of nickel is first plated over a metal substrate. Following this step, a thin layer of chromium is deposited over the nickel layer to provide a decorative and protective finish, for example, on faucets and automotive wheels. “Hard chrome plating” is a process in which a thicker layer of chromium metal is deposited directly on metal substrates such as engine parts, industrial machinery, and tools to provide greater protection against corrosion and wear.

Hexavalent chromium is emitted into the air when an electric current is applied to the plating bath. Emissions are dependent upon the amount of electroplating done per year and the control requirements. A unit of production referred to as an ampere-hour represents the amount of electroplating produced. Small facilities have an annual production rate of 100,000 – 500,000 ampere-hours, while medium-size facilities may have a production rate of 500,000 to about 3 million ampere-hours. The remaining larger facilities have a range of production rates that can be as high as 80 million ampere-hours.

The control requirements, which reduce emissions from the plating tanks, vary according to the size and type of the operation. Facilities either install add-on pollution control equipment, such as filters and scrubbers, or in-tank controls, such as fume suppressants and polyballs. With this combination of controls, the overall hexavalent chromium emissions have been reduced by over 90 percent. Larger facilities typically have better controls that can achieve efficiencies greater than 99 percent. However, even with stringent controls, the lack of maintenance and good housekeeping practices can lead to problems. And, since the material itself is inherently dangerous, any lapse in compliance poses a significant risk to nearby residents.

A 2002 ARB study in the San Diego community of Barrio Logan measured unexpectedly high concentrations of hexavalent chromium near chrome platers. The facilities were located in a mixed-use area with residences nearby. The study found that fugitive dust laden with hexavalent chromium was an important source of emissions that likely contributed to the elevated cancer risk. Largely as a result of this study, ARB is in the process of updating the current requirements to further reduce the emissions from these facilities.

In December 2004, the ARB adopted an ATCM to reduce emissions of hexavalent chromium and nickel from thermal spraying operations through the installation of best available control technology. The ATCM requires all existing facilities to comply with its requirements by January 1, 2006. New and modified thermal spraying operations must comply upon initial startup. An existing thermal spraying facility may be exempt from the minimum control efficiency

requirements of the ATCM if it is located at least 1,640 feet from the nearest sensitive receptor and emits no more than 0.5 pound per year of hexavalent chromium.[8]

Key Health Findings

Hexavalent chromium is one of the most toxic air pollutants regulated by the State of California. Hexavalent chromium is a carcinogen and has been identified in worker health studies as causing lung cancer. Exposure to even very low levels of hexavalent chromium should be avoided.

The California Office of Environmental Health Hazard Assessment has found that: 1) many epidemiological studies show a strong association between hexavalent chromium exposure in the work place and respiratory cancer; and 2) all short-term assays reported show that hexavalent chromium compounds can cause damage to human DNA.

Hexavalent chromium when inhaled over a period of many years can cause a variety of non-cancer health effects. These health effects include damage to the nose, blood disorders, lung disease, and kidney damage. The non-cancer health impacts occur with exposures considerably higher than exposures causing significant cancer risks. It is less likely that the public would be exposed to hexavalent chromium at levels high enough to cause these non-cancer health effects. Non-cancer health effects, unlike cancer health effects, have a threshold or exposure level below which non-cancer health effects would not be expected.

Distance Related Findings

ARB's 2002 Barrio Logan Study measured concentrations of hexavalent chromium in the air near two chrome plating facilities. The study was conducted from December 2001 to May 2002. There were two chrome platers on the street - one decorative and one hard plater. The purpose of the study was to better understand the near source impact of hexavalent chromium emissions. Air monitors were placed at residences next to the platers and at varying distances down the street. The monitors were moved periodically to look at the spatial distribution of the impact. Source testing and facility inspections identified one of the facilities as the likely source.

The first two weeks of monitoring results showed unexpectedly high levels of hexavalent chromium at a number of the monitoring sites. The high concentrations were intermittent. The concentrations ranged from 1 to 22 ng/m3 compared to the statewide average of 0.1 ng/m3. If these levels were to continue for 70 years, the potential cancer risk would be 150 in one million. The highest value was found at an air monitor behind a house adjacent to one of the

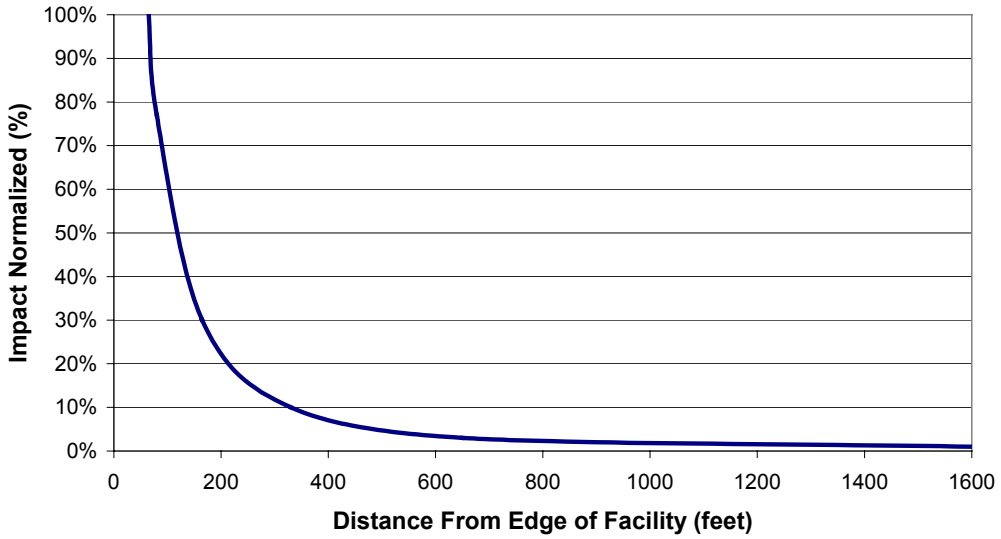
[8] For further information on the ATCM, please refer to: http://www.arb.ca.gov/regact/thermspr/thermalspr.htm

plating facilities–approximately 30 feet from the back entrance. Lower, but significant concentrations were found at an ambient air monitor 250 feet away.

The monitoring covered a period when the facility was not operating its plating tank. During this period, one of the highest concentrations was measured at an adjacent house. It appears that chromium-laden dust was responsible for high concentrations at this location since there was no plating activity at the time. Dust samples from the facility were tested and found to contain high levels of hexavalent chromium. On the day the highest concentration was measured at the house next door, a monitor 350 feet away from the plater's entrance showed very little impact. Similar proximity effects are shown in ARB modeling studies.

Figure 1-5 shows how the relative health risk varies as a function of distance from a chrome plater. This analysis is based on a medium-sized chrome plater with an annual production rate of 3 million ampere-hours. As shown in Figure 1- 5, the potential health risk drops off rapidly, with over 90 percent reduction in risk within 300 feet. This modeling was done in 2003 as part of a review of ARB's current air toxic control measure for chrome platers and is based on data from a recent ARB survey of chrome platers in California. The emission

Figure 1-5
Risk vs. Distance From Chrome Plater
(Based on plating tank emissions)



rates are only for plating operations. Because there are insufficient data available to directly quantify the impacts, the analysis does not include fugitive emissions, which the Barrio Logan analysis indicated could be significant.

Both the ARB Barrio Logan monitoring results and ARB's 2003 modeling analysis suggests that the localized emissions impact of a chrome plater diminishes significantly at 300 feet. However, in developing our recommendation, we also considered the following factors:

- some chrome platers will have higher volumes of plating activity,
- potential dust impacts were not modeled,
- we have only one monitoring study looking at the impact of distance, and,
- hexavalent chromium is one of the most potent toxic air contaminants ARB has identified.

Given these limitations in the analysis, we recommend a separation of 1,000 feet as a precautionary measure. For large chrome platers, site specific information should be obtained from the local air district.

Recommendation

- Avoid siting new sensitive land uses within 1,000 feet of a chrome plater.

References

- *Ambient Air Monitoring for Hexavalent Chromium and Metals in Barrio Logan: May 2001 through May 2002.* ARB, Monitoring and Laboratory Division (October 14, 2003)
- *Draft Barrio Logan Report.* ARB, Planning and Technical Support Division (November 2004)
- *Proposed Amendments to the Hexavalent Chromium Control Measure for Decorative and Hard Chrome Plating and Chromic Acid Anodizing Facilities.* ARB (April 1998)
- Murchison, Linda; Suer, Carolyn; Cook, Jeff. *"Neighborhood Scale Monitoring in Barrio Logan," (*AWMA Annual Conference Proceedings, June 2003)

Dry Cleaners Using Perchloroethylene (Perc Dry Cleaners)

Perchloroethylene (perc) is the solvent most commonly used by the dry cleaning industry to clean clothes or other materials. The ARB and other public health agencies have identified perc as a potential cancer-causing compound. Perc persists in the atmosphere long enough to contribute to both regional air pollution and localized exposures. Perc dry cleaners are the major source of perc emissions in California.

Since 1990, the statewide concentrations and health risk from exposure to perc has dropped over 70 percent. This is due to a number of regulatory requirements on perc dry cleaners and other sources, including degreasing operations, brake cleaners, and adhesives. ARB adopted an Airborne Toxic Control Measure (ATCM) for Perc Emissions from Dry Cleaning Operations in 1993. ARB has also prohibited the use of perc in aerosol adhesives and automotive brake cleaners.

Perc dry cleaners statewide are required to comply with ARB and local air district regulations to reduce emissions. However, even with these controls, some emissions continue to occur. Air quality studies indicate that there is still the potential for significant risks even near well-controlled dry cleaners. The South Coast AQMD has adopted a rule requiring that all new dry cleaners use alternatives to perc and that existing dry cleaners phase out the use of perc by December 2020. Over time, transition to non-toxic alternatives should occur. However, while perc continues to be used, a preventative approach should be taken to siting of new sensitive land uses.

Key Health Findings

Inhalation of perc may result in both cancer and non-cancer health effects. An assessment by California's Office of Environmental Health Hazard Assessment (OEHHA) concluded that perc is a potential human carcinogen and can cause non-cancer health effects. In addition to the potential cancer risk, the effects of long-term exposure include dizziness, impaired judgment and perception, and damage to the liver and kidneys. Workers have shown signs of liver toxicity following chronic exposure to perc, as well as kidney dysfunction and neurological effects. Non-cancer health effects occur with higher exposure levels than those associated with significant cancer risks. The public is more likely to be exposed to perchloroethylene at levels causing significant cancer risks than to levels causing non-cancer health effects. Non-cancer health effects, unlike cancer health effects, have a threshold or exposure level below which non-cancer health effects would not be expected. The ARB formally identified perc as a toxic air contaminant in October 1991.

One study has determined that inhalation of perc is the predominant route of exposure to infants living in apartments co-located in the same building with a business operating perc dry cleaning equipment. Results of air sampling within co-residential buildings indicate that dry cleaners can cause a wide range of exposures depending on the type and maintenance of the equipment. For example, a well-maintained state-of-the-art system may have risks in the range of 10 in one million, whereas a badly maintained machine with major leaks can have potential cancer risks of thousands in one million.

The California Air Pollution Control Officers Association (CAPCOA) is developing Industry-wide Risk Assessment Guidelines for Perchloroethylene Dry Cleaners which, when published, will provide detailed information on public health risk from exposure to emissions from this source.

Distance Related Findings

Risk created by perc dry cleaning is dependent on the amount of perc emissions, the type of dry cleaning equipment, proximity to the source, and how the emissions are released and dispersed (e.g., type of ventilation system, stack parameters, and local meteorology). Dry cleaners are often located near

residential areas, and near shopping centers, schools, day-care centers, and restaurants.

The vast majority of dry cleaners in California have one dry cleaning machine per facility. The South Coast AQMD estimates that an average well-controlled dry cleaner uses about 30 to 160 gallons of cleaning solvent per year, with an average of about 100 gallons. Based on these estimates, the South Coast AQMD estimates a potential cancer risk between 25 to 140 in one million at residential locations 75 feet or less from the dry cleaner, with an average of about 80 in one million. The estimate could be as high as 270 in one million for older machines.

CAPCOA's draft industry-wide risk assessment of perc dry cleaning operations indicates that the potential cancer risk for many dry cleaners may be in excess of potential cancer risk levels adopted by the local air districts. The draft document also indicates that, in general, the public's exposure can be reduced by at least 75 percent, by providing a separation distance of about 300 feet from the operation. This assessment is based on a single machine with perc use of about 100 gallons per year. At these distances, the potential cancer risk would be less than 10 potential cases per million for most scenarios.

The risk would be proportionately higher for large, industrial size, dry cleaners. These facilities typically have two or more machines and use 200 gallons or more per year of perc. Therefore, separation distances need to be greater for large dry cleaners. At a distance of 500 feet, the remaining risk for a large plant can be reduced by over 85 percent.

In California, a small number of dry cleaners that are co-located (sharing a common wall, floor, or ceiling) with a residence have the potential to expose the inhabitants of the residence to high levels of perc. However, while special requirements have been imposed on these existing facilities, the potential for exposure still exists. Avoiding these siting situations in the future is an important preventative measure.

Local air districts are a source of information regarding specific dry cleaning operations—particularly for large industrial operations with multiple machines. The 300 foot separation recommended below reflects the most common situation – a dry cleaner with only one machine. While we recommend 500 feet when there are two or more machines, site specific information should be obtained from the local air district for some very large industrial operations. Factors that can impact the risk include the number and type of machines, controls used, source configuration, building dimensions, terrain, and meteorological data.

Recommendation

- Avoid siting new sensitive land uses within 300 feet of any dry cleaning operation. For operations with two or more machines provide 500 feet. For operations with 3 or more machines, consult with the local air district.

- Do not site new sensitive land uses in the same building with perc dry cleaning operations.

References

- *Proposed Amended Rule 1421 – Control of Perchloroethylene Emissions from Dry Cleaning Systems,* Final Staff Report. South Coast AQMD. (October 2002)
- *Air Toxic Control Measure for Emissions of Perchloroethylene from Dry Cleaning Operations.* ARB (1994) (http://www.arb.ca.gov/toxics/atcm/percatcm.htm)
- *"An Assessment of Tetrachloroethylene in Human Breast Milk"*, Judith Schreiber, New York State Department of Health – Bureau of Toxic Substance Assessment, Journal of Exposure Analysis and Environmental Epidemiology, Vol.2, Suppl.2, pp. 15-26, 1992.
- Draft *Air Toxics "Hot Spots" Program Perchloroethylene Dry Cleaner Industry-wide Risk Assessment Guidelines.* (CAPCOA (November 2002)
- *Final Environmental Assessment for Proposed Amended Rule 1421 – Control of Perchloroethylene Emissions from Dry Cleaning Systems.* South Coast AQMD. (October 18, 2002)

Gasoline Dispensing Facilities

Refueling at gasoline dispensing facilities releases benzene into the air. Benzene is a potent carcinogen and is one of the highest risk air pollutants regulated by ARB. Motor vehicles and motor vehicle-related activity account for over 90 percent of benzene emissions in California. While gasoline-dispensing facilities account for a small part of total benzene emissions, near source exposures for large facilities can be significant.

Since 1990, benzene in the air has been reduced by over 75 percent statewide, primarily due to the implementation of emissions controls on motor vehicle vapor recovery equipment at gas stations, and a reduction in benzene levels in gasoline. However, benzene levels are still significant. In urban areas, average benzene exposure is equivalent to about 50 in one million.

Gasoline dispensing facilities tend to be located in areas close to residential and shopping areas. Benzene emissions from the largest gas stations may result in near source health risk beyond the regional background and district health risk thresholds. The emergence of very high gasoline throughput at large retail or

wholesale outlets makes this a concern as these types of outlets are projected to account for an increasing market share in the next few years.

Key Health Findings

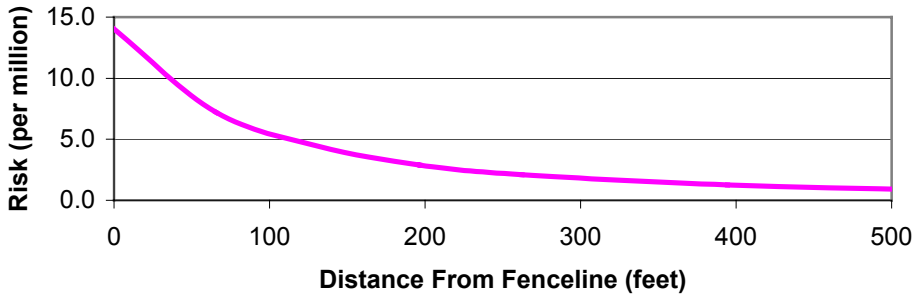
Benzene is a human carcinogen identified by ARB as a toxic air contaminant. Benzene also can cause non-cancer health effects above a certain level of exposure. Brief inhalation exposure to high concentrations can cause central nervous system depression. Acute effects include central nervous system symptoms of nausea, tremors, drowsiness, dizziness, headache, intoxication, and unconsciousness. It is unlikely that the public would be exposed to levels of benzene from gasoline dispensing facilities high enough to cause these non-cancer health effects.

Distance Related Findings

A well-maintained vapor recovery system can decrease emissions of benzene by more than 90% compared with an uncontrolled facility. Almost all facilities have emission control systems. Air quality modeling of the health risks from gasoline dispensing facilities indicate that the impact from the facilities decreases rapidly as the distance from the facility increases.

Statistics reported in the ARB's staff reports on Enhanced Vapor Recovery released in 2000 and 2002, indicated that almost 96 percent of the gasoline dispensing facilities had a throughput less than 2.4 million gallons per year. The remaining four percent, or approximately 450 facilities, had throughputs exceeding 2.4 million gallons per year. For these stations, the average gasoline throughput was 3.6 million gallons per year.

Figure 1-6
Gasoline Dispensing Facility Health Risk
for 3,600,000 gal/yr throughput



As shown in Figure 1-6, the risk levels for a gasoline dispensing facility with a throughput of 3.6 million gallons per year is about 10 in one million at a distance of 50 feet from the fenceline. However, as the throughput increases, the potential risk increases.

As mentioned above, air pollution levels in the immediate vicinity of large gasoline dispensing facilities may be higher than the surrounding area (although tailpipe emissions from motor vehicles dominates the health impacts). Very large gasoline dispensing facilities located at large wholesale and discount centers may dispense nine million gallons of gasoline per year or more. At nine million gallons, the potential risk could be around 25 in one million at 50 feet, dropping to about five in one million at 300 feet. Some facilities have throughputs as high as 19 million gallons.

Recommendation

- Avoid siting new sensitive land uses within 300 feet of a large gasoline dispensing facility (defined as a facility with a throughput of 3.6 million gallons per year or greater). A 50 foot separation is recommended for typical gas dispensing facilities.

References

- *Gasoline Service Station Industry-wide Risk Assessment Guidelines.* California Air Pollution Control Officers Association (December 1997 and revised November 1, 2001)
- *Staff Report on Enhanced Vapor Recovery.* ARB (February 4, 2000)
- *The California Almanac of Emissions and Air Quality.* ARB (2004)
- *Staff Report on Enhanced Vapor Recovery Technology Review.* ARB (October 2002)

Other Facility Types that Emit Air Pollutants of Concern

In addition to source specific recommendations, Table 1-3 includes a list of other industrial sources that could pose a significant health risk to nearby sensitive individuals depending on a number of factors. These factors include the amount of pollutant emitted and its toxicity, the distance to nearby individuals, and the type of emission controls in place. Since these types of facilities are subject to air permits from local air districts, facility specific information should be obtained where there are questions about siting a sensitive land use close to an industrial facility.

Potential Sources of Odor and Dust Complaints

Odors and dust from commercial activities are the most common sources of air pollution complaints and concerns from the public. Land use planning and permitting processes should consider the potential impacts of odor and dust on surrounding land uses, and provide for adequate separation between odor and dust sources. As with other types of air pollution, a number of factors need to be considered when determining an adequate distance or mitigation to avoid odor or

Table 1-3 – Examples of Other Facility Types That Emit[1] Air Pollutants of Concern

Categories	Facility Type	Air Pollutants of Concern
Commercial		
	Autobody Shops	Metals, Solvents
	Furniture Repair	Solvents[2], Methylene Chloride
	Film Processing Services	Solvents, Perchloroethylene
	Distribution Centers	Diesel Particulate Matter
	Printing Shops	Solvents
	Diesel Engines	Diesel Particulate Matter
Industrial		
	Construction	Particulate Matter, Asbestos
	Manufacturers	Solvents, Metals
	Metal Platers, Welders, Metal Spray (flame spray) Operations	Hexavalent Chromium, Nickel, Metals
	Chemical Producers	Solvents, Metals
	Furniture Manufacturers	Solvents
	Shipbuilding and Repair	Hexavalent chromium and other metals, Solvents
	Rock Quarries and Cement Manufacturers	Particulate Matter, Asbestos
	Hazardous Waste Incinerators	Dioxin, Solvents, Metals
	Power Plants	Benzene, Formaldehyde, Particulate Matter
	Research and Development Facilities	Solvents, Metals, etc.
Public		
	Landfills	Benzene, Vinyl Chloride, Diesel Particulate Matter
	Waste Water Treatment Plants	Hydrogen Sulfide
	Medical Waste Incinerators	Dioxin, Benzene, PAH, PCBs, 1,3-Butadiene
	Recycling, Garbage Transfer Stations	Diesel Particulate Matter
	Municipal Incinerators	Dioxin, Benzene, PAH, PCBs, 1,3-Butadiene
Transportation		
	Truck Stops	Diesel Particulate Matter
Agricultural Operations		
	Farming Operations	Diesel Particulate Matter, VOCs, NOx, PM10, CO, SOx, Pesticides
	Livestock and Dairy Operations	Ammonia, VOCs, PM10

[1]Not all facilities will emit pollutants of concern due to process changes or chemical substitution. Consult the local air district regarding specific facilities.
[2]Some solvents may emit toxic air pollutants, but not all solvents are toxic air contaminants.

dust complaints in a specific situation. Local air districts should be consulted for advice when these siting situations arise.

Table 1-4 lists some of the most common sources of odor complaints received by local air districts. Complaints about odors are the responsibility of local air districts and are covered under state law. The types of facilities that can cause odor complaints are varied and can range from small commercial facilities to large industrial facilities, and may include waste disposal and recycling operations. Odors can cause health symptoms such as nausea and headache. Facilities with odors may also be sources of toxic air pollutants (See Table 1-3). Some common sources of odors emitted by facilities are sulfur compounds, organic solvents, and the decomposition/digestion of biological materials. Because of the subjective nature of an individual's sensitivity to a particular type of odor, there is no specific rule for assigning appropriate separations from odor sources. Under the right meteorological conditions, some odors may still be offensive several miles from the source.

Table 1-4
Sources of Odor Complaints

- Sewage Treatment Plants
- Landfills
- Recycling Facilities
- Waste Transfer Stations
- Petroleum Refineries
- Biomass Operations
- Autobody Shops
- Coating Operations
- Fiberglass Manufacturing
- Foundries
- Rendering Plants
- Livestock Operations

Sources of dust are also common sources of air pollution-related complaints. Operations that can result in dust problems are rock crushing, gravel production, stone quarrying, and mining operations. A common source of complaints is the dust and noise associated with blasting that may be part of these operations. Besides the health impacts of dust as particulate matter, thick dust also impairs visibility, aesthetic values, and can soil homes and automobiles. Local air districts typically have rules for regulating dust sources in their jurisdictions, but dust sources can still be a concern. Therefore, separation of these facilities from residential and other new sensitive land uses should be considered.

In some areas of California, asbestos occurs naturally in stone deposits. Asbestos is a potent carcinogenic substance when inhaled. Asbestos-containing dust may be a public health concern in areas where asbestos-containing rock is mined, crushed, processed, or used. Situations where asbestos-containing gravel has been used in road paving materials are also a source of asbestos exposure to the general public. Planners are advised to consult with local air pollution agencies in areas where asbestos-containing gravel or stone products are produced or used.

2. Handbook Development

ARB and local air districts share responsibility for improving statewide air quality. As a result of California's air pollution control programs, air quality has improved and health risk has been reduced statewide. However, state and federal air quality standards are still exceeded in many areas of California and the statewide health risk posed by toxic air contaminants (air toxics) remains too high. Also, some communities experience higher pollution exposures than others - making localized impacts, as well regional or statewide impacts, an important consideration. It is for this reason that this Handbook has been produced - to promote better, more informed decision-making by local land use agencies that will improve air quality and public health in their communities.

Land use policies and practices, including planning, zoning, and siting activities, can play a critical role in air quality and public health at the local level. For instance, even with the best available control technology, some projects that are sited very close to homes, schools, and other public places can result in elevated air pollution exposures. The reverse is also true – siting a new school or home too close to an existing source of air pollution can pose a public health risk. The ARB recommendations in section 1 address this issue.

> *This Handbook is an informational document that we hope will strengthen the relationship between air quality and land use agencies. It highlights the need for land use agencies to address the potential for new projects to result in localized health risk or contribute to cumulative impacts where air pollution sources are concentrated.*

Avoiding these incompatible land uses is a key to reducing localized air pollution exposures that can result in adverse health impacts, especially to sensitive individuals.

Individual siting decisions that result in incompatible land uses are often the result of locating "sensitive" land uses next to polluting sources. These decisions can be of even greater concern when existing air pollution exposures in a community are considered. In general terms, this is often referred to as the issue of "cumulative impacts." ARB is working with local air districts to better define these situations and to make information about existing air pollution levels (e.g., from local businesses, motor vehicles, and other areawide sources) more readily available to land use agencies.

In December 2001, the ARB adopted "Policies and Actions for Environmental Justice" (Policies). These Policies were developed in coordination with a group of stakeholders, representing local government agencies, community interest

groups, environmental justice organizations, academia, and business (Environmental Justice Stakeholders Group).

The Policies included a commitment to work with land use planners, transportation agencies, and local air districts to develop ways to identify, consider, and reduce cumulative air pollution emissions, exposure, and health risks associated with land use planning and decision-making. Developed under the auspices of the ARB's Environmental Justice Stakeholders Group, this Handbook is a first step in meeting that commitment.

ARB has produced this Handbook to help achieve several objectives:

- Provide recommendations on situations to avoid when siting new residences, schools, day care centers, playgrounds, and medical-related facilities (sensitive sites or sensitive land uses);

- Identify approaches that land use agencies can use to prevent or reduce potential air pollution impacts associated with general plan policies, new land use development, siting, and permitting decisions;

- Improve and facilitate access to air quality data and evaluation tools for use in the land use decision-making process;

- Encourage stronger collaboration between land use agencies and local air districts to reduce community exposure to source-specific and cumulative air pollution impacts; and

- Emphasize community outreach approaches that promote active public involvement in the air quality/land use decision-making process.

This Handbook builds upon California's 2003 General Plan Guidelines. These Guidelines, developed by the Governor's Office of Planning and Research (OPR), explain the land use planning process and applicable legal requirements. This Handbook also builds upon a 1997 ARB report, "The Land Use-Air Quality Linkage" ("Linkage Report").[9] The Linkage Report was an outgrowth of the California Clean Air Act which, among other things, called upon local air districts to focus particular attention on reducing emissions from sources that indirectly cause air pollution by attracting vehicle trips. Such indirect sources include, but are not limited to, shopping centers, schools and universities, employment centers, warehousing, airport hubs, medical offices, and sports arenas. The Linkage Report summarizes data as of 1997 on the relationships between land use, transportation, and air quality, and highlights strategies that can help to reduce the use of single occupancy automobile use. Such strategies

[9] To access this report, please refer to ARB's website or click on: http://www.arb.ca.gov/ch/programs/link97.pdf

complement ARB regulatory programs that continue to reduce motor vehicle emissions.

In this Handbook, we identify types of air quality-related information that we recommend land use agencies consider in the land use decision-making processes such as the development of regional, general, and community plans; zoning ordinances; environmental reviews; project siting; and permit issuance. The Handbook provides recommendations on the siting of new sensitive land uses based on current analyses. It also contains information on approaches and methodologies for evaluating new projects from an air pollution perspective.

The Handbook looks at air quality issues associated with emissions from industrial, commercial, and mobile sources of air pollution. Mobile sources continue to be the largest overall contributors to the state's air pollution problems, representing the greatest air pollution health risk to most Californians. Based on current health risk information for air toxics, the most serious pollutants on a statewide basis are diesel PM, benzene, and 1,3-butadiene, all of which are primarily emitted by motor vehicles. From a state perspective, ARB continues to pursue new strategies to further reduce motor vehicle-related emissions in order to meet air quality standards and reduce air toxics risk.

While mobile sources are the largest overall contributors to the state's air pollution problems, industrial and commercial sources can also pose a health risk, particularly to people near the source. For this reason, the issue of incompatible land uses is an important focus of this document.

Handbook Audience

Even though the primary users of the Handbook will likely be agencies responsible for air quality and land use planning, we hope the ideas and technical issues presented in this Handbook will also be useful for:

- public and community organizations and community residents;
- federal, state and regional agencies that fund, review, regulate, oversee, or otherwise influence environmental policies and programs affected by land use policies; and
- private developers.

3. Key Community Focused Issues Land Use Agencies Should Consider

Two key air quality issues that land use agencies should consider in their planning, zoning, and permitting processes are:

1) **Incompatible Land Uses.** Localized air pollution impacts from incompatible land use can occur when polluting sources, such as a heavily trafficked roadway, warehousing facilities, or industrial or commercial facilities, are located near a land use where sensitive individuals are found such as a school, hospital, or homes.

2) **Cumulative Impacts.** Cumulative air pollution impacts can occur from a concentration of multiple sources that individually comply with air pollution control requirements or fall below risk thresholds, but in the aggregate may pose a public health risk to exposed individuals. These sources can be heavy or light-industrial operations, commercial facilities such as autobody shops, large gas dispensing facilities, dry cleaners, and chrome platers, and freeways or other nearby busy transportation corridors.

Incompatible Land Uses

Land use policies and practices can worsen air pollution exposure and adversely affect public health by mixing incompatible land uses. Examples include locating new sensitive land uses, such as housing or schools, next to small metal plating facilities that use a highly toxic form of chromium, or very near large industrial facilities or freeways. Based on recent monitoring and health-based studies, we now know that air quality impacts from incompatible land uses can contribute to increased risk of illness, missed work and school, a lower quality of life, and higher costs for public health and pollution control.[10]

Avoiding incompatible land uses can be a challenge in the context of mixed-use industrial and residential zoning. For a variety of reasons, government agencies and housing advocates have encouraged the proximity of affordable housing to employment centers, shopping areas, and transportation corridors, partially as a means to reduce vehicle trips and their associated emissions. Generally speaking, typical distances in mixed-use communities between businesses and industries and other land uses such as homes and schools, should be adequate to avoid health risks. However, generalizations do not always hold as we addressed in section 1 of this Handbook.

In terms of siting air pollution sources, the proposed location of a project is a major factor in determining whether it will result in localized air quality impacts. Often, the problem can be avoided by providing an adequate distance or setback

[10] For more information, the reader should refer to ARB's website on community health: http://www.arb.ca.gov/ch/ch.htm

between a source of emissions and nearby sensitive land uses. Sometimes, suggesting project design changes or mitigation measures in the project review phase can also reduce or avoid potential impacts. This underscores the importance of addressing potential incompatible land uses as early as possible in the project review process, ideally in the general plan itself.

Cumulative Air Pollution Impacts

The broad concept of cumulative air pollution impacts reflects the combination of regional air pollution levels and any localized impacts. Many factors contribute to air pollution levels experienced in any location. These include urban background air pollution, historic land use patterns, the prevalence of freeways and other transportation corridors, the concentration of industrial and commercial businesses, and local meteorology and terrain.

When considering the potential air quality impacts of polluting sources on individuals, project location and the concentration of emissions from air pollution sources need to be considered in the land use decision-making process. In section 4, the Handbook offers a series of questions that helps land use agencies determine if a project should undergo a more careful analysis. This holds true regardless of whether the project being sited is a polluting source or a sensitive land use project.

Large industrial areas are not the only land uses that may result in public health concerns in mixed-use communities. Cumulative air pollution impacts can also occur if land uses do not adequately provide setbacks or otherwise protect sensitive individuals from potential air pollution impacts associated with nearby light industrial sources. This can occur with activities such as truck idling and traffic congestion, or from indirect sources such as warehousing facilities that are located in a community or neighborhood.

In October 2004, Cal/EPA published its Environmental Justice Action Plan. In February 2005, the Cal/EPA Interagency Working Group approved a working definition of "cumulative impacts" for purposes of initially guiding the pilot projects that are being conducted pursuant to that plan. Cal/EPA is now in the process of developing a Cumulative Impacts Assessment Guidance document. Cal/EPA will revisit the working definition of "cumulative impacts" as the Agency develops that guidance. The following is the working definition:

> *"Cumulative impacts means exposures, public health or environmental effects from the combined emissions and discharges, in a geographic area, including environmental pollution from all sources, whether single or multi-media, routinely, accidentally, or otherwise released. Impacts will take into account sensitive populations and socio-economic factors, where applicable, and to the extent data are available."*

4. Mechanisms for Integrating Localized Air Quality Concerns Into Land Use Processes

Land use agencies should use each of their existing planning, zoning, and permitting authorities to address the potential health risk associated with new projects. Land use-specific mechanisms can go a long way toward addressing both localized and cumulative impacts from new air pollution sources that are not otherwise addressed by environmental regulations. Likewise, close collaboration and communication between land use agencies and local air districts in both the planning and project approval stages can further reduce these impacts. Local agency partnerships can also result in early identification of potential impacts from proposed activities that might otherwise escape environmental review. When this happens, pollution problems can be prevented or reduced before projects are approved, when it is less complex and expensive to mitigate.

The land use entitlement process requires a series of planning decisions. At the highest level, the General Plan sets the policies and direction for the jurisdiction, and includes a number of mandatory elements dealing with issues such as housing, circulation, and health hazards. Zoning is the primary tool for implementing land use policies. Specific or community plans created in conjunction with a specific project also perform many of the same functions as a zoning ordinance. Zoning can be modified by means of variances and conditional use permits. The latter are frequently used to insure compatibility between otherwise conflicting land uses. Finally, new development usually requires the approval of a parcel or tract map before grading and building permits can be issued. These parcel or tract maps must be consistent with the applicable General Plan, zoning and other standards.

Land use agencies can use their planning authority to separate industrial and residential land uses, or to require mitigation where separation is not feasible. By separating incompatible land uses, land use agencies can prevent or reduce both localized and cumulative air pollution impacts without denying what might otherwise be a desirable project.[11] For instance:

- a dry cleaner could open a storefront operation in a community with actual cleaning operations performed at a remote location away from residential areas;
- gas dispensing facilities with lower fuel throughput could be sited in mixed-use areas;
- enhanced building ventilation or filtering systems in schools or senior care centers can reduce ambient air from nearby busy arterials; or
- landscaping and regular watering can be used to reduce fugitive dust at a building construction site near a school yard.

[11] It should be noted that such actions should also be considered as part of the General Plan or Plan element process.

The following general and specific land use approaches can help to reduce potential adverse air pollution impacts that projects may have on public health.

General Plans

The primary purpose of planning, and the source of government authority to engage in planning, is to protect public health, safety, and welfare. In its most basic sense, a local government General Plan expresses the community's development goals and embodies public policy relative to the distribution of future land uses, forming the basis for most land use decisions. Therefore, the most effective mechanism for dealing with the central land use concept of compatibility and its relationship to cumulative air pollution impacts is the General Plan. Well before projects are proposed within a jurisdiction, the General Plan sets the stage for where projects can be sited, and their compatibility with comprehensive community goals, objectives, and policies.

In 2003, OPR revised its General Plan Guidelines, highlighting the importance of incorporating sustainable development and environmental justice policies in the planning process. The OPR General Plan Guidelines provides an effective and long-term approach to reduce cumulative air pollution impacts at the earliest planning stages. In light of these important additions to the Guidelines, land use agencies should consider updating their General Plans or Plan elements to address these revisions.

The General Plan and related Plan elements can be used to avoid incompatible land uses by incorporating air quality considerations into these documents. For instance, a General Plan safety element with an air quality component could be used to incorporate policies or objectives that are intended to protect the public from the potential for facility breakdowns that may result in a dangerous release of air toxics. Likewise, an air quality component to the transportation circulation element of the General Plan could include policies or standards to prevent or reduce local exposure to diesel exhaust from trucks and other vehicles. For instance, the transportation circulation element could encourage the construction of alternative routes away from residential areas for heavy-duty diesel trucks. By considering the relationship between air quality and transportation, the circulation element could also include air quality policies to prevent or reduce trips and travel, and thus vehicle emissions. Policies in the land use element of the General Plan could identify areas appropriate for future industrial, commercial, and residential uses. Such policies could also introduce design and distance parameters that reduce emissions, exposure, and risk from industrial and some commercial land uses (e.g., dry cleaners) that are in close proximity to residential areas or schools.

Land use agencies should also consider updating or creating an air quality element in the jurisdiction's General Plan. In the air quality element, local decision-makers could develop long-term, effective plans and policies to address

air quality issues, including cumulative impacts. The air quality element can also provide a general reference guide that informs local land use planners about regional and community level air quality, regulatory air pollution control requirements and guidelines, and references emissions and pollution source data bases and assessment and modeling tools. As is further described in Appendix C of the Handbook, new assessment tools that ARB is developing can be included into the air quality element by reference. For instance, ARB's statewide risk maps could be referenced in the air quality element as a resource that could be consulted by developers or land use agencies

Zoning

The purpose of "zoning" is to separate different land uses. Zoning ordinances establish development controls to ensure that private development takes place within a given area in a manner in which:

- All uses are compatible (e.g., an industrial plant is not permitted in a residential area);
- Common development standards are used (e.g., all homes in a given area are set back the same minimum distance from the street); and,
- Each development does not unreasonably impose a burden upon its neighbors (e.g., parking is required on site so as not to create neighborhood parking problems).

To do this, use districts called "zones" are established and standards are developed for these zones. The four basic zones are residential, commercial, industrial and institutional.

Land use agencies may wish to consider how zoning ordinances, particularly those for mixed-use areas, can be used to avoid exacerbating poor land use practices of the past or contributing to localized and cumulative air pollution impacts in the community.

Sometimes, especially in mixed-use zones, there is a potential for certain categories of existing businesses or industrial operations to result in cumulative air pollution impacts to new development projects. For example:

- An assisted living project is proposed for a mixed-use zone adjacent to an existing chrome plating facility, or several dry cleaners;
- Multiple industrial sources regulated by a local air district are located directly upwind of a new apartment complex;
- A new housing development is sited in a mixed-use zone that is downwind or adjacent to a distribution center that attracts diesel-fueled delivery trucks and TRUs; or
- A new housing development or sensitive land use is sited without adequate setbacks from an existing major transportation corridor or rail yard.

As part of the public process for making zoning changes, local land use agencies could work with community planning groups, local businesses, and community residents to determine how best to address existing incompatible land uses.

Land Use Permitting Processes

■ Questions to Consider When Reviewing New Projects

Very often, just knowing what questions to ask can yield critical information about the potential air pollution impacts of proposed projects – both from the perspective of a specific project as well as in the nature of existing air pollution sources in the same impact area. Available land use information can reveal the proximity of air pollution sources to sensitive individuals, the potential for incompatible land uses, and the location and nature of nearby air pollution sources. Air quality data, available from the ARB and local air districts, can provide information about the types and amounts of air pollution emitted in an area, regional air quality concentrations, and health risk estimates for specific sources.

General Plans and zoning maps are an excellent starting point in reviewing project proposals for their potential air pollution impacts. These documents contain information about existing or proposed land uses for a specific location as well as the surrounding area. Often, just looking at a map of the proposed location for a facility and its surrounding area will help to identify a potential adjacent incompatible land use.

The following pages are a “pull-out” list of questions to consider along with cross-references to pertinent information in the Handbook. These questions are intended to assist land use agencies in evaluating potential air quality-related concerns associated with new project proposals.

The first group of questions contains project-related queries designed to help identify the potential for localized project impacts, particularly associated with incompatible land uses. The second group of questions focuses on the issue of potential cumulative impacts by including questions about existing emissions and air quality in the community, and community feedback. Depending on the answers to these questions, a land use agency may decide a more detailed review of the proposal is warranted.

The California Department of Education has already developed a detailed process for school siting which is outlined in Appendix E. However, school districts may also find this section helpful when evaluating the most appropriate site for new schools in their area. At a minimum, using these questions may encourage school districts to engage throughout their siting process with land use agencies and local air districts. The combined expertise of these entities can be useful in devising relevant design standards and mitigation measures that can

reduce exposure to cumulative emissions, exposure, and health risk to students and school workers.

As indicated throughout the Handbook, we strongly encourage land use agencies to consult early and often with local air districts. Local air districts have the expertise, many of the analytical tools, and a working knowledge of the sources they regulate. It is also critical to fully involve the public and businesses that could be affected by the siting decision. The questions provided in the chart below do not imply any particular action should be taken by land use agencies. Rather the questions are intended to improve the assessment process and facilitate informed decision-making.

- **Project-Related Questions**

This section includes project-related questions that, in conjunction with the questions in the next section, can be used to tailor the project evaluation. These questions are designed to help identify the potential for incompatible land uses from localized project impacts.

Questions to Consider When Reviewing New Projects

Project-Related Questions	Cross-Reference to Relevant Handbook Sections
1. Is the proposed project: ▲ A business or commercial license renewal ▲ A new or modified commercial project ▲ A new or modified industrial project ▲ A new or modified public facility project ▲ A new or modified transportation project ▲ A housing or other development in which sensitive individuals may live or play	See Appendix A for typical land use classifications and associated project categories that could emit air pollutants.
2. Does the proposed project: ▲ Conform to the zoning designation? ▲ Require a variance to the zoning designation? ▲ Include plans to expand operations over the life of the business such that additional emissions may increase the pollution burden in the community (e.g., from additional truck operations, new industrial operations or process lines, increased hours of operation, build-out to the property line, etc.)?	See Appendix F for a general explanation of land use processes. In addition, Section 3 contains a discussion of how land use planning, zoning, and permitting practices can result in incompatible land uses or cumulative air pollution impacts.
3. Has the local air district provided comments or information to assist in the analysis?	See Section 5 and Appendix C for a description of air quality-related tools that the ARB and local air districts use to provide information on potential air pollution impacts.
4. Have public meetings been scheduled with the affected community to solicit their involvement in the decision-making process for the proposed project?	See Section 7 for a discussion of public participation, information and outreach tools.
5. If the proposed project will be subject to local air district regulations: ▲ Has the project received a permit from the local air district? ▲ Would it comply with applicable local air district requirements? ▲ Is the local air district contemplating new regulations that would reduce emissions from the source over time? ▲ Will potential emissions from the project	See Appendix C for a description of local air district programs.

Project-Related Questions	Cross-Reference to Relevant Handbook Sections
trigger the local air district's new source review for criteria pollutants or air toxics emissions? ▲ Is the local air district expected to ask the proposed project to perform a risk assessment? ▲ Is there sufficient new information or public concern to call for a more thorough environmental analysis of the proposed project? ▲ Are there plans to expand operations over time? ▲ Are there land-use based air quality significance thresholds or design standards that could be applied to this project in addition to applicable air district requirements?	
6. If the proposed project will release air pollution emissions, either directly or indirectly, but is not regulated by the local air district: ▲ Is the local air district informed of the project? ▲ Does the local air district believe that there could be potential air pollution impacts associated with this project category because of the proximity of the project to sensitive individuals? ▲ If the project is one in which individuals live or play (e.g., a home, playground, convalescent home, etc.), does the local air district believe that the project's proximity to nearby sources could pose potential air pollution impacts? ▲ Are there indirect emissions that could be associated with the project (e.g., truck traffic or idling, transport refrigeration unit operations, stationary diesel engine operations, etc.) that will be in close proximity to sensitive individuals? ▲ Will the proposed project increase or serve as a magnet for diesel traffic? ▲ Are there land-use based air quality significance thresholds or design standards that could be applied to this project in addition to applicable air district requirements? ▲ Is there sufficient new information or public concern to call for a more thorough environmental analysis of the proposed project? ▲ Should the site approval process include identification and mitigation of potential	See Section 1 for recommendations on situations to avoid when siting projects where sensitive individuals would be located (sensitive sites).

Project-Related Questions	Cross-Reference to Relevant Handbook Sections
direct or indirect emissions associated with the potential project?	
7. Does the local air district or land use agency have pertinent information on the source, such as: ▲ Available permit and enforcement data, including for the owner or operator of the proposed source that may have other sources in the State. ▲ Proximity of the proposed project to sensitive individuals. ▲ Number of potentially exposed individuals from the proposed project. ▲ Potential for the proposed project to expose sensitive individuals to odor or other air pollution nuisances. ▲ Meteorology or the prevailing wind patterns between the proposed project and the nearest receptor, or between the proposed sensitive receptor project and sources that could pose a localized or cumulative air pollution impact.	See Appendix C for a description of local air district programs. See Appendix B for a listing of useful information that land use agencies should have on hand or have accessible when reviewing proposed projects for potential air pollution impacts. Also, do not hesitate to contact your local air district regarding answers to any of these questions that might not be available at the land use agency. See Section 1 for recommendations on situations to avoid when siting projects where sensitive individuals would be located (sensitive sites).
8. Based upon the project application, its location, and the nature of the source, could the proposed project: ▲ Be a polluting source that is located in proximity to, or otherwise upwind, of a location where sensitive individuals live or play? ▲ Attract sensitive individuals and be located in proximity to or otherwise downwind, of a source or multiple sources of pollution, including polluting facilities or transportation-related sources that contribute emissions either directly or indirectly? ▲ Result in health risk to the surrounding community?	See Section 3 for a discussion of what is an incompatible land use and the potential cumulative air pollution impacts. See Section 1 for recommendations on situations to avoid when siting projects where sensitive individuals would be located (sensitive sites).
9. If a CEQA categorical exemption is proposed, were the following questions considered: ▲ Is the project site environmentally sensitive as defined by the project's location? (A project that is ordinarily insignificant in its impact on the environment may in a particularly sensitive environment be significant.) ▲ Would the project and successive future projects of the same type in the approximate location potentially result in cumulative impacts? ▲ Are there "unusual circumstances" creating the possibility of significant effects?	See CEQA Guidelines section 15300, and Public Resources Code, section 21084. See Section 1 for recommendations on situations to avoid when siting projects where sensitive individuals would be located (sensitive sites). See also Section 5 and Appendix C for a description of air quality-related tools that the ARB and local air districts use to provide information on potential air pollution impacts.

- **Questions Related to Cumulative Impact Assessment**

The following questions can be used to provide the decision-maker with a better understanding of the potential for cumulative air pollution impacts to an affected community. Answers to these questions will help to determine if new projects or activities warrant a more detailed review. It may also help to see potential environmental concerns from the perspective of the affected community. Additionally, responses can provide local decision-makers with information with which to assess the best policy options for addressing neighborhood-scale air pollution concerns.

The questions below can be used to identify whether existing tools and procedures are adequate to address land use-related air pollution issues. This process can also be used to pinpoint project characteristics that may have the greatest impact on community-level emissions, exposure, and risk. Such elements can include: the compliance record of existing sources including those owned or operated by the project proponent; the concentration of emissions from polluting sources within the approximate area of sensitive sites; transportation circulation in proximity to the proposed project; compatibility with the General Plan and General Plan elements; etc.

The local air district can provide useful assistance in the collection and evaluation of air quality-related information for some of the questions and should be consulted early in the process.

Questions Related to Cumulative Impact Assessment

Technical Questions	Cross-Reference to Relevant Handbook Sections
1. Is the community home to industrial facilities?	See Appendix A for typical land use classifications and associated project categories that could emit air pollutants.
2. Do one or more major freeways or high-traffic volume surface streets cut through the community?	See transportation circulation element of your general plan. See also Appendix B for useful information that land use agencies should have on hand or have accessible when reviewing proposed projects for potential air pollution impacts. See Section 1 for recommendations on situations to avoid when siting projects where sensitive individuals would be located (sensitive sites).
3. Is the area classified for mixed-use zoning?	See your general plan and zoning ordinances.
4. Is there an available list of air pollution sources in the community?	Contact your local air district.
5. Has a walk-through of the community been conducted to gather the following information:	See Appendix B for a listing of useful information that land use agencies

Technical Questions	Cross-Reference to Relevant Handbook Sections
▲ Corroborate available information on land use activities in the area (e.g., businesses, housing developments, sensitive individuals, etc.)? ▲ Determine the proximity of existing and anticipated future projects to residential areas or sensitive individuals? ▲ Determine the concentration of emission sources (including anticipated future projects) to residential areas or sensitive individuals?	should have on hand or have accessible when reviewing proposed projects for potential air pollution impacts. Also contact your local air district.
6. Has the local air district been contacted to obtain information on sources in the community?	See Section 7 for a discussion of public participation, information and outreach tools.
7. What categories of commercial establishments are currently located in the area and does the local air district have these sources on file as being regulated or permitted?	See Appendix A for typical land use classifications and associated project categories that could emit air pollutants. Also contact your local air district.
8. What categories of indirect sources such as distribution centers or warehouses are currently located in the area?	See Appendix A for typical land use classifications and associated project categories that emit air pollutants.
9. What air quality monitoring data are available?	Contact your local air district.
10. Have any risk assessments been performed on emission sources in the area?	Contact your local air district.
11. Does the land use agency have the capability of applying a GIS spatial mapping tool that can overlay zoning, sub-development information, and other neighborhood characteristics, with air pollution and transportation data?	See Appendix B for a listing of useful information that land use agencies should have on hand or have accessible when reviewing proposed projects for potential air pollution impacts. Also contact your local air district for tools that can be used to supplement available land use agency tools.
12. Based on available information, is it possible to determine if the affected community or neighborhood experiences elevated health risk due to a concentration of air pollution sources in close proximity, and if not, can the necessary information be obtained?	Contact your local air district. Also see Section 1 for recommendations on situations to avoid when siting projects where sensitive individuals would be located (sensitive sites).
13. Does the community have a history of chronic complaints about air quality?	See Section 7 for a discussion of public participation, information and outreach tools. Also contact your local air district.
14. Is the affected community included in the public participation process for the agency's decision?	See Section 7 for a discussion of public participation, information and outreach tools.
15. Have community leaders or groups been contacted about any pre-existing or chronic community air quality concerns?	See Section 7 for a discussion of public participation, information and outreach tools. Also contact your local air district.

- **Mitigation Approaches**

In addition to considering the suitability of the project location, opportunities for mitigation of air pollution impacts should be considered. Sometimes, a land use agency may find that selection of a different project location to avoid a health risk is not feasible. When that happens, land use agencies should consider design improvements or other strategies that would reduce the risk. Such strategies could include performance or design standards, consultation with local air districts and other agencies on appropriate actions that these agencies should, or plan to, undertake, and consultation and outreach in the affected community. Potential mitigation measures should be feasible, cost-effective solutions within the available resources and authority of implementing agencies to enforce.[12]

- **Conditional Use Permits and Performance Standards**

Some types of land uses are only allowed upon approval of a conditional use permit (also called a CUP or special use permit). A conditional use permit does not re-zone the land but specifies conditions under which a particular land use will be permitted. Such land uses could be those with potentially significant environmental impacts. Local zoning ordinances specify the uses for which a conditional use permit is required, the zones they may be allowed in, and public hearing procedures. The conditional use permit imposes special requirements to ensure that the use will not be detrimental to its surroundings.

In the context of land use planning, performance standards are requirements imposed on projects or project categories through conditional use permits to ensure compliance with general plan policies and local ordinances. These standards could apply to such project categories as distribution centers, very large gas dispensing facilities, autobody shops, dry cleaners, and metal platers. Land use agencies may wish to consider adding land use-based performance standards to zoning ordinances in existing mixed-use communities for certain air pollution project categories. Such standards would provide certainty and equitable treatment to all projects of a similar nature, and reserve the more resource intensive conditional or special use permits to projects that require a more detailed analysis. In developing project design or performance standards, land use agencies should consult with the local air district. Early and regular consultation can avoid duplication or inconsistency with local air district control requirements when considering the site-specific design and operation of a project.

[12] A land use agency has the authority to condition or deny a project based upon information collected and evaluated through the land use decision-making process. However, any denial would need to be based upon identifiable, generally applicable, articulated standards set forth in the local government's General Plan and zoning codes. One way of averting this is to conduct early and regular outreach to the community and the local air district so that community and environmental concerns can be addressed and accommodated into the project proposal.

Examples of land use-based air quality-specific performance standards include the following:

- Placing a process vent away from the direction of the local playground that is nearby or increasing the stack height so that emissions are dispersed to reduce the emissions impact on surrounding homes or schools.
- Setbacks between the project fence line and the population center.
- Limiting the hours of operation of a facility to avoid excess emissions exposure or foul odors to nearby individuals.
- An ordinance that requires fleet operators to use cleaner vehicles before project approval (if a new business), or when expanding the fleet (if an existing business); and
- Providing alternate routes for truck operations that discourage detours into residential neighborhoods.

Outreach to Other Agencies

When questions arise regarding the air quality impacts of projects, including potential cumulative impacts, land use agencies should consult the local air district. Land use agencies should also consider the following suggestions to avoid creating new incompatible land uses:

- Consult with the local air district to help determine if emissions from a particular project will adversely impact sensitive individuals in the area, if existing or future effective regulations or permit requirements will affect the proposed project or other sources in the vicinity of the proposed project, or if additional inspections should be required.
- Check with ARB for new information and modeling tools that can help evaluate projects seeking to site within your jurisdiction.
- Become familiar with ARB's Land Use-Air Quality Linkage Report to determine whether approaches and evaluation tools contained in the Report can be used to reduce transportation-related impacts on communities.
- Contact and collaborate with other state agencies that play a role in the land use decision-making process, e.g., the State Department of Education, the California Energy Commission, and Caltrans. These agencies have information on mitigation measures and mapping tools that could be useful in addressing local problems.

- **Information Clearinghouse**

  - Land use agencies can refer to the ARB statewide electronic information clearinghouse for information on what measures other jurisdictions are using to address comparable issues or sources.[13]

[13] This information can be accessed from ARB's website by going to: http://www.arb.ca.gov/ch/clearinghouse.htm

The next section addresses available air quality assessment tools that land use agencies can use to evaluate the potential for localized or cumulative impacts in their communities.

5. Available Tools to Evaluate Cumulative Air Pollution Emissions and Risk

Until recently, California has traditionally approached air pollution control from the perspective of assessing whether the pollution was regional, category-specific, or from new or existing sources. This methodology has been generally effective in reducing statewide and regional air pollution impacts and risk levels. However, such an incremental, category-by-category, source-by-source approach may not always address community health impacts from multiple sources - including mobile, industrial, and commercial facilities.

As a result of air toxics and children's health concerns over the past several years, ARB and local air districts have begun to develop new tools to evaluate and inform the public about cumulative air pollution impacts at the community level. One aspect of ARB's programs now underway is to consolidate and make accessible air toxics emissions and monitoring data by region, using modeling tools and other analytical techniques to take a preliminary look at emissions, exposure, and health risk in communities.

ARB has developed multiple tools to assist local air districts perform assessments of cumulative emissions, exposure, and risk on a neighborhood scale. These tools include:

- Regional risk maps that show trends in potential cancer risk from toxic air pollutants in southern and central California between 1990 and 2010. These maps are based on the U.S. EPA's ASPEN model. These maps provide an estimate of background levels of toxic air pollutant risk but are not detailed enough to assess individual neighborhoods or facilities.[14]

- The Community Health Air Pollution Information System (CHAPIS) is a user-friendly, Internet-based system for displaying information on emissions from sources of air pollution in an easy to use mapping format. CHAPIS contains information on air pollution emissions from selected large facilities and small businesses that emit criteria and toxic air pollutants. It also contains information on air pollution emissions from motor vehicles. When released in 2004, CHAPIS did not contain information on every source of air pollution or every air pollutant. However, ARB continues to work with local air districts to include all of the largest air pollution sources and those with the highest documented air pollution risk. Additional facilities will be added to CHAPIS as more data become available.[15]

[14] For further information on these maps, please visit ARB's website at: http://www.arb.ca.gov/toxics/cti/hlthrisk/hlthrisk.htm

[15] For further information on CHAPIS, please click on: http://www.arb.ca.gov/ch/chapis1/chapis1.htm

- The Hot Spots Analysis and Reporting Program (HARP) is a software database package that evaluates emissions from one or more facilities to determine the overall health risk posed by the facility(-ies) on the surrounding community. Proper use of HARP ensures that the risk assessment meets the latest risk assessment guidelines published by the State Office of Environmental Health Hazard Assessment (OEHHA). HARP is designed with air quality professionals in mind and is available from the ARB.

- The Urban Emissions Model (URBEMIS) is a computer program that can be used to estimate emissions associated with land development projects in California such as residential neighborhoods, shopping centers, office buildings, and construction projects. URBEMIS uses emission factors available from the ARB to estimate vehicle emissions associated with new land uses.

Local air districts, and others can use these tools to assess a new project, or plan revision. For example, these tools can be used to:

- Identify if there are multiple sources of air pollution in the community;
- Identify the major sources of air pollution in the area under consideration;
- Identify the background potential cancer risk from toxic air pollution in the area under consideration;
- Estimate the risk from a new facility and how it adds to the overall risk from other nearby facilities; and
- Provide information to decision-makers and key stakeholders on whether there may be significant issues related to cumulative emissions, exposure, and health risk due to a permitting or land use decision.

If an air agency wishes to perform a cumulative air pollution impact analysis using any of these tools, it should consult with the ARB and/or the local air district to obtain information or assistance on the data inputs and procedures necessary to operate the program. In addition, land use agencies could consult with local air districts to determine the availability of land use and air pollution data for entry into an electronic Geographical Information System (GIS) format. GIS is an easier mapping tool than the more sophisticated models described in Appendix C. GIS mapping makes it possible to superimpose land use with air pollution information so that the spatial relationship between air pollution sources, sensitive receptors, and air quality can be visually represented. Appendix C provides a general description of the impact assessment process and micro-scale, or community level modeling tools that are available to evaluate potential cumulative air pollution impacts. Modeling protocols will be accessible on ARB's website as they become available. The ARB will also provide land use agencies and local air districts with statewide regional modeling results and information regarding micro-scale modeling.

6. ARB Programs to Reduce Air Pollution in Communities

ARB's regulatory programs reduce air pollutant emissions through statewide strategies that improve public health in all California communities. ARB's overall program addresses motor vehicles, consumer products, air toxics, air-quality planning, research, education, enforcement, and air monitoring. Community health and environmental justice concerns are a consideration in all these programs. ARB's programs are statewide but recognize that extra efforts may be needed in some communities due to historical mixed land-use patterns, limited participation in public processes in the past, and a greater concentration of air pollution sources in some communities.

ARB's strategies are intended to result in better air quality and reduced health risk to residents throughout California. The ARB's priority is to prevent or reduce the public's exposure to air pollution, including from toxic air contaminants that pose the greatest risk, particularly to infants and children who are more vulnerable to air pollution.

In October 2003, ARB updated its statewide control strategy to reduce emissions from source categories within its regulatory authority. A primary focus of the strategy is to achieve federal and state air quality standards for ozone and particulate matter throughout California, and to reduce health risk from diesel PM. Along with local air districts, ARB will continue to address air toxics emissions from regulated sources (see Table 6-1 for a summary of ARB activities). As indicated earlier, ARB will also provide analytical tools and information to land use agencies and local air districts to help assess and mitigate cumulative air pollution impacts.

The ARB will continue to consider the adoption of or revisions to needed air toxics control measures as part of the state's ongoing air toxics assessment program.[16]

As part of its effort to reduce particulate matter and air toxics emissions from diesel PM, the ARB has developed a Diesel Risk Reduction Program[17] that lays out several strategies in a three-pronged approach to reduce emissions and their associated risk:

- Stringent emission standards for all new diesel-fueled engines;
- Aggressive reductions from in-use engines; and
- Low sulfur fuel that will reduce PM and still provide the quality of diesel fuel needed to control diesel PM.

[16] For continuing information and updates on state measures, the reader can refer to ARB's website at http://www.arb.ca.gov/toxics/toxics.htm.
[17] For a comprehensive description of the program, please refer to ARB's website at http://www.arbB.ca.gov/diesel/dieselrrp.htm.

Table 6-1
ARB ACTIONS TO ADDRESS
CUMULATIVE AIR POLLUTION IMPACTS IN COMMUNITIES

Information Collection

- Improve emission inventories, air monitoring data, and analysis tools that can help to identify areas with high cumulative air pollution impacts
- Conduct studies in coordination with OEHHA on the potential for cancer and non-cancer health effects from air pollutants emitted by specific source categories
- Establish web-based clearinghouse for local land use strategies

Emission Reduction Approaches (2004-2006)*

- Through a public process, consider development and/or amendment of regulations and related guidance to reduce emissions, exposure, and health risk at a statewide and local level for the following sources:
  - Diesel PM sources such as stationary diesel engines, transport refrigeration units, portable diesel engines, on-road public fleets, off-road public fleets, heavy-duty diesel truck idling, harbor craft vessels, waste haulers
  - Other air toxics sources, such as formaldehyde in composite wood products, hexavalent chromium for chrome plating and chromic acid anodizing, thermal spraying, and perchloroethylene dry cleaning
- Develop technical information for the following:*
  - Distribution centers
  - Modeling tools such as HARP and CHAPIS
- Adopt rules and pollution prevention initiatives within legal authority to reduce emissions from mobile sources and fuels, and consumer products
- Develop and maintain Air Quality Handbook as a tool for use by land use agencies and local air districts to address cumulative air pollution impacts

Other Approaches

- Establish guidelines for use of statewide incentive funding for high priority mobile source emission reduction projects

*Because ARB will continue to review the need to adopt or revise statewide measures, the information contained in this chart will be updated on an ongoing basis.

A number of ARB's diesel risk reduction strategies have been adopted. These include measures to reduce emissions from refuse haulers, urban buses, transport refrigeration units, stationary and portable diesel engines, and idling trucks and school buses. These sources are all important from a community perspective.[18]

[18] The reader can refer to ARB's website for information on its mobile source-related programs at: http://www.arb.ca.gov/msprog/msprog.htm, as well as regulations adopted and under consideration as part of the Diesel Risk Reduction Program at: http://www.arb.ca.gov/diesel/dieselrrp.htm

The ARB will continue to evaluate the health effects of air pollutants while implementing programs with local air districts to reduce air pollution in all California communities.

Local air districts also have ambitious programs to reduce criteria pollutants and air toxics from regulated sources in their region. Many of these programs also benefit air quality in local communities as well as in the broader region. For more information on what is being done in your area to reduce cumulative air pollution impacts through air pollution control programs, you should contact your local air district.[19]

[19] Local air district contacts can be found on the inside cover to this Handbook.

7. Ways to Enhance Meaningful Public Participation

Community involvement is an important part of the land use process. The public is entitled to the best possible information about the air they breathe and what is being done to prevent or reduce unhealthful air pollution in their communities. In particular, information on how land use decisions can affect air pollution and public health should be made accessible to all communities, including low-income and minority communities.

Effective community participation consistently relies on a two-way flow of information – from public agencies to community members about opportunities, constraints, and impacts, and from community members back to public officials about needs, priorities, and preferences. The outreach process needed to build understanding and local neighborhood involvement requires data, methodologies, and formats tailored to the needs of the specific community. More importantly, it requires the strong collaboration of local government agencies that review and approve projects and land uses to improve the physical and environmental surroundings of the local community.

Many land use agencies, especially those in major metropolitan areas, are familiar with, and have a long-established public review process. Nevertheless, public outreach can often be improved. Active public involvement requires engaging the public in ways that do not require their previous interest in or knowledge of the land use or air pollution control requirements, and a commitment to taking action where appropriate to address the concerns that are raised.

■ Direct Community Outreach

In conjunction with local air districts, land use agencies should consider designing an outreach program for community groups, other stakeholders, and local government agency staffs that address the problem of cumulative air pollution impacts, and the public and government role in reducing them. Such a program could consider analytical tools that assist in the preparation and presentation of information in a way that supports sensible decision-making and public involvement. Table 7-1 contains some general outreach approaches that might be considered.

Table 7-1
Public Participation Approaches

- Staff and community leadership awareness training on environmental justice programs and community-based issues
- Surveys to identify the website information needs of interested community-based organizations and other stakeholders
- Information materials on local land use and air district authorities
- Community-based councils to facilitate and invite resident participation in the planning process
- Neighborhood CEQA scoping sessions that allows for community input prior to technical analysis
- Public information materials on siting issues are under review including materials written for the affected community, and in different media that widens accessibility
- Public meetings
- Identify other opportunities to include community-based organizations in the process

To improve outreach, local land use agencies should consider the following activities:

- Hold meetings in communities affected by agency programs, policies, and projects at times and in places that encourage public participation, such as evenings and weekends at centrally located community meeting rooms, libraries, and schools.
- Assess the need for and provide translation services at public meetings.
- Hold community meetings to update residents on the results of any special air monitoring programs conducted in their neighborhood.
- Hold community meetings to discuss and evaluate the various options to address cumulative impacts in their community.
- In coordination with local air districts, make staff available to attend meetings of community organizations and neighborhood groups to listen to and, where appropriate, act upon community concerns.
- Establish a specific contact person for environmental justice issues.
- Increase student and community awareness of local government land use activities and policies through outreach opportunities.
- Make air quality and land use information available to communities in an easily understood and useful format, including fact sheets, mailings, brochures, public service announcements, and web pages, in English and other languages.
- On the local government web-site, dedicate a page or section to what the land use program is doing regarding environmental justice and cumulative environmental impacts, and, as applicable, activities conducted with local air districts such as neighborhood air monitoring studies, pollution prevention, air pollution sources in neighborhoods, and risk reduction.

- Allow, encourage, and promote community access to land use activities, including public meetings, General Plan or Community Plan updates, zoning changes, special studies, CEQA reviews, variances, etc.
- Distribute information in multiple languages, as needed, on how to contact the land use agency or local air district to obtain information and assistance regarding environmental justice programs, including how to participate in public processes.
- Create and distribute a simple, easy-to-read, and understandable public participation handbook, which may be based on the "Public Participation Guidebook" developed by ARB.

- **Other Opportunities for Meaningful Public Outreach**

  - Community-Based Planning Committees

  Neighborhood-based or community planning advisory councils could be established to invite and facilitate direct resident participation into the planning process. With the right training and technical assistance, such councils can provide valuable input and a forum for the review of proposed amendments to plans, zone changes, land use permits, and suggestions as to how best to prevent or reduce cumulative air pollution impacts in their community.

  - Regional Partnerships

  Consider creating regional coalitions of key growth-related organizations from both the private and public sectors, with corporations, communities, other jurisdictions, and government agencies. Such partnerships could facilitate agreement on common goals and win-win solutions tailored specifically for the region. With this kind of dialogue, shared vision, and collaboration, barriers can be overcome and locally acceptable sustainable solutions implemented. Over the long term, such strategies will help to bring about clean air in communities as well as regionally.

LAND USE CLASSIFICATIONS AND ASSOCIATED FACILITY CATEGORIES THAT COULD EMIT AIR POLLUTANTS

(1) Land Use Classifications – by Activity[i]	(2) Facility or Project Examples	(3) Key Pollutants[ii,iii]	(4) Air Pollution Permits[iv]
COMMERCIAL/ LIGHT INDUSTRIAL: SHOPPING, BUSINESS, AND COMMERCIAL			
▲ Primarily retail shops and stores, office, commercial activities, and light industrial or small business	Dry cleaners; drive-through restaurants; gas dispensing facilities; auto body shops; metal plating shops; photographic processing shops; textiles; apparel and furniture upholstery; leather and leather products; appliance repair shops; mechanical assembly cleaning; printing shops	VOCs, air toxics, including diesel PM, NOx, CO, SOx	Limited; Rules for applicable equipment
▲ Goods storage or handling activities, characterized by loading and unloading goods at warehouses, large storage structures, movement of goods, shipping, and trucking.	Warehousing; freight-forwarding centers; drop-off and loading areas; distribution centers	VOCs, air toxics, including diesel PM, NOx, CO, SOx	No[v]
LIGHT INDUSTRIAL: RESEARCH AND DEVELOPMENT			
▲ Medical waste at research hospitals and labs	Incineration; surgical and medical instrument manufacturers, pharmaceutical manufacturing, biotech research facilities	Air toxics, NOx, CO, SOx	Yes
▲ Electronics, electrical apparatus, components, and accessories	Computer manufacturer; integrated circuit board manufacturer; semi-conductor production	Air toxics, VOCs	Yes
▲ College or university lab or research center	Medical waste incinerators; lab chemicals handling, storage and disposal	Air toxics, NOx, CO, SOx, PM10	Yes
▲ Research and development labs	Satellite manufacturer; fiber-optics manufacturer; defense contractors; space research and technology; new vehicle and fuel testing labs	Air toxics, VOCs	Yes
▲ Commercial testing labs	Consumer products; chemical handling, storage and disposal	Air toxics, VOCs	Yes

(1) Land Use Classifications – by Activity[i]	(2) Facility or Project Examples	(3) Key Pollutants[ii,iii]	(4) Air Pollution Permits[iv]
INDUSTRIAL: NON-ENERGY-RELATED			
▲ Assembly plants, manufacturing facilities, industrial machinery	Adhesives; chemical; textiles; apparel and furniture upholstery; clay, glass, and stone products production; asphalt materials; cement manufacturers, wood products; paperboard containers and boxes; metal plating; metal and canned food product fabrication; auto manufacturing; food processing; printing and publishing; drug, vitamins, and pharmaceuticals; dyes; paints; pesticides; photographic chemicals; polish and wax; consumer products; metal and mineral smelters and foundries; fiberboard; floor tile and cover; wood and metal furniture and fixtures; leather and leather products; general industrial and metalworking machinery; musical instruments; office supplies; rubber products and plastics production; saw mills; solvent recycling; shingle and siding; surface coatings	VOCs, air toxics, including diesel PM, NOx, PM, CO, SOx	Yes
INDUSTRIAL: ENERGY AND UTILITIES			
▲ Water and sewer operations	Pumping stations; air vents; treatment	VOCs, air toxics, NOx, CO, SOx, PM10	Yes
▲ Power generation and distribution	Power plant boilers and heaters; portable diesel engines; gas turbine engines	NOx, diesel PM, NOx, CO, SOx, PM10, VOCs	Yes
▲ Refinery operations	Refinery boilers and heaters; coke cracking units; valves and flanges; flares	VOCs, air toxics, including diesel PM, NOx, CO, SOx, PM10	Yes
▲ Oil and gas extraction	Oil recovery systems; uncovered wells	NOx, diesel PM, VOCs, CO, SOx, PM10	Yes
▲ Gasoline storage, transmission, and marketing	Above and below ground storage tanks; floating roof tanks; tank farms; pipelines	VOCs, air toxics, including diesel PM, NOx, CO, SOx, PM10	Yes
▲ Solid and hazardous waste treatment, storage, and disposal activities.	Landfills; methane digester systems; process recycling facility for concrete and asphalt materials	VOCs, air toxics, NOx, CO, SOx, PM10	Yes
CONSTRUCTION (NON-TRANSPORTATION)			
	Building construction; demolition sites	PM (re-entrained road dust), asbestos, diesel PM, NOx, CO, SOx, PM10, VOCs	Limited; state and federal off-road equipment standards

(1) Land Use Classifications – by Activity[i]	(2) Facility or Project Examples	(3) Key Pollutants[ii,iii]	(4) Air Pollution Permits[iv]
DEFENSE			
	Ordnance and explosives demolition; range and testing activities; chemical production; degreasing; surface coatings; vehicle refueling; vehicle and engine operations and maintenance	VOCs, air toxics, including diesel PM, NOx, CO, SOx, PM10	Limited; prescribed burning; equipment and solvent rules
TRANSPORTATION			
▲ Vehicular movement	Residential area circulation systems; parking and idling at parking structures; drive-through establishments; car washes; special events; schools; shopping malls, etc.	VOCs, NOx, PM (re-entrained road dust) air toxics e.g., benzene, diesel PM, formaldehyde, acetaldehyde, 1,3 butadiene, CO, SOx, PM10	No
▲ Road construction and surfacing	Street paving and repair; new highway construction and expansion	VOCs, air toxics, including diesel PM, NOx, CO, SOx, PM10	No
▲ Trains	Railroads; switch yards; maintenance yards	VOCs, NOx, CO, SOx, PM10, air toxics, including diesel PM	Limited; Applicable state and federal MV standards, and possible equipment rules
▲ Marine and port activities	Recreational sailing; commercial marine operations; hotelling operations; loading and un-loading; servicing; shipping operations; port or marina expansion; truck idling		
▲ Aircraft	Takeoff, landing, and taxiing; aircraft maintenance; ground support activities		
▲ Mass transit and school buses	Bus repair and maintenance		
NATURAL RESOURCES			
▲ Farming operations	Agricultural burning; diesel operated engines and heaters; small food processors; pesticide application; agricultural off-road equipment	Diesel PM, VOCs, NOx, PM10, CO, SOx, pesticides	Limited[vi]; Agricultural burning requirements, applicable state and federal mobile source standards; pesticide rules
▲ Livestock and dairy operations	Dairies and feed lots	Ammonia, VOCs, PM10	Yes[vii]
▲ Logging	Off-road equipment e.g., diesel fueled chippers, brush hackers, etc.	Diesel PM, NOx, CO, SOx, PM10, VOCs	Limited; Applicable state/federal mobile source standards
▲ Mining operations	Quarrying or stone cutting; mining; drilling or dredging	PM10, CO, SOx, VOCs, NOx, and asbestos in some geographical areas	Applicable equipment rules and dust controls

(1) Land Use Classifications – by Activity[i]	(2) Facility or Project Examples	(3) Key Pollutants[ii,iii]	(4) Air Pollution Permits[iv]
RESIDENTIAL			
Housing	Housing developments; retirement developments; affordable housing	Fireplace emissions (PM10, NOx, VOCs, CO, air toxics); Water heater combustion (NOx, VOCs, CO)	No[vii]
ACADEMIC AND INSTITUTIONAL			
▲ Schools, including school-related recreational activities	Schools; school yards; vocational training labs/classrooms such as auto repair/painting and aviation mechanics	Air toxics	Yes/No[viii]
▲ Medical waste	Incineration	Air toxics, NOx, CO, PM10	Yes
▲ Clinics, hospitals, convalescent homes		Air toxics	Yes

[i] These classifications were adapted from the American Planning Association's "Land Based Classification Standards." The Standards provide a consistent model for classifying land uses based on their characteristics. The model classifies land uses by refining traditional categories into multiple dimensions, such as activities, functions, building types, site development character, and ownership constraints. Each dimension has its own set of categories and subcategories. These multiple dimensions allow users to have precise control over land-use classifications. For more information, the reader should refer to the Association's website at http://www.planning.org/LBCS/GeneralInfo/.

[ii] This column includes key criteria pollutants and air toxic contaminants that are most typically associated with the identified source categories.

Additional information on specific air toxics that are attributed to facility categories can be found in ARB's Emission Inventory Criteria and Guidelines Report for the Air Toxics Hot Spots Program (May 15, 1997). This information can be viewed at ARB's web site at http://www.arb.ca.gov/ab2588/final96/guide96.pdf.

Criteria air pollutants are those air pollutants for which acceptable levels of exposure can be determined and for which an ambient air quality standard has been set. Criteria pollutants include ozone (formed by the reaction of volatile organic compounds and nitrogen oxides in the presence of sunlight), particulate matter, nitrogen dioxide, sulfur dioxide, carbon monoxide, and lead.

Volatile organic compounds (VOCs) combine with nitrogen oxides to form ozone, as well as particulate matter. VOC emissions result primarily from incomplete fuel combustion and the evaporation of chemical solvents and fuels. On-road mobile sources are the largest contributors to statewide VOC emissions. Stationary sources of VOC emissions include processes that use solvents (such as dry-cleaning, degreasing, and coating operations) and petroleum-related processes (such as petroleum refining, gasoline marketing and dispensing, and oil and gas extraction). Areawide VOC sources include consumer products, pesticides, aerosols and paints, asphalt paving and roofing, and other evaporative emissions.

Nitrogen oxides (NOx) are a group of gaseous compounds of nitrogen and oxygen, many of which contribute to the formation of ozone and particulate matter. Most NOx emissions are produced by the combustion of fuels. Mobile sources make up about 80 percent of the total statewide NOx emissions. Mobile sources include on-road vehicles and trucks, aircraft, trains, ships, recreational boats, industrial and construction equipment, farm

equipment, off-road recreational vehicles, and other equipment. Stationary sources of NOx include both internal and external combustion processes in industries such as manufacturing, food processing, electric utilities, and petroleum refining. Areawide source, which include residential fuel combustion, waste burning, and fires, contribute only a small portion of the total statewide NOx emissions, but depending on the community, may contribute to a cumulative air pollution impact.

Particulate matter (PM) refers to particles small enough to be breathed into the lungs (under 10 microns in size). It is not a single substance, but a mixture of a number of highly diverse types of particles and liquid droplets. It can be formed directly, primarily as dust from vehicle travel on paved and unpaved roads, agricultural operations, construction and demolition.

Carbon monoxide (CO) is a colorless and odorless gas that is directly emitted as a by-product of combustion. The highest concentrations are generally associated with cold stagnant weather conditions that occur during winter. CO problems tend to be localized.

An Air Toxic Contaminant (air toxic) is defined as an air pollutant that may cause or contribute to an increase in mortality or in serous illness, or which may pose a present or potential hazard to human health. Similar to criteria pollutants, air toxics are emitted from stationary, areawide, and mobile sources. They contribute to elevated regional and localized risks near industrial and commercial facilities and busy roadways. The ten compounds that pose the greatest statewide risk are: acetaldehyde; benzene; 1,3-butadiene; carbon tetrachloride; diesel particulate matter (diesel PM); formaldehyde; hexavalent chromium; methylene chloride; para-dichlorobenzene; and perchloroethylene. The risk from diesel PM is by far the largest, representing about 70 percent of the known statewide cancer risk from outdoor air toxics. The exhaust from diesel-fueled engines is a complex mixture of gases, vapors, and particles, many of which are known human carcinogens. Diesel PM is emitted from both mobile and stationary sources. In California, on-road diesel-fueled vehicles contribute about 26 percent of statewide diesel PM emissions, with an additional 72 percent attributed to other mobile sources such as construction and mining equipment, agricultural equipment, and other equipment. Stationary engines in shipyards, warehouses, heavy equipment repair yards, and oil and gas production operations contribute about two percent of statewide emissions. However, when this number is disaggregated to a sub-regional scale such as neighborhoods, the risk factor can be far greater.

[iii] The level of pollution emitted is a major determinant of the significance of the impact.

[iv] Indicates whether facility activities listed in column 4 are generally subject to local air district permits to operate. This does not include regulated products such as solvents and degreasers that may be used by sources that may not require an operating permit per se, e.g., a gas station or dry cleaner.

[v] Generally speaking, warehousing or distribution centers are not subject to local air district permits. However, depending on the district, motor vehicle fleet rules may apply to trucks or off-road vehicles operated and maintained by the facility operator. Additionally, emergency generators or internal combustion engines operated on the site may require an operating permit.

[vi] Authorized by recent legislation SB700.

[vii] Local air districts do not require permits for woodburning fireplaces inside private homes. However, some local air districts and land use agencies do have rules or ordinances that require new housing developments or home re-sales to install U.S. EPA –certified stoves. Some local air districts also ban residential woodburning during weather inversions that concentrate smoke in residential areas. Likewise, home water heaters are not subject to permits; however, new heaters could be subject to emission limits that are imposed by federal or local agency regulations.

[viii] Technical training schools that conduct activities normally permitted by a local air district could be subject to an air permit.

LAND USE-BASED REFERENCE TOOLS TO EVALUATE NEW PROJECTS FOR POTENTIAL AIR POLLUTION IMPACTS

Land use agencies generally have a variety of tools and approaches at hand, or accessible from local air districts that can be useful in performing an analysis of potential air pollution impacts associated with new projects. These tools and approaches include:

- Base map of the city or county planning area and terrain elevations.
- General Plan designations of land use (existing and proposed).
- Zoning maps.
- Land use maps that identify existing land uses, including the location of facilities that are permitted or otherwise regulated by the local air district. Land use agencies should consult with their local air district for information on regulated facilities.
- Demographic data, e.g., population location and density, distribution of population by income, distribution of population by ethnicity, and distribution of population by age. The use of population data is a normal part of the planning process. However, from an air quality perspective, socioeconomic data is useful to identify potential community health and environmental justice issues.
- Emissions, monitoring, and risk-based maps created by the ARB or local air districts that show air pollution-related health risk by community across the state.
- Location of public facilities that enhance community quality of life, including parks, community centers, and open space.
- Location of industrial and commercial facilities and other land uses that use hazardous materials, or emit air pollutants. These include chemical storage facilities, hazardous waste disposal sites, dry cleaners, large gas dispensing facilities, auto body shops, and metal plating and finishing shops.
- Location of sources or facility types that result in diesel on-road and off-road emissions, e.g., stationary diesel power generators, forklifts, cranes, construction equipment, on-road vehicle idling, and operation of transportation refrigeration units. Distribution centers, marine terminals and ports, rail yards, large industrial facilities, and facilities that handle bulk goods are all examples of complex facilities where these types of emission sources are frequently concentrated.[1] Very large facilities, such as ports, marine terminals, and airports, could be analyzed regardless of proximity to a receptor if they are within the modeling area.
- Location and zoning designations for existing and proposed schools, buildings, or outdoor areas where sensitive individuals may live or play.
- Location and density of existing and proposed residential development.
- Zoning requirements, property setbacks, traffic flow requirements, and idling restrictions for trucks, trains, yard hostlers[2], construction equipment, or school buses.
- Traffic counts (including diesel truck traffic counts), within a community to validate or augment existing regional motor vehicle trip and speed data.

[1] The ARB is currently evaluating the types of facilities that may act as complex point sources and developing methods to identify them.

[2] Yard hostler means a tractor less than 300 horsepower that is used to transfer semi-truck or tractor-trailer containers in and around storage, transfer, or distribution yards or areas and is often equipped with a hydraulic lifting fifth wheel for connection to trailer containers.

ARB AND LOCAL AIR DISTRICT INFORMATION AND TOOLS CONCERNING CUMULATIVE AIR POLLUTION IMPACTS

It is the ARB's policy to support research and data collection activities toward the goal of reducing cumulative air pollution impacts. These efforts include updating and improving the air toxics emissions inventory, performing special air monitoring studies in specific communities, and conducting a more complete assessment of non-cancer health effects associated with air toxics and criteria pollutants.[1] This information is important because it helps us better understand links between air pollution and the health of sensitive individuals -- children, the elderly, and those with pre-existing serious health problems affected by air quality.

ARB is working with CAPCOA and OEHHA to improve air pollutant data and evaluation tools to determine when and where cumulative air pollution impacts may be a problem. The following provides additional information on this effort.

How are emissions assessed?

Detailed information about the sources of air pollution in an area is collected and maintained by local air districts and the ARB in what is called an emission inventory. Emission inventories contain information about the nature of the business, the location, type and amount of air pollution emitted, the air pollution-producing processes, the type of air pollution control equipment, operating hours, and seasonal variations in activity. Local districts collect emission inventory data for most stationary source categories.

Local air districts collect air pollution emission information directly from facilities and businesses that are required to obtain an air pollution operating permit. Local air districts use this information to compile an emission inventory for areas within their jurisdiction. The ARB compiles a statewide emission inventory based on the information collected by the ARB and local air districts. Local air districts provide most of the stationary source emission data, and ARB provides mobile source emissions as well as some areawide emission sources such as consumer products and paints. ARB is also developing map-based tools that will display information on air pollution sources.

Criteria pollutant data have been collected since the early 1970's, and toxic pollutant inventories began to be developed in the mid-1980's.

[1] A criteria pollutant is any air pollutant for which EPA has established a National Ambient Air Quality Standard or for which California has established a State Ambient Air Quality Standard, including: carbon monoxide, lead, nitrogen oxides, ozone, particulates and sulfur oxides. Criteria pollutants are measured in each of California's air basins to determine whether the area meets or does not meet specific federal or state air quality standards. Air toxics or air toxic contaminants are listed pollutants recognized by California or EPA as posing a potential risk to health.

How is the toxic emission inventory developed?

Emissions data for toxic air pollutants is a high priority for communities because of concerns about potential health effects. Most of ARB's air toxics data is collected through the toxic "Hot Spots" program. Local air districts collect emissions data from industrial and commercial facilities. Facilities that exceed health-based thresholds are required to report their air toxics emissions as part of the toxic "Hot Spots" program and update their emissions data every four years. Facilities are required to report their air toxics emissions data if there is an increase that would trigger the reporting threshold of the hotspots program. Air toxics emissions from motor vehicles and consumer products are estimated by the ARB. These estimates are generally regional in nature, reflecting traffic and population.

The ARB also maintains chemical speciation profiles that can be used to estimate toxics emissions when no toxic emissions data is available.

What additional toxic emissions information is needed?

In order to assess cumulative air pollution impacts, updated information from individual facilities is needed. Even for sources where emissions data are available, additional information such as the location of emissions release points is often needed to better model cumulative impacts. In terms of motor vehicles, emissions data are currently based on traffic models that only contain major roads and freeways. Local traffic data are needed so that traffic emissions can be more accurately assigned to specific streets and roads. Local information is also needed for off-road emission sources, such as ships, trains, and construction equipment. In addition, hourly maximum emissions data are needed for assessing acute air pollution impacts.

What work is underway?

ARB is working with CAPCOA to improve toxic emissions data, developing a community health air pollution information system to improve access to emission information, conducting neighborhood assessment studies to better understand toxic emission sources, and conducting surveys of sources of toxic pollutants.

How is air pollution monitored?

While emissions data identify how much air pollution is going into the air, the state's air quality monitoring network measures air pollutant levels in outdoor air. The statewide air monitoring network is primarily designed to measure regional exposure to air pollutants, and consists of more than 250 air monitoring sites.

The air toxics monitoring network consists of approximately 20 permanent sites. These sites are supplemented by special monitoring studies conducted by ARB and local air districts. These sites measure approximately sixty toxic air pollutants. Diesel PM, which is the major driver of urban air toxic risk, is not monitored directly. Ten of the

60 toxic pollutants, not including diesel, account for most of the remaining potential cancer risk in California urban areas.

What additional monitoring has been done?

Recently, additional monitoring has been done to look at air quality at the community level. ARB's community monitoring was conducted in six communities located throughout the state. Most sites were in low-income, minority communities located near major sources of air pollution, such as refineries or freeways. The monitoring took place for a year or more in each community, and included measurements of both criteria and toxic pollutants.

What is being learned from community monitoring?

In some cases, the ARB or local air districts have performed air quality monitoring or modeling studies covering a particular region of the state. When available, these studies can give information about regional air pollution exposures.

The preliminary results of ARB's community monitoring are providing insights into air pollution at the community level. Urban background levels are a major contributor to the overall risk from air toxics in urban areas, and this urban background tends to mask the differences between communities. When localized elevated air pollutant levels were measured, they were usually associated with local ground-level sources of toxic pollutants. The most common source of this type was busy streets and freeways. The impact these ground-level sources had on local air quality decreased rapidly with distance from the source. Pollutant levels usually returned to urban background levels within a few hundred meters of the source.

These results indicate that tools to assess cumulative impacts must be able to account for both localized, near-source impacts, as well as regional background air pollution. The tools that ARB is developing for this purpose are air quality models.

How can air quality modeling be used?

While air monitoring can directly measure cumulative exposure to air pollution, it is limited because all locations cannot be monitored. To address this, air quality modeling provides the capability to estimate exposure when air monitoring is not feasible. Air quality modeling can be refined to assess local exposure, identify locations of potential hot spots, and identify the relative contribution of emission sources to exposure at specific locations. The ARB has used this type of information to develop regional cumulative risk maps that estimate the cumulative cancer air pollution risk for most of California. While these maps only show one air pollution-related health risk, it does provide a useful starting point.

What is needed for community modeling?

Air quality models have been developed to assess near-source impacts, but they have very exacting data requirements. These near-source models estimate the impact of local sources, but do not routinely include the contribution from regional air pollution background. To estimate cumulative air pollution exposure at a neighborhood scale, a modeling approach needs to combine features of both micro-scale and regional models.

In addition, improved methods are needed to assess near-source impacts under light and variable wind conditions, when high local concentrations are more likely to occur. A method for modeling long-term exposure to air pollutants near freeways and other high traffic areas is also needed.

What modeling work has ARB developed?

A key component of ARB's Community Health Program is the Neighborhood Assessment Program (NAP). As described later in this section, the NAP studies are being conducted to better understand pollution impacts at the community level. Through two such studies conducted in Barrio Logan (San Diego) and Wilmington (Los Angeles), ARB is refining community-level modeling methodologies. Regional air toxics modeling is also being performed to better understand regional air pollution background levels.

In a parallel effort, ARB is developing modeling protocols for estimating cumulative emissions, exposure, and risk from air pollution. The protocols will cover modeling approaches and uncertainties, procedures for running the models, the development of statewide risk maps, and methods for estimating health risks. The protocols are subject to an extensive peer review process prior to release.

How are air pollution impacts on community health assessed?

On a statewide basis, ARB's toxic air contaminant program identifies and reduces public exposure to air toxics. The focus of the program has been on reducing potential cancer risk, because monitoring results show potential urban cancer risk levels are too high. ARB has also looked for potential non-cancer risks based on health reference levels provided by OEHHA. On a regional basis, the pollutants measured in ARB's toxic monitoring network are generally below the OEHHA non-cancer reference exposure levels.

As part of its community health program, the ARB is looking at potential cancer and non-cancer risk. This could include chronic or acute health effects. If the assessment work shows elevated exposures on a localized basis, ARB will work with OEHHA to assess the health impacts.

What tools has ARB developed to assess cumulative air pollution impacts?

ARB has developed the following tools and reports to assist land use agencies and local air districts assess and reduce cumulative emissions, exposure, and risk on a neighborhood scale.

Statewide Risk Maps

ARB has produced regional risk maps that show the statewide trends for Southern and Central California in estimated potential cancer risk from air toxics between 1990 and 2010.[2] These maps will supplement U.S. EPA's ASPEN model and are available on the ARB's Internet site. These maps are best used to obtain an estimate of the regional background air pollution health risk and are not detailed enough to estimate the exact risk at a specific location.

ARB also has maps that focus in more detail on smaller areas that fall within the Southern and Central California regions for these same modeled years. The finest visual resolution available in the maps on this web site is two by two kilometers. These maps are not detailed enough to assess individual neighborhoods or facilities.

Community Health Air Pollution Information System (CHAPIS)

CHAPIS is an Internet-based procedure for displaying information on emissions from sources of air pollution in an easy to use mapping format. CHAPIS uses Geographical Information System (GIS) software to deliver interactive maps over the Internet. CHAPIS relies on emission estimates reported to the ARB's emission inventory database - California Emissions Inventory Development and Reporting System, or CEIDARS.

Through CHAPIS, air district staff can quickly and easily identify pollutant sources and emissions within a specified area. CHAPIS contains information on air pollution emissions from selected large facilities and small businesses that emit criteria and toxic air pollutants. It also contains information on air pollution emissions from motor vehicle and areawide emissions. CHAPIS does not contain information on every source of air pollution or every air pollutant. It is a major long-term objective of CHAPIS to include all of the largest air pollution sources and those with the highest documented air pollution risk. CHAPIS will be updated on a periodic basis and additional facilities will be added to CHAPIS as more data becomes available.

CHAPIS is being developed in stages to assure data quality. The initial release of CHAPIS will include facilities emitting 10 or more tons per year of nitrogen oxides, sulfur dioxide, carbon monoxide, PM10, or reactive organic gases; air toxics from refineries and power plants of 50 megawatts or more; and facilities that conducted health risk

[2]ARB maintains state trends and local potential cancer risk maps that show statewide trends in potential inhalable cancer risk from air toxics between 1990 and 2010. This information can be viewed at ARB's web site at http://www.arb.ca.gov/toxics/cti/hlthrisk/hlthrisk.htm)

assessments under the California Air Toxics "Hot Spots" Information and Assessment Program.[3]

CHAPIS can be used to identify the emission contributions from mobile, area, and point sources on that community.

"Hot Spots" Analysis and Reporting Program (HARP)

HARP[4] is a software package available from the ARB and is designed with air quality professionals in mind. It models emissions and release data from one or more facilities to estimate the potential health risk posed by the selected facilities on the neighboring community. HARP uses the latest risk assessment guidelines published by OEHHA.

With HARP, a user can perform the following tasks:

- Create and manage facility databases;
- Perform air dispersion modeling;
- Conduct health risk analyses;
- Output data reports; and
- Output results to GIS mapping software.

HARP can model downwind concentrations of air toxics based on the calculated emissions dispersion at a single facility. HARP also has the capability of assessing the risk from multiple facilities, and for multiple locations of concern near those facilities. While HARP has the capability to assess multiple source impacts, there had been limited application of the multiple facility assessment function in the field at the time of HARP's debut in 2003. HARP can also evaluate multi-pathway, non-inhalation health risk resulting from air pollution exposure, including skin and soil exposure, and ingestion of meat and vegetables contaminated with air toxics, and other toxics that have accumulated in a mother's breast milk.

Neighborhood Assessment Program (NAP)

The NAP[5] has been a key component of ARB's Community Health Program. It includes the development of tools that can be used to perform assessments of cumulative air pollution impacts on a neighborhood scale. The NAP studies have been done to better understand how air pollution affects individuals at the neighborhood level. Thus far, ARB has conducted neighborhood scale assessments in Barrio Logan and Wilmington.

As part of these studies, ARB is collecting data and developing a modeling protocol that can be used to conduct cumulative air pollution impact assessments. Initially these

[3] California Health & Safety Code section 44300, et seq.
[4] More detailed information can be found on ARB's website at: http://www.arb.ca.gov/toxics/harp/harp.htm
[5] For more information on the Program, please refer to: http://www.arb.ca.gov/ch/programs/nap/nap.htm

assessments will focus on cumulative inhalation cancer health risk and chronic non-cancer impacts. The major challenge is developing modeling methods that can combine both regional and localized air pollution impacts, and identifying the critical data necessary to support these models. The objective is to develop methods and tools from these studies that can ultimately be applied to other areas of the state. In addition, the ARB plans to use these methods to replace the ASPEN regional risk maps currently posted on the ARB Internet site.

Urban Emissions Model (URBEMIS)

URBEMIS[6] is a computer program that can be used to estimate emissions associated with land development projects in California such as residential neighborhoods, shopping centers, office buildings, and construction projects. URBEMIS uses emission factors available from the ARB to estimate vehicle emissions associated with new land uses. URBEMIS estimates sulfur dioxide emissions from motor vehicles in addition to reactive organic gases, nitrogen oxides, carbon monoxide, and PM10.

Land-Use Air Quality Linkage Report[7]

This report summarizes data currently available on the relationships between land use, transportation and air quality. It also highlights strategies that can help to reduce the use of the private automobile. It also briefly summarizes two ARB-funded research projects. The first project analyzes the travel patterns of residents living in five higher density, mixed use neighborhoods in California, and compares them to travel in more auto-oriented areas. The second study correlates the relationship between travel behavior and community characteristics, such as density, mixed land uses, transit service, and accessibility for pedestrians.

[6] For more information on this model, please refer to ARB's website at http://www.arb.ca.gov/html/soft.htm.

[7] To access this report, please refer to ARB's website or click on: http://www.arb.ca.gov/ch/programs/link97.pdf

LAND USE AND AIR QUALITY AGENCY ROLES IN THE LAND USE PROCESS

A wide variety of federal, state, and local government agencies are responsible for regulatory, planning, and siting decisions that can have an impact on air pollution. They include local land use agencies, regional councils of government, school districts, local air districts, ARB, the California Department of Transportation (Caltrans), and the Governor's Office of Planning and Research (OPR) to name a few. This Section will focus on the roles and responsibilities of local and state agencies. The role of school districts will be discussed in Appendix E.

Local Land Use Agencies

Under the State Constitution, land use agencies have the primary authority to plan and control land use.[1] Each of California's incorporated cities and counties are required to adopt a comprehensive, long-term General Plan.[2]

The General Plan's long-term goals are implemented through zoning ordinances. These are local laws adopted by counties and cities that describe for specific areas the kinds of development that will be allowed within their boundaries.

Land use agencies are also the lead for doing environmental assessments under CEQA for new projects that may pose a significant environmental impact, or for new or revised General Plans.

Local Agency Formation Commissions (LAFCOs)

Operating in each of California's 58 counties, LAFCOs are composed of local elected officials and public members who are responsible for coordinating changes in local governmental boundaries, conducting special studies that review ways to reorganize, simplify, and streamline governmental structures, and preparing a sphere of influence for each city and special district within each county. Each Commission's efforts are directed toward seeing that local government services are provided efficiently and economically while agricultural and open-space lands are protected. LAFCO decisions strive to balance the competing needs in California for efficient services, affordable housing, economic opportunity, and conservation of natural resources.

[1] The legal basis for planning and land use regulation is the "police power" of the city or county to protect the public's health, safety and welfare. The California Constitution gives cities and counties the power to make and enforce all local police, sanitary and other ordinances and regulations not in conflict with general laws. State law reference: California Constitution, Article XI §7.

[2] OPR General Plan Guidelines, 2003: http://www.opr.ca.gov/planning/PDFs/General_Plan_Guidelines_2003.pdf

Councils of Government (COG)

COGs are organizations composed of local counties and cities that serve as a focus for the development of sound regional planning, including plans for transportation, growth management, hazardous waste management, and air quality. They can also function as the metropolitan planning organization for coordinating the region's transportation programs. COGs also prepare regional housing need allocations for updates of General Plan housing elements.

Local Air Districts

Under state law, air pollution control districts or air quality management districts (local air districts) are the local government agencies responsible for improving air quality and are generally the first point of contact for resolving local air pollution issues or complaints. There are 35 local air districts in California[3] that have authority and primary responsibility for regional clean air planning. Local air districts regulate stationary sources of air pollutants within their jurisdiction including but not limited to industrial and commercial facilities, power plants, construction activities, outdoor burning, and other non-mobile sources of air pollution. Some local air districts also regulate public and private motor vehicle fleet operators such as public bus systems, private shuttle and taxi services, and commercial truck depots.

- **Regional Clean Air Plans**

Local air districts are responsible for the development and adoption of clean air plans that protect the public from the harmful effects of air pollution. These plans incorporate strategies that are necessary to attain ambient air quality standards. Also included in these regional air plans are ARB and local district measures to reduce statewide emissions from mobile sources, consumer products, and industrial sources.

- **Facility-Specific Considerations**

Permitting. In addition to the planning function, local air districts adopt and enforce regulations, issue permits, and evaluate the potential environmental impacts of projects.

Pollution is regulated through permits and technology-based rules that limit emissions from operating units within a facility or set standards that vehicle fleet operators must meet. Permits to construct and permits to operate contain very specific requirements and conditions that tell each regulated source what it must do to limit its air pollution in compliance with local air district rules, regulations, and state law. Prior to receiving a permit, new facilities must go through a New Source Review (NSR) process that establishes air pollution control requirements for the facility. Permit conditions are typically contained in the permit to operate and specify requirements that businesses must follow; these may include limits on the amount of pollution that can be emitted, the

[3] Contact information for local air districts in California is listed in the front of this Handbook.

type of pollution control equipment that must be installed and maintained, and various record-keeping requirements.

Local air districts also notify the public about new permit applications for major new facilities, or major modifications to existing facilities that seek to locate within 1,000 feet of a school.

Local air districts can also regulate other types of sources to reduce emissions. These include regulations to reduce emissions from the following sources:

- hazardous materials in products used by industry such as paints, solvents, and de-greasers;
- agricultural and residential burning;
- leaking gasoline nozzles at service stations;
- public fleet vehicles such as sanitation trucks and school buses; and
- fugitive or uncontrolled dust at construction sites.

However, while emissions from industrial and commercial sources are typically subject to the permit authority of the local air district, sensitive sites such as a day care center, convalescent home, or playground are not ordinarily subject to an air permit. Local air district permits address the air pollutant emissions of a project but not its location.

Under the state's air toxics program, local air districts regulate air toxic emissions by adopting ARB air toxic control measures, or more stringent district-specific requirements, and by requiring individual facilities to perform a health risk assessment if emissions at the source exceed district-specific health risk thresholds[4], [5] (See the section on ARB programs for a more detailed summary of this program).

One approach by which local air districts regulate air toxics emissions is through the "Hot Spots" program.[6] The risk assessments submitted by the facilities under this

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[4] Cal/EPA's Office of Environmental Health Hazard Assessment has published "A Guide to Health Risk Assessment" for lay people involved in environmental health issues, including policymakers, businesspeople, members of community groups, and others with an interest in the potential health effects of toxic chemicals. To access this information, please refer to http://www.oehha.ca.gov/pdf/HRSguide2001.pdf

[5] Section 44306 of the California Health & Safety Code defines a health risk assessment as a detailed comprehensive analysis that a polluting facility uses to evaluate and predict the dispersion of hazardous substances in the environment and the potential for exposure of human populations, and to assess and quantify both the individual and population-wide health risks associated with those levels of exposure.

[6] AB-2588 (the Air Toxics "Hot Spots" Information and Assessment Act) requires local air districts to prioritize facilities by high, intermediate, and low priority categories to determine which must perform a health risk assessment. Each district is responsible for establishing the prioritization score threshold at which facilities are required to prepare a health risk assessment. In establishing priorities for each facility, local air districts must consider the potency, toxicity, quantity, and volume of hazardous materials released from the facility, the proximity of the facility to potential receptors, and any other factors that the district determines may indicate that the facility may pose a significant risk. All facilities within the highest category must prepare a health risk assessment. In addition, each district may require facilities in the intermediate and low priority categories to also submit a health risk assessment.

Table D-1
Local Sources of Air Pollution, Responsible Agencies, and Associated Regulatory Programs

Source	Examples	Primary Agency	Applicable Regulations
Large Stationary	Refineries, power plants, chemical facilities, certain manufacturing plants	Local air districts	Operating permit rules Air Toxics "Hot Spots" Law (AB 2588) Local district rules Air Toxic Control Measures (ATCMs)* New Source Review rules Title V permit rules
Small Stationary	Dry cleaners, auto body shops, welders, chrome plating facilities, service stations, certain manufacturing plants	Local air districts	Operating permit conditions, Air Toxics "Hot Spots" Law (AB 2588) Local district rules ATCMs* New Source Review rules
Mobile (non-fleet)	Cars, trucks, buses	ARB	Emission standards Cleaner-burning fuels (e.g., unleaded gasoline, low-sulfur diesel) Inspection and repair programs (e.g., Smog Check)
Mobile Equipment	Construction equipment	ARB, U.S. EPA	ARB rules U.S. EPA rules
Mobile (fleet)	Truck depots, school buses, taxi services	Local air districts, ARB	Local air district rules ARB urban bus fleet rule
Areawide	Paints and consumer products such as hair spray and spray paint	Local air district, ARB	ARB rules Local air district rules

*ARB adopts ATCMs, but local air districts have the responsibility to implement and enforce these measures or more stringent ones.

program are reviewed by OEHHA and approved by the local air district. Risk assessments are available by contacting the local air district.

Enforcement. Local air districts also take enforcement action to ensure compliance with air quality requirements. They enforce air toxic control measures, agricultural and residential burning programs, gasoline vapor control regulations, laws that prohibit air pollution nuisances, visible emission limits, and many other requirements designed to

clean the air. Local districts use a variety of enforcement tools to ensure compliance. These include notices of violation, monetary penalties, and abatement orders. Under some circumstances, a permit may be revoked.

- **Environmental Review**

As required by the California Environmental Quality Act (CEQA), local air districts also review and comment on proposed land use plans and development projects that can have a significant effect on the environment or public health.[7]

California Air Resources Board

The ARB is the air pollution control agency at the state level that is responsible for the preparation of air plans required by state and federal law. In this regard, it coordinates the activities of all local air districts to ensure all statutory requirements are met and to reduce air pollution emissions for sources under its jurisdiction.

Motor vehicles are the single largest emissions source category under ARB's jurisdiction as well as the largest overall emissions source statewide. ARB also regulates emissions from other mobile equipment and engines as well as emissions from consumer products such as hair sprays, perfumes, cleaners, and aerosol paints.

Air Toxics Program

Under state law, the ARB has a critical role to play in the identification, prioritization, and control of air toxic emissions. The ARB statewide comprehensive air toxics program was established in the early 1980's. The Toxic Air Contaminant Identification and Control Act of 1983 (AB 1807, Tanner 1983) created California's program to reduce exposure to air toxics.[8] The Air Toxics "Hot Spots" Information and Assessment Act (Hot Spots program) supplements the AB 1807 program, by requiring a statewide air toxics inventory, notification of people exposed to a significant health risk, and facility plans to reduce these risks.

Under AB 1807, the ARB is required to use certain criteria to prioritize the identification and control of air toxics. In selecting substances for review, the ARB must consider criteria relating to emissions, exposure, and health risk, as well as persistence in the atmosphere, and ambient concentrations in the community. AB 1807 also requires the ARB to use available information gathered from the Hot Spots program when prioritizing compounds.

The ARB identifies pollutants as toxic air contaminants and adopts statewide air toxic control measures (ATCMs). Once ARB adopts an ATCM, local air districts must

[7] Section 4 of this Handbook contains more information on the CEQA process.
[8] For a general background on California's air toxics program, the reader should refer to ARB's website at http://www.arb.ca.gov/toxics/tac/appendxb.htm.

implement the measure, or adopt and implement district-specific measures that are at least as stringent as the state standard. Taken in the aggregate, these ARB programs will continue to further reduce emissions, exposure, and health risk statewide.

With regard to the land use decision-making process, ARB, in conjunction with local air districts, plays an advisory role by providing technical information on land use-related air issues.

Other Agencies

Governor's Office of Planning and Research (OPR)

In addition to serving as the Governor's advisor on land use planning, research, and liaison with local government, OPR develops and implements the state's policy on land use planning and coordinates the state's environmental justice programs. OPR updated its General Plan Guidelines in 2003 to highlight the importance of sustainable development and environmental justice policies in the planning process. OPR also advises project proponents and government agencies on CEQA provisions and operates the State Clearinghouse for environmental and federal grant documents.

California Department of Housing and Community Development

The Department of Housing and Community Development (HCD) administers a variety of state laws, programs and policies to preserve and expand housing opportunities, including the development of affordable housing. All local jurisdictions must update their housing elements according to a staggered statutory schedule, and are subject to certification by HCD. In their housing elements, cities and counties are required to include a land inventory which identifies and zones sites for future residential development to accommodate a mix of housing types, and to remove barriers to the development of housing.

An objective of state housing element law is to increase the overall supply and affordability of housing. Other fundamental goals include conserving existing affordable housing, improving the condition of the existing housing stock, removing regulatory barriers to housing production, expanding equal housing opportunities, and addressing the special housing needs of the state's most vulnerable residents (frail elderly, disabled, large families with children, farmworkers, and the homeless).

Transportation Agencies

Transportation agencies can also influence mobile source-related emissions in the land use decision-making process. Local transportation agencies work with land use agencies to develop a transportation (circulation) element for the General Plan. These local government agencies then work with other transportation-related agencies, such as the Congestion Management Agency (CMA), Metropolitan Planning Organization

(MPO), Regional Transportation Planning Agency (RTPA), and Caltrans to develop long and short range transportation plans and projects.

Caltrans is the agency responsible for setting state transportation goals and for state transportation planning, design, construction, operations and maintenance activities. Caltrans is also responsible for delivering California's multibillion-dollar state Transportation Improvement Program, a list of transportation projects that are approved for funding by the California Transportation Commission in a 4-year cycle.

When safety hazards or traffic circulation problems are identified in the existing road system, or when land use changes are proposed such as a new residential subdivision, shopping mall or manufacturing center, Caltrans and/or the local transportation agency ensure the projects meet applicable state, regional, and local goals and objectives.

Caltrans also evaluates transportation-related projects for regional air quality impacts, from the perspective of travel-related emissions as well as road congestion and increases in road capacity (new lanes).

California Energy Commission (CEC)

The CEC is the state's CEQA lead agency for permitting large thermal power plants (50 megawatts or greater). The CEC works closely with local air districts and other federal, state and local agencies to ensure compliance with applicable laws, ordinances, regulations and standards in the permitting, construction, operation and closure of such plants. The CEC uses an open and public review process that provides communities with outreach and multiple opportunities to participate and be heard. In addition to its comprehensive environmental impact and engineering design assessment process, the CEC also conducts an environmental justice evaluation. This evaluation involves an initial demographic screening to determine if a qualifying minority or low-income population exists in the vicinity of the proposed project. If such a population is present, staff considers possible environmental justice impacts including from associated project emissions in its technical assessments.[9]

Department of Pesticides Regulation (DPR)

Pesticides are industrial chemicals produced specifically for their toxicity to a target pest. They must be released into the environment to do their job. Therefore, regulation of pesticides focuses on using toxicity and other information to ensure that when pesticides are used according to their label directions, potential for harm to people and the environment is minimized. DPR imposes strict controls on use, beginning before pesticide products can be sold in California, with an extensive scientific program to ensure they can be used safely. DPR and county enforcement staff tracks the use of pesticides to ensure that pesticides are used properly. DPR collects periodic

[9] See California Energy Commission, "Environmental Performance Report," July 2001 at http://www.energy.ca.gov/reports/2001-11-20_700-01-001.PDF

measurements of any remaining amounts of pesticides in water, air, and on fresh produce. If unsafe levels are found, DPR requires changes in how pesticides are used, to reduce the possibility of harm. If this cannot be done - that is, if a pesticide cannot be used safely - use of the pesticide will be banned in California.[10]

Federal Agencies

Federal agencies have permit authority over activities on federal lands and certain resources, which have been the subject of congressional legislation, such as air, water quality, wildlife, and navigable waters. The U.S. Environmental Protection Agency generally oversees implementation of the federal Clean Air Act, and has broad authority for regulating certain activities such as mobile sources, air toxics sources, the disposal of toxic wastes, and the use of pesticides. The responsibility for implementing some federal regulatory programs such as those for air and water quality and toxics is delegated by management to specific state and local agencies. Although federal agencies are not subject to CEQA they must follow their own environmental process established under the National Environmental Policy Act (NEPA).

[10] For more information, the reader is encouraged to visit the Department of Pesticide Regulation web site at www.cdpr.ca.gov/docs/empm/pubs/tacmenu.htm.

SPECIAL PROCESSES THAT APPLY TO SCHOOL SITING

The California Education Code and the California Public Resources Code place primary authority for siting public schools with the local school district, which is the 'lead agency' for purposes of CEQA. The California Education Code requires public school districts to notify the local planning agency about siting a new public school or expanding an existing school. The planning agency then reports back to the school district regarding a project's conformity with the adopted General Plan. However, school districts can overrule local zoning and land use designations for schools if they follow specified procedures. In addition, all school districts must evaluate new school sites using site selection standards established in Section 14010 of Title 5 of the California Code of Regulations. Districts seeking state funding for school site acquisition must also obtain site approval from the California Department of Education.

Before making a final decision on a school site acquisition, a school district must comply with CEQA and evaluate the proposed site acquisition/new school project for air emissions and health risks by preparing and certifying an environmental impact report or negative declaration. Both the California Education Code section 17213 and the California Public Resources Code section 21151.8 require school districts to consult with administering agencies and local air districts when preparing the environmental assessment. Such consultation is required to identify both permitted and non-permitted "facilities" that might significantly affect health at the new site. These facilities include, but are not limited to, freeways and other busy traffic corridors, large agricultural operations, and rail yards that are within one-quarter mile of the proposed school site, and that might emit hazardous air emissions, or handle hazardous or acutely hazardous materials, substances, or waste.

As part of the CEQA process and before approving a school site, the school district must make a finding that either it found none of the facilities or significant air pollution sources, or alternatively, if the school district finds that there are such facilities or sources, it must determine either that they pose no significant health risks, or that corrective actions by another governmental entity would be taken so that there would be no actual or potential endangerment to students or school workers.

In addition, if the proposed school site boundary is within 500 feet of the edge of the closest traffic lane of a freeway or traffic corridor that has specified minimum average daily traffic counts, the school district is required to determine through specified risk assessment and air dispersion modeling that neither short-term nor long term exposure poses significant heath risks to pupils.

State law changes effective January 1, 2004 (SB352, Escutia 2003, amending Education Code section 17213 and Public Resources Code section 21151.8) also provides for cases in which the school district cannot make either of those two findings and cannot find a suitable alternative site. When this occurs, the school district must adopt a statement of over-riding considerations, as part of an environmental impact

report, that the project should be approved based on the ultimate balancing of the merits.

Some school districts use a standardized assessment process to determine the environmental impacts of a proposed school site. In the assessment process, school districts can use maps and other available information to evaluate risk, including a local air district's database of permitted source emissions. School districts can also perform field surveys and record searches to identify and calculate emissions from non-permitted sources within one-quarter mile radius of a proposed site. Traffic count data and vehicular emissions data can also be obtained from Caltrans for major roadways and freeways in proximity to the proposed site to model potential emissions impacts to students and school employees. This information is available from the local COG, Caltrans, or local cities and counties for non-state maintained roads.

GENERAL PROCESSES USED BY LAND USE AGENCIES TO ADDRESS AIR POLLUTION IMPACTS

There are several separate but related processes for addressing the air pollution impacts of land use projects. One takes place as part of the planning and zoning function. This consists of preparing and implementing goals and policies contained in county or city General Plans, community or area plans, and specific plans governing land uses such as residential, educational, commercial, industrial, and recreational activities. It also includes recommending locations for thoroughfares, parks and other public improvements.

Land use agencies also have a permitting function that includes performing environmental reviews and mitigation when projects may pose a significant environmental impact. They conduct inspections for zoning permits issued, enforce the zoning regulations and issue violations as necessary, issue zoning certificates of compliance, and check compliance when approving certificates of occupancy.

Planning

- **General Plan**[1]

The General Plan is a local government "blueprint" of existing and future anticipated land uses for long-term future development. It is composed of the goals, policies, and general elements upon which land use decisions are based. Because the General Plan is the foundation for all local planning and development, it is an important tool for implementing policies and programs beneficial to air quality. Local governments may choose to adopt a separate air quality element into their General Plan or to integrate air quality-beneficial objectives, policies, and strategies in other elements of the Plan, such as the land use, circulation, conservation, and community design elements.

More information on General Plan elements is contained in Appendix D.

- **Community Plans**

Community or area plans are terms for plans that focus on a particular region or community within the overall general plan area. It refines the policies of the general plan as they apply to a smaller geographic area and is implemented by ordinances and other discretionary actions, such as zoning.

[1] In October 2003, OPR revised its General Plan Guidelines. An entire chapter is now devoted to a discussion of how sustainable development and environmental justice goals can be incorporated into the land use planning process. For further information, the reader is encouraged to obtain a copy of OPR's General Plan Guidelines, or refer to their website at: http://www.opr.ca.gov/planning/PDFs/General_Plan_Guidelines_2003.pdf

- **Specific Plan**

A specific plan is a hybrid that can combine policies with development regulations or zoning requirements. It is often used to address the development requirements for a single project such as urban infill or a planned community. As a result, its emphasis is on concrete standards and development criteria.

- **Zoning**

Zoning is the public regulation of the use of land. It involves the adoption of ordinances that divide a community into various districts or zones. For instance, zoning ordinances designate what projects and activities can be sited in particular locations. Each zone designates allowable uses of land within that zone, such as residential, commercial, or industrial. Zoning ordinances can address building development standards, e.g., minimum lot size, maximum building height, minimum building setback, parking, signage, density, and other allowable uses.

Land Use Permitting

In addition to the planning and zoning function, land use agencies issue building and business permits, and evaluate the potential environmental impacts of projects. To be approved, projects must be located in a designated zone and comply with applicable ordinances and zoning requirements.

Even if a project is sited properly in a designated zone, a land use agency may require a new source to mitigate potential localized environmental impacts to the surrounding community below what would be required by the local air district. In this case, the land use agency could condition the permit by limiting or prescribing allowable uses including operating hour restrictions, building standards and codes, property setbacks between the business property and the street or other structures, vehicle idling restrictions, or traffic diversion.

Land use agencies also evaluate the environmental impacts of proposed land use projects or activities. If a project or activity falls under CEQA, the land use agency requires an environmental review before issuing a permit to determine if there is the potential for a significant impact, and if so, to mitigate the impact or possibly deny the project.

- **Land Use Permitting Process**

In California, the authority to regulate land use is delegated to city and county governments. The local land use planning agency is the local government administrative body that typically provides information and coordinates the review of development project applications. Conditional Use Permits (CUP) typically fall within a land use agency's discretionary authority and therefore are subject to CEQA. CUPs are

intended to provide an opportunity to review the location, design, and manner of development of land uses prior to project approval. A traditional purpose of the CUP is to enable a municipality to control certain uses that could have detrimental environmental effects on the community.

The process for permitting new discretionary projects is quite elaborate, but can be broken down into five fundamental components:

- Project application
- Environmental assessment
- Consultation
- Public comment
- Public hearing and decision

Project Application

The permit process begins when the land use agency receives a project application, with a detailed project description, and support documentation. During this phase, the agency reviews the submitted application for completeness. When the agency deems the application to be complete, the permit process moves into the environmental review phase.

Environmental Assessment

If the project is discretionary and the application is accepted as complete, the project proposal or activity must undergo an environmental clearance process under CEQA and the CEQA Guidelines adopted by the California Resources Agency.[2] The purpose of the CEQA process is to inform decision-makers and the public of the potential significant environmental impacts of a project or activity, to identify measures to minimize or eliminate those impacts to the point they are no longer significant, and to discuss alternatives that will accomplish the project goals and objectives in a less environmentally harmful manner.

What is a "Lead Agency"?

A lead agency is the public agency that has the principal responsibility for carrying out or approving a project that is subject to CEQA. In general, the land use agency is the preferred public agency serving as lead agency because it has jurisdiction over general land uses. The lead agency is responsible for determining the appropriate environmental document, as well as its preparation.

What is a "Responsible Agency"?

A responsible agency is a public agency with discretionary approval authority over a portion of a CEQA project (e.g., projects requiring a permit). As a responsible agency, the agency is available to the lead agency and project proponent for early consultation on a project to apprise them of applicable rules and regulations, potential adverse impacts, alternatives, and mitigation measures, and provide guidance as needed on applicable methodologies or other related issues.

What is a "Commenting Agency"?

A commenting agency is any public agency that comments on a CEQA document, but is neither a lead agency nor a responsible agency. For example, a local air district, as the agency with the responsibility for comprehensive air pollution control, could review and comment on an air quality analysis in a CEQA document for a proposed distribution center, even though the project was not subject to a permit or other pollution control requirements.

[2] Projects and activities that may have a significant adverse impact on the environment are evaluated under CEQA Guidelines set forth in title 14 of the California Code of Regulations, sections 15000 et seq.

To assist the lead agency in determining whether the project or activity may have a significant effect that would require the preparation of an EIR, the land use agency may consider criteria, or thresholds of significance, to assess the potential impacts of the project, including its air quality impacts. The land use agency must consider any credible evidence in addition to the thresholds, however, in determining whether the project or activity may have a significant effect that would trigger the preparation of an EIR.

The screening criteria to determine significance is based on a variety of factors, including local, state, and federal regulations, administrative practices of other public agencies, and commonly accepted professional standards. However, the final determination of significance for individual projects is the responsibility of the lead agency. In the case of land use projects, the lead agency would be the City Council or County Board of Supervisors.

A new land use plan or project can also trigger an environmental assessment under CEQA if, among other things, it will expose sensitive sites such as schools, day care centers, hospitals, retirement homes, convalescence facilities, and residences to substantial pollutant concentrations.[3]

CEQA only applies to "discretionary projects." Discretionary means the public agency must exercise judgment and deliberation when deciding to approve or disapprove a particular project or activity, and may append specific conditions to its approval. Examples of discretionary projects include the issuance of a CUP, re-zoning a property, or widening of a public road. Projects that are not subject to the exercise of agency discretion, and can therefore be approved administratively through the application of set standards are referred to as ministerial projects. CEQA does not apply to ministerial projects.[4] Examples of typical ministerial projects include the issuance of most building permits or a business license.

Once a potential environmental impact associated with a project is identified through an environmental assessment, mitigation must be considered. A land use agency should incorporate mitigation measures that are suggested by the local air district as part of the project review process.

Consultation

Application materials are provided to various departments and agencies that may have an interest in the project (e.g., air pollution, building, police, fire, water agency, Fish and Game, etc.) for consultation and input.

[3] Readers interested in learning more about CEQA should contact OPR or visit their website at http://www.opr.ca.gov/.

[4] See California Public Resources Code section 21080(b)(1).

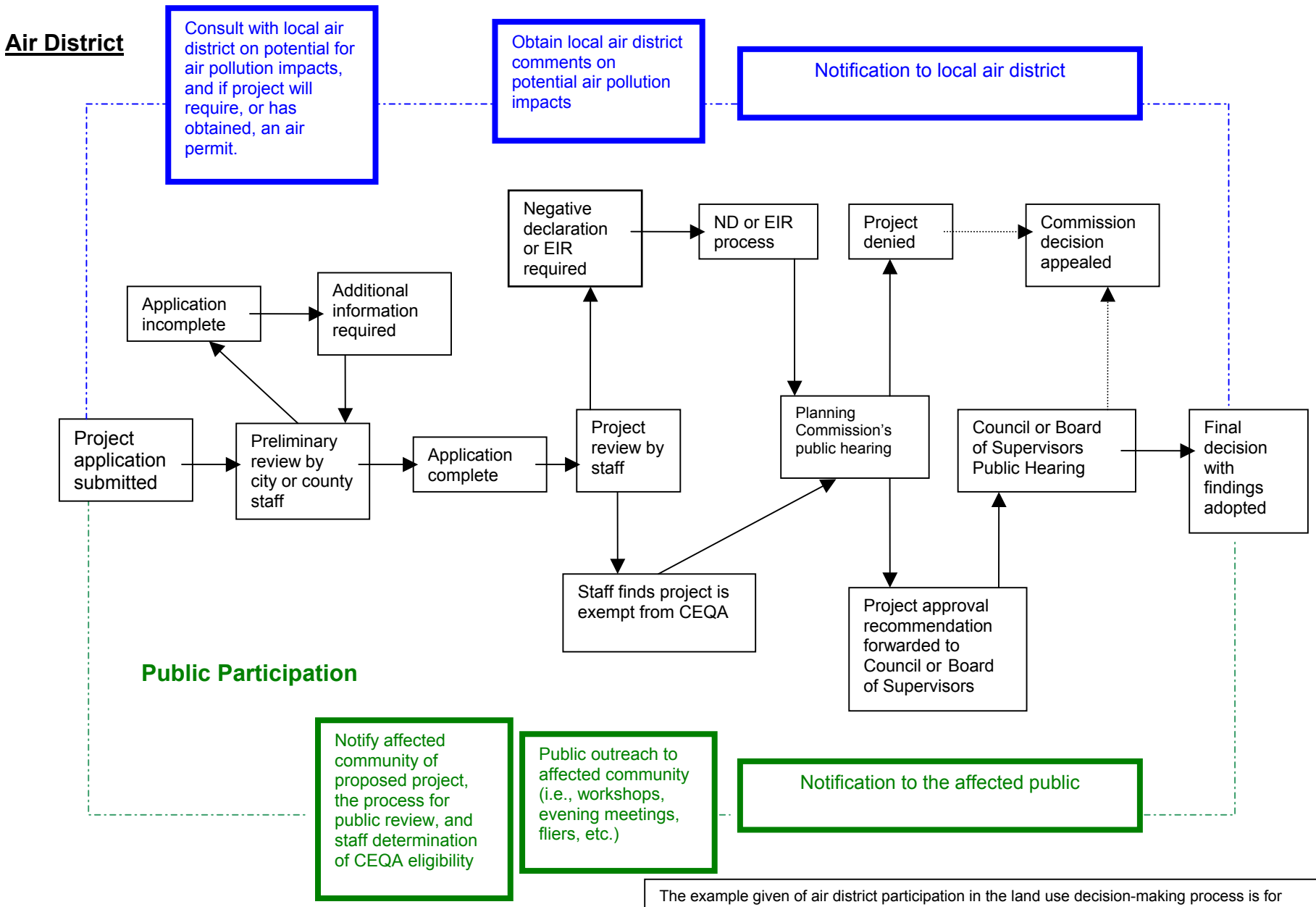
Public Comment

Following the environmental review process, the Planning Commission reviews application along with the staff's report on the project assessment and a public comment period is set and input is solicited.

Public Hearing and Decision

Permit rules vary depending on the particular permit authority in question, but the process generally involves comparing the proposed project with the land use agency standards or policies. The procedure usually leads to a public hearing, which is followed by a written decision by the agency or its designated officer. Typically, a project is approved, denied, or approved subject to specified conditions.

USE PERMIT (DISCRETIONARY ACTION) REVIEW PROCESS*



The example given of air district participation in the land use decision-making process is for illustrative purposes only. In reality, the land use siting process involves the ongoing participation of multiple affected agencies and stakeholders throughout the process.

GLOSSARY OF KEY AIR POLLUTION TERMS

Air Pollution Control Board or Air Quality Management Board: Serves as the governing board for local air districts. It consists of appointed or elected members from the public or private sector. It conducts public hearings to adopt local air pollution regulations.

Air Pollution Control Districts or Air Quality Management Districts (local air district): A county or regional agency with authority to regulate stationary and area sources of air pollution within a given county or region. Governed by a district air pollution control board.

Air Pollution Control Officer (APCO): Head of a local air pollution control or air quality management district.

Air Toxic Control Measures (ATCM): A control measure adopted by the ARB (Health and Safety Code section 39666 et seq.), which reduces emissions of toxic air contaminants.

Ambient Air Quality Standards: An air quality standard defines the maximum amount of a pollutant that can be present in the outdoor air during a specific time period without harming the public's health. Only U.S. EPA and the ARB may establish air quality standards. No other state has this authority. Air quality standards are a measure of clean air. More specifically, an air quality standard establishes the concentration at which a pollutant is known to cause adverse health effects to sensitive groups within the population, such as children and the elderly. Federal standards are referred to as National Ambient Air Quality Standards (NAAQS); state standards are referred to as California ambient air quality standards (CAAQS).

Area-wide Sources: Sources of air pollution that individually emit small amounts of pollution, but together add up to significant quantities of pollution. Examples include consumer products, fireplaces, road dust, and farming operations.

Attainment vs. Nonattainment Area: An attainment area is a geographic area that meets the National Ambient Air Quality Standards for the criteria pollutants and a non-attainment area is a geographic area that doesn't meet the NAAQS for criteria pollutants.

Attainment Plan: Attainment plans lay out measures and strategies to attain one or more air quality standards by a specified date.

California Clean Air Act (CCAA): A California law passed in 1988, which provides the basis for air quality planning and regulation independent of federal regulations. A major element of the Act is the requirement that local air districts in violation of the CAAQS

must prepare attainment plans which identify air quality problems, causes, trends, and actions to be taken to attain and maintain California's air quality standards by the earliest practicable date.

California Environmental Quality Act (CEQA): A California law that sets forth a process for public agencies to make informed decisions on discretionary project approvals. The process helps decision-makers determine whether any potential, significant, adverse environmental impacts are associated with a proposed project and to identify alternatives and mitigation measures that will eliminate or reduce such adverse impacts.[1]

California Health and Safety Code: A compilation of California laws, including state air pollution laws, enacted by the Legislature to protect the health and safety of people in California. Government agencies adopt regulations to implement specific provisions of the California Health and Safety Code.

Clean Air Act (CAA): The federal Clean Air Act was adopted by the United States Congress and sets forth standards, procedures, and requirements to be implemented by the U.S. Environmental Protection Agency (U.S. EPA) to protect air quality in the United States.

Councils of Government (COGs): There are 25 COGs in California made up of city and county elected officials. COGs are regional agencies concerned primarily with transportation planning and housing; they do not directly regulate land use.

Criteria Air Pollutant: An air pollutant for which acceptable levels of exposure can be determined and for which an ambient air quality standard has been set. Examples include ozone, carbon monoxide, nitrogen dioxide, sulfur dioxide, and PM10 and PM2.5. The term "criteria air pollutants" derives from the requirement that the U.S. EPA and ARB must describe the characteristics and potential health and welfare effects of these pollutants. The U.S. EPA and ARB periodically review new scientific data and may propose revisions to the standards as a result.

District Hearing Board: Hears local air district permit appeals and issues variances and abatement orders. The local air district board appoints the members of the hearing board.

Emission Inventory: An estimate of the amount of pollutants emitted into the atmosphere from mobile, stationary, area-wide, and natural source categories over a specific period of time such as a day or a year.

Environmental Impact Report (EIR): The public document used by a governmental agency to analyze the significant environmental effects of a proposed project, to identify

[1] To track the submittal of CEQA documents to the State Clearinghouse within the Office of Planning and Research, the reader can refer to CEQAnet at http://www.ceqanet.ca.gov.

alternatives, and to disclose possible ways to reduce or avoid the possible negative environmental impacts.

Environmental Justice: California law defines environmental justice as the fair treatment of people of people of all races, cultures, and incomes with respect to the development, adoption, implementation, and enforcement of environmental laws, regulations, and policies (California Government Code sec.65040.12(c)).

General Plans: A statement of policies developed by local governments, including text and diagrams setting forth objectives, principles, standards, and plan proposals for the future physical development of the city or county.

Hazardous Air Pollutants (HAPs): An air pollutant listed under section 112 (b) of the federal Clean Air Act as particularly hazardous to health. U.S. EPA identifies emission sources of hazardous air pollutants, and emission standards are set accordingly. In California, HAPs are referred to as toxic air contaminants.

Land Use Agency: Local government agency that performs functions associated with the review, approval, and enforcement of general plans and plan elements, zoning, and land use permitting. For purposes of this Handbook, a land use agency is typically a local planning department.

Mobile Source: Sources of air pollution such as automobiles, motorcycles, trucks, off-road vehicles, boats, and airplanes.

National Ambient Air Quality Standard (NAAQS): A limit on the level of an outdoor air pollutant established by the US EPA pursuant to the Clean Air Act. There are two types of NAAQS. Primary standards set limits to protect public health and secondary standards set limits to protect public welfare.

Negative Declaration (ND): When the lead agency (the agency responsible for preparing the EIR or ND) under CEQA, finds that there is no substantial evidence that a project may have a significant environmental effect, the agency will prepare a "negative declaration" instead of an EIR.

New Source Review (NSR): A federal Clean Air Act requirement that state implementation plans must include a permit review process, which applies to the construction and operation of new or modified stationary sources in nonattainment areas. Two major elements of NSR to reduce emissions are best available control technology requirements and emission offsets.

Office of Planning and Research (OPR): OPR is part of the Governor's office. OPR has a variety of functions related to local land-use planning and environmental programs. It provides General Plan Guidelines for city and county planners, and coordinates the state clearinghouse for Environmental Impact Reports.

Ordinance: A law adopted by a City Council or County Board of Supervisors. Ordinances usually amend, repeal or supplement the municipal code; provide zoning specifications; or appropriate money for specific purposes.

Overriding Considerations: A ruling made by the lead agency in the CEQA process when the lead agency finds the importance of the project to the community outweighs potential adverse environmental impacts.

Public Comment: An opportunity for the general public to comment on regulations and other proposals made by government agencies. You can submit written or oral comments at the public meeting or send your written comments to the agency.

Public Hearing: A public hearing is an opportunity to testify on a proposed action by a governing board at a public meeting. The public and the media are welcome to attend the hearing and listen to, or participate in, the proceedings.

Public Notice: A public notice identifies the person, business, or local government seeking approval of a specific course of action (such as a regulation). It describes the activity for which approval is being sought, and describes the location where the proposed activity or public meeting will take place.

Public Nuisance: A public nuisance, for the purposes of air pollution regulations, is defined as a discharge from any source whatsoever of such quantities of air contaminants or other material which cause injury, detriment, nuisance, or annoyance to any considerable number of persons or to the public, or which endanger the comfort, repose, health, or safety of any such persons or the public, or which cause, or have a natural tendency to cause, injury or damage to business or property. (Health and Safety Code section 41700).

Property Setback: In zoning parlance, a setback is the minimum amount of space required between a lot line and a building line.

Risk: For cancer health effects, risk is expressed as an estimate of the increased chances of getting cancer due to facility emissions over a 70-year lifetime. This increase in risk is expressed as chances in a million (e.g.,10 chances in a million).

Sensitive Individuals: Refers to those segments of the population most susceptible to poor air quality (i.e., children, the elderly, and those with pre-existing serious health problems affected by air quality).

Sensitive Sites or Sensitive Land Uses: Land uses where sensitive individuals are most likely to spend time, including schools and schoolyards, parks and playgrounds, day care centers, nursing homes, hospitals, and residential communities.

Setback: An area of land separating one parcel of land from another that acts to soften or mitigate the effects of one land use on the other.

State Implementation Plan (SIP): A plan prepared by state and local agencies and submitted to U.S. EPA describing how each area will attain and maintain national ambient air quality standards. SIPs include the technical information about emission inventories, air quality monitoring, control measures and strategies, and enforcement mechanisms. A SIP is composed of local air quality management plans and state air quality regulations.

Stationary Sources: Non-mobile sources such as power plants, refineries, and manufacturing facilities.

Toxic Air Contaminant (TAC): An air pollutant, identified in regulation by the ARB, which may cause or contribute to an increase in deaths or in serious illness, or which may pose a present or potential hazard to human health. TACs are considered under a different regulatory process (California Health and Safety Code section 39650 et seq.) than pollutants subject to State Ambient Air Quality Standards. Health effects associated with TACs may occur at extremely low levels. It is often difficult to identify safe levels of exposure, which produce no adverse health effects.

Urban Background: The term is used in this Handbook to represent the ubiquitous, elevated, regional air pollution levels observed in large urban areas in California.

Zoning ordinances: City councils and county boards of supervisors adopts zoning ordinances that set forth land use classifications, divides the county or city into land use zones as delineated on the official zoning, maps, and set enforceable standards for future develop

Risk Reduction Plan to Reduce Particulate Matter Emissions from Diesel-Fueled Engines and Vehicles



California Environmental Protection Agency

Air Resources Board

Stationary Source Division
Mobile Source Control Division

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I. EXECUTIVE SUMMARY

Particulate matter emissions from diesel-fueled vehicles and engines are about 28,000 tons per year in California. These emissions come from a wide variety of sources including over one million on-road and off-road vehicles, about 16,000 stationary engines, and close to 50,000 portable engines. On-road engines account for about 27 percent of the emissions, off-road engines about 66 percent, with the remaining 7 percent from stationary and portable engines. With full implementation of the current vehicle standards on the books and vehicle turnover, diesel particulate matter (diesel PM) will still be about 22,000 tons per year in 2010 and about 19,000 tons per year in 2020.

In 1998, following an exhaustive 10-year scientific assessment process, the Air Resources Board (ARB or Board) identified particulate matter from diesel-fueled engines as a toxic air contaminant (TAC). On a statewide basis, the average potential cancer risk associated with these emissions is over 500 potential cases per million. In the South Coast Air Basin, the potential risk associated with diesel PM emissions is estimated to be 1,000 per million people. Compared to other air toxics the Board has identified and controlled, diesel PM emissions are estimated to be responsible for about 70 percent of the total ambient air toxics risk. In addition to these general risks, diesel PM can also present elevated localized or near-source exposures. Depending on the activity and nearness to receptors, these potential risks can range from small to 1,500 per million or more. As a result of this significant potential risk, when the Board identified diesel PM as a TAC, it directed staff to convene an advisory committee of interested parties to engage in a dialogue on the steps that can be taken to reduce these emissions.

This plan, the Diesel Risk Reduction Plan or Diesel RRP, represents the staff's proposal for a comprehensive plan to significantly reduce diesel PM emissions. The basic premise behind the staff proposal is simple: to require all new diesel-fueled vehicles and engines to use state-of-the-art catalyzed diesel particulate filters (DPFs) and very low-sulfur diesel fuel. Further, all existing vehicles and engines should be evaluated, and wherever technically feasible and cost-effective, retrofitted with DPFs. As with new engines, very low-sulfur diesel fuel should be used by retrofitted vehicles and engines. In short, the staff's proposed plan contains the following three components:

1. New regulatory standards for all new on-road, off-road, and stationary diesel-fueled engines and vehicles to reduce diesel PM emissions by about 90 percent overall from current levels;

2. New retrofit requirements for existing on-road, off-road, and stationary diesel-fueled engines and vehicles where determined to be technically feasible and cost-effective; and

3. New Phase 2 diesel fuel regulations to reduce the sulfur content levels of diesel fuel to no more than 15 ppm to provide the quality of diesel fuel needed by the advanced diesel PM emission controls.

Diesel PM filter control technology is now available and has been demonstrated in over 40,000 applications worldwide. It is staff's vision that well before the end of this decade these filters will become as commonplace on diesel-fueled engines as catalysts are now on gasoline-fueled vehicles.

Upon the Board's approval of this comprehensive plan with its various control measures, staff will begin the full regulatory process to develop the actual regulations envisioned by this plan. During the regulatory development process, the details associated with each specific regulation will be fully developed. Over the next several years, staff will be developing these regulations and bringing them to the Board for consideration of adoption. To assist staff in evaluating retrofit applications and provide technical advice to staff, the Board created an Advisory Committee on Toxic Air Contaminant Emissions from Diesel-Fueled Engines and Vehicles.

While the principal focus of this plan is the reduction in emissions of diesel PM, staff are well aware that there are a number of viable alternative technologies, such as compressed natural gas and electrification that in many cases could be used to accomplish the same results. It is staff's full intent, as it develops the regulations proposed in this plan, to fully explore and engage in dialogue with interested parties concerning opportunities for using these alternatives to reduce diesel PM emissions.

The projected emission benefits associated with the full implementation of this plan, including proposed federal measures, are reductions in diesel PM emissions and associated cancer risks of 75 percent by 2010 and 85 percent by 2020. The measures recommended in this plan will have a great impact on reducing the localized risks associated with activities that expose nearby individuals to diesel PM emissions. Further, there are other benefits associated with reducing diesel PM emissions. These include reduced ambient fine particulate matter levels, increased visibility, less material damage due to soiling of surfaces, and reduced incidences of noncancer health effects, such as bronchitis and asthma. Staff expects that the costs associated with carrying out this plan will be significant and will be on the order of the costs associated with other major ARB programs.

II. BACKGROUND

The public's exposure to TACs is a significant public health issue in California. In 1983, the California Legislature enacted a program to identify the health effects of TACs and to reduce exposure to these contaminants to protect the public health (Assembly Bill (AB) 1807: Health and Safety Code sections 39650-39674). The Legislature established a two-step process to address the potential health effects from TACs. The first step is the risk assessment (or identification) phase. The second step is the risk management (or control) phase of the process.

In August 1998, the ARB identified diesel PM as a TAC, following a 10-year review process. This marked the completion of the identification phase of the process to address the potential for adverse health effects associated with diesel PM emissions.

This Diesel RRP is the first formal product of the risk management phase of the AB 1807 process. This report presents information that identifies the available options to reduce diesel PM, and identifies recommended control measures to achieve further reductions. The recommended control measures would be developed as mobile source regulations or stationary source airborne toxic control measures (ATCMs).

The next step in the AB 1807 process, following approval of this plan by the Board, is the development of the specific ATCMs and fuel or vehicular emissions regulations designed to reduce diesel PM emissions. The goal of each regulation is to reduce diesel PM to the greatest extent feasible. These regulations must be technically feasible and be cost-effective, and they will provide an opportunity to address issues associated with the application of controls on a specific source categories. In developing rules to implement the Diesel RRP, the staff will consider the availability and cost of engine modifications, add-on control technology, changes in fuel parameters, alternative fuels, and alternative methods of performing the function of the diesel engine application. Thus, although most of the Board's regulatory activities are expected to be focused on emission controls that can be added to or built into diesel-fueled engines, staff will also fully integrate alternative "non-diesel" technologies (e.g., electrification and compressed natural gas (CNG)) as possible control options for reducing diesel PM emissions.

ARB staff will develop the ATCMs and regulations with full public involvement and dialogue through public workshops and meetings with groups and individuals. Draft versions of the ATCMs and regulations will be presented to the public for review and comment, and final draft versions will be presented to the Board for approval. Public outreach is an essential element in the development of any ATCM or regulation to ensure that all affected and interested parties have full opportunity to provide input and shape rules that are both effective and workable.

As part of the identification process, the Office of Environmental Health Hazard Assessment (OEHHA) evaluated the potential for diesel exhaust to affect human health. The OEHHA found that exposures to diesel PM resulted in an increased risk of cancer and an increase in chronic noncancer health effects including a greater incidence of

cough, labored breathing, chest tightness, wheezing, and bronchitis. The OEHHA estimated that based upon available studies, the potential cancer risk from exposure to diesel PM in concentrations of one microgram per cubic meter ranged from 130 to 2400 excess cancers per million. The Scientific Review Panel (SRP) approved the OEHHA's determinations concerning health effects and approved the range of risk for particulate matter from diesel-fueled engines. The SRP concluded that a value of 300 excess cancers per million people, per microgram per cubic meter of diesel PM, was appropriate as a point estimate of unit risk for diesel PM.

The OEHHA also concluded that exposure to diesel PM in concentrations exceeding 5 micrograms per cubic meter can result in a number of long-term (chronic) noncancer health effects including greater incidence of cough, phlegm, and bronchitis. The 5 microgram per cubic meter value is referred to as the Chronic Reference Exposure Value (REL) for diesel PM. The SRP supported the OEHHA's conclusion and noted that the REL may need to be lowered further as more data emerge on potential adverse noncancer effects of diesel PM.

As part of its formal identification of diesel PM as a TAC, the Board accepted the OEHHA and SRP's conclusions and directed the ARB staff to begin the risk management process. The staff was directed to develop control measures to reduce both diesel PM and other potentially harmful pollutants. The staff was also directed to form a diesel risk management working group to advise the staff during its risk management efforts. This working group, the Advisory Committee and subcommittees, are discussed in Section B., below.

A. How is this report structured?

This report consists of a main report and appendices that summarize and discuss the proposed Diesel RRP to reduce emissions, exposure, and potential cancer risk associated with particulate matter from diesel-fueled engines.

The main report provides the following information:

- defines the term "diesel-fueled engine" and identifies the categories of diesel-fueled engines and vehicles evaluated in this report;
- summarizes current regulations that address diesel PM emissions from diesel-fueled engines and vehicles;
- presents diesel PM emission inventory estimates, estimated ambient concentrations, and associated potential cancer risk information for the years 1990, 2000, 2010, and 2020;
- presents current near-source diesel PM emissions exposure and potential cancer risk estimates;
- discusses available diesel PM emissions control technology options;
- present's ARB staff's recommendation, based upon the above information, to further control particulate matter emissions from diesel-fueled engines and vehicles;

- estimates the reduction in diesel PM emissions, exposure, and risk by 2010 and 2020 that could be achieved if all recommended measures were implemented; and
- recommends specific measures to be developed to further reduce diesel PM emissions from diesel-fueled engines and vehicles.

Appendix I is a list of terms, definitions and acronyms used in both the main report and appendices. Appendix II is a report on the need for further regulation of stationary and portable diesel-fueled engines. Appendix III is a report on the need for further regulation of mobile on-and off-road diesel-fueled engines (excluding portable equipment, which is addressed in Appendix II). Appendix IV is a report on the need for further regulation of diesel fuel. Appendix V is a summary of existing regulations addressing diesel-fueled engines, vehicles, and diesel fuel. Appendix VI is a discussion of the methodology for estimating the ambient concentrations of diesel PM emissions from diesel-fueled engines and vehicles. Appendix VII is a discussion of the potential risks associated with typical activities where diesel-fueled engines and vehicles are used (risk characterization scenarios). Appendix VIII is Health and Safety Code Section 39665, which identifies the requirements this report must meet. Appendix IX is a discussion of diesel PM control technologies.

B. What does this report contain and how was it developed?

In accordance with California Health and Safety Code Section 39665 (see Appendix VIII), this report includes the following information:

- number (population) and categories of diesel-fueled engines and vehicles;
- consideration of all past and current measures for reducing diesel PM;
- emissions and associated ambient and near-source potential risk levels for diesel PM;
- available technologies for reducing diesel PM;
- initial estimates for the costs of reducing diesel PM;
- alternative methods of emission reductions;
- recommended measures to be developed to reduce emissions and potential risk;
- potential adverse health, safety, or environmental impacts from implementation of the recommended measures; and
- impact of the recommended measures on diesel PM emissions and potential risk.

While the above items are addressed in this plan, staff will further refine and update this information as it develops the various control measures identified in this plan.

To ensure full opportunity for public consultation and input in developing this report, an Advisory Committee was created to serve as a forum for on-going communication, cooperation, and coordination in identifying opportunities to reduce

diesel PM emissions. The Advisory Committee consists of the Stationary Source, Fuels, Mobile Source/Alternative Strategies, and Risk Management subcommittees. The Advisory Committee and each of the four subcommittees include representatives from industry, local districts, environmental organizations, ARB, the United States Environmental Protection Agency (U.S. EPA), and the public.

ARB staff presented a draft of this document to each of the four subcommittees and the Advisory Committee for review and comment. All comments were considered and the draft report was revised in a number of ways to reflect these comments.

III. DIESEL-FUELED ENGINES: DEFINITION AND USES

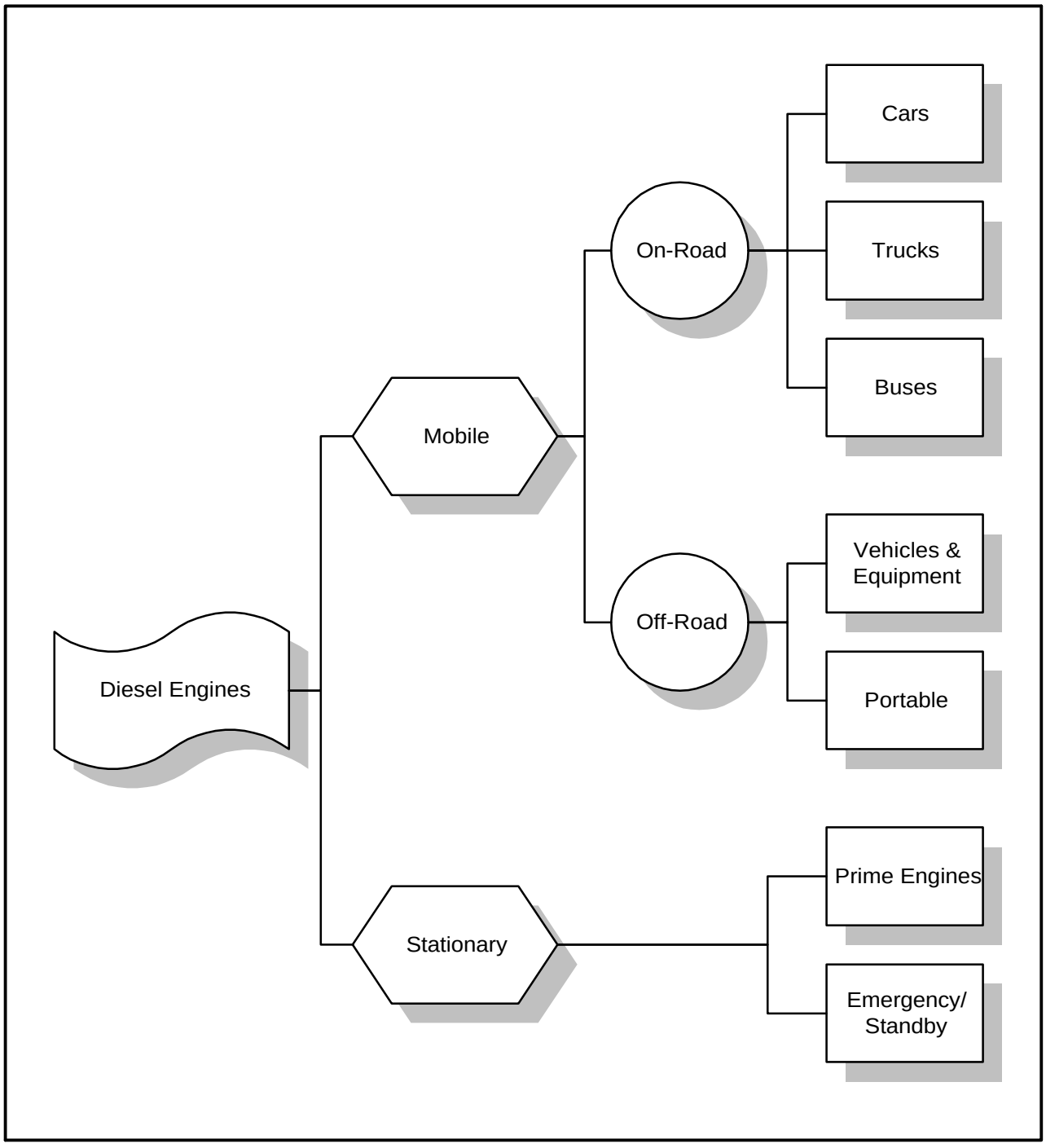
A. How is "diesel-fueled engine" defined?

For purposes of this report, a diesel-fueled engine is defined as any internal combustion, compression-ignition (diesel-cycle) engine. It is generally assumed that the engine will be using diesel fuel. However, diesel-cycle engines using alternative fuels or fuel reformulation (e.g., jet fuel, biodiesel, CNG, and diesel/water mixtures) will also be addressed during the development of each specific ATCM or regulation.

B. What categories of diesel-fueled engines and vehicles were evaluated in this report?

Staff's goal in this plan was to address all diesel-fueled engines in California. Figure 1 identifies the specific categories of diesel-fueled engines and vehicles evaluated in this report. The following paragraphs provide a brief description of each category. Detailed descriptions can be found in Appendix II for Stationary Engines and in Appendix III for Mobile Engines.

Figure 1: Diesel-Fueled Engines and Vehicle Categories



C. What are mobile engines?

Mobile engines can be divided into two categories: on-road vehicles and off-road engines and vehicles.

On-Road Vehicles: Diesel-fueled engines are used in every category of on-road vehicles except motorcycles, and include light to heavy-duty trucks, school buses, urban buses, and passengers vehicles. In California, the majority of on-road diesel-fueled engines are found in the heavy-duty vehicles with a gross vehicle weight rating (GVWR) greater than 14,000 pounds. There are approximately 700,000 on-road diesel-fueled vehicles currently in use in California.

Off-Road Engines and vehicles: Diesel-fueled off-road engines comprise over 100 individual off-road vehicle and equipment types classified into 17 equipment categories. Engine sizes range from under 15 horsepower to over 10,000 horsepower. These equipment categories include agriculture, airport ground support, construction and mining, commercial, industrial, logging, transportation refrigeration units, lawn and garden, commercial marine vessels, pleasure craft, and locomotives. Many of the off-road categories contain equipment types that are classified as portable (equipment of 25 horsepower or greater that is designed and capable of being carried or moved from one location to another). There are approximately 550,000 off-road diesel-fueled engines and vehicles currently in use in California. A more detailed breakdown is presented in Appendix III.

D. What are stationary engines?

Stationary engines can be divided into two categories: emergency/standby engines and prime engines.

Emergency/standby engine: Emergency/standby engines are typically used for emergency back-up electric power generation or the emergency pumping of water. Sizes range from 50 to 6,000 horsepower, depending on the needs of the user. There are over 11,000 diesel-fueled emergency/standby engines in use in California. Emergency/standby engines make up about 70 percent of the total number of stationary engines throughout the State. Several local air pollution control and air quality management districts (districts) have rules that regulate NOx and CO emissions, but not PM from internal combustion engines. However, some districts currently exempt emergency/standby engines from complying with these requirements.

Prime Engines: Prime engines are stationary engines that are not used in an emergency back-up or standby mode. There are approximately 5,000 diesel-fueled prime engines currently in use in California. Examples include diesel-fueled engines that are used to power compressors, cranes, generators, pumps, and grinders. Prime engines make up about 30 percent of the total stationary engine inventory throughout the State.

Of the prime engines operating throughout the State, about 70 percent are agricultural irrigation pump engines.

IV. SUMMARY OF EXISTING AND PROPOSED REGULATIONS

The ARB has the responsibility for control of emissions from mobile sources. The local air districts have the primary responsibility for control of air pollution for all sources, other than emissions for mobile sources. State law, however, provides the South Coast AQMD with the authority to require fleets of 15 or more vehicles to purchase clean vehicles when adding or replacing vehicles, authority which they have recently exercised.

There are certain categories of mobile sources, however, for which ARB lacks direct authority to regulate. The federal Clean Air Act Amendments of 1990 (CAA) preempt state and local authorities from the control of emissions from new farm and construction equipment under 175 horsepower and from new locomotives or locomotive engines (CAA Section 209(e)(1)(A)); only the U.S. EPA has the authority to establish emission standards for those engines. In addition, heavy-duty diesel vehicles that travel in California but are registered in other states are subject only to federal emission certification standards; these vehicles contribute approximately 25 percent of the heavy heavy-duty vehicle-miles-traveled in California.

The CAA also requires California to receive authorization from the U.S. EPA for controls over on-road (CAA Section 209(b)(1)) and the non-preempted off-road sources (CAA section 209(e)(2)(A)). Overall these provisions make the U.S. EPA an important partner in control of emissions from diesel engines.

The following sections briefly describe the existing federal, state, and local programs that currently apply to diesel-fueled engines and vehicles operating in California. A more detailed summary of the statutes and regulations may be found in the tables in Appendix V.

A. What current federal, state, or local regulations address diesel PM emissions from mobile diesel-fueled engines?

Virtually all new diesel-fueled on-road and off-road motor engines and vehicles sold in California are required to meet both federal and state emission certification requirements. Preempted engines, as noted above, must meet only the federal requirements. In most cases, California's motor vehicle and diesel-fueled engine programs are designed to be consistent with the federal programs. To ensure the on-road engines continue to have functional controls and proper maintenance, California has implemented Heavy-Duty Vehicle Inspection and Periodic Smoke Inspection Programs to reduce excessive smoke emissions and tampering with on-road diesel-fueled vehicles over 6,000 pounds gross vehicular weight for both in-state and out-of-state registered heavy-duty diesel vehicles. Non-regulatory strategies, which

include incentives and voluntary agreements with vehicle and engine manufacturers, have also been implemented in California to accelerate reductions in certain criteria pollutants.

B. What current federal, state, or local regulations address diesel PM emissions from stationary and portable diesel-fueled engines?

In California, the local air pollution control and air quality management districts (Districts) establish rules and regulations for controlling emissions from new and existing stationary sources of air contaminants. These rules and regulations address both criteria and toxic air contaminant emissions.

District preconstruction and operating permit programs implement the local, State, and federal air pollution control requirements applicable to new or modified sources of air pollution. Larger new or modified sources located in a nonattainment area must apply the Lowest Achievable Emission Rate control technology to minimize emissions, and they must "offset" the remaining emissions with reductions from other sources when appropriate. A new or modifying source located in an attainment or unclassified area must apply the Best Available Control Technology and meet additional requirements aimed at maintaining the region's clean air. In addition, "major sources" of air pollution must obtain federal Title V operating permits that govern continuing operation.

Many Districts have also adopted, pursuant to the California Health and Safety Code, Reasonably Available Control Technology/Best Available Retrofit Control Technology requirements that apply to existing sources located in nonattainment, attainment, and unclassified areas. These requirements are also implemented through the district's permit program.

Pursuant to State law, the ARB has established the Portable Equipment Registration Program (PERP) which is a voluntary program for the registration and regulation of portable engines and associated equipment. Several Districts have implemented similar registration programs. Portable equipment not registered through the ARB or a local district may be subject to District stationary source permit requirements, depending on the size of the engine. In addition, the U.S. EPA and ARB have established engine certification standards for new off-road engines (of which portable engines are a subset). These engines are available for use in portable equipment.

C. What current federal, state or local regulations address diesel fuel formulation?

Current federal U.S. EPA regulations establish fuel registration and formulation requirements. All diesel fuels and all additives for on-road motor vehicles are required to be registered with the U.S. EPA. The ARB has established California fuel formulation requirements, applicable to all motor vehicles, that either meet or exceed existing

federal formulation requirements. In addition, ASTM D 975 specifies standards which diesel fuels should meet to ensure safety, reliability, and performance. Generally, alternative diesel fuels do not meet all of the ASTM specifications.

Since 1993, the sulfur content limit of California diesel (as well as diesel fuel sold to on-road vehicles nationwide) has been set at a maximum 500 parts per million by weight (ppmw). However, the average sulfur content of complying fuel formulations currently being sold in California is about 140 ppmw.[1] Further, California's diesel fuel specifications include an aromatics limit and the fuel specifications apply to both on-road and off-road vehicles (EPA's fuel sulfur requirements only apply to on-road vehicles). Although stationary engines are not required to use fuel that meets California Air Resources Board diesel (CARB diesel) formulation requirements, virtually all use complying fuel because of California's single fuel distribution network. Also, under state law, districts have the authority to establish formulation requirements for fuels to be used in stationary engines. To date, several districts have established diesel-fueled engine best available control technology requirements specifying the use of CARB diesel. Portable engines registered under ARB's Statewide Portable Equipment Registration program are required to use CARB diesel. Beginning July 1, 2002, medium and larger transit agencies must use diesel fuel with a sulfur content no greater than 15 ppmw in all diesel buses.

V. EMISSION INVENTORY AND RISK

This section summarizes the statewide diesel PM emissions inventory from diesel-fueled engines and provides ambient and near-source potential cancer risk estimates for those emissions. A detailed description of how the inventory, ambient concentration, and ambient risk values listed in Tables 1 through 5 of this chapter were determined is presented in Appendix VI.

A. What are the estimated diesel particulate matter emissions for 1990, 2000, 2010, and 2020?

Table 1 lists the estimates for the statewide diesel PM emissions inventory from diesel-fueled engines and vehicles for 1990. Tables 2, 3, and 4 provide similar estimates for 2000, 2010, and 2020. The relative contribution of the major subcategories of engines and vehicles that comprise the stationary and mobile categories are also shown. All tables take into account growth in engines due to population and economic growth and emission reductions due to both federal and state regulations in effect at the time of the inventory estimate. These estimates do not include proposed recommended measures discussed in Chapter VIII, including the recently proposed 2007 federal on-road and diesel fuel standards.

[1] 141 ppmw is the volume-weighted average determined by the California Energy Commission's 1997 California refiner survey. (See Appendix IV.)

Table 1: Estimated Statewide Diesel PM Emissions Inventory – Diesel-Fueled Engines and Vehicles (1990)

Category	Engine Population	Diesel PM (tons per year)	% of Total Diesel PM Emissions
STATIONARY			
Prime	4,600	400	0.9
Emergency Stand-by	10,200	124	0.3
MOBILE			
On-road	606,700	18,400	39.7
Off-road (Excluding Portable Equipment)	476,300	25,300	54.5
Portable	47,600	2,200	4.7
TOTAL	**1,145,300**	**46,400**	**100.0**

Table 2: Estimated Statewide Diesel PM Emissions Inventory – Diesel-Fueled Engines and Vehicles (2000)

Category	Engine Population	Diesel PM (tons per year)	% of Total Diesel PM Emissions
STATIONARY			
Prime	4,800	420	1.5
Emergency Stand-by	11,300	138	0.5
MOBILE			
On-road	687,200	7,500	26.8
Off-road (Excluding Portable Equipment)	498,200	18,500	66.1
Portable	49,200	1,400	5.0
TOTAL	**1,250,700**	**28,000**	**100.0**

Table 3: Estimated Statewide Diesel PM Emissions Inventory – Diesel-Fueled Engines and Vehicles (2010)

Category	Engine Population	Diesel PM (tons per year)	% of Total Diesel PM Emissions
STATIONARY			
Prime	4,400	360	1.6
Emergency/Standby	12,300	143	0.6
MOBILE			
On-road	643,900	5,200	22.9
Off-road (Excluding Portable Equipment)	521,300	15,900	70.0
Portable	53,600	1,100	4.9
TOTAL	**1,235,500**	**22,700**	**100.0**

Table 4: Estimated Statewide Diesel PM Emissions Inventory – Diesel-Fueled Engines and Vehicles (2020)

Category	Engine Population	Diesel PM (tons per year)	% of Total Diesel PM Emissions
STATIONARY			
Prime	4,400	350	1.9
Emergency/Standby	13,200	149	0.8
MOBILE			
On-road	610,200	4,900	26.0
Off-road (Excluding Portable Equipment)	527,800	12,800	67.9
Portable	55,200	660	3.5
TOTAL	**1,210,800**	**18,900**	**100.0**

The current inventory of diesel PM emissions in Table 2 shows that there are about 28,000 tons per year of diesel PM that can potentially be reduced from a variety of sources. The inventory also shows that the sources are numerous, with over 1.25 million diesel-fueled engines operating statewide. Comparing the statewide diesel PM emissions in Table 1 (1990) and Table 2 (2000), shows that significant progress has been made to reduce diesel PM emissions in California.

The bulk of the 30 percent decrease in diesel PM emissions from 2000 to 2020 is due to currently adopted on-road standards and fleet turn-over as new vehicles with controls replace older vehicles with little or far less effective controls. Proposed federal standards for diesel-fueled engines are not considered in this inventory, but would reduce total diesel PM in California by approximately 3,500 tons per year (or an additional 15 percent when compared to year 2000 emissions) in 2020. Some reduction in diesel PM emissions is due to a slight decrease in the on-road engine population.

B. What are the estimated statewide potential cancer risks associated with diesel PM emissions?

Table 5 lists the estimates for the statewide population-weighted annual outdoor average diesel PM concentrations and corresponding percent change in the concentration for the years 1990, 2000, 2010, and 2020 resulting from diesel PM emissions. These estimates are based on the emission inventory estimates presented in Tables 1 through 4.

The Proposed Identification of Diesel Exhaust as a Toxic Air Contaminant, Appendix III, Part A, Exposure Assessment[2] (ID Report) reported the statewide population–weighted annual outdoor average diesel PM concentration as 3.0 $\mu g/m^3$ for 1990. The ARB staff reviewed studies conducted in the San Joaquin Valley, the South

[2] As approved by the Scientific Review Panel on April 22, 1998.

Coast Air Basin, and the city of San Jose to obtain more complete PM_{10} ambient data. These data, along with routinely collected ambient PM_{10} monitoring network data and the 1990 PM_{10} emissions inventory, were used in a receptor model to estimate the statewide outdoor concentration of diesel PM in 1990.

We estimated the statewide outdoor concentration of diesel PM for 1990, 2000, 2010, and 2020 by assuming that the ambient concentration is proportional (linearly) to the statewide emissions. The ratio of the ambient concentration to statewide emissions was assumed to remain constant for the years 1990, 2000, 2010, and 2020. For 1990, this ratio was determined by using the ambient concentration from the ID report (3.0 $\mu g/m^3$) and the statewide emission estimate for 1990 from Table 1 (46,400 TPY). Using the 1990 ratio and the statewide emissions estimates for 2000, 2010, and 2020 from Tables 2, 3, and 4, the ambient concentration estimates for 2000, 2010, and 2020 were estimated. These are presented in Table 5.

Table 5: Statewide Population-Weighted Annual Outdoor Average Diesel PM Concentration for 1990, 2000, 2010, and 2020

	1990	2000	2010	2020
Concentration ($\mu g/m^3$)	3.0	1.8	1.5	1.2
Percent Reduction in Diesel PM from 1990 Concentration	N/A	40%	50%	60%

The ID Report provided estimates of indoor and total exposure to diesel PM. Applying the 1990 ratio to the estimated population-weighted annual outdoor average diesel PM concentrations for 2000, 2010, and 2020 results in the following indoor exposure estimates, respectively: 1.2 μ/m^3, 1.0 μ/m^3, and 0.8 μ/m^3. Total exposure estimates for 2000, 2010, and 2020 are 1.3 μ/m^3, 1.1 μ/m^3, and 0.84 μ/m^3. The potential risk was estimated by multiplying the statewide ambient concentration by the unit risk factor of 300 excess cancers per million people per microgram per cubic meter of diesel PM.[3] This information, along with the estimated potential cancer risk values, is summarized in Table 6.

[3] The full range of unit risk factors identified by the SRP is 130 to 2400 excess cancers per million per microgram per cubic meter of diesel particulate matter. The 300 value was recommended by the SRP for use as a point estimate of the unit risk.

Table 6: Estimated Exposure of Californians to Diesel PM for 2000, 2010 and 2020

	Estimated Average Air Exposure Concentration – 1990 μg/m^3	1990 Ratio	Estimated Average Air Exposure Concentration (μg/m^3) and Potential Risk (excess cancers/million)					
			2000		2010		2020	
			Conc.	Risk	Conc.	Risk	Conc.	Risk
Outdoor Ambient Estimate	3.0		1.8	540	1.5	450	1.2	360
Total Indoor Exposure Estimate	2.0	2.0/3.0	1.2	360	1.0	300	0.8	240
Total Exposure Estimate	2.1	2.1/3.0	1.26	380	1.05	315	0.84	252

C. How much of the estimated statewide potential cancer risk level from air toxics is due to diesel PM emissions?

To provide a perspective on the contribution that diesel PM has on the overall statewide average ambient air toxics potential cancer risk, ARB staff evaluated risks from other compounds using data from ARB's ambient monitoring network. ARB maintains a 21 site air toxics monitoring network which measures outdoor ambient concentration levels for approximately 60 air toxics.

Table 7 shows the potential cancer risk from the top ten inhalation risk contributors that the State of California has identified as TACs and routinely monitors. The diesel PM values are calculated based on the procedure discussed in the previous section. The risk values for the other compounds are based on the annual average concentration (determined from ambient monitoring) multiplied by the unit risk factor for each compound. Table 7 also shows that for the top ten risk contributors, diesel PM contributes over 70 percent of the state estimated potential cancer risk levels.

Table 7: Estimated Statewide Average Potential Cancer Risk from Outdoor Ambient Levels of Air Toxics for the year 2000

Compound	Potential Cancer Risk[1,2] Excess Cancers/Million	Percent Contribution to Total Risk
Diesel Exhaust PM_{10}	540	71.2
1,3-Butadiene	74	9.8
Benzene	57	7.5
Carbon Tetrachloride	30	4.0
Formaldehyde	19	2.5
Hexavalent Chromium	17	2.2
para-Dichlorobenzene	9	1.2
Acetaldehyde	5	0.7
Perchloroethylene	5	0.7
Methylene Chloride	2	0.3
TOTAL	**758**	**100**

1. Diesel exhaust PM_{10} potential cancer risk based on 2000 emission inventory estimates presented in Table 5. All other potential cancer risks based on air toxics network data. Used 1997 data for para-Dichlorobenzene. Used 1998 monitoring data for all others.
2. Assumes measured concentrations are equivalent to annual average concentrations and duration of exposure is 70 years, inhalation pathway only.

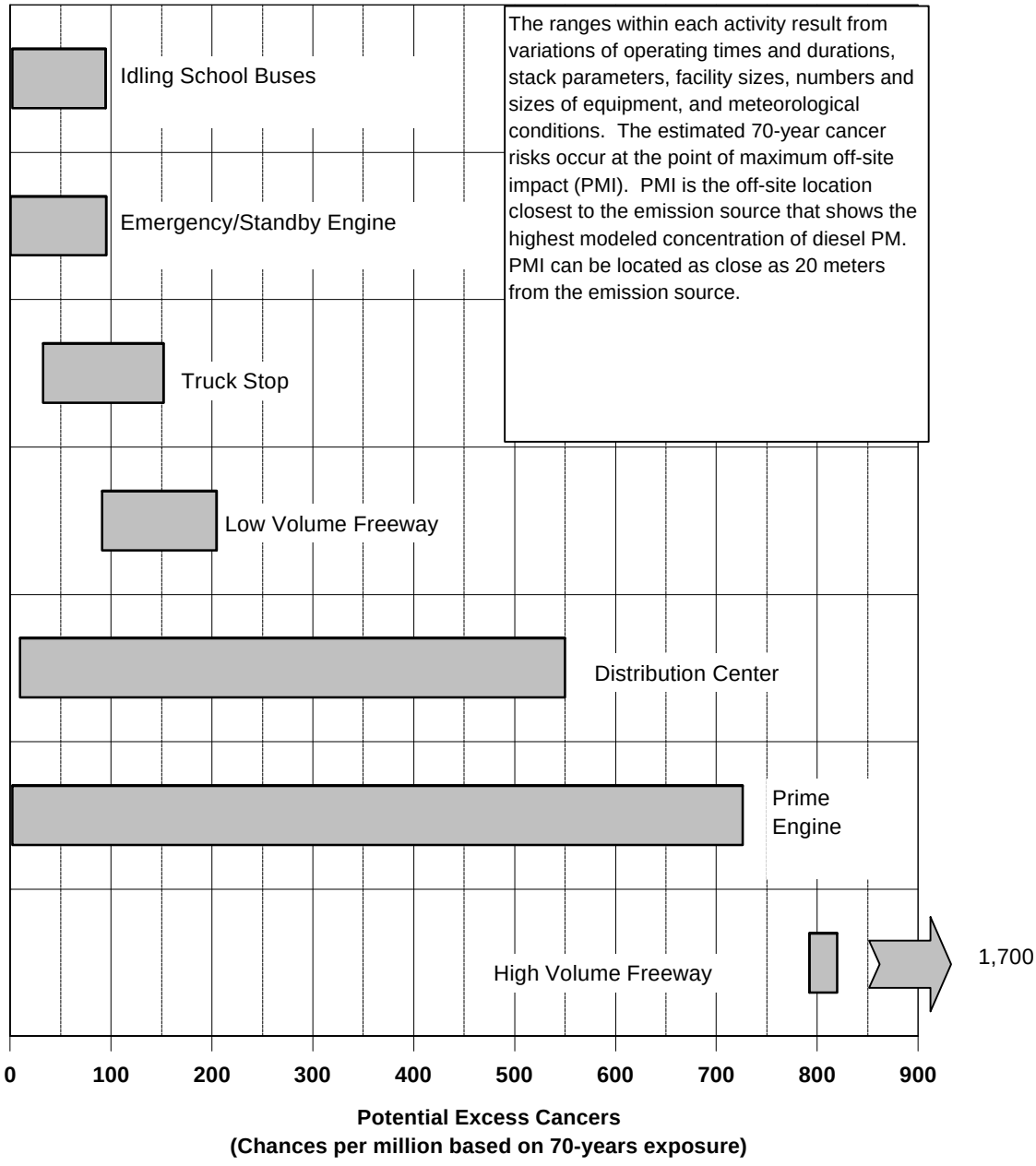
The South Coast Air Quality Management District also conducted a study of air toxics in the South Coast Air Basin (Multiple Air Toxics Exposure Study II (MATES-II)) in 1998 and 1999. The MATES-II study estimated that the average basin wide potential cancer risk from diesel PM was about 1,000 excess cancers per million, or 71 percent of the average cancer risk from all air toxics in the South Coast Air Basin.

ARB staff's findings are consistent with the MATES-II study in that diesel PM is a major contributor to potential ambient risk levels and accounts for approximately 70 percent of the ambient air toxics cancer risk. Our analysis also indicates that average ambient concentrations of air toxics are higher in the South Coast Air Basin than elsewhere in the state, resulting in higher estimates of risk for residents of that air basin. Staff concludes that reducing the risk from diesel PM is an essential element in reducing the public's overall ambient exposure to air toxics.

D. What are the potential cancer risks associated with some typical activities where diesel-fueled engines are used?

ARB staff estimated the range of potential cancer risks from seven common activities or situations to determine if the concentrated operation of diesel-fueled engines could expose nearby individuals to locally elevated diesel PM concentrations higher than average regional concentrations. The specific situations investigated included idling school buses, truck stops, freeways, emergency and standby diesel engine operations, prime engine operations, and warehouse distribution center operations. Figure 2 shows the range of potential cancer risk, above background levels, estimated for each type of activity. The risk estimate for each activity does not account for the risk from any other diesel-fueled engines or vehicles and assumes a 70-year, or lifetime, exposure. For more detailed information regarding each activity and the methodology used to derive the estimates, see Appendix VII.

Figure 2: Potential Cancer Risk Range of Activities Using Diesel-Fueled Engines



Risk is a function of the lifetime average daily dose and the carcinogenic potency of the compound. The potential risks reported here were estimated by multiplying the modeled concentration of a toxic compound by the carcinogenic potency value, also known as the unit risk factor. The unit risk factor is defined as the estimated probability of a person contracting cancer as a result of constant exposure to an ambient concentration of 1 $\mu g/m^3$ over a 70-year lifetime. This approach and the use of a 70-year lifetime is consistent with the OEHHA/ARB methodology for evaluating the potential risk from exposure to air toxics.

We expect the estimated 70-year potential cancer risk range for each of these activities will fall within the ranges in Figure 2. Each range assumes a 70-year exposure to diesel PM emissions at current levels, and uses SRP's diesel PM unit risk factor point estimate of 300 excess cancers per million people per microgram per cubic meter of diesel PM. The ranges within each activity result from variations in assumptions of operating times and durations, stack parameters, facility sizes, numbers and sizes of equipment, and meteorological conditions. For example, in the Idling School Buses scenario the activity ranged from five buses idling two minutes each twice per day to 20 buses idling 15 minutes each twice per day for 180 days per year.

The estimated 70-year potential cancer risks in Figure 2 are based on the modeled diesel PM concentrations at the point of maximum impact (PMI). PMI is the off-site location closest to the emission source that shows the highest modeled concentration of diesel PM. The PMI can be located as close as 20 meters from the emission point. The diesel PM concentrations and associated potential risk decreases as one moves away from the point of maximum impact. For example, the potential cancer risk at the point of maximum impact for the Low-Volume Freeway scenario is estimated to be 200 excess cancers per million if a residence were located 20 meters away. For a residence located 500 meters away, the estimated potential cancer risk drops to 30 excess cancers per million.

The estimated risks presented in Figure 2, and the assumptions used to determine these risks, are not based on a specific source of diesel PM. Instead, general assumptions bracketing a fairly broad range of possible operating scenarios were used. The estimated risks are based on the diesel PM concentration at the point of maximum impact as determined using air dispersion modeling. The estimated risk ranges are used to provide a "qualitative" assessment of potential risk levels near sources of diesel PM. These estimates are based on the risk assessment methodology and assumptions identified in Appendix VII. Actual risk levels from these types of sources at any individual site will vary due to site specific parameters, including equipment technologies and emission rates, fuel properties, operating schedules, meteorology, and the actual location of off-site receptors.

Figure 2 shows that each of the investigated activities has the potential of significant increases in potential cancer risk under certain circumstances. The potential cancer risk associated with these activities, combined with the high statewide ambient

risk levels reported earlier, provide additional evidence that all categories of diesel-fueled engines should be subject to further control requirements.

VI. CONTROL TECHNOLOGY AND FUEL OPTIONS

A. Has ARB identified control technology options that can further reduce diesel PM emissions from diesel-fueled engines and vehicles?

Yes. The ARB has evaluated various types of control options identifying the control efficiency, description of technology, cost, and source test data. Technical evaluations of the control technologies, including summaries of the available emission test information, are included in Appendix IX. Because emission test information was deemed essential for a thorough evaluation of diesel PM control technologies, detailed technical evaluations were not performed where the technology proponent did not provide adequate emission test information. The most effective control technologies evaluated by ARB staff are catalyst-based diesel particulate filters (catalyst-based DPFs).

Catalyst-based DPFs use catalyst materials to reduce the temperature at which collected diesel PM oxidizes. The catalyst material can either be directly incorporated into the filter system, or can be added to the fuel as a fuel-borne catalyst (FBC-DPF). Although catalyst-based DPFs can be used with diesel fuels of varying sulfur content, the greatest reductions come from using very low-sulfur fuels. Used with very low-sulfur (<15 ppmw sulfur) diesel fuel, catalyst-based DPFs have been reported to reduce diesel PM emissions by over 85 percent.

Table 8 provides a description and range of control efficiencies of catalyst-based DPFs and new diesel-fueled engines. The control efficiency information is based on available test information summarized in Appendix IX. As shown, the range of control efficiencies for catalyst-based DPFs is 85 to 97 percent.

Table 8: Control Technology Efficiencies

Control Technology	Diesel PM Control Efficiency	Description
Catalyst-Based DPFs / Very low-sulfur Fuel	85% - 97%	Particulate filter system where the catalyst material is either incorporated into the filter or added to the fuel; Diesel fuel with a sulfur content $\leq$ 15 ppmw.
New Engine	Up to 85%	Replaces existing engines with engines certified to meet ARB/U.S. EPA off-road engine emission standards.

For existing diesel engine applications, catalyst-based DPFs have been shown to be effective in reducing diesel PM emissions. Worldwide, DPFs have been used in over 20,000 applications. In several European countries, catalyst-based DPFs have been installed on more than 6,500 buses, heavy-duty trucks, and municipal vehicles. In the United States, the application of catalyst-based DPF's is less prevalent, but several demonstration projects have been initiated. In California, diesel-fueled school buses and tanker trucks have been retrofitted with catalyzed DPFs as part of a program to evaluate the effectiveness of a refiner's low-sulfur diesel formulation. In New York, the New York City Transit Authority's fleet demonstration program will test the effectiveness of catalyzed DPF's on 50 diesel-fueled buses.

For new diesel engine applications, catalyst-based DPF technology is playing a key role in both establishing and complying with new more stringent diesel PM standards. The U.S. EPA recently announced its proposed regulation for heavy-duty engine and vehicle standards and highway diesel fuel sulfur control requirements. A diesel PM emission standard of 0.01 g/bhp/hr is proposed. This proposed standard is based on the anticipated emission reductions from low-sulfur diesel fuel and the use of a catalyst-based diesel particulate filter. To comply with a 2005 European Union (EU) emission standard for diesel fueled vehicles, the French automaker, Peugeot Citroen, recently unveiled a diesel PM catalyst-based DPF system which is expected to go into production in the year 2000.

B. What are the costs associated with these control technology options?

Tables 9a through 9d present information on the costs associated with applying catalyst-based DPFs[4] to stationary, off-road, and on-road diesel engines, including both retrofit and new engine applications. Table 9a provides information on the capital costs associated with retrofitting stationary diesel engines with catalyst-based DPFs. This information was obtained from representative catalyst-based DPF manufacturers and is intended to represent the range in the retail costs at this time. These cost estimates are mostly consistent with the $30 to $50 per horsepower range reported by the Manufacturers of Emission Controls Association (MECA) in "Emission Control Technology for Stationary Internal Combustion Engines" dated July 1997.

Table 9a: Stationary Engines - Current Catalyst-Based DPF Retrofit Costs

Technology	40 hp	100 hp	275 hp	400 hp	1,400 hp
Capital Cost	$1,300 - $5,000	$2,000 - $7,500	$3,500 - $9,000	$7,000 – $10,500	$30,000 - $44,000

[4] Some Catalyst-Based DPFs require, and all Catalyst-Based DPF's will benefit from, the use of very low-sulfur fuel. The incremental cost of this fuel is projected to be less than $ 0.05 per gallon and is discussed further in Appendix IV.

The costs associated with retrofitting off-road engines with catalyst-based DPFs are presented in Table 9b. This information also assumes a cost of $30 to $50 per horsepower, as reported by MECA representatives in "Exhaust Controls Available to Reduce Emissions from Non-road Heavy-Duty Engines."

Table 9b: Off-Road Engines - Current Catalyst-Based DPF Retrofit Costs

Technology	190 hp[5]	275 hp	475 hp
Catalyst-Based DPF	$5,700-9,500	$8,250-13,750	$13,500- 23,750

Table 9c provides an estimate of the current cost to retrofit on-road engines and vehicles with catalyst-based DPFs. This information assumes a cost of $10 to $20 per horsepower, as reported by MECA in "Emission Control Retrofit of Diesel-Fueled Vehicles" dated March 2000.

Table 9c: On-Road Engines - Current Catalyst-Based DPF Retrofit Costs

Vehicle Class	**LHD**	**MHD**	**HHD**
Average Horsepower[6]	**190 hp**	**250 hp**	**475 hp**
Capital Cost	$1,900 - $3,800	$2,500 - $5,000	$4,750 - $9,500

In contrast to the retrofit costs presented in Tables 9a – 9c, Table 9d presents the U.S. EPA's estimate of the future (2007) costs of applying catalyst-based DPFs to new on-road engines and vehicles. The U.S. EPA estimates are based on higher production volumes, and they are similar to the future cost projections presented by MECA in "Emission Control Retrofit of Diesel-Fueled Vehicles (March 2000)."

Table 9d: On-Road Engines - Future (2007) Catalyst-Based DPF Costs

Vehicle Class	**LHD**	**MHD**	**HHD**
Average Horsepower[7]	**190 hp**	**250 hp**	**475 hp**
Catalyst-Based DPF Costs[8]	$670	$890	$1,100

5 The power range noted has been selected to facilitate comparison with on-road costs.

6 The average horsepower was derived from the U.S. EPA's engine certification database for LHDD, MHDD, and HHDD engines for model years 1999 and 2000.

7 The engine horsepower ranges were derived from the U.S. EPA's engine certification database for LHDD, MHDD, and HHDD engines for model years 1999 and 2000.

8 The U.S. EPA Catalyst Based-DPF cost estimates include both fixed costs (e.g., tooling, research and development, and certification) and variable costs (e.g., hardware, assembly and markup).

There is a stark difference between the current costs associated with retrofitting existing engines and the future costs associated with applying catalyst-based DPFs to new engines and vehicles. However, we expect these costs to decline as production volumes and experience increase. ARB staff expects that, over the next few years, the retrofit costs presented in Tables 9a- 9c will approach the new engine costs presented in Table 9d.

Detailed cost and cost-effectiveness analyses will be completed during the preparation of each control measure. However, staff expects that the costs associated with carrying out this plan will be significant and will be on the order of the costs associated with other major ARB programs. In addition, ARB staff recognize that there may be unique situations that require a special evaluation of the feasibility and/or cost-effectiveness of applying catalyst-based DPF technology. These issues will be fully investigated and considered during the development of the specific control measures.

VII. ALTERNATIVE TECHNOLOGIES

A. What alternatives to diesel-fueled engines and vehicles exist today that would result in lower diesel PM emissions?

Diesel-fueled engines are extensively used throughout California in equipment and vehicles that provide for the transportation of goods, construction of homes, and emergency power generation. (See Chapter III for more information on the uses of diesel-fueled engines.) Diesels are the engines of choice for most “heavy-duty” applications. However, for a significant number of applications, lower PM emitting alternatives to existing diesel-fueled engines exist. As ARB staff develop the control measures recommended in this report, the feasibility and cost of these alternatives will be evaluated and considered. In most cases, it is expected that well controlled diesel engines using very low-sulfur fuel will have equivalent PM emissions as benchmark gasoline or CNG fueled engines. Where this is true, it is envisioned that regulations would be structured to provide a choice of fuels. In cases where alternatively-fueled engines offer emission performance that cannot be matched by diesel-fueled engines, the feasibility and costs of setting standards based on the capability of alternatively fueled engines will be assessed.

Current alternatives to diesel-fueled vehicles and equipment include:

- natural gas fueled vehicles and equipment;
- gasoline-fueled vehicles and equipment;
- dual-fueled vehicles and equipment;
- electrically-powered vehicles and equipment;
- fuel cell technology; and
- other alternatively fueled (e.g., Bio-diesel) vehicles and equipment.

The next step in the AB 1807 process, following approval of this report, is the development of the specific ATCMs and regulations designed to reduce diesel PM emissions from diesel-fueled engines and vehicles. Chapter VIII identifies the specific control measures we currently recommend be developed. As part of the process in developing these recommended measures, where appropriate, the ARB staff will thoroughly evaluate available alternatives to diesel-fueled engines and diesel fuel. Criteria evaluated by the ARB staff when considering the recommendation of alternative technologies include:

- reduction in emissions of air toxics;
- the availability and quality of source test information;
- cost and cost-effectiveness of the alternative technology; and
- operation or design constraints associated with the alternative.

In summary, diesel-fueled engines have established themselves for a variety of reasons as the preferred power source for many functions in our industrial society. However, cleaner alternatives do exist which ARB staff will consider when developing the measures recommended in this report.

ARB staff will develop the ATCMs and regulations in an open and public process. Draft versions of ATCMs and regulations will be presented to the public for review and comment, and a final draft version will be presented to the Board for approval. Public outreach is an essential element in the development of any ATCM or regulation to ensure that all affected and interested parties have full opportunity to provide input and shape rules that are both effective and workable.

VIII. STAFF'S RECOMMENDATION

In August 1998, the ARB identified particulate matter emissions from diesel fueled engines as a TAC, and staff was directed to begin the risk management process. A working group was convened to advise the staff with its risk management efforts. Since October 1998, staff has been working with the advisory committee to develop this report on the need for further control of particulate emissions from diesel engines. Staff finds that:

1. The current inventory of diesel PM emissions, as presented in Chapter V of this report, demonstrates that stationary and mobile diesel engines currently emit over 28,000 tons per year of diesel PM in California;
2. The current statewide population-weighted annual outdoor and indoor risk from exposure to diesel PM emissions, as presented in Chapter V of this report, is estimated at over 500 and 350 potential excess cancers per million people, respectively; and
3. The evaluation of available diesel PM control technologies and strategies, as presented in Appendix II, Appendix III, and Appendix IX to this report,

demonstrates that technically feasible and commercially available diesel PM control measures are available for diesel-fueled engines and vehicles.

Therefore, we recommend that the Board direct staff to develop measures to reduce diesel PM emissions from all diesel-fueled engines and vehicles. Measures that we recommend to be developed are presented below. None of the recommended measures will result in an increase in NOx emissions above applicable NOx emission certification levels.

The recommended measures for regulation development are discussed in sections A, B, and C below. Section D discusses the actions we believe the U.S. EPA needs to pursue to support our recommendations and to reduce diesel PM emissions in California. Section E discusses possible adverse impacts associated with the recommended measures. A more detailed description of each recommended measure and the associated emission reduction, risk reduction, cost analysis, and proposed implementation date for each measure can be found in Appendices II, III, and IV.

A. What measures does ARB recommend be developed to further reduce diesel PM emissions from mobile diesel-fueled engines and vehicles?

Table 10 summarizes the recommended measures for all mobile sources except for retrofit of off-road portable equipment, which is discussed in the next section. Together, these measures comprise a comprehensive program to be implemented in California to control and reduce potential cancer risk from exposure to diesel particulate matter from mobile sources. These measures are further subcategorized for on-road and off-road applications. Alternative strategy applications, which are non-regulatory, are also part of the comprehensive program. They are discussed later in this section.

As discussed in Chapter II, the recommended measures will be developed in accordance with the requirements of AB 1807. The specific control requirements of each measure will be developed in an open and public process. Details concerning each specific recommended measure, which include the cost and cost-effectiveness of controls and the availability of alternative technologies, will be explored as each recommended measure is developed.

Table 10: Recommended Measures to Reduce Diesel PM from Mobile Sources

Measures	Proposed Board Adoption Date	Proposed Implementation Date	Est. PM Reduction, tons per year	Est. PM Reduction, tons per year	Est. Cost per Unit, $
On-Road Measures			**2010**	**2020**	
Supplemental test procedures HDV certification	2000	2005	n/a	n/a	to be determined
Lower emission standards for new HDV engines	2001	2007	1,600	3,500	670-1,100
Control of emissions from existing engines (retrofit)	2002	2002-2008	1,870	280	1,900-9,500
Solid waste collection vehicles		2002			
Other public HDV fleets		2002			
Other public & private HDV fleets		2003-2008			
Control of HDV in-use emissions	2003	2005	n/a	n/a	130-150
Off-Road Measures					
Lower emission standards for new engines	2002	2006-2008	910	3,600	1,300-1,800
Control of emissions from existing engines (retrofit)	2002	2002-2008	6,000	1,500	5,700-23,800
Public fleets		2002-2003			
Other off-road fleets		2006-2008			
Control of in-use emissions	2003	2006-2008	n/a	n/a	to be determined
PM standards for new diesel pleasure craft engines	2002	2005	9	24	to be determined
Federal Measures					
Locomotive retrofit			860	760	to be determined
Commercial marine vessels retrofit			3900	4500	to be determined

On-Road

The recommended measures for diesel-fueled on-road mobile vehicles listed in Table 10 address both new and existing vehicles. The proposed implementation dates listed in Table 10 are tentative. The actual implementation dates may vary based on engine type or service and on the availability of very low-sulfur fuel. For new vehicles, ARB staff is proposing new engine diesel PM standards that will reduce diesel PM emission by at least 90 percent from the current on-road standards. This proposal is based upon the U.S. EPA's proposed heavy-duty engine and vehicle standards and highway diesel fuel sulfur control requirements rule, and the expected engine, fuel, and control technology development needed to meet the proposed standards. For existing vehicles, ARB staff is proposing diesel PM emissions be reduced, for almost all (90 percent) engines, by at least 85 percent. This equates to an overall diesel PM emission reduction of 75 percent from existing vehicles. This reduction can be achieved through the addition of after-treatment technology, or replacement of existing engines with new technology or alternatively fueled engines. The details of each of the recommended measures will be addressed during the actual regulation development process. In-use compliance programs will be implemented or enhanced to maintain the diesel PM emission reductions achieved through cleaner new engine standards and retrofits.

Off-Road

The recommended measures for diesel-fueled off-road engines are similar to those for on-road vehicles: more stringent diesel PM standards, after-treatment control retrofit requirements, and in-use compliance programs. In contrast, to on-road vehicles, most off-road engines are not registered by the State, with the exception of portable engines, boats, and off-highway motorcycles that are permitted and/or registered by local districts or the State. Therefore, to ensure the application of recommended measures such as inspection and maintenance programs, in-use compliance testing, or mandatory retrofitting of older equipment, the ARB and district staff may rely on mechanisms such as warranty registration, local operating permits, and contract requirements.

Non-Regulatory Strategies

Non-regulatory strategies for mobile sources include guideline development, voluntary memoranda of understanding, and non-regulatory incentive programs. A variety of voluntary and incentive programs are being proposed to achieve reductions beyond those California can achieve through regulatory action. These are activities the ARB does not currently have the authority to regulate and for which regulations may not be the most effective action. While pursuing these non-regulatory strategies, ARB staff will work with the appropriate stakeholders to achieve voluntary reductions in diesel PM. The non-regulatory strategies being considered by the ARB staff include:

- the voluntary application of diesel particulate filters for locomotives;
- the voluntary application of diesel particulate filters for commercial marine vessels;
- developing a memorandum of understanding (MOU) for the retrofit of airport ground support equipment;
- the voluntary retrofit of emergency vehicles; and
- implementing transportation control measures – idling restrictions;

B. What measures does ARB recommend be developed to further reduce diesel PM emissions from stationary and off-road portable diesel-fueled engines?

Table 11 summarizes the recommended measures designed to reduce diesel PM emissions from stationary and off-road portable diesel-fueled engines. The proposed implementation dates listed in Table 11 are tentative. The actual implementation dates may vary based on engine type or service and on the availability of very low-sulfur fuel. The measures identified in this section are discussed in more detail in Appendix II. For new engines, the recommended control measures presented in Table 11 require the application of catalyst-based DPFs or a similar technology that will reduce diesel PM emissions by at least 90 percent from uncontrolled levels. For existing vehicles, ARB staff is proposing diesel PM emissions be reduced, for almost all (90 percent) engines, by at least 85 percent. This equates to an overall diesel PM emission reduction of 75 percent from existing vehicles. This reduction will be achieved through the addition of after-treatment technology, replacement of older technology engines with new technology or alternatively fueled engines, or restrictions placed on the operation of existing equipment. The details of each of the recommended measures will be addressed during the development of each of the air toxic control measures and regulations. Because of the variety of existing engines, as well as the multitude of applications, staff expects that no single control technology will be universally applicable to all retrofit applications.

Tables 9a and 9b presented information on the costs associated with applying catalyst-based DPFs on both new and retrofit stationary and portable engines. The preliminary cost-effectiveness for the control measures identified in Table 11 ranges from 5 to 200 dollars per pound of diesel PM reduced. The cost per pound of diesel PM reduced reflects the predicted costs associated with purchasing, installing, and maintaining a catalyst-based DPF on each of the diesel-fueled engines addressed by the recommended measures. We believe these cost-effectiveness estimates similar to the cost-effectiveness estimates for regulations developed to reduce other particulate compounds that have been identified as toxic air contaminants (e.g., hexavalent chromium and lead).

Table 11: Recommended Measures to Reduce Diesel PM from Stationary and Off-Road Portable Sources

Control Measure	Proposed Board Adoption Date	Proposed Implementation Date	Estimated PM Reduction 2010 (TPY)	Estimated PM Reduction 2020 (TPY)
Stationary Engine				
New Engines	2002	2002	33	21
Prime Engine Retrofit	2002	2003	70	66
Emergency Standby Retrofit	2002	2003	105	105
Off-Road Portable Engine Retrofit	2002	2003-2005	712	252
Agricultural Engine Retrofit	2002	2003-2005	297	197

Stationary

The recommended measures for stationary diesel-fueled engines listed in Table 11 address both new and existing engines. For new engines, the ARB staff recommends an ATCM be developed based on the requirements of the ARB's permitting guidance document, Risk Management Guidance for the Permitting of New Stationary Diesel-fueled Engines, (September 2000). (See Appendix II for a more detailed description of Guidance requirements.) Diesel PM emission reductions from new stationary diesel-fueled engines will be accomplished by requiring these engines to meet either specific technology requirements (i.e., stringent diesel PM engine certification levels, usage of low-sulfur diesel fuel, and application of catalyst-based DPFs); or an equally stringent performance standard.

For existing prime (non-emergency) engines and emergency standby engines, ARB staff recommends the development of ATCMs that define retrofit control requirements. As shown in Table 11, ARB staff predicts the implementation of the prime engine and emergency standby engine ATCMs by 2003 will result in diesel PM reductions of up to 70 tons and 105 tons in 2010, respectively. To achieve this reduction, ARB staff is proposing diesel PM emissions be reduced, for almost all (90 percent) engines, by at least 85 percent. This represents a 75 percent reduction in diesel PM emissions from engines in these categories. The details of each of the recommended measures will be addressed during the development of the regulations. Although catalyst-based DPFs are available, for these sources, this technology may not prove to be cost-effective for all engines especially smaller engines with limited hours of operation. During the ATCM development process, the ARB staff will conduct a more detailed cost-effectiveness analysis to help in determining the appropriateness of these controls. It is anticipated that both of these ATCMs would be fully implemented prior to 2010.

There are over 6,000 agricultural irrigation pump engines in California, representing about 11 percent of the total stationary and portable engine inventory. Because of the high use of these engines, they are a significant source of diesel PM and contribute about half of the diesel PM emissions from the entire stationary engine category. In addition, agricultural irrigation pumps tend to be concentrated in specific regions of the State, contributing proportionally higher emissions within these regions.

H&SC section 42310(e) prohibits districts from requiring a permit for most equipment used in agricultural operations. However, the State and districts may establish emission control requirements for stationary agricultural equipment. Therefore, ARB staff recommends working with the agricultural community to develop a comprehensive program to reduce emissions from engines used in agricultural operations. This program should evaluate both the substitution of diesel engines with electrically driven equipment and a comprehensive retrofit element.

ARB staff predicts a reduction of diesel PM from agricultural irrigation pumps of up to 297 tons per year by 2010 and 197 tons per year by 2020. To achieve this reduction, ARB staff is proposing diesel PM emissions be reduced, for almost all (90 percent) engines, by at least 85 percent. This represents a 75 percent reduction in diesel PM emissions from the engines in this category. This reduction will be achieved through the addition of after-treatment technology, replacement of older technology engines with new technology engines, use of alternative-fueled engines, or electrification. The details of each of the recommended measures will be addressed during the development of each of the regulations.

Off-Road Portable

Staff recommends that the ARB develop regulations to reduce diesel PM emissions from existing off-road portable diesel engines. New engines for off-road portable equipment will be regulated by the off-road rules discussed above. The ARB currently administers the Statewide Portable Equipment Registration Program (Statewide Registration Program) Regulation (Title 13 California Code of Regulation §2450 - 2466), which is a voluntary program for the statewide registration and regulation of off-road portable engines. To date, approximately 12,000 off-road portable engines have been registered. The staff recommends that the Statewide Registration Program Regulation be amended to include requirements for reducing diesel PM emissions from portable diesel engines through the application of catalyst-based DPFs, electrification where feasible, and consideration of alternate fuels. In addition, staff recommends the development of an ATCM, for implementation by local districts, consistent with amendments to the PERP regulation. Staff predicts compliance with the ATCM would reduce diesel PM emissions up to 712 tons per year in 2010 and up to 252 tons per year by 2020. To achieve this reduction, ARB staff is proposing diesel PM emissions be reduced, for almost all (90 percent) engines, by at least 85 percent. This represents a 75 percent reduction in diesel PM emissions the engines in this category. This reduction will be achieved through the addition of after-treatment technology, replacement of existing engines with new technology or alternatively fueled engines, or

restrictions placed on the operation of existing equipment. The details of each of the recommended measures will be addressed during the development of the regulations.

C. What measures does ARB recommend regarding diesel fuel reformulation?

Table 12 summarizes the recommended measures regarding diesel fuel reformulation. The measures identified in this section are discussed in more detail in Appendix IV.

Table 12: Summary of Recommendations

Recommendation	Emission Reduction (%) Diesel PM	Incremental Cost ($/gal)	Implementation or Issue Date
Very low-sulfur CARB diesel (≤ 15 ppmw S)	> 90 *	< 0.05	2005-2006
Guidance on alternative "diesel" fuels	20 **	< 0.18 **	2001

* Emission reductions with after-treatment.

** Estimated for emulsions of water in CARB diesel.

ARB staff recommends that a regulation be adopted in 2001 that requires very low-sulfur CARB diesel for all diesel-fueled engines statewide, effective in 2006. ARB also recommends that programs be developed to ensure the adequate supply of very low-sulfur diesel fuel for vehicle fleets and stationary engines that are required through state or local rules to install catalytic add-on controls prior to 2006. The U.S. EPA has published proposed regulations which would require that all diesel fuel sold for use in on-road vehicles have a sulfur content no greater than 15 ppmw, beginning June 1, 2006. It is envisioned that the ARB regulation would apply to on-road and off-road sources but would otherwise be consistent with the U.S. EPA's efforts and enable the retrofit of off-road and stationary diesel engines with catalyst-based after-treatment control technologies.

ARB staff is also proposing to develop guidance on synthetic or alternative diesel fuel options. Synthetic or alternative diesel fuels may cost more than reformulated very low-sulfur CARB diesel, but should be considered if shown to be cost-effective for reducing diesel PM. These alternatives may result in significant benefits for higher-emitting categories, such as off-road engines. Synthetic or alternative diesel fuels may also prove to be part of the preferred control strategy for diesel-fueled engines or vehicles that result in relatively high risk, or where control retrofit options are very expensive or difficult to implement.

The guidance will identify alternative diesel fuels and provide information on associated emission reductions and cost. The guidance would assist local districts in their permitting of fleets and equipment, and may be especially useful in cases where control equipment retrofits are impractical.

D. What impact will the recommended measures have on diesel PM emissions and risk?

As illustrated in Figures 3 and 4, ARB staff estimates the full implementation of the recommended measures, including retrofit of locomotives and commercial marine vessels, will result in an overall 75 percent reduction in the diesel PM inventory and the associated potential cancer risk for 2010, and an 85 percent reduction for 2020, when compared to today's diesel PM inventory and risk. These reductions will occur through the combined actions of both California and the U.S. EPA to adopt and implement rules that reduce diesel PM.

From 2000 to 2010, ARB staff predicts diesel PM emissions and risk would decrease by only about 20 percent if the recommended measures are not implemented. This reduction would result from the implementation of existing federal and state regulations and the attrition of older diesel-fueled passenger cars and light-duty trucks from the on-road fleet. The U.S. EPA has proposed new, lower emission standards for heavy-duty trucks for 2007 and lower sulfur limits for diesel fuel (on-road vehicles only) in 2006. The benefits of these proposed rules are not included as existing measures because they have not been adopted as of the date of this Plan.

The recommended measures can be grouped as follows: measures addressing on-road vehicles; measures addressing off-road equipment and vehicles, and measures addressing stationary and portable engines. These measures include the U.S. EPA proposed 2007 new heavy-duty truck standards and the proposed 2006 low-sulfur fuel limits. Figure 4 illustrates the impact of each of these groups of measures on projected diesel PM emission levels for 2010 and 2020. As shown, off-road recommended measures have the largest impact. Of the off-road recommended measures, the retrofit measures (see Table 10) result in over 90 percent of the diesel PM reductions associated with all of the off-road measures.

Figure 3: Projected Percent Reduction in Diesel PM Cancer Risk from year 2000 Levels With and Without ARB Risk Reduction Plan (RRP) Implemented

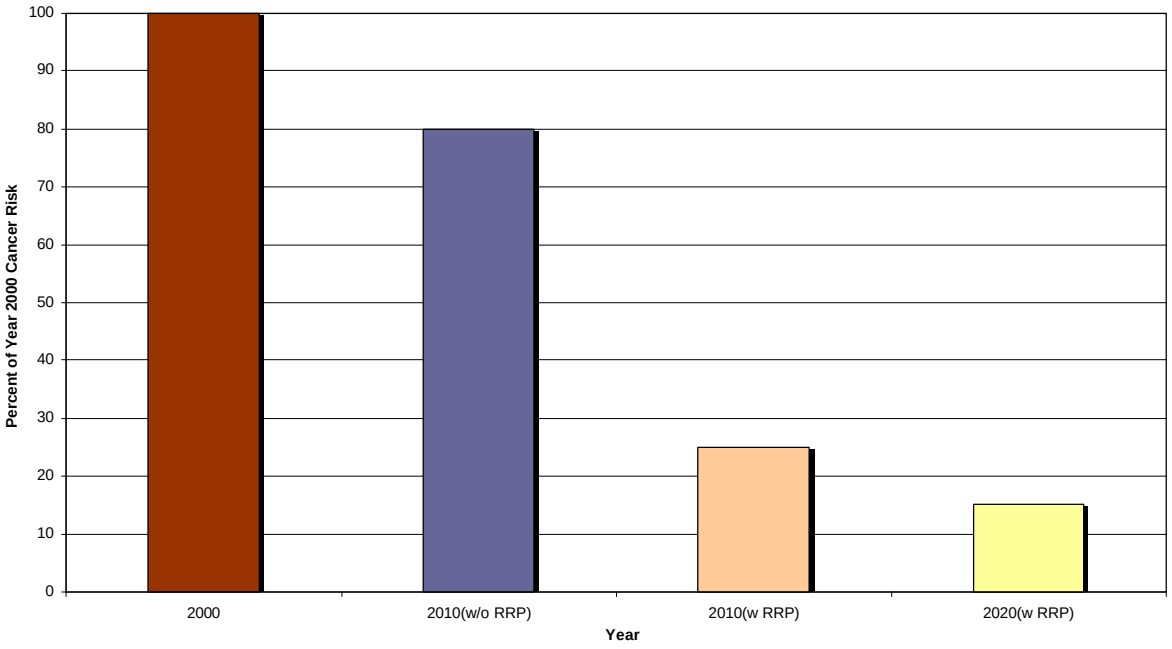
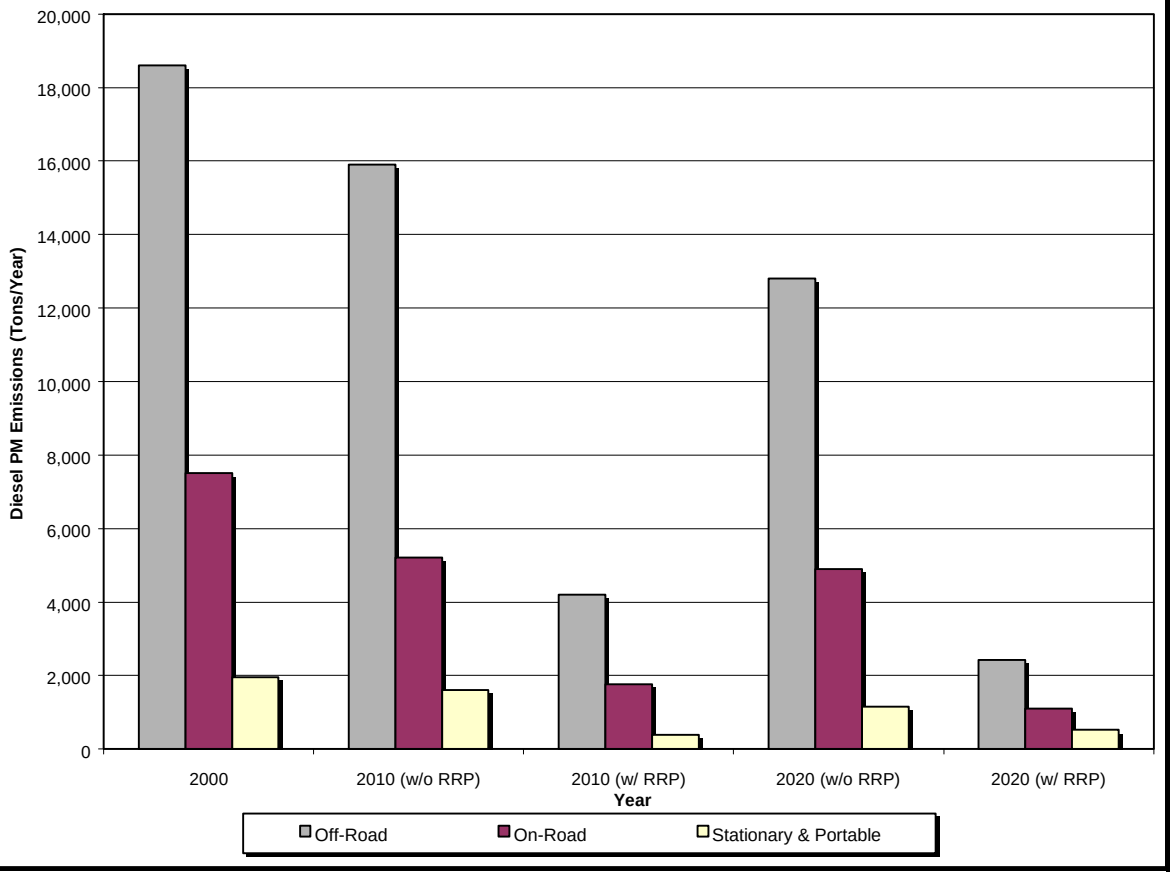


Figure 4: Projected Diesel PM Emission Levels With and Without ARB Risk Reduction Plan (RRP) Implemented



E. What other expected benefits are associated with implementing the recommended measures?

As discussed in the previous two sections, full implementation of the measures in this plan will result in significant reductions in diesel PM emissions and the associated risk. There are additional benefits associated with reducing diesel PM emissions. These include:

- Increased visibility;
- Less material damage due to "soiling" of surfaces with diesel PM;
- Decreased noncancer health effects associated with diesel PM; and
- Decreased deposits of diesel PM and toxic chemicals on to surface water.

F. What possible adverse impacts may be associated with the recommended measures?

Most recommended measures require the use of add-on control devices, engine modifications, catalysts, low-sulfur diesel fuel and/or alternative fuel formulations. ARB staff has identified possible adverse environmental and safety impacts associated with the recommended measures. Each of these impacts will be fully investigated and addressed during the rulemaking process. Possible adverse impacts are identified below.

- Potential for decrease in fuel economy;
- Potential for increases in emissions of hydrocarbons (HC), oxides of nitrogen (NOx), and carbon monoxide (CO);
- Potential for changes in composition of diesel exhaust that could result in an increase in emissions of other toxic air pollutants.
- Potential for contamination of ground and surface waters;
- Potential safety issues due to use and handling of gaseous-fuels; and
- Potential increase in hazardous waste from the disposal of spent catalyst material.

G. What actions should the U.S. EPA pursue to support the ARB staff's recommended measures?

ARB staff recommends that the U.S. EPA adopt standards and regulations applicable to all 50 states that are similar in both scope and stringency to the measures in this plan. Further, ARB staff recommends the U.S. EPA take the following actions to support the measures in this plan and to reduce diesel PM emissions nationwide.

- *The U.S. EPA should implement more stringent emission standards for diesel PM in the Tier 3 rulemaking than are currently envisioned in the Off-Road Statement of Principles.*

Currently, the federal Clean Air Act preempts California from regulating new construction and farm equipment below 175 horsepower, new locomotives and locomotive engines, and commercial marine engines. Preempted off-road vehicles and equipment generate approximately 60 percent of the diesel PM emissions from off-road sources, thus limiting California's ability to achieve significant emission reductions on its own. Recent developments suggest that off-road engine control can move directly to after-treatment technology-based standards with higher emission reductions, on a cost-effective per engine basis. The U.S. EPA should, therefore, consider accelerating the implementation of emission standards based on after-treatment technologies with the goal of reducing diesel PM emissions by 90 percent from engines in these categories.

- *Require all diesel-fueled on-road and off-road engines and vehicles to use very low-sulfur diesel fuel (≤15 ppm).*
  The U.S. EPA has proposed regulations that would require all very low-sulfur diesel fuel to be sold for use in on-road vehicles beginning June 1, 2006, but has not proposed to extend this requirement to off-road sources. ARB staff's recommended measures for off-road engines are based on the use of very low-sulfur diesel fuel and the use of exhaust after-treatment devices which would require low-sulfur fuel. It is critical that very low-sulfur diesel fuel be required to be sold nationwide for use in both on-road and off-road engines and vehicles. If not, California-only off-road regulations should be developed, but issues concerning the cost-effectiveness of developing California-only engine/after treatment systems and the compatibility of those systems with a higher sulfur national off-road diesel fuel need to be explored.

- *The U.S. EPA should require more stringent control of PM emissions from commercial marine vessels through retrofit of existing engines.*
  Emissions from commercial marine vessels, which include ocean-going vessels, tugboats, fishing boats, cruise ships, and other large ships, are a major source of diesel PM which is expected to grow from 2000 to 2010. A program to retrofit existing engines could provide significant benefits over the adopted controls for new engines recently adopted by the U.S. EPA. The U.S. EPA should, therefore, develop standards to reduce diesel PM emissions from these engines.

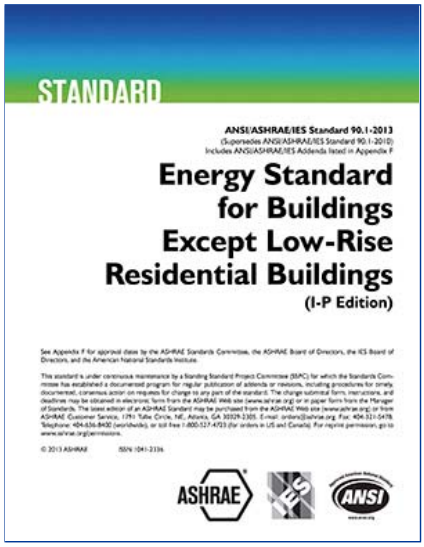
- *The U.S. EPA should require the implementation of a retrofit program to reduce diesel PM from locomotives.*
  The current national rule only affects particulate matter emissions from model year 2005 and later locomotives and does not significantly reduce PM emissions from older locomotives. Recent developments in diesel particulate filter technology suggest that a locomotive retrofit program may be feasible and cost-effective. The U.S. EPA should, therefore, develop retrofit standards to reduce diesel PM emissions from engines in these categories.

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About Standard 90.1

This standard provides the minimum requirements for energy-efficient design of most buildings, except low-rise residential buildings. It offers, in detail, the minimum energy-efficient requirements for design and construction of new buildings and their systems, new portions of buildings and their systems, and new systems and equipment in existing buildings, as well as criteria for determining compliance with these requirements. It is an indispensable reference for engineers and other professionals involved in design of buildings and building systems.

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- Revised, stricter opaque element and fenestration requirements at a reasonable level of cost-effectiveness
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- New provisions for commercial refrigeration equipment and improved controls for heat rejection and boiler equipment
- Improved requirements for expanded use of energy recovery, small-motor efficiencies, and fan power control and credits
- Improved equipment efficiencies for chillers
- Clarifications for the use of prescriptive provisions when performing building energy use modeling, and revisions to enhance capturing daylighting when performing modeling calculations
- A new alternate compliance path to Section 6, "Heating, Ventilating, and Air-Conditioning," for computer room systems, developed with ASHRAE Technical Committee (TC) 9.9.

In addition to offering immediate access to the content, the PDF download of this standard presents selected graphics in color for enhanced readability.

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90.1-2013 User's Manual

This User's Manual provides detailed instruction for the design of commercial and high-rise residential buildings to ensure their compliance with ANSI/ASHRAE/IES Standard 90.1-2013. It includes measurements and calculations in both I-P and SI units, sample calculations, application examples, forms to demonstrate compliance, and references to helpful resources and websites.



ICC -- Significant Changes to the International Energy Conservation Code and ANSI/ASHRAE/IES Standard 90.1-2010

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BAY AREA AIR QUALITY MANAGEMENT DISTRICT

Planning, Rules and Research | CEQA Guidelines

CEQA Guidelines

UPDATE: January 16, 2014: On June 2, 2010, the Bay Area Air Quality Management District's Board of Directors unanimously adopted thresholds of significance to assist in the review of projects under the California Environmental Quality Act. These Thresholds are designed to establish the level at which the District believed air pollution emissions would cause significant environmental impacts under CEQA and were posted on the Air District's website and included in the Air District's updated CEQA Guidelines (updated May 2012).

On March 5, 2012 the Alameda County Superior Court issued a judgment finding that the Air District had failed to comply with CEQA when it adopted the Thresholds. The court did not determine whether the Thresholds were valid on the merits, but found that the adoption of the Thresholds was a project under CEQA. The court issued a writ of mandate ordering the District to set aside the Thresholds and cease dissemination of them until the Air District had complied with CEQA. The Air District has appealed the Alameda County Superior Court's decision. The Court of Appeal of the State of California, First Appellate District, reversed the trial court's decision. The Court of Appeal's decision was appealed to the California Supreme Court, which granted limited review, and the matter is currently pending there.

In view of the trial court's order which remains in place pending final resolution of the case, the Air District is no longer recommending that the Thresholds be used as a generally applicable measure of a project's significant air quality impacts. Lead agencies will need to determine appropriate air quality thresholds of significance based on substantial evidence in the record. Although lead agencies may rely on the Air District's updated CEQA Guidelines (updated May 2012) for assistance in calculating air pollution emissions, obtaining information regarding the health impacts of air pollutants, and identifying potential mitigation measures, the Air District has been ordered to set aside the Thresholds and is no longer recommending that these Thresholds be used as a general measure of project's significant air quality impacts. Lead agencies may continue to rely on the Air District's 1999 Thresholds of Significance and they may continue to make determinations regarding the significance of an individual project's air quality impacts based on the substantial evidence in the record for that project.

Various tools and resources are available on this website to assist local jurisdictions in applying the Air District's CEQA Guidelines.

For more information, please contact Alison Kirk, Senior Environmental Planner at akirk@baaqmd.gov or 415-749-5169.

Learn more about the updated CEQA Guidelines.

View the District's 1999 CEQA Guidelines.

To view the State CEQA Guidelines and related materials visit the California Resources Agency.

California Air Districts Launch Greenhouse Gas Exchange

Update: January 2, 2014

The California Air Pollution Control Officers Association (CAPCOA), representing California's 35 local air districts, has launched the CAPCOA *Greenhouse Gas Exchange*. The *Exchange* provides a reliable, low-cost, secure platform to encourage locally generated, high quality GHG emission reduction credits that can be used to meet CEQA or other compliance requirements.

CalEEMod Release

Update: August 5, 2013

On July 31, 2013, the California Air Pollution Control Officers Association (CAPCOA) released CalEEMod 2013.2. This land use model can be downloaded from www.caleemod.com. From this point forward, the BAAQMD will no longer support the use of Urbemis. Please perform all future analyses using CalEEmod. For more information or to ask questions, please contact Alison Kirk, Senior Environmental Planner at akirk@baaqmd.gov or 415-749-5169.

Last Updated: 1/12/2015

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BAY AREA
AIR QUALITY
MANAGEMENT
DISTRICT

BAAQMD

Air Toxics NSR Program

Health Risk Screening Analysis

(HRSA) Guidelines

January 2010

BAY AREA AIR QUALITY MANAGEMENT DISTRICT
939 ELLIS STREET
SAN FRANCISCO, CA 94109

BAAQMD Air Toxics NSR Program
Health Risk Screening Analysis (HRSA) Guidelines

1. INTRODUCTION

This document describes the Bay Area Air Quality Management District's guidelines for conducting health risk screening analyses. Any health risk screening analysis (HRSA) that is required pursuant to Regulation 2 Permits, Rule 1 General Requirements or Rule 5 New Source Review of Toxic Air Contaminants shall be conducted in accordance with these guidelines.

In accordance with Regulation 2-5-402, these guidelines generally conform to the Health Risk Assessment Guidelines adopted by Cal/EPA's Office of Environmental Health Hazard Assessment (OEHHA) for use in the Air Toxics Hot Spots Program. In addition, these guidelines are in accordance with State risk assessment and risk management policies and guidelines in effect as of June 1, 2009. Through the District's rule development process, these guidelines will periodically be updated to clarify procedures, amend health effects data, or incorporate other revisions to regulatory guidelines.

2. PROCEDURES

The procedures described below constitute the Regulation 2-5-603 Health Risk Screening Analysis Procedures. Any HRSA shall be completed by following the procedures described in the OEHHA Health Risk Assessment Guidelines for the Air Toxics Hot Spots Program that were adopted by OEHHA on October 3, 2003 and any State risk assessment and risk management policies and guidelines in effect as of June 1, 2009.

The OEHHA Health Risk Assessment Guidelines contain several sections which identify (a) the overall methodology, (b) the exposure assessment assumptions and procedures, and (c) the health effects data (cancer potency factors, chronic reference exposure levels, and acute reference exposure levels).

A summary of OEHHA's Health Risk Assessment Guidelines and an index of the relevant documents are located at:

http://www.oehha.ca.gov/air/hot_spots/index.html

OEHHA's risk assessment methodology is located at:

http://www.oehha.ca.gov/air/risk_assess/index.html

The exposure assessment and stochastic technical support document (Part IV of OEHHA's Risk Assessment Guidelines) is located at:

http://www.oehha.ca.gov/air/exposure_assess/index.html

The Technical Support Document for Cancer Potency Factors: Methodologies for Derivation, Listing of Available Values, and Adjustments to Allow for Early Life Stage Exposures (May 2009) is located at:

http://www.oehha.ca.gov/air/hot_spots/tsd052909.html

The Technical Support Document for the Derivation of Noncancer Reference Exposure Levels is located at:

http://www.oehha.ca.gov/air/hot_spots/rels_dec2008.html

Sections 2.1 through 2.3 below clarify and highlight some of the exposure assessment procedures including exposure assumptions (e.g., breathing rate and exposure duration) and health effect values to be used for conducting HRSAs.

2.1 Clarifications of Exposure Assessment Procedures

This section clarifies and highlights some of the exposure assessment procedures that should be followed when conducting an HRSA. Please note that OEHHA is currently revising the Technical Support Document (TSD) for Exposure Assessment. When the revised TSD for Exposure Assessment is finalized and adopted, the District will revise the HRSA Guidelines accordingly.

2.1.1 Breathing Rate

On October 9, 2003, a statewide interim Risk Management Policy for inhalation-based residential cancer risk was adopted by the California Air Resources Board (ARB) and Cal/EPA's OEHHA (http://www.arb.ca.gov/toxics/rmpolicy.pdf). For the HRSA methodology used in the Air Toxics NSR Program, the District has conformed with these State guidelines and adopted the interim exposure assessment recommendations made by ARB and OEHHA. The interim policy recommends where a single cancer risk value for a residential receptor is needed or prudent for risk management decision-making, the potential cancer risk estimate for the inhalation exposure pathway be based on the breathing rate representing the 80th percentile value of the breathing rate range of values (302 L/kg-day).

To assess potential inhalation exposure to offsite workers, OEHHA recommends assuming a breathing rate of 149 L/kg-day. This value corresponds to a 70 kg worker breathing 1.3 m^3/hour (breathing rate recommended by USEPA as an hourly average for outdoor workers) for an eight-hour day.

For children, OEHHA recommends assuming a breathing rate of 581 L/kg-day to assess potential risk via the inhalation exposure pathway. This value represents the upper 95% percentile of daily breathing rates for children.

2.1.2 Exposure Time and Frequency

Based on OEHHA recommendations, the District will estimate cancer risk to residential receptors assuming exposure occurs 24 hours per day for 350 days per year. For a worker receptor, exposure is assumed to occur 8 hours per day for 245 days per year. However, for some professions (e.g., teachers) a different schedule may be more appropriate. For children at school sites, exposure is assumed to occur 10 hours per day for 180 days (or 36 weeks) per year.

2.1.3 Exposure Duration

Based on OEHHA recommendations, the District will estimate cancer risk to residential receptors based on a 70-year lifetime exposure. Although 9-year and 30-year exposure scenarios may be presented for information purposes, risk management decisions will be made based on 70-year exposure duration for residential receptors. For worker receptors, risk management decisions will be made based on OEHHA's recommended exposure duration of 40 years. Cancer risk estimates for children at school sites will be calculated based on a 9 year exposure duration.

2.2 Health Effects Values

Chemical-specific health effects values have been consolidated and are presented in Table 2-5-1 for use in conducting HRSAs. Toxicity criteria summarized in Table 2-5-1 represent health effects values that were adopted by OEHHA/ARB as of June 1, 2009. Although 8-hour RELs for six chemicals were adopted in December 2008, these 8-hour RELs will not be used in conducting HRSAs until OEHHA finalizes and adopts the revised TSD for Exposure Assessment. Prior to use in Regulation 2, Rule 5, any new or revised health effects values adopted by OEHHA/ARB after June 1, 2009 will be reviewed by the District through a rule development process. The District will evaluate the new criteria for implementation, enforcement, and feasibility of compliance with the project risk limits.

2.3 Cancer Risk Calculations

In accordance with OEHHA's revised health risk assessment guidelines (specifically, OEHHA's Technical Support Document (TSD) for Cancer Potency Factors, adopted June 1, 2009), calculation of cancer risk estimates should incorporate age sensitivity factors (ASFs).

The revised TSD for Cancer Potency Factors provides updated calculation procedures used to consider the increased susceptibility of infants and children to carcinogens, as compared to adults. The updated calculation procedure includes the use of age-specific weighting factors in calculating cancer risks from exposures of infants, children and adolescents, to reflect their anticipated special sensitivity to carcinogens. OEHHA recommends weighting cancer risk by a factor of 10 for exposures that occur from the third trimester of pregnancy to 2 years of age, and by a factor of 3 for exposures that occur from 2 years through 15 years of age. These weighting factors should be applied to all carcinogens. For estimating cancer risk for residential receptors, the incorporation of the ASFs results in a cancer risk adjustment factor of 1.7. For estimating cancer risk for student receptors, a cancer risk adjustment factor of 3 should be applied. For estimating cancer risk for worker receptors, a cancer risk adjustment factor of 1 should be applied.

The cancer risk adjustment factors were developed based on the following:

Receptor	Age Bins	ASF	Duration	Cancer Risk Adjustment Factor
Resident	Third trimester to age 2 years	10	2.25/70	0.32
	Age 2 to age 16 years	3	14/70	0.60
	Age 16 to 70 years	1	54/70	0.77
	Total lifetime			***1.7***
Student	Age 2 to age 16 years	3	9 years	***3***
Worker	Age 16 to 70 years	1	40 years	***1***

Since the exposure duration for a student receptor (9 years), and worker receptor (40 years), falls within a single age bin, the student cancer risk adjustment factor is 3 and the worker cancer risk adjustment factor is 1.

Cancer risk adjustment factors should be used to calculate all cancer risk estimates. Please note that these ASFs represent default values. In cases where there are adequate data for specific carcinogen potency by age, OEHHA will recommend chemical-specific adjustments to cancer risk estimates. In addition, OEHHA is currently revising the TSD for Exposure Assessment. When the revised TSD for Exposure Assessment is finalized and adopted, the District will revise the HRSA Guidelines accordingly.

Below is the equation for calculating cancer risk estimates:

Cancer Risk = Dose * Cancer Risk Adjustment Factor * Cancer Potency Factor

2.4 Stochastic Risk Assessment

For a stochastic, multipathway risk assessment, the potential cancer risk should be reported for the full distribution of exposure from all exposure pathways included in the risk assessment. For risk management decisions, the potential cancer risk from a stochastic, multipathway risk assessment should be based on the 95th percentile cancer risk.

3. Assessment of Acrolein Emissions

Currently, CARB does not have certified emission factors or an analytical test method for acrolein. Therefore, since the appropriate tools needed to implement and enforce acrolein emission limits are not available, the District will not conduct a HRSA for emissions of acrolein. When the necessary tools are developed, the District will re-evaluate this specific evaluation procedure and the HRSA guidelines will be revised.

References

1 *"Air Toxics "Hot Spots" Program Risk Assessment Guidelines, The Air Toxics Hot Spots Program Guidance Manual for Preparation of Health Risk Assessments, ", OEHHA, August 2003*

2 *"Air Toxics "Hot Spots" Program Risk Assessment Guidelines, Part IV. Technical Support Document for Exposure Assessment and Stochastic Analysis", OEHHA, September 2000*

3 *"Air Toxics "Hot Spots" Program Risk Assessment Guideline, Technical Support Document for Cancer Potency Factors: Methodologies for derivation, listing of available values, and adjustments to allow for early life stage exposures", OEHHA, May, 2009.*

4 *"Air Toxics "Hot Spots" Program Risk Assessment Guidelines Technical Support Document for the Determination of Noncancer Reference Exposure Levels", OEHHA, June 2008.*

5 *"Guidance for School Site Risk Assessment Pursuant to Health and Safety Code Section 901(f): Guidance for Assessing Exposures and Health Risks at Existing and Proposed School Sites: Final Report", Integrated Risk Assessment Section, Office of Environmental Health Hazard Assessment, California Environmental Protection Agency, February, 2004.*

6 *"Consolidated Table of OEHHA/ARB Approved Risk Assessment Health Values", California Air Resources Board, updated February, 2009.*

BAY AREA AIR QUALITY MANAGEMENT DISTRICT

Air Quality Standards and Attainment Status

Ambient air quality standards are set to protect public health. There are currently both Federal and State ambient air quality standards by USEPA and state air quality agencies, CALEPA for California. California air quality standards are generally more stringent that federal standards. Continuous air monitoring by these agencies and BAAQMD ensure that air quality standards are being met and improved.

Pollutant	Averaging Time	California Standards[1]		National Standards[2]	
		Concentration	Attainment Status	Concentration[3]	Attainment Status
Ozone	8 Hour	0.070 ppm (137µg/m^3)	N[9]	0.075 ppm	N[4]
	1 Hour	0.09 ppm (180 µg/m^3)	N		See footnote # 5
Carbon Monoxide	8 Hour	9.0 ppm (10 mg/m^3)	A	9 ppm (10 mg/m^3)	A[6]
	1 Hour	20 ppm (23 mg/m^3)	A	35 ppm (40 mg/m^3)	A
Nitrogen Dioxide	1 Hour	0.18 ppm (339 µg/m^3)	A	0.100 ppm (see footnote 11)	U
	Annual Arithmetic Mean	0.030 ppm (57 µg/m^3)		0.053 ppm (100 µg/m^3)	A
Sulfur Dioxide (See Footnote #12)	24 Hour	0.04 ppm (105 µg/m^3)	A	0.14 ppm (365 µg/m^3)	A
	1 Hour	0.25 ppm (655 µg/m^3)	A	0.075 ppm (196 µg/m^3)	A
	Annual Arithmetic Mean			0.030 ppm (80 µg/m^3)	A
Particulate Matter (PM10)	Annual Arithmetic Mean	20 µg/m^3	N[7]		
	24 Hour	50 µg/m^3	N	150 µg/m^3	U

	Annual Arithmetic Mean	12 µg/m^3	N[7]	15 µg/m^3	A
	24 Hour			35 µg/m^3 See Footnote 10	N
Sulfates	24 Hour	25 µg/m^3	A		
Lead (See Footnote 13)	30 day Average	1.5 µg/m^3		-	A
	Calendar Quarter	-		1.5 µg/m^3	A
	Rolling 3 Month Average[14]	-		0.15 µg/m^3	(See Footnote 14)
Hydrogen Sulfide	1 Hour	0.03 ppm (42 µg/m^3	U		
Vinyl Chloride (chloroethene)	24 Hour	0.010 ppm (26 µg/m^3	No information available		
Visibility Reducing particles	8 Hour (10:00 to 18:00 PST)	See Footnote 8	U		
A=Attainment N=Nonattainment U=Unclassified					
mg/m^3=milligrams per cubic meter		ppm=parts per million		µg/m^3=micrograms per cubic meter	

NOTES

1. California standards for ozone, carbon monoxide (except Lake Tahoe), sulfur dioxide (1-hour and 24-hour), nitrogen dioxide, suspended particulate matter - PM10, and visibility reducing particles are values that are not to be exceeded. The standards for sulfates, Lake Tahoe carbon monoxide, lead, hydrogen sulfide, and vinyl chloride are not to be equaled or exceeded. If the standard is for a 1-hour, 8-hour or 24-hour average (i.e., all standards except for lead and the PM10 annual standard), then some measurements may be excluded. In particular, measurements are excluded that ARB determines would occur less than once per year on the average. The Lake Tahoe CO standard is 6.0 ppm, a level one-half the national standard and two-thirds the state standard.

2. National standards shown are the "primary standards" designed to protect public health. National standards other than for ozone, particulates and those based on annual averages are not to be

exceeded more than once a year. The 1-hour ozone standard is attained if, during the most recent three-year period, the average number of days per year with maximum hourly concentrations above the standard is equal to or less than one. The 8-hour ozone standard is attained when the 3-year average of the 4th highest daily concentrations is 0.075 ppm (75 ppb) or less. The 24-hour PM10 standard is attained when the 3-year average of the 99th percentile of monitored concentrations is less than 150 µg/m3. The 24-hour PM2.5 standard is attained when the 3-year average of 98th percentiles is less than 35 µg/m3.

> Except for the national particulate standards, annual standards are met if the annual average falls below the standard at every site. The national annual particulate standard for PM10 is met if the 3-year average falls below the standard at every site. The annual PM2.5 standard is met if the 3-year average of annual averages spatially-averaged across officially designed clusters of sites falls below the standard.

3. National air quality standards are set by US EPA at levels determined to be protective of public health with an adequate margin of safety.

4. Final designations effective July 20, 2012.

5. The national 1-hour ozone standard was revoked by U.S. EPA on June 15, 2005.

6. In April 1998, the Bay Area was redesignated to attainment for the national 8-hour carbon monoxide standard.

7. In June 2002, CARB established new annual standards for PM2.5 and PM10.

8. Statewide VRP Standard (except Lake Tahoe Air Basin): Particles in sufficient amount to produce an extinction coefficient of 0.23 per kilometer when the relative humidity is less than 70 percent. This standard is intended to limit the frequency and severity of visibility impairment due to regional haze and is equivalent to a 10-mile nominal visual range.

9. The 8-hour CA ozone standard was approved by the Air Resources Board on April 28, 2005 and became effective on May 17, 2006.

10. On January 9, 2013, EPA issued a final rule to determine that the Bay Area attains the 24-hour PM2.5 national standard. This EPA rule suspends key SIP requirements as long as monitoring data continues to show that the Bay Area attains the standard. Despite this EPA action, the Bay Area will continue to be designated as "non-attainment" for the national 24-hour PM2.5 standard until such time as the Air District submits a "redesignation request" and a "maintenance plan" to EPA, and EPA approves the proposed redesignation.

11. To attain this standard, the 3-year average of the 98th percentile of the daily maximum 1-hour average at each monitor within an area must not exceed 0.100ppm (effective January 22, 2010).

12. On June 2, 2010, the U.S. EPA established a new 1-hour SO2 standard, effective August 23, 2010, which is based on the 3-year average of the annual 99th percentile of 1-hour daily maximum concentrations. The existing 0.030 ppm annual and 0.14 ppm 24-hour SO2 NAAQS however must continue to be used until one year following U.S. EPA initial designations of the new 1-hour SO2 NAAQS. EPA expects to designate areas by June 2012.

13. ARB has identified lead and vinyl chloride as 'toxic air contaminants' with no threshold level of exposure below which there are no adverse health effects determined.

14. National lead standard, rolling 3-month average: final rule signed October 15, 2008. Final designations effective December 31, 2011.

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BAAQMD CEQA GUIDELINES
Assessing the Air Quality Impacts of Projects and Plans

Prepared by the Planning and Research Division of the
Bay Area Air Quality Management District
939 Ellis Street
San Francisco, CA 94109

December, 1999

This document is intended to serve as a guide for those who prepare or evaluate air quality impact analyses for projects and plans in the San Francisco Bay Area. The GUIDELINES include information on legal requirements, BAAQMD rules, plans and procedures, methods of analyzing air quality impacts, thresholds of significance, mitigation measures, and background air quality information. Copies and updates are available from the BAAQMD Public Information Office at (415) 749-4900. Questions on content may be addressed to the BAAQMD's Planning and Transportation Section at (415) 749-4995.

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CHAPTER 1 - INTRODUCTION

1.1 Background

The purpose of these Guidelines is to assist Lead Agencies, as well as consultants, project proponents and other interested parties, in evaluating potential air quality impacts of projects and plans proposed in the San Francisco Bay Area. Specifically, these Guidelines explain the procedures that the Bay Area Air Quality Management District (BAAQMD or "District") recommends be followed during environmental review processes required by the California Environmental Quality Act (CEQA). The Guidelines provide direction on how to evaluate potential air quality impacts, how to determine whether these impacts are significant, and how to mitigate these impacts. It is hoped that by providing this guidance, the air quality impacts of plans and development proposals will be analyzed accurately and consistently, and adverse impacts will be minimized.

These guidelines do not attempt to address every type of project that may be subject to CEQA analysis. Greatest emphasis is placed on: development proposals, such as commercial or residential projects, that generate significant numbers of vehicle trips (and associated air pollutant emissions); impacts related to nuisances (such as odors and dust), toxic air contaminants and accidental releases of hazardous materials, often resulting from air pollutant sources and members of the public being in close proximity; and preparation or revision of plans, such as general plans or specific plans.

1.2 How to Use These Guidelines

This document replaces the District's previous CEQA guidance document, *Air Quality and Urban Development: Guidelines for Assessing Impacts of Projects and Plans*, published in November 1985 (with revisions through August 1991). This 1996 document has more current information regarding issues including federal and State requirements, regional air quality plans, emission inventories, analytical procedures and mitigation strategies. Some of the more significant additions or revisions in this document include the following:

- Recommendations regarding early consultation procedures between Lead Agencies and project proponents on issues such as land use and design measures to reduce auto use, land use conflicts and sensitive receptors, and District regulatory requirements. (See pages 9-11.)

- Thresholds of significance for impacts associated with construction, project operations, odors, toxics, accidental releases, cumulative impacts, and plans. (See pages 13-25.)

- Calculating mobile source emissions using the URBEMIS model. (See pages 31-33.)

- Determining background carbon monoxide (CO) concentrations for use in microscale CO modeling. (See pages 41-46.)

- Mitigating air quality impacts through land use and design measures. (See pp. 9-11, 53-56.)

The recommendations in these Guidelines should be viewed as minimum considerations for air quality analysis. A Lead Agency or a project proponent may substitute more sophisticated models, more precise input data, innovative mitigation measures and/or other features. The District encourages creative approaches to impact analysis and mitigation in planning for air quality improvement.

Portions of these Guidelines will be revised as new information becomes available on such matters as revised emission factors for the Bay Area motor vehicle fleet or emission inventories. Copies and updates of these Guidelines are available from the District's Public Information Office at (415) 749-4900. Questions on content may be addressed to the District's Planning and Transportation Section at (415) 749-4995.

Organization of the Guidelines

Chapter 1 provides a summary of the purpose of the document, a brief overview of District responsibilities, and summary information regarding air pollution in the Bay Area.

Chapter 2 suggests early consultation procedures and issues for consideration by Lead Agencies, discusses preparation of the Initial Study, and provides thresholds of significance for determining whether an air quality impact is significant.

Chapter 3 describes methods for estimating air quality impacts. The chapter addresses impacts from project construction, project operations, and plans.

Chapter 4 describes methods for mitigating air quality impacts. The chapter discusses mitigation strategies to be considered at the general plan level, and project-specific mitigation measures.

Appendix A discusses laws, regulations, programs and plans related to air quality management.

Appendix B summarizes sources and effects of air pollutants.

Appendix C summarizes the region's attainment status with respect to national and State air quality standards, and discusses air quality problems and trends.

Appendix D discusses how climate and topography influence air quality conditions, and provides a detailed description of climate and topography for various subregions in the Bay Area.

Appendix E summarizes the District's activities with respect to toxic air contaminants.

Appendix F summarizes recommended resources and guidance documents that Lead Agencies may wish to consult when developing mitigation measures.

Appendix G provides a glossary.

Appendix H provides the references used in the preparation of this document.

1.3 District Responsibilities

The District is the agency primarily responsible for assuring that national and State ambient air quality standards are attained and maintained in the San Francisco Bay Area. Among the District's many responsibilities are the following: preparation of plans for attaining and maintaining ambient air quality standards in the region; adoption and enforcement of rules and regulations concerning air pollutant sources; issuing permits for stationary sources of air pollutants; inspecting stationary sources of air pollutants and responding to citizen complaints; monitoring ambient air quality and meteorological conditions; awarding grants to reduce motor vehicle emissions; conducting public education campaigns; and many other activities. The District's jurisdiction includes all of Alameda, Contra Costa, Marin, Napa, San Francisco, San Mateo and Santa Clara Counties, and the southern portions of Solano and Sonoma Counties. Figure 1 shows the boundaries of the District's jurisdiction. Further information about District activities is provided in Appendix A.

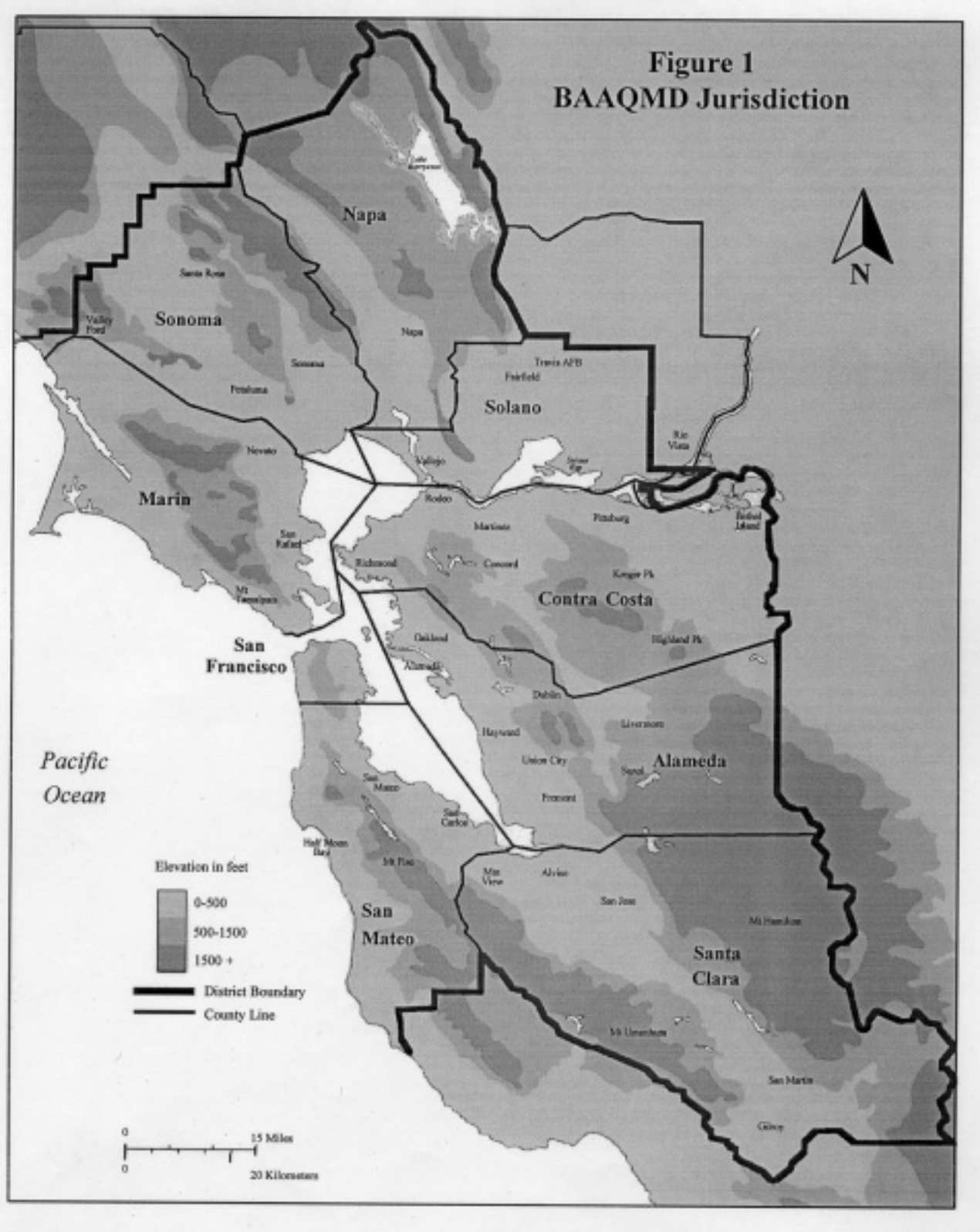
In its efforts to reduce air pollution and achieve ambient air quality standards, the District also works with many other agencies and organizations, including: U.S. Environmental Protection Agency, California Air Resources Board, Metropolitan Transportation Commission, Association of Bay Area Governments, congestion management agencies, cities and counties, and various non-governmental organizations. Appendix A provides further information regarding other agencies with whom the District cooperates. Appendix A also provides an overview of federal and State laws and programs that affect air quality.

The District is involved in the CEQA process in a variety of ways.

Lead Agency - The District acts as a Lead Agency when it has the primary authority to implement or approve a project. The District acts as a Lead Agency when it adopts air quality plans for the region, as well as when it adopts rules and regulations. The District also occasionally acts as a Lead Agency, or prepares supplemental environmental documentation, for projects subject to District permit requirements.

Responsible Agency - The District acts as a Responsible Agency when it has discretionary authority over a project, but does not have the primary discretionary authority of a Lead Agency. As a Responsible Agency, the District may coordinate the environmental review process with the District's permitting process, provide comments to the Lead Agency regarding potential impacts, and recommend mitigation measures.

Commenting Agency - The District acts as a Commenting Agency when it is not a Lead or Responsible Agency (i.e., it does not have discretionary authority over a project), but when it may have concerns about the air quality impacts of a proposed project or plan. As a Commenting Agency, the District reviews environmental documents prepared for development proposals and plans in the Bay Area and provides comments to Lead Agencies regarding air quality impacts and mitigation measures.


Figure 1
BAAQMD Jurisdiction
N
Napa
Sonoma
Solano
Marin
San Francisco
Contra Costa
Alameda
San Mateo
Santa Clara
Pacific Ocean
Elevation in feet
0-500
500-1500
1500 +
District Boundary
County Line
0
15 Miles
0
20 Kilometers

1.4 Air Pollutants of Concern in the Bay Area

State and national ambient air quality standards have been established for the following pollutants: ozone, carbon monoxide, nitrogen dioxide, sulfur dioxide, fine particulate matter (PM_{10}) and lead. For some of these pollutants, notably ozone and PM_{10}, the State standards are more stringent than the national standards. The State has also established ambient air quality standards for sulfates, hydrogen sulfide, vinyl chloride and visibility reducing particles. The above-mentioned pollutants are generally known as "criteria pollutants." Appendix A provides further information on ambient air quality standards.

District regulations and programs seek to minimize emissions of all air pollutants. These Guidelines, however, focus primarily on the criteria pollutants for which the region still periodically exceeds State and national standards (ozone and PM_{10}) or for which the region occasionally exceeded State or national standards in the recent past (carbon monoxide).

Ground level ozone, often referred to as smog, is not emitted directly, but is formed in the atmosphere through complex chemical reactions between nitrogen oxides (NO_x) and reactive organic gases (ROG) in the presence of sunlight. The principal sources of NO_x and ROG, often termed ozone precursors, are combustion processes (including motor vehicle engines) and evaporation of solvents, paints and fuels. Motor vehicles are the single largest source of ozone precursor emissions in the Bay Area. Exposure to ozone can cause eye irritation, aggravate respiratory diseases and damage lung tissue, as well as damage vegetation and reduce visibility.

Fine particulate matter (PM_{10}, or particulate matter less than 10 microns in diameter) includes a wide range of solid or liquid particles, including smoke, dust, aerosols and metallic oxides. There are many sources of PM_{10} emissions, including combustion, industrial processes, grading and construction, and motor vehicles. Of the PM_{10} emissions associated with motor vehicle use, some are tailpipe and tire wear emissions, but greater quantities are generated by resuspended road dust. Consequently, improvements in motor vehicle engines and fuels have not reduced PM_{10} emissions as significantly as they have reduced emissions of other pollutants. Reductions in motor vehicle *use* are needed to significantly reduce PM_{10} emissions from resuspended road dust. District research also has shown that wood burning in fireplaces and stoves is a significant source of PM_{10}, particularly during episodes when PM_{10} levels are at their highest.

Fine particulate matter is of concern because it can bypass the body's natural filtration system more easily than larger particles, and can lodge deep in the lungs. Health effects of PM_{10} vary depending on a variety of factors, including the type and size of particle. Research has demonstrated a correlation between high PM_{10} concentrations and increased mortality rates. Elevated PM_{10} concentrations can also aggravate chronic respiratory illness such as bronchitis and asthma.

U.S. EPA in 1997 announced new ambient air quality standards for ozone and fine particulate matter. The new standards were intended to provide greater protection of public health. EPA proposed to phase out the 1-hour ozone standard and replace it with an 8-hour standard. With respect to fine particulate, EPA proposed a new standard for the smaller particles, $PM_{2.5}$, or particulate matter less than 2.5 microns in diameter. The new $PM_{2.5}$ standards included an

annual standard and a 24-hour standard. Following the announcement of the new national standards, the District began collecting monitoring data to determine the region's attainment status with respect to the new standards. Industry groups challenged the new standards in court, but as of December 1999 the status of the new standards was uncertain.

Carbon monoxide (CO) is an odorless, colorless gas that is formed by the incomplete combustion of fuels. Motor vehicles are by far the single largest source of CO in the Bay Area. At high concentrations, CO reduces the oxygen-carrying capacity of the blood and can cause headaches, dizziness, unconsciousness, and even death. CO also can aggravate cardiovascular disease.

In addition to the criteria pollutants discussed above, toxic air contaminants (TACs) are another group of pollutants of concern in the Bay Area. There are many different types of TACs, with varying degrees of toxicity. Sources of TACs include industrial processes such as petroleum refining and chrome plating operations, commercial operations such as gasoline stations and dry cleaners, and motor vehicle exhaust. Public exposure to TACs can result from emissions from normal operations, as well as accidental releases of hazardous materials during upset conditions. Health effects of TACs include cancer, birth defects, neurological damage and death.

Diesel exhaust is a growing concern in the Bay Area and throughout California. The California Air Resources Board (ARB) in 1998 identified diesel engine particulate matter as a toxic air contaminant. The exhaust from diesel engines includes hundreds of different gaseous and particulate components, many of which are toxic. Many of these toxic compounds adhere to the particles, and because diesel particles are very small, they penetrate deeply into the lungs. Diesel engine particulate matter has been identified as a human carcinogen. Mobile sources – including trucks, buses, automobiles, trains, ships and farm equipment – are by far the largest source of diesel emissions. Studies show that diesel particulate matter concentrations are much higher near heavily traveled highways and intersections. District analysis shows that the cancer risk from exposure to diesel exhaust is much higher than the risk associated with any other toxic air pollutant routinely measured in the region.

Prior to the listing of diesel exhaust as a toxic air contaminant, California had already adopted various regulations that would reduce diesel emissions. These regulations include new standards for diesel fuel, emission standards for new diesel trucks, buses, autos, and utility equipment, and inspection and maintenance requirements for heavy duty vehicles. Following the listing of diesel engine particulate matter as a toxic air contaminant, ARB is currently (as of December 1999) evaluating what additional regulatory action is needed to reduce public exposure. ARB does not plan on banning diesel fuel or engines. ARB may consider additional requirements for diesel fuel and engines, however, as well as other measures to reduce public exposure.

Other air quality issues of concern in the Bay Area include nuisance impacts of odors and dust. Objectionable odors may be associated with a variety of pollutants. Common sources of odors include wastewater treatment plants, landfills, composting facilities, refineries and chemical plants. Similarly, nuisance dust may be generated by a variety of sources including quarries, agriculture, grading and construction. Odors rarely have direct health impacts, but they can be very unpleasant and can lead to anger and concern over possible health effects among the public. Each year the District receives thousands of citizen complaints about objectionable odors. Dust

emissions can contribute to increased ambient concentrations of PM_{10}, particularly when dust settles on roadways where it can be pulverized and resuspended by traffic. Dust emissions also contribute to reduced visibility and soiling of exposed surfaces.

1.5 Air Quality Conditions in the Bay Area

Air quality conditions in the San Francisco Bay Area have improved significantly since the District was created in 1955. Ambient concentrations of air pollutants and the number of days on which the region exceeds air quality standards have fallen dramatically. Public health benefits, improved visibility, and reduced damage to plants and materials are among the benefits of this progress.

Continued progress is necessary, however. Following years of declining emissions and ambient concentrations of ozone, the Bay Area in 1995 was redesignated as an attainment area for the national 1-hour ozone standard. However, unusual heat waves triggered new exceedances of the national ozone standard during the summers of 1995 and 1996. As a result, in 1998 U.S. EPA redesignated the region back into nonattainment status for the national 1-hour ozone standard. The region also periodically exceeds State ambient air quality standards for ozone and particulate matter. The State standards for these pollutants are more stringent than the national standards. Exceedances of air quality standards occur primarily during meteorological conditions conducive to high pollution levels, such as cold, windless winter nights (for particulate matter) or hot, sunny summer afternoons (for ozone). As is true throughout much of the U.S., motor vehicle use is projected to increase substantially in the region. The District, local jurisdictions, and other parties responsible for protecting public health and welfare will need to continue to minimize the air quality impacts of growth and development.

Table 1 provides a summary of the current attainment status for the San Francisco Bay Area with respect to national and State ambient air quality standards. Appendix B provides information regarding sources and effects of air pollutants. Appendix C discusses air pollutant status, problems and trends in the Bay Area and summarizes ambient air quality monitoring data for recent years.

TABLE 1
BAY AREA ATTAINMENT STATUS AS OF DECEMBER 1999

Pollutant	Averaging Time	California Standards [1]		National Standards [2]	
		Concentration	Attainment Status	Concentration	Attainment Status
Ozone	8-hour			0.08 ppm	U[5]
	1-hour	0.09 ppm	N	0.12 ppm	N[3]
Carbon Monoxide	8-hour	9.0 ppm	A	9 ppm	A[4]
	1-hour	20 ppm	A	35 ppm	A
Nitrogen Dioxide	Annual Average			0.053 ppm	A
	1 Hour	0.25 ppm	A		
Sulfur Dioxide	Annual Average			0.03 ppm	A
	24 Hour	0.05 ppm	A	0.14 ppm	A
	1-hour	0.25 ppm	A		
Fine Particulate Matter (PM_{10})	Annual Arithmetic Mean			50 $\mu g/m^3$	A
	Annual Geometric Mean	30 $\mu g/m^3$	N		
	24 Hour	50 $\mu g/m^3$	N	150 $\mu g/m^3$	U
Fine Particulate Matter ($PM_{2.5}$)	Annual Arithmetic Mean			15 $\mu g/m^3$	U[5]
	24 Hour			65 $\mu g/m^3$	U[5]

A=Attainment N=Nonattainment U=Unclassified
ppm=parts per million $\mu g/m^3$=micrograms per cubic meter

1. California standards for ozone, carbon monoxide (except Lake Tahoe), sulfur dioxide (1-hour and 24-hour), nitrogen dioxide, and PM_{10} are values that are not to be exceeded. If the standard is for a 1-hour, 8-hour or 24-hour average, then some measurements may be excluded. In particular, measurements are excluded that ARB determines would occur less than once per year on the average.
2. National standards other than for ozone and those based on annual averages or annual arithmetic means are not to be exceeded more than once a year. For example, the ozone standard is attained if, during the most recent three-year period, the average number of days per year with maximum hourly concentrations above the standard is equal to or less than one.
3. In August 1998 the Bay Area was redesignated to nonattainment for the national 1-hour ozone standard.
4. In June 1998 the Bay Area was redesignated to attainment for the national 8-hour CO standard.
5. In 1997 EPA established an 8-hour standard for ozone, and annual and 24-hour standards for very fine particulate matter (PM2.5). As of December 1999, the District did not have sufficient monitoring data to determine the region's attainment status. The new standards were challenged in court, and as of December 1999 their status was uncertain.

CHAPTER 2 - PRELIMINARY REVIEW AND THRESHOLDS OF SIGNIFICANCE

This chapter of the District's CEQA Guidelines provides guidance regarding early consultation between project proponents and local governments. This chapter also provides thresholds to be used to determine whether a project or plan will have a significant air quality impact.

2.1 Early Consultation

The District encourages local jurisdictions to address air quality issues as early as possible in the development review process. Issues such as potential land use conflicts (e.g., odors) or site design to encourage alternatives to the automobile should be considered. Addressing land use and site design issues while a proposed project is still in the conceptual stage increases opportunities to incorporate mitigation measures and desirable modifications to minimize air quality impacts. By the time a project enters the CEQA process, it is usually more costly and time-consuming to redesign the project to incorporate mitigation measures. Early consultation may be achieved by including a formal step in the jurisdiction's development review procedures or simply by discussing air quality concerns at the planning counter when a project proponent makes an initial contact regarding a proposed development. Regardless of the specific procedures a local jurisdiction employs, the objective should be to incorporate air quality beneficial features into a project before significant resources (public and private) have been devoted to the project.

The following air quality considerations warrant particular attention during early consultation between Lead Agencies and project proponents: 1) land use and design measures to encourage alternatives to the automobile and conserve energy; 2) land use conflicts and exposure of sensitive receptors to odors, toxics and criteria pollutants; and 3) applicable District rules, regulations and permit requirements. Lead Agencies and project proponents also are encouraged to consult with the District on these issues.

Land Use and Design Considerations - Land use decisions are critical to air quality planning because land use patterns greatly influence transportation needs, and motor vehicles are the largest source of air pollution. The location, intensity and design of land use development projects significantly influences how people travel. For example, land use strategies such as locating moderate or high density development near transit stations increases opportunities for residents/employees to use transit rather than drive their cars. Similarly, design considerations such as orienting a building entrance towards a sidewalk and/or transit stop increases the attractiveness of walking and transit as an alternative to driving. Some important land use and design issues to consider include the following:

- Encourage the development of higher density housing and employment centers near transit stations.
- Encourage compact development featuring a mix of uses that locates residences near jobs and services.
- Provide neighborhood retail within or adjacent to large residential developments.

- Provide services, such as restaurants, banks, copy shops, post office, etc., within office parks and other large employment centers.
- Encourage infill development.
- Ensure that the design of streets, sidewalks and bike paths/routes within a development encourages walking and biking.
- Orient building entrances towards sidewalks and transit stops.
- Provide landscaping to reduce energy demand for cooling.
- Orient buildings to minimize energy required for heating and cooling.

Local governments and other Lead Agencies are encouraged to consider land use and design measures to reduce auto use and promote energy conservation early in planning and development review processes. By incorporating such measures in local plans and addressing them during initial contacts with project proponents, Lead Agencies greatly increase the likelihood of their implementation. The environmental impacts of development proposals may be lessened and environmental review processes simplified.

Further information regarding land use and design strategies is provided in Chapter 4 and Appendix F. Also, the District and ABAG have prepared a guidance document on these issues entitled *Improving Air Quality Through Local Plans and Programs*. The document provides guidance to local officials and staff on developing and implementing local policies and programs to improve air quality. Lead Agency staff also may contact District planners for assistance.

Land Use Conflicts and Sensitive Receptors - The location of a development project is a major factor in determining whether it will result in localized air quality impacts. The potential for adverse air quality impacts increases as the distance between the source of emissions and members of the public decreases. Impacts on sensitive receptors are of particular concern. Sensitive receptors are facilities that house or attract children, the elderly, people with illnesses or others who are especially sensitive to the effects of air pollutants. Hospitals, schools, convalescent facilities, and residential areas are examples of sensitive receptors.

For each of the situations discussed below, the impacts generally are not limited only to sensitive receptors. *All* members of the population can be adversely affected by criteria pollutants, toxic air contaminants, odor and dust, and thus any consideration of potential air quality impacts should include all members of the population. This discussion focuses on sensitive receptors, however, because they are the people most vulnerable to the effects of air pollution.

Air quality problems arise when sources of air pollutants and sensitive receptors are located near one another. There are several types of land use conflicts that should be avoided:

- A sensitive receptor is in close proximity to a congested intersection or roadway with high levels of emissions from motor vehicles. High concentrations of carbon monoxide, fine particulate matter or toxic air contaminants are the most common concerns.

- A sensitive receptor is close to a source of toxic air contaminants or a potential source of accidental releases of hazardous materials.

- A sensitive receptor is close to a source of odorous emissions. Although odors generally do not pose a health risk, they can be quite unpleasant and often lead to citizen complaints to the District and to local governments.

- A sensitive receptor is close to a source of high levels of nuisance dust emissions.

Localized impacts to sensitive receptors generally occur in one of two ways:

- A (new) source of air pollutants is proposed to be located close to existing sensitive receptors. For example, an industrial facility is proposed for a site near a school.

- A (new) sensitive receptor is proposed near an existing source of air pollutants. For example, a residential development is proposed near a wastewater treatment plant.

Early consultation between project proponents and Lead Agency staff can avoid or minimize localized impacts to sensitive receptors. When evaluating whether a development proposal has the potential to result in localized impacts, Lead Agency staff need to consider the nature of the air pollutant emissions, the proximity between the emitting facility and sensitive receptors, the direction of prevailing winds, and local topography. Often, the provision of an adequate distance, or buffer zone, between the source of emissions and the receptor(s) is necessary to mitigate the problem. This underscores the importance of addressing these potential land use conflicts during the preparation of the general plan and as early as possible in the development review process for specific projects.

It should be noted that there may be instances when some of the land use considerations discussed above, such as infill development and mixed use projects, could result in localized impacts to sensitive receptors. For example, an infill or mixed use project might result in residences being in close proximity to a source of odors or toxic air contaminants. Or a child care facility might be proposed at a worksite in an area where large quantities of hazardous materials are stored and used. Such situations should be avoided. Lead Agencies should bear in mind that while infill and mixed use development are desirable (to reduce auto trips), such projects should be approved only when they do not subject receptors to health or nuisance impacts.

BAAQMD Rules and Regulations - District regulations and permit requirements apply to most industrial processes (e.g., manufacturing facilities, cement terminals, food processing), many commercial operations (e.g., print shops, drycleaners, gasoline stations), and other miscellaneous activities (e.g., demolition of buildings containing asbestos and aeration of contaminated soils). During early consultation, Lead Agency staff should address air pollution regulations and requirements of other public agencies that may apply to the proposed project. Lead Agency staff are encouraged to coordinate directly with the District during the environmental review process on issues such as regulatory requirements, impact analyses and mitigation measures.

2.2 Preparation of the Initial Study

Projects that are subject to CEQA generally undergo a preliminary evaluation in an Initial Study, which is prepared by the Lead Agency. The Initial Study is used to determine if a project may have a significant effect on the environment. The Initial Study should evaluate the potential impact of a proposed project upon air quality. The air quality impact of a project is determined by examining the types and levels of emissions generated by the project, the existing air quality conditions and neighboring land uses. The Initial Study should analyze all phases of project planning, construction and operation, as well as cumulative impacts. The District recommends that the answers/determinations provided in an Initial Study checklist be explained.[1]

The District has established significance thresholds to assist Lead Agencies in determining whether a project or plan may have a significant air quality impact. The District's thresholds of significance are based on the State Office of Planning and Research definitions of significant environmental effect. Section 15382 of the State CEQA Guidelines defines "significant effect on the environment" as "a substantial, or potentially substantial, adverse change in any of the physical conditions within the area affected by the project including ... air."

Appendix G to the State CEQA Guidelines contains a list of effects that will normally be considered significant. These include:

- A project that will "violate any ambient air quality standard, contribute substantially to an existing or projected air quality violation, or expose sensitive receptors to substantial pollutant concentrations,"
- A project that "conflicts with adopted environmental plans or goals of the community where it is located,"
- A project that would "create a potential public health hazard or involve the use, production or disposal of materials which pose a hazard to people or animal or plant populations in the area affected," or
- A project that would "have a substantial, demonstrable negative aesthetic effect."

Appendix I of the State CEQA Guidelines also indicates that a project could have a significant air quality impact if it would result in:

- "The creation of objectionable odors," or
- "Alteration of air movement, moisture, or temperature, or change in climate, either locally or regionally."

The Lead Agency should determine whether the proposed project or plan would exceed any of the thresholds discussed in this chapter. If any of the thresholds are exceeded, then an EIR should be prepared. The more comprehensive analysis of an EIR will provide a more detailed picture of the project's or plan's impacts and will help identify the most appropriate and effective mitigation measures to minimize the impacts. Where no significant air quality impacts of a

[1] The Initial Study identifies potential effects by use of a checklist, matrix or other method. The process, contents, and use of the Inital Study are contained in Section 15063 and Appendix I of the State CEQA Guidelines.

project or plan can be identified in the Initial Study (i.e., none of the significance thresholds are exceeded), the District recommends the Lead Agency either prepare a Negative Declaration or include in an EIR a statement indicating the reasons why potential air quality impacts were determined not to be significant.

Sources of air pollutant emissions complying with all applicable District regulations generally will not be considered to have a significant air quality impact.[2] Stationary sources that are exempt from District permit requirements because they fall below emission thresholds for permitting will not be considered to have a significant air quality impact (unless it is demonstrated that they may have a significant cumulative impact). The Lead Agency can and should make exception to this determination if special circumstances suggest that the emissions from the permitted or exempt source may cause a significant air quality impact. For example, if a permitted or exempt source may emit objectionable odors, then odor impacts on nearby receptors should be considered a potentially significant air quality impact.

2.3 Thresholds of Significance

This section describes the District's recommended thresholds of significance to be used by a Lead Agency when preparing an Initial Study. If, during the preparation of the Initial Study, the Lead Agency finds that any of the following thresholds may be exceeded, then an EIR should be prepared in order to more accurately evaluate project impacts and identify mitigation measures. These thresholds also may be used when preparing an EIR. If the more detailed analysis in an EIR indicates that any of these thresholds would be exceeded, the document should identify the impact as a significant air quality impact and propose mitigation measures. Chapter 3 explains how to calculate emissions to determine whether the thresholds have been exceeded. The following thresholds address impacts associated with: 1) project construction, 2) project operations, and 3) plans.

Threshold of Significance for Construction Impacts

Construction-related emissions are generally short-term in duration, but may still cause adverse air quality impacts. Fine particulate matter (PM_{10}) is the pollutant of greatest concern with respect to construction activities.[3] PM_{10} emissions can result from a variety of construction activities, including excavation, grading, demolition, vehicle travel on paved and unpaved surfaces, and vehicle and equipment exhaust. Construction-related emissions can cause substantial increases in localized concentrations of PM_{10}. Particulate emissions from construction activities can lead to adverse health effects as well as nuisance concerns such as reduced visibility and soiling of exposed surfaces.

Construction emissions of PM_{10} can vary greatly depending on the level of activity, the specific operations taking place, the equipment being operated, local soils, weather conditions and other factors. Despite this variability in emissions, experience has shown that there are a number of

[2]CEQA Guidelines, Section 15064(i).

[3] Construction equipment emits carbon monoxide and ozone precursors. However, these emissions are included in the emission inventory that is the basis for regional air quality plans, and are not expected to impede attainment or maintenance of ozone and carbon monoxide standards in the Bay Area.

feasible control measures that can be reasonably implemented to significantly reduce PM_{10} emissions from construction. The District's approach to CEQA analyses of construction impacts is to emphasize implementation of effective and comprehensive control measures rather than detailed quantification of emissions.

The District has identified a set of feasible PM_{10} control measures for construction activities. These control measures are listed in Table 2. As noted in the table, some measures ("Basic Measures") should be implemented at all construction sites, regardless of size. Additional measures ("Enhanced Measures") should be implemented at larger construction sites (greater than 4 acres) where PM_{10} emissions generally will be higher. Table 2 also lists other PM_{10} controls ("Optional Measures") that may be implemented if further emission reductions are deemed necessary by the Lead Agency.

The determination of significance with respect to construction emissions should be based on a consideration of the control measures to be implemented. From the District's perspective, quantification of construction emissions is not necessary (although a Lead Agency may elect to do so - see Section 3.3 of these Guidelines, "Calculating Construction Emissions," for guidance). The Lead Agency should review Table 2. If all of the control measures indicated in Table 2 (as appropriate, depending on the size of the project area) will be implemented, then air pollutant emissions from construction activities would be considered a less than significant impact. If all of the appropriate measures in Table 2 will not be implemented, then construction impacts would be considered to be significant (unless the Lead Agency provides a detailed explanation as to why a specific measure is unnecessary or not feasible).

Project construction sometimes requires the demolition of existing buildings at the project site. Buildings constructed prior to 1980 often include building materials containing asbestos. Airborne asbestos fibers pose a serious health threat. The demolition, renovation or removal of asbestos-containing building materials is subject to the limitations of District Regulation 11, Rule 2: Hazardous Materials; Asbestos Demolition, Renovation and Manufacturing. The District's Enforcement Division should be consulted prior to commencing demolition of a building containing asbestos building materials. Any demolition activity subject to but not complying with the requirements of District Regulation 11, Rule 2 would be considered to have a significant impact.

TABLE 2
FEASIBLE CONTROL MEASURES FOR CONSTRUCTION EMISSIONS OF PM_{10}

Basic Control Measures. - The following controls should be implemented at all construction sites.
• Water all active construction areas at least twice daily. • Cover all trucks hauling soil, sand, and other loose materials *or* require all trucks to maintain at least two feet of freeboard. • Pave, apply water three times daily, or apply (non-toxic) soil stabilizers on all unpaved access roads, parking areas and staging areas at construction sites. • Sweep daily (with water sweepers) all paved access roads, parking areas and staging areas at construction sites. • Sweep streets daily (with water sweepers) if visible soil material is carried onto adjacent public streets.
Enhanced Control Measures. - The following measures should be implemented at construction sites greater than four acres in area.
• All "Basic" control measures listed above. • Hydroseed or apply (non-toxic) soil stabilizers to inactive construction areas (previously graded areas inactive for ten days or more). • Enclose, cover, water twice daily or apply (non-toxic) soil binders to exposed stockpiles (dirt, sand, etc.) • Limit traffic speeds on unpaved roads to 15 mph. • Install sandbags or other erosion control measures to prevent silt runoff to public roadways. • Replant vegetation in disturbed areas as quickly as possible.
Optional Control Measures. - The following control measures are strongly encouraged at construction sites that are large in area, located near sensitive receptors or which for any other reason may warrant additional emissions reductions.
• Install wheel washers for all exiting trucks, or wash off the tires or tracks of all trucks and equipment leaving the site. • Install wind breaks, or plant trees/vegetative wind breaks at windward side(s) of construction areas. • Suspend excavation and grading activity when winds (instantaneous gusts) exceed 25 mph. • Limit the area subject to excavation, grading and other construction activity at any one time.

Thresholds of Significance for Impacts From Project Operations

For many types of land use development, such as office parks, shopping centers, residential subdivisions and other "indirect sources", motor vehicles traveling to and from the projects represent the primary source of air pollutant emissions associated with project operations. Significance thresholds discussed below address the impacts of these indirect source emissions on local and regional air quality. Thresholds are also provided for other potential impacts related to project operations, such as odors and toxic air contaminants.

(Lead Agencies may refer to Section 2.4, Project Screening, for guidance on determining whether significance thresholds for project operations may be exceeded, and thus whether more detailed air quality analysis may be needed.)

1. Local Carbon Monoxide Concentrations. Localized carbon monoxide concentrations should be estimated for projects in which: 1) vehicle emissions of CO would exceed 550 lb./day, 2) project traffic would impact intersections or roadway links operating at Level of Service (LOS) D, E or F or would cause LOS to decline to D, E or F, or 3) project traffic would increase traffic volumes on nearby roadways by 10% or more.[4] A project contributing to CO concentrations exceeding the State Ambient Air Quality Standard of 9 parts per million (ppm) averaged over 8 hours and 20 ppm for 1 hour would be considered to have a significant impact.

2. Total Emissions. Total emissions from project operations should be compared to the thresholds provided in Table 3.[5] Total operational emissions evaluated under this threshold should include all emissions from motor vehicle use associated with the project. A project that generates criteria air pollutant emissions in excess of the annual *or* daily thresholds in Table 3 would be considered to have a significant air quality impact.

TABLE 3
THRESHOLDS OF SIGNIFICANCE
FOR PROJECT OPERATIONS

Pollutant	ton/yr	lb/day	kgm/day
ROG	15	80	36
NO_X	15	80	36
PM_{10}	15	80	36

3. Odors. While offensive odors rarely cause any physical harm, they still can be very unpleasant, leading to considerable distress among the public and often generating citizen complaints to local governments and the District. Any project with the potential to frequently expose members of the public to objectionable odors would be deemed to have a significant

[4] Unless the increase in traffic volume is less than 100 vehicles per hour.

[5] The thresholds for ROG and NOx are equivalent to the District offset requirement threshold (15 tons per year) for stationary sources (Regulation 2-2-302). The threshold for PM_{10} is based on the District's definition of a major modification to a major facility (Regulation 2-2-221).

impact. Odor impacts on residential areas and other sensitive receptors warrant the closest scrutiny, but consideration should also be given to other land uses where people may congregate, such as recreational facilities, worksites and commercial areas. Analysis of potential odor impacts should be conducted for both of the following situations: 1) sources of odorous emissions locating near existing receptors, *and* 2) receptors locating near existing odor sources.[6]

Determining the significance of potential odor impacts involves a two-step process. *First*, determine whether the project would result in an odor source and receptors being located within the distances indicated in Table 4. Table 4 lists types of facilities known to emit objectionable odors. The Lead Agency should evaluate facilities not included in Table 4 or projects separated by greater distances than indicated in Table 4 if warranted by local conditions or special circumstances. *Second*, if the proposed project would result in an odor source and receptors being located closer than the screening level distances indicated in Table 4, a more detailed analysis, as described in Chapter 3, should be conducted.

After reviewing District enforcement records as described in Chapter 3, a determination of significance should be made. For a project locating near an existing source of odors, the project should be identified as having a significant odor impact if it is proposed for a site that is closer to an existing odor source than any location where there has been:

a) more than one confirmed complaint per year averaged over a three year period, or
b) three unconfirmed complaints per year averaged over a three year period.

For projects locating near a source of odors where there is currently no nearby development *and* for odor sources locating near existing receptors, the determination of significance should be based on the distance and frequency at which odor complaints from the public have occurred in the vicinity of a similar facility.

If a proposed project is determined to result in potential odor problems, mitigation measures should be identified. For some projects, add-on controls or process changes, such as carbon absorption, incineration or relocation of stacks/vents, can reduce odorous emissions. In many cases, however, the most effective mitigation strategy is the provision of a sufficient distance, or buffer zone, between the source and the receptor(s).

TABLE 4

[6] In a January, 1995 decision (*Baird v. County of Contra Costa*, 32 Cal. App. 4th 1464), a California appellate court held that the effects of a contaminated pre-existing environment upon the residents of a proposed project were beyond the scope of CEQA.

Notwithstanding this decision, the District believes that the Legislature generally did intend that CEQA documents should consider the effects of the pre-existing environment on a proposed project, and that the ruling in the *Baird* case should be limited to the factual particulars of the decision (which involved a neighborhood group's attempt to set aside the approval of an addiction treatment facility).

In the District's view, Lead Agencies therefore should not rely on the *Baird* decision and should analyze the impacts of existing sources of air pollution on occupants or residents of proposed projects. Such impacts include, but are not limited to, those from toxic air contaminants, odors and dust.

PROJECT SCREENING TRIGGER LEVELS FOR POTENTIAL ODOR SOURCES

Type of Operation	Project Screening Distance
Wastewater Treatment Plant	1 mile
Sanitary Landfill	1 mile
Transfer Station	1 mile
Composting Facility	1 mile
Petroleum Refinery	2 miles
Asphalt Batch Plant	1 mile
Chemical Manufacturing	1 mile
Fiberglass Manufacturing	1 mile
Painting/Coating Operations (e.g. auto body shops)	1 mile
Rendering Plant	1 mile
Coffee Roaster	1 mile

4. Toxic Air Contaminants. Any project with the potential to expose sensitive receptors (including residential areas) or the general public to substantial levels of toxic air contaminants would be deemed to have a significant impact. This applies to receptors locating near existing sources of toxic air contaminants, as well as sources of toxic air contaminants locating near existing receptors.

Proposed development projects that have the potential to expose the public to toxic air contaminants in excess of the following thresholds would be considered to have a significant air quality impact. These thresholds are based on the District's Risk Management Policy.

Thresholds of Significance for Toxic Air Contaminants

1. Probability of contracting cancer for the Maximally Exposed Individual (MEI) exceeds 10 in one million.
2. Ground-level concentrations of non-carcinogenic toxic air contaminants would result in a Hazard Index greater than 1 for the MEI.

5. Accidental Releases/Acutely Hazardous Air Emissions. The determination of significance for potential impacts from accidental releases of acutely hazardous materials should be made in consultation with the local administering agency of the Risk Management Prevention Program (RMPP). The county health department is usually the administering agency. A determination of significance regarding accidental releases of acutely hazardous materials (AHMs) should be made for: 1) projects using or storing AHMs locating near existing receptors, and 2) development projects resulting in receptors locating near existing facilities using or storing AHMs.

The District recommends, at a minimum, that the Lead Agency, in consultation with the administering agency of the RMPP, find that any project resulting in receptors being within the Emergency Response Planning Guidelines (ERPG) exposure level 2 for a facility has a significant air quality impact. ERPG exposure level 2 is defined as "the maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to one hour without experiencing or developing irreversible or other serious health effects or symptoms which could impair an individual's ability to take protective action".[7]

6. Cumulative Impacts. Any proposed project that would individually have a significant air quality impact (see Thresholds of Significance for Impacts from Project Operations, above) would also be considered to have a significant cumulative air quality impact.

For any project that does not individually have significant operational air quality impacts, the determination of significant cumulative impact should be based on an evaluation of the consistency of the project with the local general plan *and* of the general plan with the regional air quality plan. (The appropriate regional air quality plan for the Bay Area is the most recently adopted Clean Air Plan.) See Thresholds of Significance for Plan Impacts, below, for guidance on evaluating the consistency of a local general plan with the Clean Air Plan. Figure 2 provides a flow chart depicting the process for evaluating cumulative impacts.

Projects in Jurisdictions with Local Plans Consistent with the Clean Air Plan

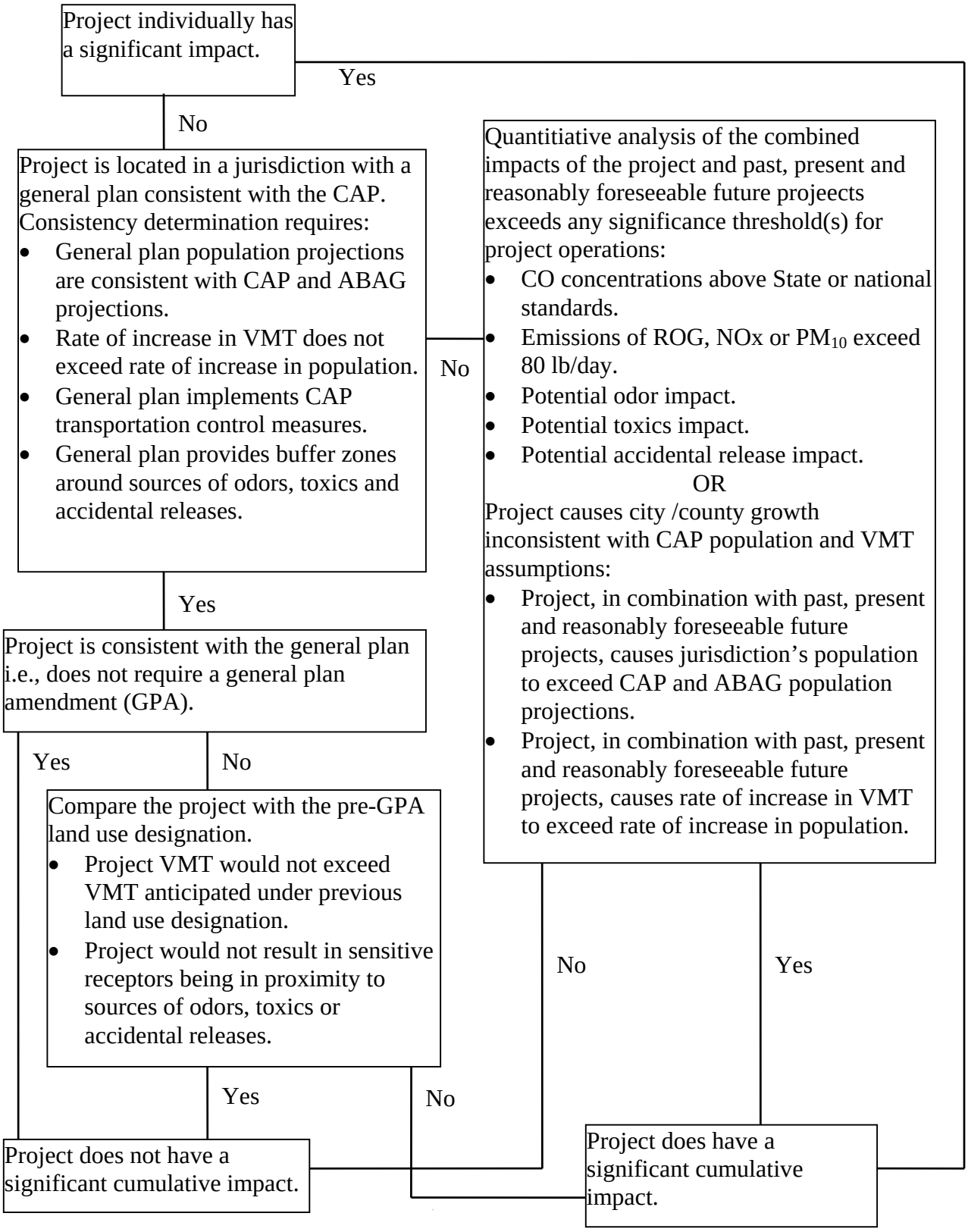
If a project is proposed in a city or county with a general plan that is consistent with the Clean Air Plan (see below) *and* the project is consistent with that general plan (i.e., it does not require a general plan amendment), then the project will not have a significant cumulative impact (provided, of course, the project does not individually have any significant impacts). No further analysis regarding cumulative impacts is necessary.

In a jurisdiction with a general plan consistent with the Clean Air Plan, a project may be proposed that is not consistent with that general plan because it requires a general plan amendment (GPA). In such instances, the cumulative impact analysis should consider the difference(s) between the project and the original (pre-GPA) land use designation for the site with respect to motor vehicle use and potential land use conflicts. A project would not have a significant cumulative impact if: VMT from the project would not be greater than the VMT that would be anticipated under the original land use designation, and 2) the project would not result in sensitive receptors being in close proximity to sources of objectionable odors, toxics or accidental releases of hazardous materials.

[7] State of California Guidance for the Preparation of a Risk Management and Prevention Program, California Office of Emergency Services, November 1989, pg. D-2.

FIGURE 2

EVALUATING CUMULATIVE IMPACTS



Lead Agencies should note that demonstrating general plan consistency with the CAP (and project consistency with the general plan) is the minimum that must be done to support a finding of no significant cumulative impact. Depending on the specific type of project and its setting, there may be additional measures - such as additional measures to reduce auto use, scrappage of high emitting vehicles, conversion to alternative fuels, etc. - that could be implemented to reduce emissions. Even in jurisdictions with a general plan consistent with the CAP, Lead Agencies are encouraged to pursue all feasible measures to minimize cumulative air quality impacts.

Projects in Jurisdictions with Local Plans Not Consistent with the Clean Air Plan

For a project in a city or county with a general plan that is not consistent with the Clean Air Plan, the cumulative impact analysis should consider the combined impacts of the proposed project and past, present and reasonably anticipated future projects. ("Reasonably anticipated future projects" should include, at a minimum, projects of which the Lead Agency is aware based on applications for permits and other land use entitlements, environmental documents, and discussions with probable future developers.) A project would have a significant cumulative impact if these combined impacts would exceed any of the thresholds established above for project operations. A quantitative analysis of past, present and future projects would be required as part of this determination. The analysis should also address how the project and past, present and future projects would influence population and vehicle use projections (see Thresholds of Significance for Plan Impacts, Determining Consistency with Clean Air Plan Population and VMT Assumptions, below).

Thresholds of Significance for Plan Impacts

Regarding plans, the State CEQA Guidelines, Section 15125(b), states that an EIR shall discuss "any inconsistencies between a proposed project and applicable general plans and regional plans. Such regional plans include, but are not limited to, the applicable Air Quality Management Plan (or State Implementation Plan)...". General Plans of cities and counties must show consistency with regional plans and policies affecting air quality to claim a less than significant impact on air quality. General plan amendments, redevelopment plans, specific area plans, annexations of lands and services, and similar planning activities should receive the same scrutiny as general plans with respect to consistency with regional air quality plans.

For a local plan to be consistent with the regional air quality plan it must be consistent with the most recently adopted Clean Air Plan (CAP). (At the time of this writing, December 1999, the most recently adopted CAP is the *Bay Area '97 Clean Air Plan*.) The goal of the CAP is to reduce ground-level ozone and satisfy other California Clean Air Act (CCAA) requirements (e.g., performance objectives related to motor vehicle use). *All of the following criteria must be satisfied for a local plan to be determined to be consistent with the CAP*. Local plans found to be consistent with the CAP would have a less than significant impact on air quality.

1. Determining Local Plan Consistency With Clean Air Plan Population and VMT Assumptions. Plans must show over the planning period of the plan that:

a) population growth for the jurisdiction will not exceed the values included in the current CAP[8], and
b) the rate of increase in VMT for the jurisdiction is equal to or lower than the rate of increase in population.

The first criterion (a) is necessary to establish that population growth in cities and counties will not exceed the growth assumed in the preparation of the CAP emission inventory. Air pollutant emissions are a function of population and human activity. If growth in population is greater than assumed in the CAP emission inventory, then population-based emissions also are likely to be greater than assumed in the CAP. Consequently, attainment of the State air quality standards would be delayed. Therefore, plans showing estimated population greater than that assumed in the *ABAG Projections* would be inconsistent with air quality planning and have a significant air quality impact.

The second plan criterion (b) is derived from the CCAA, Section 40919(d), which requires regions to implement "transportation control measures to substantially reduce the rate of increase in passenger vehicle trips and miles traveled." Plans showing a VMT growth rate higher than the population growth rate would be considered to be hindering progress towards achieving this performance objective, and thus inconsistent with regional air quality planning. This would represent a significant air quality impact.[9]

2. Determining Local Plan Consistency With Clean Air Plan Transportation Control Measures. Determining consistency of local plans with the CAP also involves assessing whether CAP transportation control measures (TCMs) for which local governments are implementing agencies are indeed being implemented. The CAP identifies implementing agencies/entities for each of the TCMs included in the Plan. Cities and counties are identified among the implementing agencies for some of the TCMs. These TCMs are listed in Table 5. Local plans that do not demonstrate reasonable efforts to implement TCMs in the CAP would be considered to be inconsistent with the regional air quality plan and therefore have a significant air quality impact. For further information regarding CAP TCMs, refer to Appendix A of these Guidelines and the *Bay Area '97 Clean Air Plan*.

[8] For the *1997 CAP*, ABAG's *Projections '96* are the appropriate set of population projections.

[9] In some cases, estimating total VMT at the general plan horizon year may be beyond the level of analysis historically conducted in assessing general plan impacts. Lead Agencies may wish to consult with MTC and the county congestion management agency for assistance in developing VMT estimates.

TABLE 5
CAP TCMs TO BE IMPLEMENTED BY LOCAL GOVERNMENT

Transportation Control Measure	Description
1. Support Voluntary Employer-Based Trip Reduction Programs	• Provide assistance to regional and local ridesharing organizations; advocate legislation to maintain and expand incentives (e.g., tax deductions/credits).
9. Improve Bicycle Access and Facilities	• Improve and expand bicycle lane system by providing bicycle access in plans for all new road construction or modifications. • Establish and maintain bicycle advisory committees in all nine Bay Area counties. • Designate a staff person as a Bicycle Program Manager. • Develop and implement comprehensive bicycle plans. • Encourage employers and developers to provide bicycle access and facilities. • Provide bicycle safety education.
12. Improve Arterial Traffic Management	• Study signal preemption for buses on arterials with high volume of bus traffic. • Improve arterials for bus operations and to encourage bicycling and walking. • Continue and expand local signal timing programs, only where air quality benefits can be demonstrated.
15. Local Clean Air Plans, Policies and Programs	• Incorporate air quality beneficial policies and programs into local planning and development activities, with a particular focus on subdivision, zoning and site design measures that reduce the number and length of single-occupant automobile trips.
17. Conduct Demonstration Projects	• Promote demonstration projects to develop new strategies to reduce motor vehicle emissions. Projects include: low emission vehicle fleets and LEV refueling infrastructure.
19. Pedestrian Travel	• Review/revise general/specific plan policies to promote development patterns that encourage walking and circulation policies that emphasize pedestrian travel and modify zoning ordinances to include pedestrian-friendly design standards. • Include pedestrian improvements in capital improvement programs. • Designate a staff person as a Pedestrian Program Manager.
20. Promote Traffic Calming Measures	• Include traffic calming strategies in the transportation and land use elements of general and specific plans. • Include traffic calming strategies in capital improvement programs.

3. Local Plan Impacts Associated with Odors and Toxics. For local plans to have a less than significant impact with respect to potential odors and/or toxic air contaminants, buffer zones should be established around existing and proposed land uses that would emit these air pollutants. Buffer zones to avoid odors and toxics impacts should be reflected in local plan policies, land use map(s), and implementing ordinances (e.g., zoning ordinance). Refer to the discussion regarding project operations impacts related to odors, toxics and accidental releases for guidance in establishing buffer zones in local plans.

2.4 Project Screening

It sometimes may be evident to the Lead Agency that an EIR will be required for a project. In such cases the Lead Agency may forgo preparing an Initial Study and immediately begin preparing an EIR (State CEQA Guidelines, Section 15060(c)). In many cases, however, the Lead Agency will need to prepare an Initial Study to determine whether any of the thresholds of significance discussed in this chapter would be exceeded. Chapter 3 provides guidance on how to assess the air quality impacts of a proposed project.

For one of the thresholds of significance (total emissions from project operations), project screening may provide a simple indication of whether a project may exceed the threshold. The Lead Agency may consult Table 6 for an indication as to whether the threshold for total emissions from project operations might be exceeded. Table 6 provides size or activity levels for various types of land uses which, based on default assumptions, would result in mobile source emissions exceeding the District's threshold of significance for NOx (80 lbs/day). The values provided in Table 6 are based on average, default assumptions for modeling inputs using the URBEMIS7G model (described in Section 3.4).[10] Therefore, the values in Table 6 represent approximate sizes of projects for which total emissions may exceed the threshold. The values should be used only for project screening, and should not be considered absolute thresholds of project significance. Projects approaching or exceeding the levels indicated in Table 6 should undergo a more detailed analysis, as described in Chapter 3. The District recommends that a more detailed analysis be conducted for any project whose size is within 20% of the values indicated in Table 6. The District generally does not recommend a detailed air quality analysis for projects generating less than 2,000 vehicle trips per day, unless warranted by the specific nature of the project or project setting.

[10] The values were calculated using the URBEMIS7G model based on default assumptions for the SF Bay Area:

- Emission factors based on EMFAC7G.
- Average speed of 30 mph and URBEMIS7G default trip lengths.
- Analysis year of 2000.
- Trip generation rates as indicated in table.

The total number of trips for projects with potentially significant impacts varies somewhat between land uses. This is primarily because different land uses generate different distributions of trip type (e.g., home to work, home to shop, etc.) with varying percentages of cold and hot starts.

The Lead Agency should note that Table 6 only addresses one threshold of significance. There are other air quality issues, such as high CO concentrations, odors, toxics and cumulative impacts, that must be considered when evaluating a project's potential for causing adverse air quality impacts. Depending on the nature of the project and local conditions, a project below the values in Table 6 could still cause an adverse air quality impact.

TABLE 6
PROJECTS WITH POTENTIALLY SIGNIFICANT EMISSIONS

Land Use Category	Trip Generation Rate*	Size of Project Likely to Generate 80 lb/day NOx
Housing		
Single Family	9.4/d.u.	320 units
Apartments	5.9/d.u.	510 units
Retail		
Discount Store	48.3/1000 sq.ft.	87,000 sq.ft.
Regional Shopping Center	96.2/1000 sq.ft.	44,000 sq.ft.
Supermarket	178/1000 sq.ft.	24,000 sq.ft.
Office		
General Office	10.9/1000 sq.ft.	280,000 sq.ft.
Government Office	68.9/1000 sq.ft.	55,000 sq.ft.
Office Park	12.8/1000 sq.ft.	210,000 sq.ft.
Medical Office	37.1/1000 sq.ft.	110,000 sq.ft.
Other		
Hospital	13.8/1000 sq.ft.	240,000 sq.ft.
Hotel	8.7/room	460 rooms

* Trip rates for many land uses will vary depending upon size of project. See latest edition of Trip Generation, Institute of Transportation Engineers.

CHAPTER 3 - ASSESSING AIR QUALITY IMPACTS

3.1 Introduction

This chapter provides guidance on how to evaluate the impact(s) of a proposed project or plan[11] on local and regional air quality. The impact assessment portion of an environmental document should evaluate all stages of a project. This chapter addresses the following issues:

- Information that should be discussed in the description of the project's environmental setting
- Evaluating emissions from project construction
- Calculating emissions from project operations, including:
  - mobile source (or "indirect") emissions
  - localized carbon monoxide concentrations
  - stationary source emissions
  - odor impacts
  - toxic air contaminants
- Cumulative impacts

The basic method for calculating project emissions is to apply specific emission factors to sources of air pollutants whose magnitude and characteristics are either known or estimated. Emission factors may be defined as standardized relationships between particular sources of air pollution, such as motor vehicles or pieces of industrial equipment, and their air pollutant emissions. For example, emission factors for motor vehicles generally specify the amount (in grams) of certain air pollutants emitted, per mile traveled. This chapter provides emission factors and quantification procedures for construction activities, motor vehicles, and stationary sources. This chapter also describes methods for evaluating air quality impacts that are not easily quantified, such as impacts associated with objectionable odors.

Once the impacts of a proposed project have been identified, a determination must be made as to whether the project would have a significant adverse impact on the environment. Significance criteria discussed in Chapter 2 of these Guidelines should be used in making this determination. For any potentially significant impacts, mitigation measures should be incorporated into the project to reduce the impact(s) to a level of insignificance. Chapter 4 provides guidance on mitigation measures.

CEQA requires that the project description include a list of agencies that are expected to use the EIR in their decision-making, and a list of the approvals for which the EIR will be used (State CEQA Guidelines Section 15124(d)). If the project will require a permit from the District, all applicable District regulations should be cited in the project description section of the EIR.

[11] This chapter discusses how to evaluate the air quality impacts of development projects and plans. For the sake of brevity, this chapter generally refers only to "project(s)". The reader should note, however, that unless specifically noted otherwise, the discussion also addresses plans.

3.2 Environmental Setting

In order to assess whether a proposed project would have a significant air quality impact, it is necessary to prepare a detailed description of the environmental setting in which the project would be located. Developing the environmental setting, or baseline, is necessary for establishing a basis for comparing the project's subsequent air quality impacts. The environmental setting should also discuss the adverse health effects of air pollutants. With respect to air quality impacts, the description of the project's environmental setting should include the following components:

- Climate and topography influencing the project's impacts on local and regional air quality should be described. Appendix D provides an overview of how climate and topography affect air quality conditions. Appendix D also provides more detailed information on climate, topography and pollution potential for various climatological subregions in the Bay Area.

- Existing air quality conditions should be described. A discussion of trends and expected future conditions (without the project) also should be included. Data from the air quality monitoring station(s) closest to the project site should be included. Appendix C provides ambient air quality monitoring data. Appendix C also provides projections of expected emissions for future years.

- Any sensitive receptors located near the project site should be identified. Areas that are currently undeveloped but that may include sensitive receptors in the future, for example a future school site or residential area, also should be identified.

- Sources of air pollutants located near the project site (including existing sources *at* the project site, if applicable) should be identified. The description of existing air pollution sources should include criteria pollutants, toxic air contaminants and nuisance emissions such as odors and dust. More detailed information regarding existing emissions, including emissions of odors and toxic air contaminants, may be obtained by contacting the District.

- The transportation system serving the project site should be described. Describe traffic conditions, including traffic volumes and levels of service; transit service; and other relevant transportation facilities such as bicycle facilities, shuttle services, telecommuting centers, etc. The discussion of the existing transportation system should describe both current conditions and future conditions without the project.

- Any special circumstances, such as sources of odors, toxic air contaminants or accidental releases of hazardous materials located near the project site, should be described.

- Provide a discussion of why air pollution is a concern, including adverse health effects of criteria and toxic pollutants, nuisance impacts such as odors and dust, and other effects such as reduced visibility and plant damage. Appendix B provides information on effects of air pollution.

Special emphasis should be placed on air quality resources that are rare or unique to the region and would be affected by the project (State CEQA Guidelines Section 15125 (a)). Regulatory requirements identify areas which are pristine and classified as Class I airsheds. These airsheds are subject to specific standards (Prevention of Significant Deterioration requirements). Within the Bay Area, the Point Reyes National Seashore is designated as a Class I area. Projects proposed in the vicinity of that area should note the project's proximity to a Class I area in the description of the project setting.

3.3 Evaluating Construction Emissions

Construction activities result in air pollutant emissions and should be addressed in environmental documents. Although construction-related emissions are generally temporary in duration, they can be substantial and can represent a significant impact on air quality. This is particularly true with respect to emissions of PM_{10}. Construction-related emissions come from a variety of activities including: 1) grading, excavation, roadbuilding and other earthmoving activities, 2) travel by construction equipment, especially on unpaved surfaces, and 3) exhaust from construction equipment. Demolition of buildings also generates PM_{10} emissions, and is of particular concern if the building(s) contain any asbestos-bearing materials.

PM_{10} emissions from construction activity can vary considerably depending on factors such as the level of activity, the specific operations taking place, and weather and soil conditions. As noted in Section 2.3, the District emphasizes implementation of effective and comprehensive control measures rather than detailed quantification of construction emissions. The District urges Lead Agencies to consider the size of the construction area and the nature of the activities that will occur, and require the implementation of all feasible control measures (indicated in Table 2).

If a Lead Agency wants to quantify construction emission, however, generalized emission factors are available. U.S. EPA has developed an approximate emission factor for construction-related emissions of total suspended particulate of 1.2 tons per acre per month of activity. This factor assumes a moderate activity level, moderate silt content in soils being disturbed, and a semi-arid climate. ARB estimates that 64% of construction-related total suspended particulate emissions is PM_{10}.[12] This yields the following **emission factors for uncontrolled construction-related PM_{10} emissions:**

- 0.77 tons per acre per month of PM_{10}, or
- 51 lbs. per acre per day of PM_{10}.[13]

The emission factors provided above are approximate values and do not reflect site-specific conditions and operations. EPA recommends that if construction emissions from a specific site are to be quantified, the construction process should be divided into component operations (e.g., bulldozing, loading of excavated materials, vehicular traffic, etc.) and more specific emission factors should be used. See Section 13.2.3, Heavy Construction Operations, and related sections

[12] California Air Resources Board, Methods for Assessing Area Source Emissions in California, September 1991.

[13] EPA's emission factor was derived based on the assumption that construction activity occurs 30 days per month. See Section 13.2.3, Heavy Construction Operations, U.S. EPA, Compilation of Air Pollutant Emission Factors, Volume I: Stationary, Point and Area Sources, AP-42, 5th Edition, January 1995.

of U.S. EPA, Compilation of Air Pollutant Emission Factors, Volume I: Stationary, Point and Area Sources, AP-42, 5th Edition, January 1995 for further information.

In addition to particulate emissions from earthmoving, air pollutants also are emitted in the exhaust of construction equipment. Table 7 presents emission factors for estimating construction equipment emissions (assuming an average of 0.27 gallons of fuel burned per cubic yard of earth moved). These emission factors represent a composite fleet of heavy and light duty construction equipment in the Bay Area. Emissions from construction equipment during building construction, as differentiated from earthmoving in site preparation, vary greatly from project to project. Table 7 can be used to estimate construction exhaust emissions based on gallons of fuel consumed or cubic yards of material moved. Lead Agencies also may consult the most recent edition of U.S. EPA's AP-42 for emission factors for specific types of construction equipment.

TABLE 7
HEAVY AND LIGHT DUTY CONSTRUCTION EQUIPMENT
EXHAUST EMISSION FACTORS

Contaminant	gm/yd^3*	gm/gallon**
PM_{10}	2.2	8.0
CO	138.0	511.0
ROG	9.2	34.0
NO_x	42.4	157.0
SO_x	4.6	17.0

* Grams per cubic yard of earth moved. ** Grams per gallon of fuel burned.

Project construction sometimes involves the demolition of existing buildings. Demolition also produces PM_{10} emissions. PM_{10} emissions from demolition activities may be estimated using the following emission factor: 0.00042 lbs PM_{10} per cubic feet of building volume.[14] Buildings constructed prior to 1980 often include building materials containing asbestos. As noted in Section 2.3, Thresholds of Significance, the demolition, renovation or removal of asbestos-containing building materials is subject to District Regulations. The District's Enforcement Division should be consulted prior to commencing demolition of a building containing asbestos building materials.

The emission factors provided above represent uncontrolled emissions. Section 2.3, Thresholds of Significance, and Section 4.2, Mitigating Construction Impacts, provide information on mitigating construction-related emissions. If an environmental document will include quantification of construction emissions, the Lead Agency should be sure to apply the estimated control effectiveness to the appropriate emission source. For example, watering a construction site can reduce PM_{10} emissions from earthmoving activities, but will not reduce equipment exhaust emissions.

[14] South Coast Air Quality Management District, CEQA Air Quality Handbook, April 1993.

3.4 Calculating Emissions from Project Operations

Introduction

Several types of emissions should be considered when evaluating the impacts of a project's operations. For many types of land use development projects, the principal sources of air pollutant emissions are the motor vehicle trips generated by the project. These are often referred to as "indirect sources" and include projects such as shopping centers, office buildings, arenas and residential developments. The evaluation of an indirect source's impact should consider localized pollutants such as carbon monoxide and PM_{10}, as well as regional pollutants such as ozone. This section describes methods for estimating total project emissions from motor vehicles (see "Calculating Mobile Source Emissions"), as well as methods for estimating localized CO concentrations (see "Calculating Carbon Monoxide Concentrations").

Most land use projects also generate "area source" emissions. Area sources are sources that individually emit fairly small quantities of air pollutants, but which cumulatively may represent significant quantities of emissions. Water heaters, fireplaces, lawn maintenance equipment, and application of paints and lacquers are examples of area source emissions.

Certain projects also may generate stationary, or "point", source emissions. Although most area sources discussed above are usually stationary, the terms stationary or point source usually refer to equipment or devices operating at industrial and commercial facilities. Examples of facilities with stationary sources include manufacturing plants, quarries, print shops and gasoline stations.

Depending on the nature of the proposed project and/or the land uses near the project site, other air quality impacts associated with project operation may arise. These impacts include odor problems, emissions of toxic air contaminants and accidental releases of hazardous/toxic materials. Most of this chapter addresses the evaluation of the impacts a project would have on the surrounding environment. However, with respect to potential impacts related to odors, toxics, and accidental releases it is equally important to also consider the impact of the surrounding environment on the proposed project. For example, if a residential development were proposed for a site near an existing wastewater treatment plant, exposure of the new residents to objectionable odors would be a significant air quality impact associated with the project.

Calculating Mobile Source Emissions

As noted above, virtually all land use development projects result in indirect source emissions due to the motor vehicle trips generated by the project. The following discussion describes how to calculate these emissions.

Whenever possible, the air quality impact analysis for a project should be based on the results of a traffic study conducted specifically for the project. The number of vehicle trips that a project will generate, and the average speed and length of the trips, will vary depending on a variety of factors such as the specific nature of the project and its location. If project-specific data are not available, then the default values provided in this chapter may be used. The most recently

published set of trip generation rates from the Institute of Transportation Engineers (ITE) also may be used.

Transportation analyses for projects consisting of two or more land uses often adjust the number of anticipated new vehicle trips to account for internal trips. These adjustments (or "capture rates") reflect the fact that some trips at multi-use projects will occur internally to the project. As a result, the total number of new vehicle trips associated with the project would be less than the sum of the trips expected from all of the individual land uses. Traffic studies for such projects should include a clear explanation of all capture rate assumptions. Internal trips should be excluded from the air quality analysis only if they are expected to occur by walking, bicycling or other nonpolluting mode.

Traffic studies for commercial projects often distinguish between primary trips and pass-by and diverted linked trips.[15] The air quality analysis for such projects should include emissions from pass-by and diverted linked trips. While the emissions from these trips will be lower than for primary trips (due to shorter trip lengths), they still do produce emissions (trip end emissions and some running emissions). Adjustments can be made to trip length and cold start/hot start assumptions for pass-by and diverted linked trips. Assumptions regarding pass-by and diverted linked trips should be clearly identified and the underlying rationale explained.

ARB calculates motor vehicle emissions using computer models. Currently, ARB is using the Motor Vehicle Emissions Inventory model (MVEI). Motor vehicle emission factors are calculated with the EMFAC model, which is a component of MVEI. ARB periodically revises emission factors. At the time of this writing (December 1999), the most current set of motor vehicle emission factors is MVEI7G, Version 1.0c. The emission factors provided in these Guidelines (Table 10) are based on MVEI7G,1.0c. The differences between successive versions of the model can lead to significant variation in estimates of mobile source emissions calculated using these emission factors. As of December 1999, ARB was preparing updated emission factors ("EMFAC2000"), but it is uncertain when the new emission factors will be released. As future revisions to the model are approved by ARB, the District will revise the emission factors in Table 10. Lead Agencies should always use the most recent emission factors prepared by the District.

URBEMIS7G

The Air Resources Board developed the URBEMIS model to calculate mobile source emissions associated with various types of land use projects, using EMFAC emission factors and ITE trip generation rates. URBEMIS calculates emissions of ROG, NO_x, CO and PM_{10}, as well as total vehicle trips. ARB's last update of the model was URBEMIS5, released in 1995. In 1998, the San Joaquin Valley Unified Air Pollution Control District coordinated an update of the URBEMIS model, released as URBEMIS7G. The new version is different from previous versions in several ways. URBEMIS7G uses more recent motor vehicle emission factors, EMFAC7G, as well as updated ITE trip generation rates. It can calculate construction emissions

[15] Primary trips are trips made specifically to visit a particular facility. Pass-by trips are trips made as intermediate stops on the way to a primary trip destination. Diverted linked trips are trips attracted from roadways near a facility, but which require a diversion from the roadway to another roadway to access the facility.

and area source emissions, and also can estimate emission reductions from construction and area source mitigation measures. URBEMIS7G also can calculate air quality benefits of mitigation measures to reduce motor vehicles emissions. The model includes options to minimize "double-counting" of trips in mixed use projects and to account for "pass-by" trips.

URBEMIS7G is a sketch planning tool for calculating criteria air pollutant emissions from land use development projects. URBEMIS7G is not appropriate for calculating air pollutant emissions associated with plans. Other models, such as the Direct Travel Impact Model (DTIM), may be used to quantify (mobile source) air pollutant emissions associated with plans.

The program provides default values for all modeling parameters for several regions within California, including the San Francisco Bay Area. The user may use the default values or may provide project-specific values for parameters including trip generation, trip length, trip speed, vehicle fleet mix, percentage of cold starts, and temperature. The District recommends that the following input assumptions be used for projects in the San Francisco Bay Area. If project-specific travel data are available, that data should be used. The source(s) of any project-specific data should be described.

Recommended URBEMIS7G Inputs for the San Francisco Bay Area

Trip Generation - Use the default values for the San Francisco Bay Area or the most recent version of ITE's *Trip Generation* manual if project-specific data are not available.

Fleet Mix – Generally, use the default values for the San Francisco Bay Area. If evaluating a project that is likely to have a different fleet mix, e.g., an industrial project with many heavy duty vehicle trips, make the necessary adjustments.

Temperature - Meteorological conditions in the Bay Area vary considerably between climatological subregions. Refer to Appendix D for subregional information. Use mean summer maximum temperatures for all pollutants except CO. Use mean winter minimum temperatures for CO.

Trip Length - Use the data in Table 9 or the most recent edition of MTC's *Bay Area Travel Forecasts* if project-specific data are not available.

Variable Starts - Use the default values for the San Francisco Bay Area if project-specific data are not available.

Trip Speed - Use 25 mph for San Francisco and 30 mph for all other Bay Area counties if project-specific data are not available.

Percent Trip - Use the default values for the San Francisco Bay Area if project-specific data are not available.

The URBEMIS7G program and Users'Guide is available free of charge on the ARB's website, at www.arb.ca.gov/urbemis7/urbemis7.htm. Because of URBEMIS7G's many enhancements, its

ease of use, and its ready availability, the District strongly encourages Lead Agencies to use the model to estimate motor vehicle emissions from development proposals. Because URBEMIS7G includes the most current emission factors (EMFAC7G), as well as other improvements, older versions of URBEMIS should not be used.

Manual Calculation

The District has developed a methodology for manually calculating mobile source emissions associated with land use development. The manual method may be useful for project screening purposes or for quickly generating rough estimates of project impacts. For this calculation it is necessary to provide the following inputs: trip generation rate, average trip length, exhaust emission factors (varying by analysis year), and trip end emission factors.

As previously noted, project-specific traffic data should be used in the air quality analysis whenever it is available. If project-specific data are not available, the default values provided in these Guidelines may be used. Table 8 provides trip generation rates for various types of land uses. The trip generation rates provided in Table 8 are based on data in the Institute of Transportation Engineers (ITE) *Trip Generation*, 6th Edition, 1997. For land use projects not included in Table 8 and for which project-specific data are not available, consult the most recent edition of ITE's *Trip Generation* manual.

Table 9 provides average trip lengths for each of the nine Bay Area counties. These trip lengths were derived from MTC travel data used by the District in the preparation of the Bay Area mobile source emission inventory.

Table 10 provides emission factors, based on MVEI7G,1.0c. The emission factors in Table 10 are representative of Bay Area driving conditions and the District's emission inventory. They reflect the mix of vehicles typical of Bay Area roadways, as well as climatic conditions assumed in the emission inventory. The emission factors also include the benefits of the 1995 motor vehicle Inspection and Maintenance program and reformulated fuels requirements.

Table 11 provides trip end emission factors. These include start emissions for ROG, NO_x and CO (reflecting cold and hot start emissions consistent with Bay Area driving conditions) and “hot soak” emissions for ROG. The total mobile source emissions from a project are the sum of trip end emissions and “running” emissions.

TABLE 8
AVERAGE TRIP GENERATION RATES FOR SELECTED LAND USES

LAND USE	UNIT OF MEASURE	TRIP RATE	LAND USE	UNIT OF MEASURE	TRIP RATE
RESIDENTIAL			***INDUSTRIAL***		
Single Family Housing	D.U.	9.6	Light Industrial	1000 GSF	7.0
Apartment	D.U.	6.6	Industrial Park	1000 GSF	7.0
Resid. Condominium	D.U.	5.9	Manufacturing	1000 GSF	3.8
Mobile Home Park	D.U.	4.8	Warehousing	1000 GSF	5.0
RETAIL			Mini Warehouse	1000 GSF	2.5
Discount Store (Saturday)	1000 GFA	72.0	***OFFICE***		
Factory Outlet Center (Saturday)	1000 GFA	41.0	General Office Building	1000 GSF	11.0
Shopping Center (Saturday)	1000 GLA	50.0	Corp. Headquarters Building	1000 GSF	7.7
Supermarket (Saturday)	1000 GSF	177.6	Gov't Office Building	1000 GSF	68.9
Convenience Market (24 hour) (Saturday)	1000 GSF	863.1	Medical/Dental Office Building	1000 GSF	36.1
INSTITUTIONAL			Office Park	1000 GSF	11.4
High School	1000 GSF	13.3	Business Park	1000 GSF	12.8
Community College	1000 GSF	18.4	Research and Development Center	1000 GSF	8.1
Church (Sunday)	1000 GSF	36.6	***RECREATIONAL***		
Hospital	1000 GSF	16.8	Movie Theater (w/Matinee) (Saturday)	screen	529.5
Library	1000 GSF	54.0	Racquet Club (Saturday)	1000 GSF	24.5
Post Office	1000 GSF	108.2	Golf Course (Saturday)	Acre	5.8
LODGING					
Hotel	Room	8.2			
Motel	Room	5.6			

GSF = Gross Square Feet; GLA = Gross Leasable Area; GFA = Gross Floor Area; D.U. = Dwelling Unit

All rates are for weekdays unless otherwise noted.

For some land uses, trip rates will vary depending upon size of project. See the most recent edition of *Trip Generation*, Institute of Transportation Engineers.

Source: Institute of Transportation Engineers, *Trip Generation*, 6th Ed. 1997.

TABLE 9
AVERAGE TRIP LENGTH (in miles)
BY COUNTY AND YEAR

County	1995	2000	2005	2010	2015
Alameda	7.7	7.7	7.7	7.3	7.0
Contra Costa	7.5	7.5	7.5	7.2	6.9
Marin	8.0	8.0	8.2	7.7	7.2
Napa	6.5	6.5	6.5	6.2	5.9
San Francisco	6.5	6.5	6.2	6.0	5.9
San Mateo	8.0	7.8	7.7	7.5	7.2
Santa Clara	6.9	6.9	6.9	6.9	6.9
Solano	10.4	10.1	9.8	8.8	8.2
Sonoma	7.2	7.0	6.9	6.5	6.2
District Average	7.5	7.4	7.3	7.6	6.9

Average trip lengths are based on MTC data used in preparation of Bay Area mobile source emission inventory.

TABLE 10
AVERAGE EXHAUST EMISSION RATES

	Emissions (grams per mile)				
Year	**ROG**	**NO_x**	**CO**	**SO_x**	**PM_{10}**
1995	1.08	2.04	13.45	0.06	0.47
2000	0.62	1.42	7.27	0.03	0.45
2005	0.36	0.97	4.63	0.03	0.44
2010	0.22	0.76	3.66	0.03	0.44
2015	0.15	0.66	3.07	0.03	0.44

Notes:
1) Emission rates from CARB's MVEI7G,1.0c (5/97).
2) Fleet mix as per CARB's MVEI7G,1.0c (5/97).
3) Inspection and Maintenance Program effectiveness included.
4) Ambient temperatures consistent with District Planning Inventory (varies throughout region).
5) ROG emission rates include evaporative running loss emissions.
6) Particulate matter emission rates include exhaust, tire wear, and entrained road dust emissions.
7) Trip end emissions are not included and must be calculated separately as described in the text.

Mobile source emissions from land use projects may be calculated using the equation provided below. A separate calculation must be made for each pollutant.

$$E = (U \times T) \times [(L \times R) + S]$$

Where:

E equals total emissions (of each pollutant), in grams per day;

U equals number of units in the project, e.g. number of dwelling units or thousands of square feet in shopping center buildings (see units in Table 8);

T equals trip generation rate, or average trips per day generated per unit of land use (Table 8);

L equals average trip length, in miles per trip (Table 9);

R equals motor vehicle emission rate, or emission factor, for each pollutant, by analysis year (Table 10);

S equals trip end emissions, comprised of start emissions for ROG, NO_x and CO, and "hot soak" emissions for ROG (Table 11).

To convert grams per day to pounds per day, divide the total by 454. To convert grams per day to tons per day, divide the total by 908,000.

TABLE 11
TRIP END EMISSION FACTORS
(grams per trip)

Year	ROG	NO_x	CO
1995	3.44	1.89	49.89
2000	2.20	1.35	35.53
2005	1.36	1.08	21.07
2010	0.79	0.89	12.85
2015	0.50	0.78	8.33

Calculating Carbon Monoxide Concentrations

Emissions and ambient concentrations of carbon monoxide have decreased greatly in recent years. These improvements are due largely to the introduction of cleaner burning motor vehicles and motor vehicle fuels. No exceedances of the State or national CO standard have been recorded at any of the region's monitoring stations since 1991. The Bay Area has attained the State and national CO standard.

Despite this progress, however, localized CO concentration still warrant concern in the Bay Area and should be addressed in environmental documents. The reasons for this are twofold. First, State and federal laws require the region to attain *and maintain* ambient air quality standards. The region must ensure that increased motor vehicle use and congestion do not nullify the great strides that have been made with respect to ambient concentrations of CO. Secondly, the region must safeguard against localized high concentrations of CO that may not be recorded at monitoring sites. Because elevated CO concentrations are generally fairly localized, heavy traffic volumes and congestion can lead to high levels of CO, or "hotspots," while concentrations at the closest air quality monitoring station may be below State and national standards.

A variety of computer models have been developed to estimate local CO concentrations resulting from motor vehicle emissions. One of the most common models is CALINE4, developed by and available from the California Department of Transportation. The District has developed a simplified screening method, which is based on CALINE4 and takes into account CO field studies conducted by the District in the Bay Area. The screening method enables the user to manually calculate local CO concentrations resulting from motor vehicles. Except for very large projects, the District recommends that the manual method be used to estimate CO concentrations. The resulting estimated CO concentrations should be compared to State and national CO standards to determine whether the project would have a significant air quality impact. If the results of the manual method indicate CO concentrations below the standards, then no further CO analysis is required. If the manual method predicts concentrations above the standards, the Lead Agency may either: make a finding of a significant impact and identify mitigation measures, or conduct a more detailed analysis using the CALINE4 model. Similarly, if the results of a CALINE4 analysis indicate a significant impact, mitigation measures should be identified. The effectiveness of any proposed mitigation measure(s) should be quantified by estimating the effects of the measure(s) on traffic volumes and/or speeds, and CO concentrations.

Manual Calculation of CO Concentrations

The following procedure is designed to provide a reasonable estimate of carbon monoxide concentrations near roads under worst case conditions. It is a simplified version of CALINE4. The District suggests that the full CALINE4 model be used, instead of this simplified formula, for any projects or plans that will generate 10,000 or more motor vehicle trips per day. The full CALINE4 model also may be used for smaller projects if the simplified screening method indicates that an air quality standard may be exceeded.

In the Bay Area, the highest CO concentrations usually occur in winter, on cold, clear days and nights with little or no wind. Low wind speeds inhibit horizontal dispersion and radiation inversions inhibit vertical mixing. Worst case conditions are built into the simplified model formula. Default conditions are as follows:

1. wind direction parallel to the primary roadway, 90^o angle to secondary road;
2. wind speed less than 1 meter per second;
3. extreme atmospheric stability (class F);
4. receptor at edge of the roadway.

The carbon monoxide concentration, C, is the sum of a background value, C_o, and the total contribution from local traffic C_t,

$$C = C_o + C_t$$

The total contribution from local traffic, C_t, is the sum of the contributions from each contributing local road, C_i,

$$C_t = C_{i1} + C_{i2}$$

The contribution from one road, C_i, can be computed by the formula:

$$C_i = C_{ri} \times \frac{V_i \times EF_i}{V_r \times EF_r}$$

where:

C_{ri} is a reference case concentration for the i-th roadway,

V_r is the traffic volume for the reference case,

V_i is the traffic volume for the i-th roadway,

EF_r is the emission factor for the reference case,

EF_i is the emission factor for the i-th roadway,

Table 12 gives reference case concentrations for various road configurations with traffic volumes of 1000 vehicles per hour and emission factors of 100 grams per mile. The concentration relative to this reference case is then computed in parts per million (ppm), by the formula:

$$C_i = \frac{C_{ri} \times V_i \times EF_i}{100{,}000}$$

where Cr_i is taken from Table 12, V_i is the estimated traffic volume in vehicles per hour, and EF_i is the emission factor taken from Table 10 for the appropriate year of analysis.

The following discussion provides guidance on how to use the formulas provided above, and describes in detail each step of the manual method for calculating CO concentrations.

TABLE 12
REFERENCE CARBON MONOXIDE CONCENTRATIONS (ppm)

Roadway Type	Primary Road (Highest Volume Road)						Secondary Road (Intersecting Road)					
	(receptor distance from edge--in feet)											
At Grade	**At Edge**	**25'**	**50'**	**100'**	**300'**	**500'**	**At Edge**	**25'**	**50'**	**100'**	**300'**	**500'**
2 lane	14.0	7.6	5.7	4.0	1.7	0.9	3.7	2.7	2.2	1.7	1.0	0.8
4 lane	11.9	7.0	5.4	3.8	1.6	0.9	3.3	2.6	2.2	1.7	1.1	0.8
6 lane	9.5	6.1	4.9	3.5	1.6	0.8	2.8	2.3	2.0	1.7	1.1	0.9
8 lane	8.5	5.7	4.6	3.4	1.5	0.8	2.6	2.2	1.9	1.6	1.1	0.9
Depressed 15 feet												
2 lane	20.9	8.2	4.7	3.3	1.5	0.8	4.8	2.4	1.4	1.1	0.8	0.5
8 lane	15.4	6.3	3.6	2.7	1.3	0.7	3.7	1.9	1.1	1.0	0.7	0.6
Depressed 30 feet												
2 lane	26.8	7.9	3.4	1.7	0.8	0.3	5.2	3.2	2.0	0.8	0.4	0.3
8 lane	21.3	6.0	2.3	1.1	0.6	0.2	4.1	2.7	1.7	0.7	0.5	0.4
Elevated 15 feet												
2 lane	14.0	7.3	5.7	4.0	1.7	0.9	3.7	2.6	2.2	1.7	1.0	0.8
8 lane	8.5	5.4	4.6	3.4	1.5	0.8	2.6	2.1	1.9	1.6	1.1	0.9
Elevated 30 feet												
2 lane	14.0	7.3	5.4	4.0	1.7	0.9	3.6	2.6	2.2	1.7	1.0	0.8
8 lane	8.5	5.4	4.3	3.4	1.5	0.8	2.5	2.1	1.9	1.6	1.1	0.9

Notes: Normalized CO concentration is calculated based on the following assumptions: wind direction parallel to the highest volume roadway; wind speed less than 1 meter per second; extreme atmospheric stability (class F); receptor at edge of roadway; emission rate = 100 gm/mi.; vehicles per hour = 1,000; surface roughness = 100 cm; mixing cell width = roadway width (2 lane = 40 ft; 4 lane = 64 ft; 6 lane = 88 ft; 8 lane = 112 ft).

This simplified model was adapted from CALINE3 and CALINE4 (California Department of Transportation) by Mike Kim, Senior Transportation Engineer, BAAQMD.

Step by Step Procedure for CO Analysis

Make separate computations for current conditions, future no-project conditions (including cumulative), and future conditions with the project. For future year project and no-project conditions, select an analysis year corresponding to the estimated year of project completion. Also use the procedure to show the effects of mitigation measures, where such effects are quantifiable.

1. Identify intersections and/or roadway links that will be most impacted by the proposed project, according to the traffic impact analysis. An analysis should be made for each such intersection and link. (Include a map showing these points.)

2. Obtain peak-hour traffic volumes in both directions on each roadway considered for each year of consideration. If only average daily traffic is known, assume 10% for peak hour volumes. Use actual traffic counts, if available, for current year. Traffic levels for future years should include traffic generated by the proposed project plus other estimated growth distributed among roadway links.

3. Obtain the CO emission factor for each roadway, for each relevant year from Table 10. (Interpolate if necessary.)

4. Determine the number of lanes and type of each roadway. (Do not count turning or parking lanes.) If the road is to be altered, use the appropriate width for the year being analyzed.

5. Based on the number of lanes, obtain the reference one hour concentration for each roadway from Table 12. The road with the most traffic should be considered the "Primary Road". Be careful to use the proper reference factor in the table if the receptor is not at the edge of the road or if one or both of the roadways is elevated or depressed.

6. Compute each roadway's contribution to the total concentration by using the equation above. If modeling an intersection, add the concentrations of all roadways.

7. Add the total roadway (local) contribution to the one hour background value from the background map (Figure 3) to obtain the estimated worst case concentration. Interpolate between isopleth lines and apply rollback factors for future years (Table 13) to determine the appropriate background value. Refer to the discussion below for guidance on determining background values.

8. To obtain the worst case eight hour concentration, multiply the one hour value for the local contribution by 0.7 (persistence factor). Add this derived eight hour local contribution to the eight hour background level (Figure 4). Interpolate between isopleth lines and apply rollback factors (Table 13) to determine the appropriate background value. Refer to the discussion below for guidance on determining background values.

Determining Background CO Concentrations

As noted above, estimating a project's impact on ambient CO concentrations involves adding the contribution from the project to existing background levels. Background carbon monoxide is defined as that part of the ambient CO concentration that is not attributable to traffic sources from a nearby street or intersection. Thus, during stagnant conditions, the background conditions at a site may include carbon monoxide emitted from outside the modeling area, as well as carbon monoxide emitted within the modeling area during the previous time periods.

In order to determine a reasonable background CO concentration, refer to Figures 3, 4 and 5 and Table 13. Figures 3 and 4 are isopleth maps of the Bay Area Air Basin showing estimated one hour and eight hour background CO values, respectively, in parts per million (ppm) for 1992. The maps are based on 1990 to 1992 CO concentration data from multiple monitoring sites of various types located throughout the region. Table 13 provides rollback factors to be used in conjunction with the isopleth maps when determining CO background concentrations for years beyond 1992. 1992 background values may be derived from the maps according to the following procedures, after first locating the project on the map.

If the project site happens to fall on an isopleth (contour) line, use the value marked for that line. If the project is determined to be between two different isopleth lines (i.e., between 3.0 and 6.0 or between 6.0 and 9.0 ppm), interpolate to select the appropriate intermediate value. Calculate the shortest distance to the lower and higher isopleths. Call these distances X and Y, respectively. Divide X by the sum of X + Y. Multiply this quotient by 3.0 ppm, and add this product to the lower isopleth value, I. This methodology is illustrated in Figure 5 and is represented by the following formula:

$\{[X / (X+Y)] \times 3.0 \text{ ppm}\} + I_L$ = CO background concentration in ppm, where

I_L = the lower isopleth concentration
X = shortest distance to lower isopleth
Y = shortest distance to higher isopleth

TABLE 13
FUTURE YEAR CARBON MONOXIDE
ROLLBACK FACTORS

*Rollback Factors to be used in conjunction with Figures 3 and 4 to determine one hour and eight hour average carbon monoxide background concentrations from 1993 to 2010**

Year	Rollback Factor
1992	1.0
1993	.97
1994	.94
1995	.90
1996	.87
1997	.84
1998	.81
1999	.78
2000	.75
2001	.73
2002	.70
2003	.67
2004	.65
2005	.63
2006	.62
2007	.60
2008	.59
2009	.59
2010	.58

*After the 1992 carbon monoxide background concentration has been determined, estimates of any year through 2010 can be made using the factors above. For the year desired, multiply the 1992 concentration times the appropriate factor. For example, if the 1992 concentration is 6.0 ppm, the 1999 concentration is calculated to be (6.0 ppm) x (.78) = 4.7 ppm.

Note: Ambient concentrations of carbon monoxide are expected to decline, *on average*, in future years. This will occur because emission controls on new vehicles will reduce CO emission rates faster than vehicle travel increases. (*Local* CO emissions and concentrations might increase under conditions of intense development and increasing travel. These procedures are intended to assess such situations.)

FIGURE 3

ONE HOUR CO BACKGROUND CONCENTRATIONS

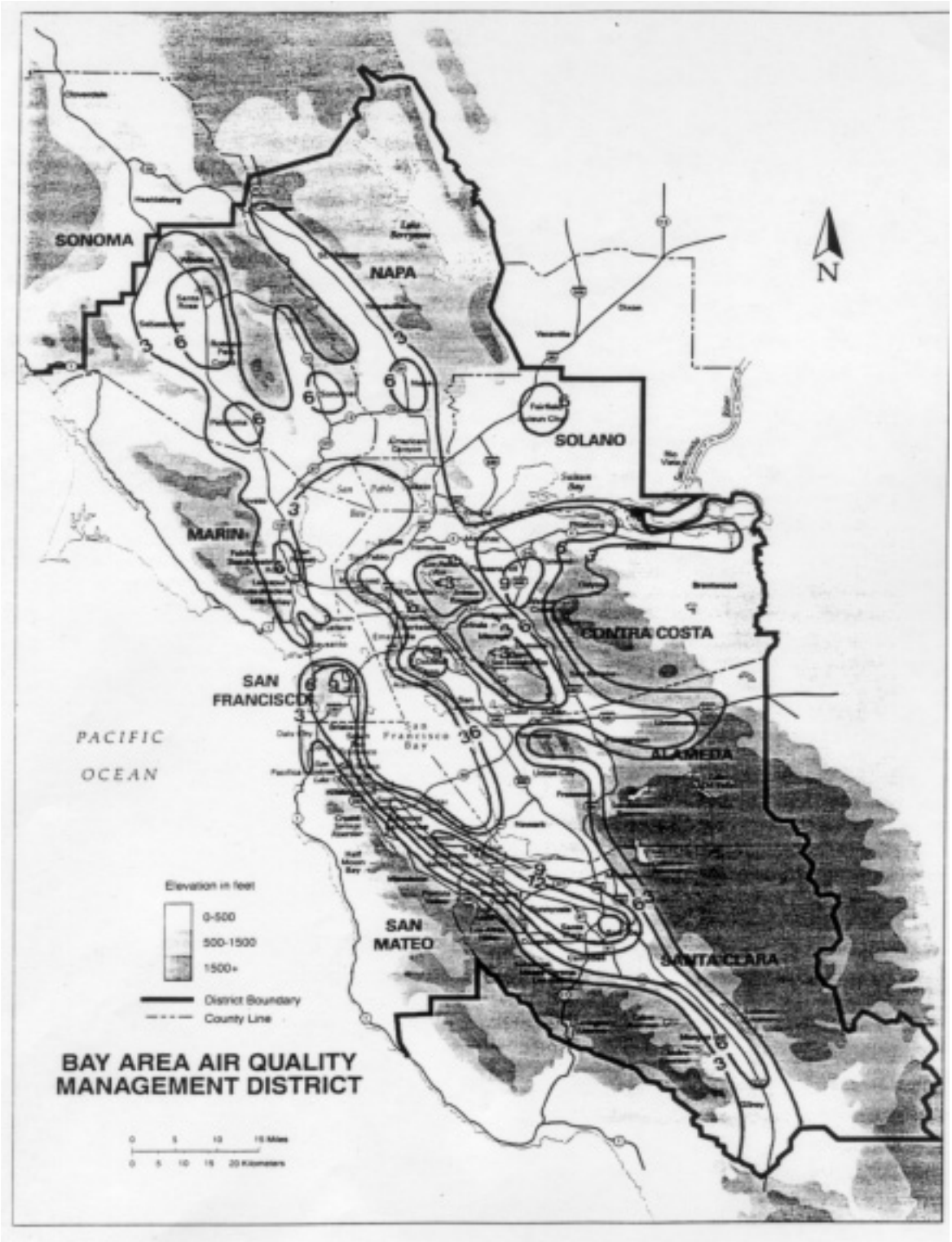


FIGURE 4

EIGHT HOUR CO BACKGROUND CONCENTRATIONS

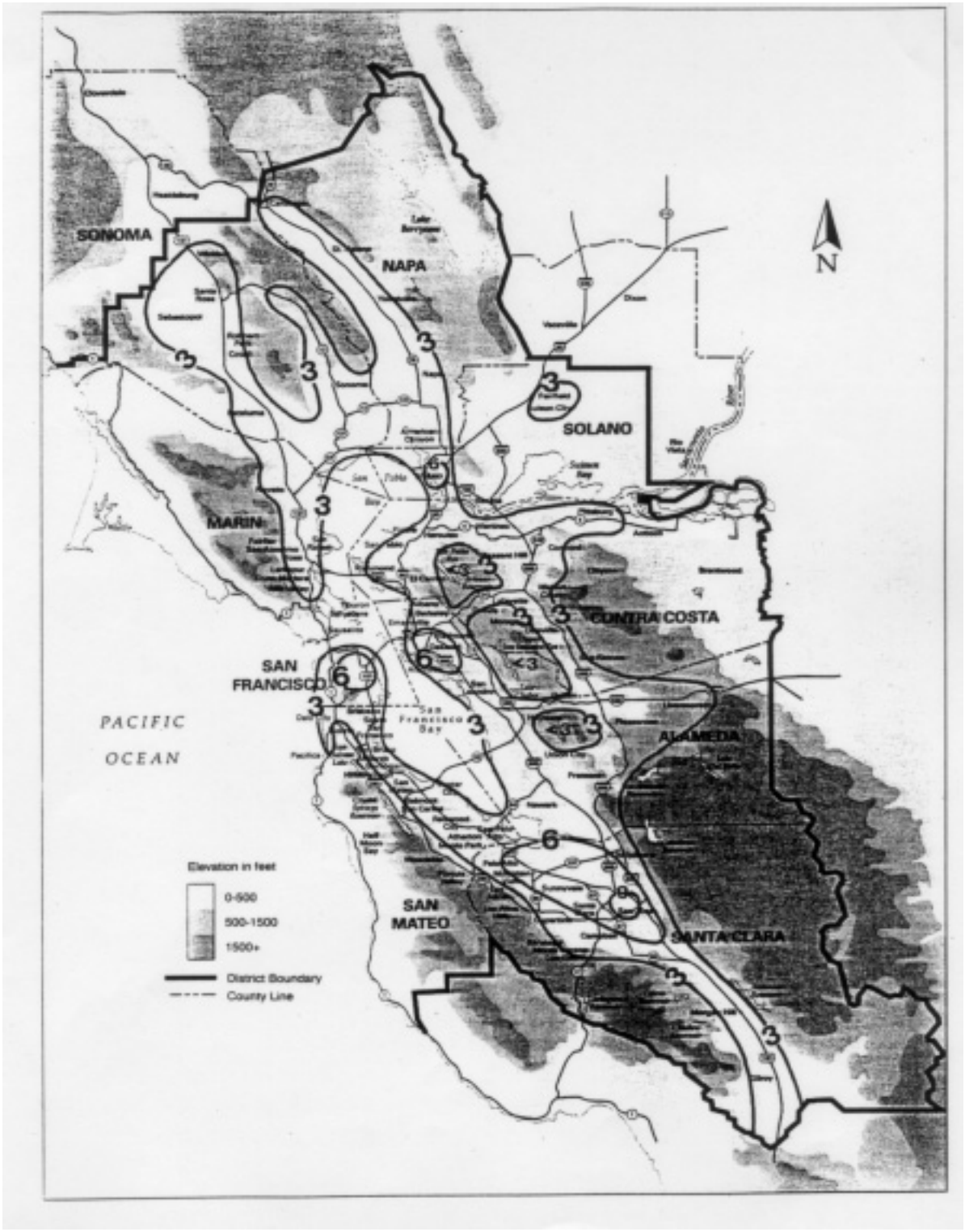


FIGURE 5

DETERMINING CO BACKGROUND CONCENTRATIONS EXAMPLE

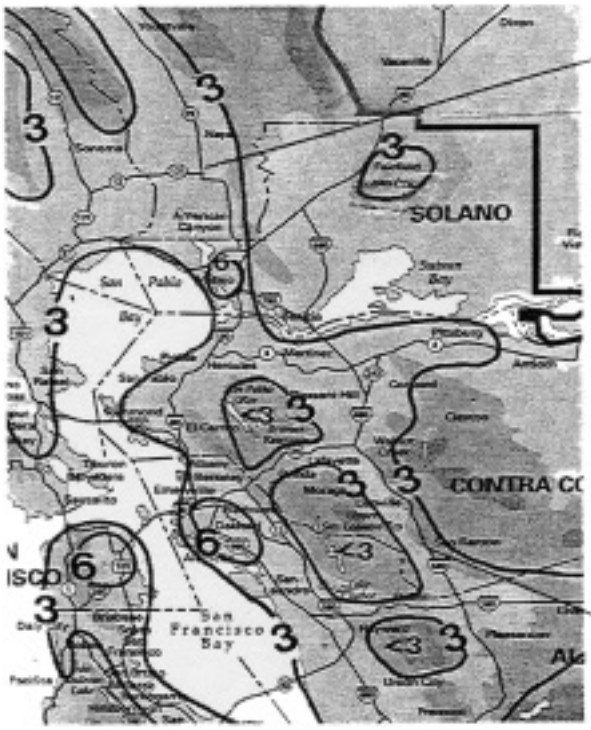




Figure 1A:

Intersection of Rtes. 29 and 121 in Napa County:
An intersection project at this location would be between the 3.0 and 6.0 isopleths. The shortest distance to the 3.0 isopleth is represented by line segment X, and measures 5mm. The shortest distance to the 6.0 isopleth is represented by line segment Y, and measures 13mm. The background concentration for the project would thus be found as follows:

(5mm)/(5mm + 13mm) = 5/18 = .28

(.28)(3.0 ppm) + 3.0 ppm = the background concentration = 3.83 ppm



Figure 1B:

Project on I-680 in San Ramon:
A project on this section of interstate would be between the 3.0 and 6.0 isopleths. The shortest distance to the 3.0 isopleth is represented by line segment X, and measures 2mm. (Note that the project is roughly equidistant from 2 distinct 3.0 isopleths. One is due east, and one is due west.) The shortest distance to the 6.0 isopleth is 23mm. The background concentration for the project would thus be found as follows:

(2mm)/(2mm + 23mm) = 2/25 = .08

(.08)(3.0 ppm) + 3.0 ppm = the background concentration = 3.24 ppm



Figure 1C:

Project on I-980 in Oakland roughly intermediate between I-580 and I-880:
Such a project is located within a peak on the map. The shortest distance to the 6.0 isopleth forming the boundary of the peak is 2mm, and is represented by the line segment X. The distance to the centroid is also 2mm, and is represented by line segment Z. The background concentration for the project would be calculated as follows:

(2mm)/(2mm + 2mm) = 2/4 = .5

(.5)(2.9 ppm) + 6.0 ppm = the background concentration = 7.5 ppm

If the project is located within a "peak" on the map (i.e., within an enclosed area free of a higher isopleth), use the following procedure. (Such a peak could be above a 3.0, 6.0 or 9.0 ppm isopleth.) Measure the shortest distance to the isopleth forming the boundary of the peak. Call this distance X. Measure the distance to the centroid of the enclosure. Call this distance Z. Divide X by the sum of X + Z. Multiply this quotient by 2.9 ppm, and add this product to the boundary isopleth value, I_B. This methodology is illustrated in Figure 5 and is represented by the following formula:

$$\{[X / (X + Z)] \times 2.9 \text{ ppm}\} + I_B = \text{CO background concentration in ppm, where}$$

I_B = boundary isopleth concentration
X = shortest distance to boundary isopleth
Y = distance to centroid

For projects located in areas of the map below the 3.0 isopleth, a background concentration of 2.5 ppm should be assumed.

Example Calculation

Situation: Analysis year: 2000

Intersection of 6-lane highway and a 4-lane road at grade level.

Receptor point at edge of roadway.

Background one hour CO concentration is 9.0 ppm.

Background eight hour CO concentration is 6.0 ppm.

	Primary Road	Secondary Road
Hourly Traffic Volume	3400	2700
Equation	$\frac{(9.5)(3400)(7.27)}{100,000}$	$\frac{(3.3)(2700)(7.27)}{100,000}$

1-Hr Local Concentration: 2.4 + 0.7 = 3.1 ppm

1-Hr Total Concentration: 3.1 (intersection) + 9.0 (1-hr background) = 12.1 ppm

8-Hr Local Concentration: (3.1) x (.7) = 2.2 ppm

8-Hr Total Concentration: 2.2 (intersection) + 6.0 (8-hr background) = 8.2 ppm

Evaluating Diesel Engine Exhaust Emissions

As noted in Section 1.4, ARB in 1998 identified diesel engine particulate matter as a toxic air contaminant, and is evaluating what regulatory action may be needed to reduce public exposure. ARB and the District do not currently have recommended methodologies for Lead Agencies to use in quantifying impacts from diesel exhaust emissions. Because of the potential public health impacts, however, the District strongly encourages Lead Agencies to consider the issue and address potential impacts based on the best information available at the time the analysis is prepared. Particular attention should be paid to projects that might result in sensitive receptors being exposed to high levels of diesel exhaust. This applies both to situations where a new or modified source of emissions is proposed near existing receptors and to new receptors locating near an existing source. Facilities that may have substantial diesel exhaust emissions include the following.

- Truck stop
- Warehouse/distribution center
- Large retail or industrial facility
- High volume transit center
- School with high volume of bus traffic
- High volume highway
- High volume arterial/roadway with high level of diesel traffic

The most current information regarding ARB programs to reduce emissions from diesel engines is available at ARB's website at http://www.arb.ca.gov/toxics/diesel/diesel.htm.

Estimating Stationary Source Emissions

Environmental documents for proposed stationary sources of air pollutants should include a detailed analysis of the project's emissions of criteria pollutants and toxic air contaminants. The document also should describe District regulations applicable to the project and summarize how project design and operations will comply with applicable regulations. Lead Agencies should consult the District's Permit Services Division for guidance on calculating emissions from stationary sources of air pollutants.

For stationary sources being evaluated at an early planning stage, only a general planning or zoning classification may be available, e.g. "research and development" or "light industry". Use of specific emission factors may be difficult. In such cases, the best estimate of future uses should be made. Where an industry designation like "electronic components" or "food processing" is known or assumed, generalized emission factors may be used. Table 14 provides generalized estimates of air contaminant emissions for various categories of industrial land uses in the region. These generalized emission factors were derived from information in the District's emission inventory. Caution should be exercised in using these figures because of the wide range of facilities under each of the categories. However, they may be useful as first estimates of contaminant levels to be expected when only the general category of development is known.

These estimates do not include emissions that can be expected from motor vehicles attracted to these facilities. The indirect source emissions should be calculated separately, as explained earlier in this chapter. Total emissions generated by a proposed project would be the sum of the direct and indirect emissions calculated.

TABLE 14
GENERALIZED EMISSION FACTORS
FOR SELECTED INDUSTRY GROUPS*

Industry Group (Sub-groups)	Average Emissions per Facility (lbs/acre/day)				
	Part.	Org.**	NO_x	SO_2	CO
Manufacturing					
Food Canning (2032, 2033)	0.3	0.5	19.0	22.0	2.2
Paper Prod.(2643, 2647, 2649, 2653, 2654)	0.2	4.4	2.8	0.01	0.6
Printing & Publishing (2700-2771)	3.5	31.0	42.0	0.2	6.0
Inorganic Chemicals (2812, 2813, 2816, 2819)	1.6	0.6	4.9	2.6	5.9
Paints, Varnishes, etc. (2851)	0.2	20.0	0.5	0.0	0.1
Organic Chemicals (2861, 2865, 2869)	1.4	8.5	3.0	0.5	1.6
Petroleum Refining (2911)	1.4	18.0	26.0	16.0	1.3
Paving & Roofing (2951, 2952)	17.0	1.9	11.0	0.7	5.3
Plastic Products, Misc. (3079)	1.1	51.0	0.6	0.0	0.1
Stone, Clay, Glass & Concrete Prod. (3200-3299)	14.0	2.4	17.0	4.6	3.0
Iron & Steel Foundries (3321, 3324, 3325)	11.0	44.0	5.0	2.8	23.0
Metal Containers (3411, 3412)	0.5	90.0	5.5	0.03	0.8
Heating Equipment (3433)	0.1	2.7	0.2	0.00	0.03
Metal Work (3443, 3444, 3448, 3449)	5.3	11.0	1.3	0.01	0.2
Metal Coating (3471, 3479)	0.3	13.0	0.8	0.00	0.1
Machinery, except electrical (3500-3599)	72.0	23.0	0.5	0.02	0.1
Semiconductors, etc. (3674)	0.1	32.0	0.3	0.01	0.1
Electronic Components (3679)	0.1	5.6	0.1	0.00	0.02
Instruments (3800-3873)	0.3	23.0	1.4	0.01	0.2
Other					
Electric Utility plus Other Services (4931)	17.0	12.0	410.0	78.0	32.0
Petroleum Bulk Stations & Terminals (5171)	0.01	150.0	0.1	0.02	0.01
Dry Cleaning Plants (7216)	0.00	6.6	0.1	0.00	0.01
General Hospitals (8062)	2.9	2.3	30.0	0.2	6.0
National Security (9711)	2.8	2.5	22.0	0.01	5.5

* Based on U.S. Standard Industrial Classification (S.I.C.) Code groupings. As compiled by the Statistical Policy Division, Office of Management and Budget.

** Table lists total organic gases (TOG). Reactive organic gases (ROG) is virtually the same for the industrial categories.

3.5 Evaluating Odor Impacts

As noted in Chapter 2, an analysis of potential odor impacts should be conducted for both of the following situations: 1) a potential source of objectionable odors is proposed for a location near existing sensitive receptors, *and* 2) sensitive receptors are proposed to be located near an existing source of objectionable odors. Section 2.3 discusses thresholds of significance for odor impacts.

Odor problems vary greatly. The occurrence and severity of odor impacts depends on numerous factors, including: the nature, frequency and intensity of the source; wind speed and direction; and the sensitivity of the receptor(s). Therefore, to the extent feasible, the analysis of potential odor impacts should be based on District experience and data regarding similar facilities in similar settings. Lead Agencies should consult the District's Enforcement Division for information regarding specific facilities and categories of facilities, and associated odor complaint records.

Any project that would result in an odor source and sensitive receptors being located closer to one another than the distances indicated in Table 4 should be subjected to a more detailed analysis. (Table 4 lists types of facilities that commonly emit objectionable odors.) For any projects triggering the screening level distances in Table 4, the District's Enforcement Division should be contacted for information regarding odor complaints. For projects involving a new receptor being located near an existing odor source(s), the District's inventory of odor complaints for the nearest odor emitting facility(ies) should be reviewed for the previous three years. Odor complaints should be mapped in relation to the odor source to establish a general boundary of any existing impacts.[16] The location of the proposed project should be identified.

For projects involving new receptors locating near an existing odor source where there is currently no nearby development, and for new odor sources locating near existing receptors, the analysis should be based on a review of odor complaints for similar facilities.

In assessing potential odor impacts, consideration also should be given to local meteorological conditions, particularly the intensity and direction of prevailing winds. Refer to Appendix D or contact the District for local meteorological data.

3.6 Evaluating Impacts of Toxic Air Contaminants

The District limits emissions of and public exposure to toxic air contaminants (TACs) through a number of programs. TAC emissions from new and modified stationary sources are limited through an air toxics new source review program, which implements the District's Risk Management Policy via the District's permitting process for stationary sources. TAC emissions from existing sources are limited by: 1) District adoption and enforcement of rules aimed at specific types of sources known to emit high levels of TACs (e.g., chrome plating operations), and 2) implementation of the Air Toxics "Hot Spots" (AB 2588) Program. Appendix E provides more detailed information on District air toxics programs.

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[16] Due to confidentiality requirements regarding odor complaints, only the block number will be provided for mapping. The name of the complainant, date of complaint, and specific address of the complainant will not be provided.

When considering potential impacts related to TACs, Lead Agencies should consider both of the following situations: 1) a new or modified source of TACs is proposed for a location near an existing residential area or other sensitive receptor, and 2) a residential development or other sensitive receptor is proposed for a site near an existing source of TACs.

For the first scenario, a source of TACs proposed near sensitive receptors, the Lead Agency should consult with the District's Toxics Evaluation Section for information regarding anticipated TAC emissions, potential health impacts and control measures. Preparation of the environmental document should be closely coordinated with the District review of the facility's permit application.

For the second scenario, sensitive receptors locating near sources of TACs, the Lead Agency should consult the District's Toxics Evaluation Section to review information gathered pursuant to the AB 2588 Program. AB 2588 requires plants emitting TACs to prepare inventories of TAC emissions from the facility. The District has prioritized these facilities based on the quantity and toxicity of the emissions, and their proximity to areas where the public may be exposed. Facilities put in a "high priority" category were required to prepare a comprehensive, facility-wide health risk assessment. The Lead Agency should review the health risk assessments for facilities subject to AB 2588 on file at the District offices. For facilities for which risk assessments have been conducted, these assessments may be used to identify an area around the facility within which individuals would be exposed to cancer or noncancer risks that would be identified as significant impacts. For facilities for which risk assessments have not been conducted, the District's Toxics Evaluation Section should be consulted to determine whether location of nearby sensitive receptors would expose individuals to cancer or noncancer risks that would be considered significant.

3.7 Evaluating Impacts of Accidental Releases of Hazardous Materials

Health and safety impacts associated with accidental releases of acutely hazardous materials (AHMs) should be evaluated when: 1) a facility storing or using AHMs is proposed near an existing residential area or other sensitive receptor, and 2) a proposed project would result in new receptors locating near an existing facility storing or using AHMs. As noted in Section 2.3, this evaluation should be based on the analyses conducted pursuant to the Risk Management Prevention Program (RMPP) process. Lead Agencies should consult with the local administering agency of the RMPP process (usually the county health department) for guidance in evaluating impacts from accidental releases.

3.8 Evaluating Cumulative Impacts

The evaluation of a project's cumulative impacts should be based on an analysis of the consistency of the project with the local general plan and the local general plan with the regional air quality plan. Refer to the discussion in Section 2.3 of these Guidelines regarding Cumulative Impacts and Plan Impacts for guidance on evaluating cumulative impacts.

3.9 Evaluating Plans

Planning documents such as city and county general plans, specific area plans and redevelopment plans should be evaluated for their potential air quality impacts. The evaluation of a plan's air quality impacts should focus on an analysis of the plan's consistency with the most recently adopted regional air quality plan. At the time of this writing, the most recently adopted regional air quality plan is the *Bay Area 1997 Clean Air Plan* (CAP). (As the CAP is updated in future years, the analysis should evaluate consistency with the updated CAP.)

To evaluate local plan consistency with the CAP, the Lead Agency should consider the following: the local plan's consistency with CAP population and vehicle use projections, the extent to which the plan implements CAP transportation control measures, and whether the plan provides buffer zones around sources of odors and toxics. Refer to Section 2.3, Thresholds of Significance, for guidance on how to determine whether a local plan is consistent with the CAP.

In most cases, quantification of future air pollutant emissions is not necessary as part of this analysis. If a Lead Agency does quantify emissions, note that the URBEMIS7G model discussed previously should not be used to analyze plan impacts. Other models, such as DTIM or BURDEN, may be more appropriate. There may be some instances where quantification of a plan's air quality impacts is appropriate. For example, a specific plan or a redevelopment plan might lead to increased traffic congestion (and possibly cause high CO concentrations) or result in substantial growth in stationary sources of air pollutants. Lead Agencies should consider including a quantitative assessment of a plan's impacts if warranted by special circumstances.

CHAPTER 4 - MITIGATING AIR QUALITY IMPACTS

4.1 Introduction

CEQA requires Lead Agencies to eliminate or minimize significant environmental impacts associated with projects subject to their (discretionary) approval. If an environmental document indicates that a proposed project will have any significant environmental impacts, the document should identify feasible mitigation measures to reduce the impacts below a level of significance. If, after the identification of all feasible mitigation measures, a project is still deemed to have significant environmental impacts, the Lead Agency must adopt a Statement of Overriding Considerations to explain why further mitigation measures are not feasible and why approval of a project with significant unavoidable impacts is warranted.

The District considers a project's air quality impacts to be reduced below a level of significance if the impacts are mitigated to levels below the thresholds discussed in Chapter 2 of these Guidelines. CEQA documents should identify all significant air quality impacts that may result from a project, propose mitigation measures to reduce those impacts, and evaluate the effectiveness of the mitigation measures. To the extent feasible, the effectiveness of mitigation measures should be quantified. The analysis of mitigation measures' effectiveness should be based on reasonable assumptions, and the analysis and underlying assumptions should be clearly explained. The estimation of the effectiveness of mitigation measures is discussed further below.

This chapter provides guidance on mitigation measures that may be implemented to reduce air quality impacts from project construction and operations. The chapter also provides guidance regarding evaluating mitigation measure effectiveness, addresses mitigation monitoring and reporting requirements, and identifies other useful resources and guidance documents. The lists of mitigation measures included in this chapter are not considered to be exhaustive, and Lead Agencies and project proponents are encouraged to think creatively in devising measures to mitigate air quality impacts.

4.2 Mitigating Construction Impacts

Although the impacts from construction related air pollutant emissions are temporary in duration, such emissions can still represent a significant air quality impact. In some cases, construction impacts may represent the largest air quality impact associated with a proposed project. Construction activities such as grading, excavation and travel on unpaved surfaces can generate substantial amounts of dust, and can lead to elevated concentrations of PM_{10}. Emissions from construction equipment engines also can contribute to high localized concentrations of PM_{10}, as well as increased emissions of ozone precursors and carbon monoxide.

Control measures for construction emissions of PM_{10} are discussed in Section 2.3, Thresholds of Significance. Table 2 describes a variety of measures to mitigate construction-related emissions of PM_{10}. Some control measures, e.g., watering the site twice daily and sweeping roadways, should be implemented at all construction sites, regardless of size. Additional measures are recommended for larger sites (over four acres) where emissions will usually be greater.

As noted previously in these Guidelines, the District does not expect Lead Agencies to provide detailed quantification of construction emissions. Similarly, Lead Agencies need not quantify emission reductions from construction-related mitigation measures. The District's recommended approach to mitigating construction emissions focuses on a consideration of whether all feasible control measures are being implemented. (See Section 2.3 for further information.) If a Lead Agency chooses to quantify the effect of construction-related mitigation measures, the Lead Agency should consult Section 13.2.3, Heavy Construction Operations, and related sections of the most recent edition of U.S. EPA's Compilation of Air Pollutant Emission Factors, Volume I: Stationary, Point and Area Sources, AP-42. (When quantifying the effectiveness of construction mitigation measures, the estimated effectiveness of each mitigation measure should be applied only to the corresponding source of emissions. For example, paving or sweeping access roads will reduce emissions of entrained dust from travel on the roadways, but will not reduce emissions from grading and earth moving.)

The discussion of construction impacts and mitigation measures in these Guidelines focuses primarily on PM_{10} emissions from fugitive dust sources. Lead Agencies seeking to reduce emissions from construction equipment exhaust should consider the following mitigation measures:

- Use alternative fueled construction equipment.
- Minimize idling time (e.g., 5 minute maximum).
- Maintain properly tuned equipment.
- Limit the hours of operation of heavy duty equipment and/or the amount of equipment in use.

4.3 Mitigating Air Quality Impacts Through Land Use and Design Measures

There is a growing recognition among air quality professionals that the location, intensity, configuration and design of land use development greatly influences travel behavior and air quality. Land use patterns typical of post-World War II development have contributed greatly to increases in motor vehicle use and emissions. Characteristics that contribute to automobile dependency include low residential and commercial densities, segregated land uses, and street and site design guided solely by the needs of the automobile. Air quality and transportation planners are concluding that we must reexamine the way we build our communities in order to reduce reliance on the automobile. There are myriad ways in which land use influences travel behavior. Examples of such considerations include the following:

- Are residential and commercial developments of sufficient density to support transit service?

- Are neighborhoods sufficiently "compact" to encourage walking and biking for errands, socializing, etc.?

- Are houses, jobs and services located close enough together to allow walking and biking for at least some trips?
- Does the circulation network and the design of individual streets provide a safe and attractive environment for bicyclists and pedestrians?

- Do the designs of individual development projects provide direct, safe and attractive pedestrian access to transit stops and nearby development?

- Does the community have a rough balance between the number of jobs and the number of employed residents?

Solutions do not necessarily have to occur on a grand scale. Incremental improvements can be made by actions as simple as including a neighborhood commercial center within a residential development, locating a child care center near a transit station, placing parking in the rear of a commercial building, or providing sidewalks and benches in new subdivisions or commercial development. The District strongly encourages Lead Agencies and project proponents to take advantage of every opportunity to make development projects more pedestrian-, bicycle- and transit-friendly.

In recent years, increased attention is also being paid to more ambitious solutions, such as "Transit-Oriented Development". Transit-Oriented Development (TOD) is a land use strategy which is intended to reduce the automobile dependence of typical suburban growth. TOD designs specifically emphasize the needs of pedestrians and transit users. TOD designs include features such as clustering of public and commercial uses around a "town center", a range of residential densities, narrower street widths, and a gridded street pattern. TODs can be defined as follows:

> (TODs) are mixed-use neighborhoods, up to 160 acres in size, which are developed around a transit stop and core commercial area. The entire TOD site must be within an average 2,000 foot walking distance of a transit stop. Secondary areas of lower density housing, schools, parks, and commercial and employment uses surround TODs for up to one mile.[17]

TODs may come in various shapes and sizes, depending on the surrounding built environment. "Urban TODs" are oriented toward rail stations and express bus stops, and are characterized by a greater proportion of employment-generating land uses and higher commercial and residential densities. "Neighborhood TODs" are more appropriate for high frequency bus routes and feeder routes, and place greater emphasis on housing and local-serving shopping and services.

Improved coordination of land use and transportation planning and greater emphasis on making communities more transit-, bicycle- and pedestrian-friendly can reduce reliance on the automobile for all kinds of trips: trips to work, shopping, school, recreation, personal business. Such strategies can result in many other benefits to the community as well, such as reduced traffic congestion, energy conservation, preservation of open space, improved water quality (fewer contaminants in urban run-off), and more attractive, cohesive communities.

Land use considerations also can reduce air quality problems not related to motor vehicle use. By separating residential areas and other sensitive receptors from sources of odors, dust and

[17] Calthorpe Associates, "Transit-Oriented Development Design Guidelines," prepared for the City of San Diego, 1992.

toxic air contaminants, health and nuisance impacts can be minimized. Buffer zones should *always* be provided between sensitive receptors and sources of odors, dust, toxics and accidental releases of hazardous materials. (As noted in Section 2.1, Early Consultation, some infill and mixed use projects occasionally may result in sensitive receptors and sources of odors or toxics being in close proximity. Lead Agencies are encouraged to promote infill and mixed use development, but should avoid locations that would lead to health or nuisance impacts to sensitive receptors.)

Many land use and design measures can be implemented on a project-by-project level. For instance, the site plan for a commercial development can promote pedestrian access by locating parking lots in the rear of the building and placing building entrances near transit stops and sidewalks. Or the circulation plan for a residential subdivision can provide dedicated bicycle routes and direct pedestrian access to transit stops and adjacent development. (As noted in Section 2.1, Early Consultation, land use and design measures targeted at individual projects should be addressed as early in the development review process as possible so as to minimize costs to developers and local government and increase the likelihood of implementation.)

Many land use and design measures, however, are most effective if implemented community-wide, or even at the subregional level. Issues such as allowable land use densities, mixing of land uses, street standards, parking requirements, etc. are most appropriately addressed throughout the entire community or subregion. Policy documents such as general plans and specific area plans, as well as implementing mechanisms such as zoning ordinances, parking standards and design guidelines, may need to be revised. Ad hoc implementation of these strategies to individual projects can still be beneficial, even absent a community-wide strategy, but the benefits will be greater if implemented broadly. For example, a 1993 study by U.C. Berkeley researchers examined the effects of (rail) transit-based development on transit ridership.[18] The study found that residents of higher density housing located near rail transit stations commuted by rail at much higher rates than did residents living further away from transit stations. The study concluded, however, that the increases in transit ridership were much more pronounced if the worksite also was located near a transit station and if the worksite charged for parking. In other words, concentrating housing near transit helps, but the location and parking policies of the destinations are also critical factors.

Therefore, the District strongly encourages local governments to examine local plans and implementing programs to look for opportunities to better coordinate land use, transportation and air quality planning. To the extent that cities and counties can make their communities more transit-, bicycle- and pedestrian-friendly, and minimize land use conflicts that lead to toxics and nuisance problems, the need to mitigate significant air quality impacts of individual development proposals will be minimized. The District and ABAG have jointly prepared a guidance document to assist local governments in developing these strategies, *Improving Air Quality Through Local Plans and Programs, A Guidebook for City and County Governments*. Copies are available from ABAG. Appendix F of these Guidelines lists additional resources that may be useful.

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[18] Cervero, Robert, "Ridership Impacts of Transit-Focused Development in California", for the National Transit Access Center, November 1993.

A study released by the ARB in June 1995 may be especially useful to Lead Agencies considering land use strategies to reduce air pollutant emissions. The report, prepared by JHK & Associates, is titled *Transportation-Related Land Use Strategies to Minimize Motor Vehicle Emissions: An Indirect Source Research Study*. The report discusses a number of land use strategies that can reduce motor vehicle use and emissions:

- Provide pedestrian facilities.
- Increase density near transit corridors.
- Increase density near transit stations.
- Encourage mixed-use development.
- Encourage infill and densification.
- Develop concentrated activity centers.
- Strengthen downtowns.
- Develop interconnected street network.
- Provide strategic parking facilities.

The report provides estimates of the measures' effectiveness in reducing vehicle use and emissions in various types of communities (urban, suburban and exurban). The estimated ranges of effectiveness are based on quantitative data from existing California communities. It is hoped that by identifying ranges of effectiveness for the land use measures, local officials will be able to set performance goals (e.g., vehicle trips or emissions per household) for their communities. The report recommends combinations of strategies to achieve the performance goals, and provides guidance on implementation mechanisms. One of the study's findings is that although it is difficult to quantify reductions in vehicle use and emissions from individual strategies applied at individual sites, combinations of strategies implemented community-wide can achieve significant reductions in vehicle use and emissions. The report is available from ARB's Transportation Strategies Group.

4.4 Mitigating Impacts of Project Operations

Introduction

In many cases, motor vehicles traveling to and from a facility represent the principal source of air pollutants associated with the project. Therefore, this section focuses primarily on measures to reduce mobile source emissions by reducing motor vehicle trips and vehicle miles traveled. If the procedures outlined in Chapters 2 and 3 of these Guidelines indicate that a project's motor vehicle emissions would be a significant impact, mitigation measures should be identified to reduce the impact to a level of insignificance.

A wide variety of measures may be implemented to reduce air pollutant emissions resulting from land use development. The appropriateness of a given mitigation measure depends on a number of factors, such as the type and size of project being proposed, the location and characteristics of the community in which the project will be located, neighboring land uses, availability of transit, etc. For example, consider the provision of bicycle racks and showers and lockers at a worksite in order to encourage commuters to bike to work. Such measures will be more effective in a

community with a comprehensive network of bicycle routes and fairly flat terrain than in a community with poor bicycle access and hilly terrain. Lead Agencies and project proponents should carefully consider the specific nature of the project and its setting when developing mitigation measures.

Estimating the Effectiveness of Mitigation Measures for Project Operations

To the extent feasible, the effectiveness of proposed mitigation measures should be quantified. Because the measures' effectiveness will depend greatly on the specific characteristics of the project and its setting, this quantification should be based on a project-specific analysis whenever possible. For mitigation measures to reduce vehicle use, this means conducting a travel analysis for the project using appropriate local modeling inputs.

Tables 15 and 16 identify mitigation measures that may be used to reduce motor vehicle emissions from commercial and residential projects, respectively. The tables provide estimates of each measure's effectiveness in reducing vehicle trips. In cases where a range of estimated effectiveness is provided, the low end of the range should be used unless local conditions warrant a higher figure. The column of supporting factors should be consulted to see if a higher figure is justified. The effectiveness estimates are based on a review of published literature and represent what the District believes to be reasonable expectations regarding effectiveness. However, the percentages in Tables 15 and 16 are default values, and should be used only in the absence of project-specific analysis.

Several cautionary notes regarding estimating the effectiveness of mitigation measures are warranted.

Clearly explain the assumptions underlying the environmental document's analysis of mitigation measures' effectiveness. The analysis should specifically describe the mitigation measure, identify the source(s) of air pollutants that are expected to be affected by the measure, clearly explain how and to what extent the measure will affect the source(s), and identify the basis for the estimate (empirical observations, computer modeling, case studies, etc.). Critical assumptions should be linked to the mitigation monitoring and reporting program. For example, if the environmental analysis for a commercial development assumes that 20% of employees will carpool to work, then such an objective should be included in the mitigation monitoring and reporting program as a test of whether the measure is being implemented.

Be specific regarding implementation of mitigation measures. The environmental document should describe each mitigation measure in detail, identify who is responsible for implementing the measure, and clearly explain how and when the measure will be implemented. Methods for assessing the measure's effectiveness once it is in place, and possible triggers for additional mitigation if necessary, are also desirable. This level of detail regarding mitigation measure implementation frequently is not addressed until the preparation of the mitigation monitoring and reporting program, which often takes place very late in the environmental review process. In order to reliably assess the effectiveness and feasibility of mitigation measures, however, the District believes it is necessary to

consider the specifics of mitigation measure implementation as early in the environmental review process as possible.

Be sure not to double count the effect of proposed mitigation measures. The project description and assumptions underlying the analysis of project impacts should be carefully considered when estimating the effect of mitigation measures. If certain conditions or behavior are assumed in the impact analysis, then credit may not be claimed when proposing mitigation measures. For example, if the traffic and air quality analyses for a proposed project assume that a certain percentage of people will access the project by transit or bicycle, then any credit claimed for transit- or bicycle-related mitigation must clearly demonstrate effectiveness above and beyond the mode split assumed in the impact analysis.

In some cases it simply may not be possible to quantify the effect of proposed mitigation measures. It may be that the specific conditions surrounding a particular project are so unique as to render extrapolation from other examples unreliable. A proposed measure may be innovative, with little precedent. The combined effects of a package of measures may be too difficult to quantify. While a certain degree of professional judgment is usually involved in estimating the effectiveness of mitigation measures, overly speculative estimates should be avoided. If the Lead Agency cannot quantify mitigation effectiveness with a reasonable degree of certainty, the environmental document should at least address effectiveness qualitatively. If the Lead Agency makes a finding that non-quantified mitigation measures reduce an impact to a level of insignificance, the document should provide a detailed justification of that conclusion.

Mitigating Impacts from Motor Vehicles

Several general approaches can be taken to reduce emissions from motor vehicles:

- Reduce vehicle trips. These measures reduce air pollutant emissions by eliminating entirely some of the vehicle trips associated with a project. An example would be the provision of bicycle facilities to encourage bicycle use instead of driving.

- Reduce vehicle miles traveled. These measures reduce emissions by reducing the length of vehicle trips associated with a project. An example would be the provision of satellite offices/telecommuting centers to reduce the distance of employee commute trips.

- Use of low emission vehicles. These measures do not aim to reduce trips or VMT, but rather promote the use of fuels that are less polluting than gasoline or diesel. An example would be the conversion of a vehicle fleet to operate on compressed natural gas.

- Improve traffic flows/reduce congestion. These measures reduce emissions by reducing traffic congestion and/or reducing stops and starts. This allows vehicles to operate at steady and moderate speeds, and thus lowers pollution per mile traveled. An example would be timing the traffic signals on an arterial to facilitate uninterrupted travel.

- Support measures. These measures may not directly reduce emissions, but rather support and facilitate other emission reduction strategies. An example would be a guaranteed ride home program implemented at a worksite in order to encourage employees to use commute alternatives by allaying concerns over being without a vehicle in case of emergency.

Emission reduction measures from each of the above categories can be implemented in combination with one another. (Support measures, by definition, are implemented to reinforce other emission reduction strategies.) In general, the District prefers measures that reduce vehicle trips entirely, as they achieve the greatest emission reductions. (This is because vehicle emissions are highest during the first several miles of a trip.) Strategies to reduce VMT should also be pursued, however. Reducing VMT has a greater impact on PM_{10} emission than other pollutants, because PM_{10} emission (due to entrained road dust) are more directly correlated to VMT. Measures to encourage low emission vehicles are also desirable, especially for projects that include a sizable fleet of vehicles (delivery services, taxis, airport shuttles, airport ground support equipment, etc.). Traffic flow improvements may be beneficial if congestion is a major factor in the air quality impact, but particular caution is warranted to avoid traffic-inducing effects of increased roadway capacity.

There is an increasing range of alternatively-fueled, low emission vehicles and equipment available on the market. Examples include light and medium duty automobiles and vans, heavy duty trucks and buses, and specialty equipment such as forklifts, construction equipment, parking enforcement vehicles, and airport ground support equipment. Compressed natural gas-powered vehicles and electric vehicles (EVs) are probably the most common in the Bay Area, but other fuels such as liquefied natural gas and propane are also in use. Emerging technologies such as hybrid electric vehicles and fuel cells also are promising.

While the District urges Lead Agencies to emphasize measures to reduce trips and VMT, careful consideration should always be given to opportunities to promote use of low emission fuels. Low emission vehicles and equipment are particularly well suited in situations where there is a large fleet of vehicles, at large facilities (either a single facility or a conglomeration of multiple facilities in proximity) where there may be the critical mass to justify a fueling facility, and at projects where trip reduction strategies are less promising due to specific circumstances (e.g., little or no transit service, poor bike/ped access, etc.). Low emission vehicles and equipment also are a good complement to trip reduction strategies. For trips that can't or won't be eliminated, low emission vehicles reduce emissions with little or no change in behavior. Use of low emission vehicles and equipment will help implement mobile source control measures in the *1997 CAP* that aim to increase the use of this equipment.

Table 17 provides examples of low emission vehicle projects that may be appropriate at a variety of land uses. Lead Agencies and project proponents should always consider such opportunities when devising mitigation strategies. More information on low emission vehicles and equipment is available at the websites listed below.

The District administers several programs that provide funding assistance for low emission vehicles and infrastructure. Information on these programs, as well as information on low emission vehicle technology in general, is available on the District's website at

www.baaqmd.gov/planning/plntrns/tfcapage.htm. ARB and the U.S. Department of Energy also provide extensive information on low emission vehicles at www.arb.ca.gov/altfuels/altfuels.htm and www.afdc.nrel.gov, respectively.

If a project may result in public exposure to high levels of diesel exhaust, the Lead Agency should propose mitigation measures to reduce this impact. Although the District does not currently (as of December 1999) provide a methodology for quantifying the effectiveness of these measures, they should be given careful consideration. In addition to reducing toxic diesel exhaust emissions, these measures also will reduce emissions of NO_x and PM_{10}. Possible mitigation measures include the following.

Heavy Duty Truck Emissions

- Truck stop electrification – minimize truck idling for heating, air conditioning and refrigeration units
- Conversion to cleaner engines
- Use of cleaner (reduced sulfur) fuel
- Regular maintenance – keep equipment well tuned
- Add-on control devices, e.g., particulate traps, catalytic oxidizers
- Buffer zone between facility and sensitive receptors

Heavy Duty Bus Emissions

- Conversion to cleaner engines
- Use of cleaner (reduced sulfur) fuel
- Regular maintenance – keep equipment well tuned
- Reduce idling
- Add-on control devices, e.g., particulate traps, catalytic oxidizers
- Buffer zone between facility and sensitive receptors

Other Mobile Equipment Emissions (construction equipment, locomotives, marine vessels)

- Conversion to cleaner engines
- Use of cleaner (reduced sulfur) fuel
- Regular maintenance – keep equipment well tuned
- Add-on control devices, e.g., particulate traps, catalytic oxidizers
- Buffer zone between facility and sensitive receptors

TABLE 15
MITIGATION MEASURES FOR REDUCING MOTOR VEHICLE EMISSIONS FROM COMMERCIAL, INSTITUTIONAL AND INDUSTRIAL PROJECTS

Mitigation Measure	Supporting Factors to Enhance Effectiveness	Effectiveness
Rideshare Measures		
Implement carpool/vanpool program e.g., carpool ridematching for employees, assistance with vanpool formation, provision of vanpool vehicles, etc.	• Employer provides support measures such as carpool/vanpool subsidies, preferential parking, guaranteed ride home program, etc. • Coordinate with regional ridesharing organization, e.g., RIDES for Bay Area Commuters. • Multiple smaller worksites coordinate programs. • Limited parking supply and/or implementation of parking fees or parking cash-out.	1% - 4% (work trips)
Transit Measures		
Construct transit facilities such as bus turnouts/bus bulbs, benches, shelters, etc.	• Transit service with frequent headways available at project or on roadways adjacent to project. • Transit use incentives for employees, e.g., on-site distribution of passes, subsidized transit passes, etc. • Transit route maps and schedules posted at stops. • Shade trees/landscaping planted at transit stops.	0.5% - 2% (all trips)
Design and locate buildings to facilitate transit access, e.g., locate building entrances near transit stops, eliminate building setbacks, etc.	• Jurisdiction provides design guidelines addressing transit accessibility. • Consultation with transit provider during project design, review.	0.1% - 0.5% (all trips)
Services Measures		
Provide on-site shops and services for employees, such as cafeteria, bank/ATM, dry cleaners, convenience market, etc.	• Sufficient number of employees at worksite, or cooperation among multiple worksites. • Safe, direct pedestrian access between employment and retail areas. • Jurisdiction provides density bonuses, other incentives to encourage mixed land uses.	0.5% - 5% (work trips)
Provide on-site child care, or contribute to off-site child care within walking distance.	• Sufficient number of employees at worksite, or cooperation among multiple worksites.	0.1% - 1% (work trips)

Shuttle Measures		
Establish mid-day shuttle service from worksite to food service establishments/commercial areas.	• Sufficient number of employees at worksite, or cooperation among multiple worksites. • Commercial area located within 3 miles. • Frequent, scheduled service during lunch hours. • Coordination among multiple employers, e.g., at business parks. • Provide commute shuttle to transit station, use same vehicle for mid-day shuttle.	0.5% - 1.5% (work trips)
Provide shuttle service to transit stations/multimodal centers.	• Major transit facility/multimodal center located within 3 miles of project. • Transit use incentives for employees, e.g., on-site distribution of passes, subsidized transit passes, etc. • Frequent, scheduled service during peak commute periods. • Coordination among multiple employers, e.g., at business parks. • Free or subsidized service. • Provide mid-day shuttle to commercial areas, use same vehicle for commute shuttle.	1% - 2% (work trips)
Parking Measures		
Provide preferential parking (e.g., near building entrance, sheltered area, etc.) for carpool and vanpool vehicles.	• Most effective if parking supply is limited and/or located far from building entrance.	0.5% - 1.5% (work trips)
Implement parking fees for single occupancy vehicle commuters.	• Reduced or waived fees for carpools and vanpools. • Complemented by transit, ridesharing programs, other commute alternatives. • Revenues used to support commute alternatives. • Provisions in place to avoid offsite parking spillover.	2% - 20% (work trips)

Implement parking cash-out program for employees (i.e., non-driving employees receive transportation allowance equivalent to value of subsidized parking).	• Complemented by transit, ridesharing programs, other commute alternatives. • Implement at worksites not subject to State parking cash-out requirements. • Tax benefits if travel allowance offered as transit/ridesharing subsidy. • Provisions in place to avoid offsite parking spillover.	2% - 20% (work trips)
Bicycle and Pedestrian Measures		
Provide secure, weather-protected bicycle parking for employees.	• Bicycle parking location is more convenient than auto parking. • Project located adjacent to, or within 1/4 mile of, Class I bicycle path or Class II bicycle lane. • Significant number of employees live within 5 miles of worksite. • Employer provides bicycle support measures, e.g., bicycle route maps, tools for emergency repairs, etc.	0.5% - 2% (work trips)
Provide safe, direct access for bicyclists to adjacent bicycle routes.	• Local jurisdiction has adopted comprehensive bicycle plan. • Significant number of employees live within 5 miles of worksite. • Employer provides bicycle support measures, e.g., bicycle route maps, tools for emergency repairs, etc. • Provide push buttons or sensors to activate traffic signals.	0.5% - 2% (work trips)

Provide showers and lockers for employees bicycling or walking to work.	• Significant number of employees live within 5 miles (bicycling)/2 miles (walking). • Project located adjacent to, or within 1/4 mile of, Class I bicycle path or Class II bicycle lane. • Employer provides bicycle support measures, e.g., bicycle route maps, tools for emergency repairs, etc.	0.5% - 2% (work trips)
Provide secure short-term bicycle parking for retail customers and other non-commute trips.	• Bicycle parking location is more convenient than auto parking. • Project located adjacent to, or within 1/4 mile of, Class I bicycle path or Class II bicycle route.	1% - 2% (non-work trips)
Provide direct, safe, attractive pedestrian access from project to transit stops and adjacent development.	• Jurisdiction provides design guidelines addressing pedestrian accessibility. • Pedestrians separated from traffic, parking areas. • Shade trees/landscaping planted at pedestrian areas. • Benches, fountains, other amenities provided to enhance pedestrian environment.	0.5% - 1.5% (all trips)
Other Measures		
Implement compressed work week schedule (e.g., 4/40, 9/80).	• Consult with employees prior to program implementation.	2% - 10% (work trips)
Implement home-based telecommuting program.	• Participation increased if employer provides/assists with provision of equipment (modem, computer, etc.). • Especially effective if employee commute trips are long.	0.5% - 1.5% (work trips)

TABLE 16
MITIGATION MEASURES FOR REDUCING MOTOR VEHICLE EMISSIONS FROM RESIDENTIAL PROJECTS

Mitigation Measure	Supporting Factors to Enhance Effectiveness	Effectiveness
Provide neighborhood-serving shops and services within or adjacent to (1/4-1/2 mile) residential project.	• Direct pedestrian/bicycle access is available. • Medium or high residential densities located closer to commercial areas. • Jurisdiction has design guidelines addressing issues such as pedestrian access, parking, compatibility with neighboring land uses, etc.	1% - 4% (all trips)
Provide transit facilities, e.g., bus bulbs/turnouts, benches, shelters, etc.	• Transit service is available in or adjacent to project. • Project is of sufficient density to support transit service. • Transit service with frequent headways. • Consultation with transit provider during project design, review	0.2% - 2% (all trips)
Provide shuttle service to regional transit system or multimodal center.	• Transit station or multimodal center located within 5 miles of project. • Medium to high residential densities.	0.1% - 0.5% (all trips)
Provide shuttle service to major destinations such as employment centers, shopping centers, schools.	• Destinations located within 5 miles of project. • Medium to high residential densities.	0.1% - 0.3% (all trips)
Provide bicycle lanes and/or paths, connected to community-wide network.	• Local jurisdiction has adopted comprehensive bicycle plan. • Project is located adjacent to, or within 1/4 mile of, Class I bicycle path or Class II bicycle lane. • Routes are direct and convenient, not curving recreational paths.	0.1% - 2% (all trips)

Provide sidewalks and/or paths, connected to adjacent land uses, transit stops, and/or community-wide network.	• Destinations such as commercial areas, schools, parks, community centers, etc. are located nearby. • Cul-de-sacs are discouraged, or easements are provided for pedestrian access. • Shade trees/landscaping provided.	0.1% - 1% (all trips)
Provide satellite telecommute centers in large residential developments.	• Most effective if residential area is located far from employment centers	0.1% - 1.5% (work trips)
Provide interconnected street network, with a regular grid or similar interconnected street pattern.	• Multiple ingress/egress points are available. • Large, multi-lane arterials are discouraged. • Reduced street widths and curb radii. • Cul-de-sacs are discouraged. • Street trees required.	1% - 5% (all trips)

TABLE 17
LOW EMISSION VEHICLE MITIGATION MEASURES

	Office (office building, office park)	Retail (large retail building, shopping center, mall)	Institutional (airport, university, hospital, etc.)	Residential
Electric Vehicles/Equipment				
Install EV charging facility	X	X	X	
Provide EVs in vehicle fleet	X	X	X	
Preferential parking location for EVs	X	X	X	
Reduced/no parking fee for EVs	X	X	X	
Use electric lawn & garden equipment	X	X	X	
Use electrically powered specialty equipment, e.g., utility carts, airport ground support equipment, etc.	X	X	X	
Require/provide incentives for airport tenants to use electrically powered shuttles, GSE, rental cars, etc.			X	
Provide electrical power in garage/driveway for EV charging				X
Provide electrical power outdoors to allow use of electric lawn & garden equipment				X
At multifamily residential projects, provide EV charging facilities and/or preferential parking for EVs				X
Compressed Natural Gas Vehicles/Equipment				
Provide CNG vehicles in vehicle fleet	X	X	X	
Preferential parking location for CNG vehicles	X	X	X	
Reduced/no parking fee for CNG vehicles	X	X	X	
Install CNG fueling facility	X	X	X	
Use CNG specialty equipment, e.g., utility carts, airport ground support equipment, etc.	X	X	X	
Require/provide incentives for airport tenants to use CNG powered shuttles, GSE, rental cars, etc.			X	
Other Vehicles/Equipment				
Use propane powered specialty equipment, e.g., forklifts, utility carts, airport GSE, etc.		X	X	

4.5 Mitigating Odor Impacts

Projects that have a significant odor impact because they place sources of odors and members of the public near each other should establish a buffer zone to reduce odor impacts to a less than significant level. The dimensions of the buffer zone must ensure that the encroaching project does not expose the public to nuisance levels of odorous emissions. In establishing the appropriate dimensions of the buffer zone, the Lead Agency should consider actions currently being taken at the facility to control odors, as well as any future actions to which the facility is firmly committed. A safety margin also should be considered in establishing a buffer zone to allow for future expansion of operations at the source of the odors.

In order to reduce the dimensions of the buffer zone, add-on control devices (e.g., filters or incinerators) and/or process modifications implemented at the source of the odors may be feasible, depending on the specific nature of the facility. Lead Agencies should consult the District's Enforcement Division for further information regarding add-on controls and process modifications to control odors. Odor mitigation measures that are targeted at the *receptors* (e.g., residential areas) that rely on sealing buildings, filtering air or disclosure statements are not appropriate mitigation measures to be used in lieu of buffer zones or technical controls.

4.6 Mitigating Impacts from Toxic Air Contaminants and Accidental Releases of Hazardous Materials

A project would have a significant impact if it resulted in members of the public being close enough to either 1) a source of toxic air contaminants (TACs) or 2) a potential source of accidental releases of hazardous materials, such that the thresholds described in Section 2.3 would be exceeded. To mitigate such impacts, a buffer zone should be provided between the source and the receptors. The appropriate dimensions of the buffer zone will depend on a variety of factors, including the nature of the activities occurring at the source, the types and quantities of materials being stored or used at the facility, and local topography and meteorology.

As discussed in Section 2.3, the determination of significant impact with respect to accidental releases should be based on analyses prepared pursuant to the Risk Management Prevention Program (RMPP). RMPP analyses will be key inputs in establishing the appropriate dimensions of buffer zones around potential sources of accidental releases. Lead Agencies should consult with the local administering agency of the RMPP process (usually the county health department) when establishing buffer zones around sources of accidental releases to assure that the thresholds described in Section 2.3 are not exceeded.

The determination of significance with respect to TAC emissions will generally be based on analyses conducted as part of the District’s permitting process and/or implementation of the Air Toxics “Hot Spots” (AB 2588) program. Section 3.6 describes processes for evaluating

potential TAC impacts. These analyses will assist Lead Agencies in establishing buffer zones and, if necessary, identifying other mitigation measures to reduce TAC impacts.

In most cases, control devices and/or changes in industrial processes may be implemented at the source(s) in order to reduce the risk from TAC emissions or accidental releases. All feasible measures to reduce risks from TAC emissions and accidental releases should be implemented. While such measures may reduce the necessary dimensions of a buffer zone, they do not obviate the need to maintain buffer zones to protect public health and safety. This is particularly true in situations where residential development (or any other sensitive receptor) is encroaching on an existing source of TACs or accidental releases. Also, as noted above regarding odor impacts, mitigation measures for TACs or accidental releases (such as disclosure statements, sealing of buildings, community alert procedures, etc.) that are targeted at potential *receptors* are not appropriate mitigations to be used in lieu of buffer zones or technical controls.

4.7 Mitigation Monitoring and Reporting

State law requires that when a public agency makes findings based on an EIR that mitigation measures are required to avoid or lessen significant environmental effects identified in the EIR, the public agency must adopt a reporting or monitoring program for those mitigation measures (California Public Resources Code, Section 21086.6). This requirement is intended to assure that mitigation measures included in a certified EIR are indeed implemented. A mitigation monitoring and reporting program should include the following components:

- A description of each mitigation measure adopted by the Lead Agency.
- The party responsible for implementing each mitigation measure.
- A schedule for the implementation of each mitigation measure.
- The agency or entity responsible for monitoring mitigation measure implementation.
- Criteria for assessing whether each measure has been implemented.
- Enforcement mechanism(s).

Although the mitigation monitoring and reporting program is not required to be included in the EIR, the District recommends that the Lead Agency do so. This will encourage the Lead Agency and other entities to specifically consider the feasibility and effectiveness of each mitigation measure while the environmental analysis is still underway.

If a responsible agency or any agency having jurisdiction over natural resources affected by the project proposes mitigation measures, the Lead Agency may require that agency to prepare a monitoring and reporting program for those mitigation measures.

APPENDIX A - AIR QUALITY LAWS, PROGRAMS AND STANDARDS

This appendix summarizes the major federal and State laws, regulations and programs that establish the legal framework for protecting and improving air quality in the Bay Area. Some of these regulations have air quality improvement as their primary purpose. Others deal with air quality within the context of other public objectives. Table A-1 summarizes national and State ambient air quality standards — the quantitative air quality objectives that the Bay Area is required to attain.

FEDERAL PROGRAMS

Federal Clean Air Act and 1990 Clean Air Act Amendments. National ambient air quality standards (NAAQS) were established in 1970 by the federal Clean Air Act for six pollutants: carbon monoxide, ozone, particulate, nitrogen dioxide, sulfur dioxide and lead. These pollutants are commonly referred to as "criteria" pollutants because they are considered the most prevalent air pollutants that are known to be hazardous to human health and because criteria documents, including ambient air quality standards, have been prepared for each of these contaminants.

The Act required states exceeding the NAAQS to prepare air quality plans showing how the standards were to be met by December 1987. The Act was amended in 1977, and again in 1990, to extend the deadline for compliance and require that revised State Implementation Plans (SIP) be prepared. Failure to submit and implement an acceptable plan meant a state could be denied federal highway funding and/or be required to increase emission offsets for industrial expansion. The 1990 Clean Air Act Amendments established categories of air pollution severity for nonattainment areas ("marginal" to "extreme"). SIP requirements varied, depending on degree of severity. (For a discussion of the Bay Area's portion of the California SIP, see "Bay Area Regional Agencies and their Programs" below.)

The conformity provisions of the Act are essentially designed to ensure that federal agencies contribute to, instead of jeopardizing, efforts to achieve the NAAQS. In November of 1993, U.S. EPA issued two regulations implementing these provisions. The transportation conformity regulation deals with transportation projects. The general conformity regulation addresses actions of federal agencies other than the Federal Highway Administration and the Federal Transit Administration.

The primary requirements of transportation conformity of note to Lead Agencies are that transportation plans and programs cannot produce more emissions than were budgeted for in the latest SIP. Projects receiving federal funds or approvals also must undergo localized air quality modeling. Finally, emissions from local projects with no federal funding must be included in regional plans and programs, if the sponsoring agency receives any federal funds.

TABLE A-1 AMBIENT AIR QUALITY STANDARDS

Pollutant	Averaging Time	California Standards[1, 3]	National Standards[2, 3]
Ozone[4]	1 Hour	0.09 ppm	0.12 ppm
	8 Hour		0.08 ppm
Carbon Monoxide	8 Hour	9.0 ppm	9 ppm
	1 Hour	20 ppm	35 ppm
Nitrogen Dioxide	Annual Average		0.053 ppm
	1 Hour	0.25 ppm	
Sulfur Dioxide	Annual Average		80 $\mu g/m^3$
	24 Hour	0.04 ppm	365 $\mu g/m^3$
	1 Hour	0.25 ppm	
Fine Particulate Matter (PM_{10})	Annual Arithmetic Mean		50 $\mu g/m^3$
	Annual Geometric Mean	30 $\mu g/m^3$	
	24 Hour	50 $\mu g/m^3$	150 $\mu g/m^3$
Fine Particulate Matter ($PM_{2.5}$)[4]	Annual Arithmetic Mean		15 $\mu g/m^3$
	24 Hour		65 $\mu g/m^3$
Sulfates	24 Hour	25 $\mu g/m^3$	
Lead	Calendar Quarter		1.5 $\mu g/m^3$
	30 Day Average	1.5 $\mu g/m^3$	
Hydrogen Sulfide	1 Hour	0.03 ppm	
Vinyl Chloride (chloroethene)	24 Hour	0.010 ppm	
Visibility Reducing Particles[5]	8 Hour (10 am to 6 pm PST)	10-mile visual range when relative humidity is less than 70%	

ppm = parts per million. $\mu g/m^3$ = micrograms per cubic meter.

FOOTNOTES

1. California standards for ozone, carbon monoxide (except Lake Tahoe), sulfur dioxide (1-hour and 24-hour), nitrogen dioxide, fine particulate matter, and visibility reducing particles are values that are not to be exceeded. The standards for sulfates, lead, hydrogen sulfide, and vinyl chloride are not to be equaled or exceeded. If the standard is for a 1-hour, 8-hour or 24-hour average (i.e., all standards except for lead and the PM_{10} annual standard), then some measurements may be excluded. In particular, measurements are excluded that ARB determines would occur less than once per year on the average.
2. National standards other than for ozone and those based on annual averages or arithmetic means are not to be exceeded more than once a year. The ozone standard is attained if, during the most recent 3-year period, the average number of days per year with maximum hourly concentrations above the standard is one or less.
3. National air quality standards are set at levels determined, by the U.S. Environmental Protection Agency, to be protective of public health with an adequate margin of safety. The State of California has set more stringent standards for a number of contaminants, based on independent medical judgment.
4. In 1997 EPA established an 8-hour standard for ozone, and annual and 24-hour standards for very fine particulate matter (PM2.5). The new standards were challenged in court, and as of December 1999 their status was uncertain.
5. This standard is intended to limit the frequency and severity of visibility impairment due to regional haze and is equivalent to a 10-mile nominal visual range when relative humidity is less than 70 percent.

General conformity applies to a wide range of actions or approvals by federal agencies. Potentially covered by the regulation are actions of concern to local governments such as decisions on wastewater treatment facilities and airport expansions. Essentially, projects are subject to general conformity if they generate more emissions than minimum thresholds set in the rule (currently 100 tons per year of ROG, NO_x, or CO in the Bay Area), and that are not specifically exempted by the regulation. Such projects are required to fully offset or mitigate the emissions caused by the action. This includes both direct emissions and indirect emissions over which the federal agency has some control.

The U.S. EPA also has programs for identifying and regulating toxic air pollutants (air toxics). The Clean Air Act Amendments of 1990 directed EPA to set standards for air toxics and to require facilities to sharply reduce emissions of controlled chemicals. The 1990 Amendments specified 174 industrial sources that are to be regulated. An industry is classified as a major source — and must be regulated — if it emits ten tons per year of any of the listed air toxics, or a combination of 25 tons or more of all listed air toxics.

National Environmental Policy Act (NEPA). NEPA requires that major projects to be conducted or approved by the federal government be subject to environmental assessments. If the potential for significant adverse environmental impacts exists, an Environmental Impact Statement (EIS) must be prepared and circulated to affected jurisdictions and the interested public.

Intermodal Surface Transportation Efficiency Act, 1991 (ISTEA). This law requires a regional transportation planning process that includes consideration of 15 factors, two of which address consistency with adopted land use plans and potential environmental effects. ISTEA also provides funds for transportation projects and activities that contribute to meeting air quality standards, including transit, pedestrian, and bicycle-oriented projects. The Congestion Management and Air Quality Improvement Program (CMAQ) directs funds toward transportation projects that will contribute to the attainment of NAAQS for ozone and carbon monoxide. The funds are distributed based on population size and severity of a region's air pollution problem.

CALIFORNIA PROGRAMS

California Clean Air Act, 1988. The 1988 California Clean Air Act (CCAA), amended in 1992, requires regions to develop and implement strategies to attain California's ambient air quality standards. For some pollutants, the California standards are more stringent than the national standards. In addition to the six criteria pollutants regulated by the federal Clean Air Act, California has established standards for three other pollutants: hydrogen sulfide, sulfates, and vinyl chloride. In general, the CCAA requires regions like the Bay Area, which exceed certain State air quality standards for criteria pollutants, to reduce emissions of harmful pollutants by five percent or more per year or implement all feasible measures to meet the state air quality standards as expeditiously as possible. Regional air quality management districts like the BAAQMD must prepare air quality plans specifying how State

standards would be met. State agencies are required to implement a number of statewide automobile emission control regulations, including the "Smog Check" program.

State Motor Vehicle Emission Control Program. The California Air Resources Board (ARB) regulates the amount of pollutants that can be emitted by new motor vehicles sold in California. California motor vehicle emission standards are more stringent than the federal standards and have become increasingly more stringent since they were first imposed in 1961 by the State Motor Vehicle Pollution Control Board (the predecessor to the ARB). To help meet the State ambient air quality standards, the ARB has instituted regulations that will require manufacturers selling vehicles in California to manufacture and phase-in a proportion of motor vehicles in the following categories: Transitional Low Emission Vehicles, Low Emission Vehicles, Ultra-Low Emission Vehicles, and Zero Emission Vehicles (e.g., electric vehicles — 10% of California-sold vehicles by 2003). These requirements apply to passenger vehicles and are intended to reduce emissions of carbon monoxide, reactive hydrocarbons, and nitrogen oxides. The ARB has also set requirements for the distribution of alternative fuels.

ARB also has implemented a heavy duty vehicle inspection program, which applies to diesel-powered trucks and buses. The ARB is also working on fuel requirements that would reduce toxic emissions from motor vehicles. The California Bureau of Automotive Repair continues to administer the vehicle inspection and maintenance program (I/M or "Smog Check" Program).

Air Toxics "Hot Spots" Information and Assessment Act, 1987. The Air Toxic "Hot Spots" Information and Assessment Act was enacted by the California Legislature to identify toxic air contaminant hot spots where emissions from specific sources may expose individuals to elevated risk of adverse health effects. The State Department of Health Services and the Air Resources Board work together to administer the provisions of this Act statewide, but its implementation and enforcement are the responsibility of local/regional air districts. The Act requires that a business or other establishment, identified as a significant source of toxic emissions, notify the affected population and provide them with information about health risks posed by the emissions. (While not part of the Hot Spots program, the State of California Health and Safety Code, Section 25534 allows "Administering Agencies" — usually county health departments — to require "Risk Management and Prevention Plans" of facilities which handle hazardous materials.) Appendix E provides further information on the Air Toxics "Hot Spots" program.

California Planning Law and Guidelines. The State of California does not require air quality elements for general plans. Seven elements are mandated by the California Government Code. Air quality is mentioned as an optional issue in the "Conservation" element. Nonetheless, the District has been urging all cities and counties in the Bay Area to include an air quality element or section in their general plans since 1986.

One of the most important features of California general plans is that even though air quality elements are not mandated, general plans are required by law to be consistent with any air

quality policies and programs that exist within local jurisdiction. Local plans must also be consistent with regional air quality plans such as the Bay Area Clean Air Plan.

California Transportation Plan. The most recent State transportation plan prepared by Caltrans addresses air quality, and cites the funding of transportation control measures (TCMs) as a high priority. In addition, telecommuting is promoted as well as other "nonstructural" transportation solutions such as: reducing demand, increasing transit service, and implementing market-based measures (e.g., a demonstration project of congestion pricing on the San Francisco-Oakland Bay Bridge).

BAY AREA REGIONAL AGENCIES AND THEIR PROGRAMS

Bay Area Air Quality Plan, 1979 and 1982. The *Bay Area Air Quality Plan* is a regional plan required by the federal government. It is prepared jointly by the District, the Metropolitan Transportation Commission (MTC), and the Association of Bay Area Governments (ABAG) to address how the Bay Area will attain the NAAQS. The plan contains stationary source controls, motor vehicle emission controls, and transportation system improvement measures that would reduce the amount of air pollutants released into the atmosphere. These measures are implemented primarily by the District, ARB and MTC, respectively.

The federal Clean Air Act (1970, 1977) required the District, MTC and ABAG to prepare the first Bay Area Air Quality Plan in 1979 and then amend it in 1982. Its primary objective was to attain NAAQS by 1987. The 1982 Air Quality Plan required that: (1) major stationary sources install emission control devices, (2) new sources apply for air quality permits, (3) registered Bay Area vehicles pass a vehicle inspection and maintenance program (e.g., "Smog Check") every two years, (4) transportation control measures be implemented, and (5) MTC assess the conformity of regional transportation plans, programs and projects to air quality objectives.

Although these requirements resulted in significant air quality improvement, the Bay Area failed to attain NAAQS for carbon monoxide and ozone by 1987. In 1989, in response to a court order, MTC implemented contingency measures to assure that the Bay Area was making all reasonable further progress toward attaining NAAQS. These measures included additional transportation control measures and a revised conformity assessment procedure.

Ozone Maintenance Plan, 1993. Through 1989, the Bay Area air basin had continued to violate the national ozone standard. Under the 1990 federal Clean Air Act amendments, the Bay Area was classified as a “moderate” nonattainment area for the national ozone standard. But because of significant improvements in Bay Area air quality over the last couple of decades, the number of exceedances of the national ozone standard declined greatly. Air quality monitoring data from 1990 to 1994 indicated that the region had attained the national ozone standard. Based on monitoring data collected from 1990 to 1992, the District, MTC and ABAG requested in 1993 that the U.S. EPA redesignate the Bay Area as an attainment area and approve the Ozone Maintenance Plan. In June, 1995 U.S. EPA approved the

request and the Bay Area was redesignated an attainment area with respect to the national ozone standard. EPA also approved the Ozone Maintenance Plan.

Ozone Attainment Plan, 1999. Hot stagnant weather in the summers of 1995 and 1996 led to exceedances of the national 1-hour ozone standard, leading U.S. EPA in 1998 to redesignate the region back into nonattainment status for the national 1-hour ozone standard. EPA's redesignation required the region to prepare a plan with three principal elements: 1) a 1995 emission inventory for ROG and NO_x, 2) an assessment of the reductions in these precursor pollutants needed to attain the national standard by 2000 ("attainment assessment"), and 3) a control strategy of adopted regulations and/or control measures sufficient to meet reasonable further progress and attain the 1-hour standard no later than November 15, 2000. The attainment assessment estimates the amount by which ROG and NO_x emissions must be reduced between 1995 and 2000 in order to meet the national 1-hour ozone standard of 0.12 parts per million, and the control strategy describes how these reductions will be achieved.

The *San Francisco Bay Area Ozone Attainment Plan* was prepared by the three co-lead agencies: the District, MTC and ABAG. The Plan includes control measures to reduce emissions from stationary, area and mobile sources sufficient to achieve the necessary emission reductions by June 2000. The Plan also includes contingency measures in case the control measures do not result in attainment by the deadline. The Plan was adopted by the co-lead agencies in June 1999. The Plan was approved by ARB in July 1999 and transmitted to U.S. EPA.

Carbon Monoxide Maintenance Plan, 1994. From 1992 to 1998, no District monitor has registered an exceedance of the national carbon monoxide standard. A *San Francisco Bay Area Redesignation Request and Maintenance Plan for the National Carbon Monoxide Standard* was adopted in 1994 by the three regional agencies. In 1998, U.S. EPA redesignated the Bay Area as an attainment area for the national CO standard.

Bay Area Clean Air Plan, 1997. The *Bay Area 1997 Clean Air Plan* (CAP) was prepared pursuant to the 1988 California Clean Air Act. Prepared by the District in cooperation with MTC and ABAG, its main objective is to attain the State air quality standards for ozone. The CAP presents a comprehensive strategy to reduce emissions from stationary, area and mobile sources. The CAP includes a specific measure which encourages cities and counties to develop and implement local plans, policies and programs to reduce auto use and improve air quality. The California Clean Air Act requires regions to update their (State) air quality plans every three years. The CAP will be updated in 2000.

Under the California Clean Air Act nonattainment classifications, the Bay Area is classified as a "serious" air basin for ozone. (The state classification system for nonattainment areas uses the designations "Moderate," "Serious," "Severe," and "Extreme.") The region had been classified a "moderate" air basin for CO, but the region was redesignated an attainment area

for the State CO standard in 1994 and thus the Act's planning requirements for CO nonattainment areas no longer apply to the Bay Area. The CAP must indicate how the District will attain the State ozone standard by the earliest practicable date, including: (1) additional control measures for existing stationary sources, (2) a permitting program that will result in no net increase in emissions from new stationary sources, (3) provisions for indirect source controls, and (4) transportation control measures.

The prime objective of transportation control measures (TCMs) is to reduce vehicle trips and vehicle miles traveled within the region. These measures are geared toward the following: (1) trip reduction, (2) mobility improvements, (3) implementation support, (4) traffic operation management, (5) user incentives, and (6) pricing strategies.

The CAP also strives to reduce emissions by implementing additional and more stringent stationary source control measures. These include measures to control emissions from surface coating and solvent use, fuels/organic liquids storage and distribution, refinery and chemical processes, combustion of fuels, and other industrial/commercial processes.

The California Clean Air Act expanded the scope and accelerated the pace of air pollution control efforts in California. If possible, air quality plans should achieve a reduction in district-wide emissions of 5% per year for each nonattainment pollutant or its precursors. As an alternative strategy (employed in the Bay Area CAP), the adoption of all feasible measures on an expeditious schedule is acceptable, even if a district is unable to achieve 5% annual reduction.

Other legal requirements applicable to the Bay Area include the following:

- Indirect source and area source control programs.
- A regional public education program.
- Transportation controls to achieve a 1.4 average vehicle ridership during weekday commute hours by 1999, substantial reduction in the rate of increase of vehicle trips and vehicle miles traveled and no net increase in motor vehicle emissions after 1997.
- An assessment of cost-effectiveness of proposed control measures.
- Transport mitigation requirements.

Toxic Air Contaminant Control Program. The Toxic Air Contaminant Control Program is a regional program administered by the District. Its main objective is to reduce public exposure to toxic air contaminants. Appendix E provides further information on the District's Air Toxics program.

Odorous Substances Regulation. The District has enacted an odorous substance control program as part of its effort to control the use and emission of odorous substances within the Bay Area. This program places general limitations on odorous substances and provides the

District with authority to respond to public complaints about offensive odors. The regulation is intended to help the public identify and control offensive odors that are not otherwise controlled by other federal or State air quality laws.

Regional Transportation Plan, 1994. The Metropolitan Transportation Commission's Regional Transportation Plan (RTP) guides Bay Area transportation system improvement projects and shows how they will help attain regional air quality objectives. The plan promotes projects that will provide reasonable and predictable mobility within the region, ensure that all people have equitable access to transportation, support a healthy environment and mitigate any adverse impacts, and promote economic vitality within the region. The plan identifies and evaluates the Bay Area Metropolitan Transportation System, a network of regionally significant streets and highways, transit systems and intermodal transfer facilities, and recommends projects that will improve its performance. Many of these recommendations implement federal (1982 Bay Area Air Quality Plan and contingencies) and state ('94 CAP) TCMs.

Congestion Management Program. Each county in the state is required to establish a Congestion Management Agency (CMA) and prepare a Congestion Management Program (CMP). The main goals of the CMP are to establish a political process through which countywide roadway congestion can be controlled or relieved, and to develop a comprehensive strategy to respond to countywide transportation needs. State law requires that each CMA prepare, implement and biennially update the CMP. The CMP consists of the following basic elements: (1) a transportation network that includes State highways and principal arterials, (2) traffic level of service (LOS) standards for the CMP network, (3) performance measures to evaluate current and future multimodal system performance for the movement of people and goods, (4) a travel demand program to promote travel by alternative transportation modes (non-single-occupancy vehicle), (5) a land use impact analysis program to evaluate land use development impacts on the CMP network, and (6) a multi-year capital improvement program (CIP) to fund transportation projects that support CMP goals. The CMP must be updated biennially to reflect changing transportation needs and conditions within the county. The CMP CIP must be submitted to MTC every two years to be incorporated into the Bay Area Regional Transportation Improvement Program.

If traffic conditions on a roadway segment or intersection fall below the LOS standard, the local jurisdiction is required to develop a Deficiency Plan. In some instances, cities and counties may be monitoring LOS based upon transportation models, attempting to predict conditions in the future. The intent is to develop plans for deficient segments prior to the actual occurrence of a deficiency. The CMP statutes direct the District to establish and periodically update a list of improvements, programs and actions which can be used by local governments in developing Deficiency Plans. The list should include items that "...measurably improve multimodal performance, and contribute to significant improvements in air quality, such as improved public transit service and facilities, improved non-motorized transportation facilities, high occupancy vehicle facilities, parking cash out programs, and transportation control measures." The statutes also state that "if an improvement, program, or action is not on the approved list, it shall not be implemented unless approved by the local

air quality management district." In 1992, the District prepared the *Deficiency List: Programs, Actions and Improvements for Inclusion in Congestion Management Program Deficiency Plans.* Subsequent consultation with Bay Area CMAs has not indicated a need to revise the deficiency list.

Transportation Fund for Clean Air (AB 434). Assembly Bill 434 (Sher, 1991) established a vehicle registration surcharge to fund specified TCMs. This bill gave the District the authority to impose a $4 surcharge on motor vehicle registrations within the Bay Area to pay for programs that reduce mobile source emissions. These fees generate approximately $17 million per year. The District directly allocates 40 percent of the funds to county program managers who then distribute the funds to agencies sponsoring eligible projects. The District allocates the remaining 60 percent regionwide to public agencies sponsoring the most cost-effective projects.

The projects and programs eligible for AB 434 funds are: (1) ridesharing and trip reduction programs, (2) clean fuel buses for schools and transit operators; (3) feeder bus/shuttle service to rail and ferry stations and airports; (4) local arterial traffic management; (5) rail-bus integration and regional transit information; (6) congestion pricing and low emission vehicle demonstration projects; (7) vehicle buy back; (8) a smoking vehicle program (citizen reports to the District about vehicles with visible exhaust); and (9) bicycle facility improvements.

APPENDIX B - AIR POLLUTANT SOURCES AND EFFECTS

This appendix discusses the harmful effects of air contaminants on health and other qualities of life and the environment. Sources of air pollution are described. Appendix C provides more detailed information on air pollutant emissions in the Bay Area.

CRITERIA CONTAMINANTS — HEALTH EFFECTS AND SOURCES

Criteria contaminants are those air pollutants for which ambient air quality standards have been set by the United States Environmental Protection Agency or the California Air Resources Board. Most of the criteria contaminants are generated to a large degree by motor vehicles, as well as by industry and other stationary sources. Appendix C provides further detail regarding the sources of each criteria contaminant in each county of the Bay Area.

Carbon Monoxide (CO) is an odorless, colorless gas. It is formed by the incomplete combustion of fuels. The single largest source of CO is the motor vehicle. Emissions are highest during cold starts, hard acceleration, stop-and-go driving, and when a vehicle is moving at low speeds. New findings indicate that CO emissions per mile are lowest at about 45 mph for the average light-duty motor vehicle and begin to increase again at higher speeds.

When inhaled at high concentrations, CO combines with hemoglobin in the blood and reduces the oxygen-carrying capacity of the blood. This results in reduced oxygen reaching the brain, heart and other body tissues. This condition is especially critical for people with cardiovascular diseases, chronic lung disease or anemia, as well as fetuses. Even healthy people exposed to high CO concentrations can experience headaches, dizziness, fatigue, unconsciousness, and even death.

Ozone (O_3), or smog, is not emitted directly into the environment, but is formed in the atmosphere by complex chemical reactions between oxides of nitrogen and reactive organic gases (ROG) in the presence of sunlight. Ozone formation is greatest on warm, windless, sunny days. The main sources of nitrogen oxides (NO_X) and ROG, often referred to as ozone precursors, are combustion processes (including motor vehicle engines) and the evaporation of solvents, paints and fuels. As with CO, automobiles are the single largest source of ozone precursors in the Bay Area. Tailpipe emissions of ROG follow CO. They are highest during cold starts, hard acceleration, stop-and-go conditions, and slow speeds. They decline as speeds increase up to about 50 mph, then increase again at high speeds and high engine loads. ROG emissions associated with evaporation of unburned fuel depends on vehicle and ambient temperature cycles. Nitrogen oxide emissions exhibit a different curve; emissions decrease as the vehicle approaches 30 mph and then begin to increase with increasing speeds.

Ozone levels usually build up during the day and peak in the afternoon hours. Short-term exposure can irritate the eyes and cause constriction of the airways. Besides causing shortness of breath, it can aggravate existing respiratory diseases such as asthma, bronchitis and emphysema. Chronic exposure to high ozone levels can permanently damage lung tissue. Ozone can also damage plants and trees, and materials such as rubber and fabrics (see Non-Health Effects, below).

Nitrogen dioxide (NO_2) is a reddish brown gas that is a by-product of combustion processes. Automobiles and industrial operations are the main sources of NO_2. Aside from its contribution to ozone formation, nitrogen dioxide can increase the risk of acute and chronic respiratory disease and reduce visibility. NO_2 may be visible as a coloring component of a brown cloud on high pollution days, especially in conjunction with high ozone levels.

Sulfur dioxide (SO_2) is a colorless acid gas with a strong odor. It has potential to damage materials and it can have health effects at high concentrations. It is produced by the combustion of sulfur-containing fuels, such as oil, coal and diesel. Sulfur dioxide can irritate lung tissue and increase the risk of acute and chronic respiratory disease.

PM_{10} (Particulate matter 10 microns or less in diameter) refers to a wide range of solid or liquid particles in the atmosphere, including smoke, dust, aerosols, and metallic oxides. Some particulate matter, such as pollen, is naturally occurring. However, in the Bay Area most particulate matter is caused by combustion, factories, construction, grading, demolition, agricultural activities and motor vehicles. Extended exposure to particulate matter can increase the risk of chronic respiratory disease. PM_{10} is of concern because it bypasses the body's natural filtration system more easily than larger particles, and can lodge deep in the lungs. Thus, the U.S. EPA and the state of California revised their PM standards several years ago to apply only to these fine particles.

As with CO and ozone precursors, motor vehicles constitute the single largest source of PM_{10} in the Bay Area, based on the best available data. Motor vehicles produce particulates through direct tailpipe emissions of particulate matter; direct emissions of nitrogen oxides, which become particulate ammonium nitrate in the atmosphere; and the kicking up of road dust by tires. Vehicles also produce PM_{10} from brake pad and tirewear. Motor vehicles are currently responsible for about half of Bay Area particulates.

Fine particulate pollution is an example of a problem that is projected to increase in the Bay Area as motor vehicle use increases, though there may be short-term decreases. For instance, when construction activity is reduced during a recession, direct construction dust is reduced. Therefore there is less dirt spilled on roads via trucks and other mobile equipment, reducing the amount of dust that can be resuspended by the tires of passing motor vehicles. But, as seen in the graph of Bay Area Emissions Inventory Projections (in Appendix C), total PM_{10} emissions are expected to increase, and the proportion attributable to motor vehicles will also increase. Resuspended road dust has not been reduced by improvements in motor vehicle air pollution controls. In fact, road dust is expected to continue to increase unless there is a reduction in motor vehicle use and adoption of dust control measures. Dust control measures may be needed at construction sites, unpaved roads and parking lots, agricultural and other area sources that emit dust directly into the ambient air and/or convey mud and dirt to roadways.

Wood burning in fireplaces and stoves is another large source of fine particulates. The District and consultants have recently analyzed the results of a study of the sources of particulates at two monitoring sites in San Jose. In and near downtown San Jose — and

perhaps in many other parts of the Bay Area — wood smoke can contribute up to 40% of the particulate mix during the winter months. Wood burning alone may cause exceedances of California's particulate standard.[19]

Among the criteria pollutants that the District regulates, particulates appear to represent the most serious overall health hazard. Studies in a number of cities have demonstrated statistically significant correlations between daily and average annual particulate levels and mortality. According to one estimate, elevated particulate levels contribute to the death of approximately 200 people annually for the Bay Area.[20] Other studies, which include findings from the Bay Area, yield higher estimates of mortality — 300 to 500 deaths per year in the Bay Area — based on a one percent increase in mortality per 10 micrograms per cubic meter increase in PM_{10} levels.[21][22] High levels of particulates have also been known to exacerbate chronic respiratory ailments, such as bronchitis and asthma, and have been associated with increased emergency room visits and hospital admissions.

TOXIC AIR CONTAMINANTS

In addition to the *criteria pollutants* listed above, another group of pollutants, commonly referred to as toxic air contaminants (TACs) or hazardous air pollutants, has received increasing scrutiny in recent years and warrant concern for several reasons. First, the health effects can be quite severe. Many hazardous air pollutants are confirmed or suspected carcinogens, or are known or suspected to cause birth defects or neurological damage. Secondly, many hazardous air pollutants can be toxic at very low concentrations. For some chemicals, such as carcinogens, there are no thresholds below which exposure can be considered risk-free.

Industrial facilities are significant sources of toxic air contaminants. Rather than coming out of a smokestack, however, toxic contaminants often result from "fugitive emissions," such as leaking valves and pipes. The electronics industry, including semiconductor manufacturing, has the potential to contaminate both air and water due to the highly toxic chlorinated solvents commonly used in semiconductor production processes. Sources of air toxics go beyond industry, however. Various common urban facilities also produce hazardous pollutants, such as gasoline stations (benzene), hospitals (ethylene oxide), and dry cleaners (perchloroethylene). Automobile exhaust also contains toxic air pollutants such as benzene and 1,3-butadiene. (Lead as a gasoline additive has been phased out in California). District research indicates that mobile source emissions of benzene and 1,3-butadiene represent a substantial portion of the ambient background risk from toxic air contaminants in the Bay

[19]Chow, Judith, and David Fairley et al., "Source Apportionment of Wintertime PM_{10} at San Jose, California," Journal of Environmental Engineering, May 1995.

[20]Fairley, David, "The Relationship of Daily Mortality to Suspended Particulates in Santa Clara County, 1980-1986," Environmental Health Perspectives, Vol. 89, 1990.

[21]Ostro, Bart, "The Association of Air Pollution and Mortality: Examining the Case for Inference," Archives of Environmental Health, September/October 1993.

[22]Dockery, Douglas and C.A. Pope III, "Acute Respiratory Effects of Particlate Air Pollution," Annual Review of Public Health, 1994.

Area. Reformulated fuel requirements that have already been adopted are expected to reduce, but not eliminate, mobile source TAC emissions.

NON-HEALTH EFFECTS OF AIR POLLUTION

Visibility Reduction

Visibility reduction and discoloration of the sky are obvious effects of air pollution. Reduced visibility may be caused by the brownish haze of nitrogen dioxide or by the accumulation of particulate matter in the atmosphere. When particles are present in sufficient quantities, distant objects become obscured. Visibility reduction is primarily caused by emissions from the following sources:

- Construction and demolition.
- Auto exhaust, diesel soot, and resuspended road dust.
- Wood burning, incineration, and other combustion activities.
- Particles or aerosols formed by photochemical reactions occurring in the atmosphere.
- Agricultural and mining activities.
- Stationary sources such as cement kilns and refineries.
- Naturally occurring particles from salt water, vegetation, soil, and wind erosion processes.
- Atmospheric particles, normally too small to affect visibility, which grow to visibility-reducing size through the process of agglomeration (clustering) or through condensation, where moisture condenses on small particles causing them to grow to visibility-reducing size.

Visibility in the Bay Area can vary dramatically, depending on meteorological conditions. The major factors causing these fluctuations are the amount of moisture in the air, the strength of the air currents, and the volume of air available for dilution and dispersion of visibility-reducing particles. Under adverse weather conditions, particularly high heat and intense sunlight, some or all of the factors discussed above cause visibility to become very restricted. These conditions are especially common in summer and early fall.

During the winter months, visibility-reducing particles from photochemical activity are greatly diminished due to colder temperatures and the decreased intensity of ultraviolet light. Thus, when restricted visibility occurs during this period, it is often caused by smoke and dust particles and the growth of particles through agglomeration and condensation.

Effects on Materials

Air pollution effects on materials vary widely in type and severity among the different contaminants. For example, ozone, the primary constituent of photochemical smog, can

harden and crack rubber materials, causing them to lose their flexibility. It also affects other types of synthetic materials. For example, it can weaken nylon, and can cause fabric dye fading and paint damage.

Other pollutants in combination produce synergistic effects, causing greater damage than each could cause alone. The interaction of sulfur dioxide and particulate matter has a greatly enhanced ability to corrode materials such as steel, iron, copper, zinc, tin, and stone. In some industries, extensive measures must be taken to protect equipment from polluted air. In the aerospace industry, for example, where silver and other metals used in sensitive electronic equipment are particularly vulnerable to corrosion, great care must be taken to protect components.

Particles settling on buildings, automobiles, outdoor furniture, and other surfaces are usually considered to be nuisances causing soiling, even when they do not produce damage to health or materials.

Plant Damage

The effects of air pollution on plants, crops, and forests depend both on plant susceptibility and the types of pollutants involved. Plant damage is difficult to assess because damage is often manifested as stunted growth or diminished yields, rather than the death of the plant.

Among the recorded effects of air pollution on plants are flower and foliage discoloration; bloom failure; plant malformation; leaf, needle, and fruit drop; and failure of fruit to ripen. Particularly vulnerable to ozone damage are grapes, lettuce, spinach and many garden flowers and shrubs. Additionally, some greenhouse crops, including flowers and some herbs, suffer damage when certain hydrocarbon levels are elevated.

Localized plant damage has been noted in the Bay Area from other gases, including nitric oxide, hydrogen chloride, formaldehyde, sulfur dioxide, and fluorides. Sulfur dioxide, for example, is particularly damaging to pasture crops and leafy vegetables. And although a highly localized problem, fluoride threatens both plants and animals. The susceptibility of plants to fluoride damage varies greatly; apricots, grapes, strawberries, bulb crops, and conifers have low resistance. The more serious effect is seen in animals, who may consume fodder that offers no detectable signs of damage but in fact contains relatively high concentrations of fluorides. Over a period of time, animals build up a concentration of fluorides in their tissues, which eventually leads to fluorosis, a bone disease.

APPENDIX C - AIR POLLUTION — STATUS, PROBLEMS AND TRENDS

Monitoring Data and Attainment Status

The District operates a regional air quality monitoring network that regularly measures the concentrations of the five major criteria air pollutants. Figure C-1 indicates the location of the District's permanent monitoring stations and lists the pollutants monitored at each station. Tables C-1, C-2, C-3 and C-4 summarize the exceedance records for the last decade for ozone, CO and PM_{10}.

Air quality conditions in the San Francisco Bay Area have improved significantly since the District was created in 1955. Ambient concentrations and the number of days on which the region exceeds standards have declined dramatically. Following years of declining emissions and ambient concentrations, the Bay Area in 1995 was redesignated as an attainment area for the national 1-hour ozone standard. However, hot stagnant weather led to new exceedances of the national ozone standard in the summers of 1995 and 1996. As a result, U.S. EPA in 1998 redesignated the region back as a nonattainment area for the national 1-hour ozone standard. Table C-1 summarizes recent monitoring data with respect to the national 1-hour ozone standard.

The Bay Area also violates the State ozone standard. The State 1-hour ozone standard, 9 parts per hundred million (9 pphm), is considerably more stringent than the national standard of 12 pphm. Table C-2 indicates the number of days the State ozone standard has been exceeded in recent years.

The region has made significant progress in reducing carbon monoxide levels in the Bay Area. The District's air monitoring records of 1992 through 1998 demonstrate attainment of the national and State 8-hour standard, and neither the national 1-hour standard nor the State 1-hour standard has been exceeded since the 1980s. The Bay Area is now an attainment area for the State and national CO standard. Table C-3 summarizes recent monitoring data for the State and national CO standard.

With regard to fine particulate matter (PM_{10}), the State standard has been exceeded fairly frequently in recent years. The national standard was exceeded a few times in 1990 and 1991, but has not been exceeded since then. Table C-4 summarizes recent monitoring data for the State and national PM_{10} standards.

Additional criteria pollutants include nitrogen dioxide, sulfur dioxide, sulfates, lead, hydrogen sulfide, and vinyl chloride (chloroethane). Neither State nor national ambient air quality standards of these chemicals have been violated in recent decades. Table 1 (in Chapter 1 of these Guidelines) summarizes the Bay Area's attainment status for the State and national ambient air quality standards.

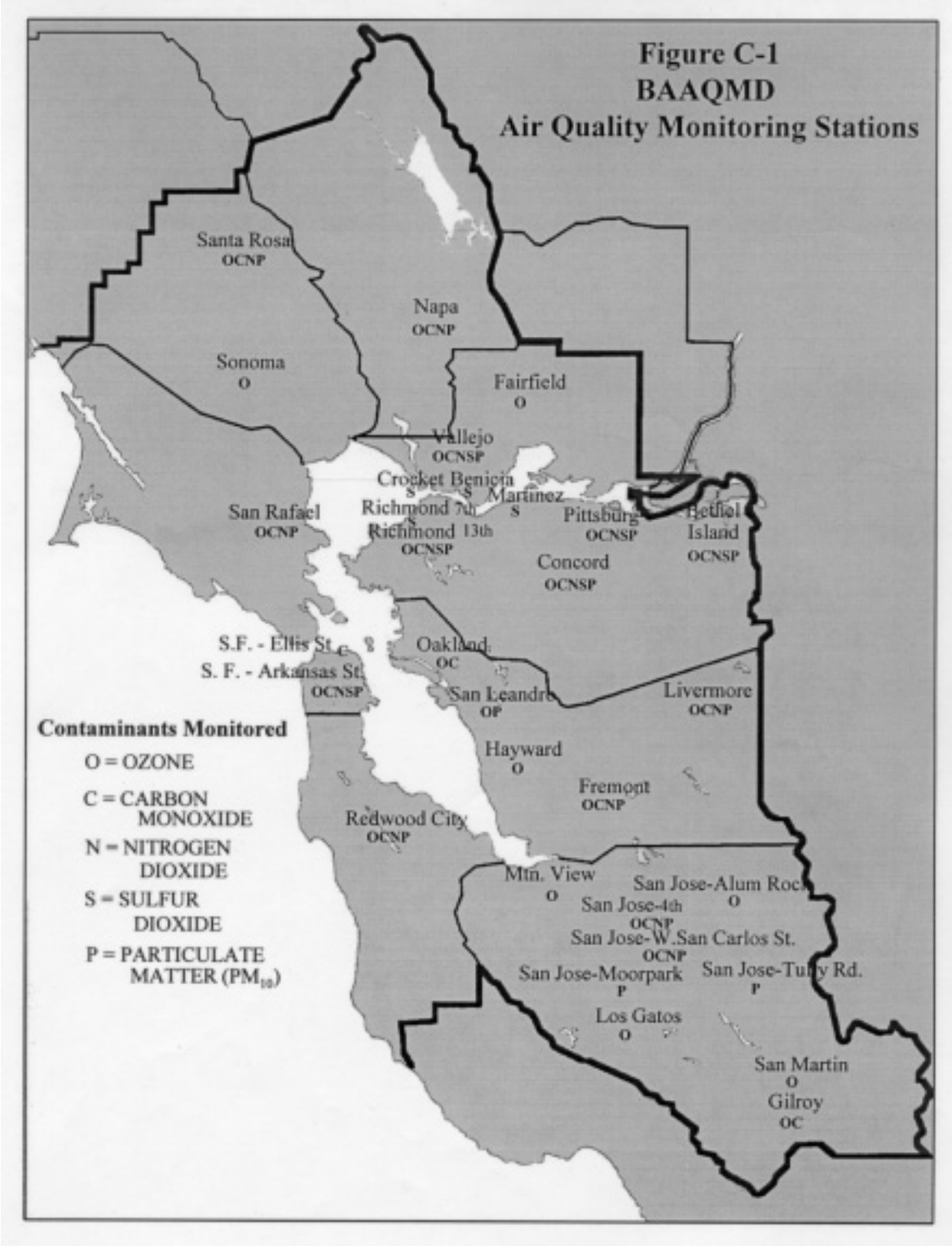

Figure C-1
BAAQMD
Air Quality Monitoring Stations
Santa Rosa
OCNP
Napa
OCNP
Sonoma
O
Fairfield
O
Vallejo
OCNSP
Crocket
S
Benicia
S
Martinez
S
San Rafael
OCNP
Richmond 7th
S
Richmond 13th
OCNSP
Pittsburg
OCNSP
Bethel Island
OCNSP
Concord
OCNSP
S.F. - Ellis St.
C
S. F. - Arkansas St.
OCNSP
Oakland
OC
San Leandro
OP
Livermore
OCNP
Hayward
O
Fremont
OCNP
Redwood City
OCNP
Mtn. View
O
San Jose-Alum Rock
O
San Jose-4th
OCNP
San Jose-W.San Carlos St.
OCNP
San Jose-Moorpark
P
San Jose-Tully Rd.
P
Los Gatos
O
San Martin
O
Gilroy
OC
Contaminants Monitored
O = OZONE
C = CARBON MONOXIDE
N = NITROGEN DIOXIDE
S = SULFUR DIOXIDE
P = PARTICULATE MATTER (PM_{10})

TABLE C-1
EXCEEDANCES OF THE NATIONAL OZONE STANDARD
Number Of Days With Maximum One-Hour Concentration Exceeding 12 Parts Per Hundred Million (pphm)
1988 - 1998

County	Site	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Alameda County	Fremont	1	0	1	0	0	1	0	2	0	0	0
	Hayward	0	0	0	0	1	0	0	2	0	0	0
	Livermore	4	2	1	1	0	1	2	7	8	0	6
	Oakland	0	0	0	0	0	0	0	0	0	0	0
	San Leandro	0	0	0	0	0	0	0	3	0	0	0
Contra Costa County	Concord	1	0	0	0	0	2	0	3	1	0	2
	Pittsburg	0	0	0	0	0	1	0	0	0	0	0
	Richmond	0	0	0	0	0	0	0	0	0	-	-
	Bethel Island	0	0	0	0	0	0	0	1	1	0	0
Marin County	San Rafael	0	0	0	0	0	0	0	0	0	0	0
Napa County	Napa	0	0	0	0	0	0	0	1	0	0	1
San Francisco	San Francisco	0	0	0	0	0	0	0	0	0	0	0
San Mateo County	Redwood City	0	0	0	0	0	0	0	1	0	0	0
Santa Clara County	Mountain View	0	0	0	0	0	0	0	0	0	0	0
	San Martin	-	-	-	-	-	-	1	1	0	0	3
	Gilroy	1	2	0	1	0	0	0	1	0	0	2
	Los Gatos	1	0	0	0	1	1	0	4	1	0	1
	San Jose-4th Street	0	1	0	0	0	0	0	1	0	0	1
	San Carlos St./ Burbank	-	-	1	0	0	1	0	-	-	-	-
	Alum Rock	0	0	0	0	1	0	0	3	-	-	-
Solano County	Fairfield	1	0	0	0	0	1	0	1	0	0	0
	Vallejo	0	0	0	0	0	0	0	1	0	0	0
Sonoma County	Santa Rosa	0	0	0	0	0	0	0	0	0	0	0
	Sonoma	0	0	0	0	0	0	0	0	0	-	-
AIR DISTRICT DAYS		5	4	2	2	2	3	2	11	8	0	8

"*AIR DISTRICT DAYS*" are the number of days in a year that one or more monitoring stations recorded an exceedance. Air District Days are not usually the sums of the numbers above them in the column because two or more monitoring stations often record exceedances during the same day. More than three exceedances in three years, at any one monitoring station, rates a federal classification of "nonattainment" for ozone for the entire air basin.

- = Monitor not operational.

TABLE C-2
EXCEEDANCES OF THE STATE OZONE STANDARD
Number Of Days With Maximum One-Hour Concentration Exceeding 9 Parts Per Hundred Million (pphm)
1988-1998

County	Site	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Alameda County	Fremont	7	11	3	6	5	5	4	10	2	2	7
	Hayward	9	1	0	2	1	0	1	7	2	2	4
	Livermore	21	9	8	17	14	7	5	20	22	3	21
	Oakland	1	0	0	0	0	1	0	0	0	0	0
	San Leandro	0	0	0	2	2	3	0	6	2	3	2
Contra Costa County	Concord	10	6	3	4	3	7	4	9	11	2	13
	Pittsburg	8	5	4	0	3	4	3	8	5	0	4
	Richmond	2	1	0	0	0	2	0	0	0	-	-
	Bethel Island	7	11	5	3	7	3	5	6	6	1	10
Marin County	San Rafael	1	0	0	0	0	0	0	0	2	1	0
Napa County	Napa	1	2	0	3	0	2	0	4	0	0	3
San Francisco	San Francisco	0	0	0	0	0	0	0	0	0	0	0
San Mateo County	Redwood City	2	1	0	0	0	1	0	5	1	0	0
Santa Clara County	Mountain View	13	6	1	3	1	2	0	2	3	1	2
	San Martin	-	-	-	-	-	-	5	14	18	0	15
	Gilroy	23	10	5	5	12	6	3	10	15	1	10
	Los Gatos	12	1	5	7	3	8	2	13	10	1	5
	San Jose-4th St.	12	10	4	6	3	3	2	14	5	0	4
	San Carlos St./ Burbank	-	-	5	0	1	4	1	-	-	-	-
	Alum Rock	13	9	1		5	5	3	15	-	-	-
Solano County	Fairfield	3	4	1	3	3	3	2	10	5	0	9
	Vallejo	5	2	2	2	1	3	2	6	5	1	3
Sonoma County	Santa Rosa	0	0	0	0	0	0	0	1	0	0	0
	Sonoma	2	3	0	3	0	0	0	0	0	-	-
AIR DISTRICT DAYS		41	22	14	23	23	19	13	28	34	8	29

"*AIR DISTRICT DAYS*" are the number of days in a year that one or more monitoring stations recorded an exceedance. Air District Days are not usually the sums of the numbers above them in the column because two or more monitoring stations often record exceedances during the same day.

- = Monitor not operational.

TABLE C-3
EXCEEDANCES OF NATIONAL AND STATE* CARBON MONOXIDE STANDARD
Number Of Days With Maximum 8-Hour Concentration Exceeding 9 Parts Per Million (ppm)
1988-1998

County	Site	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Alameda County	Fremont	0	0	0	0	0	0	0	0	0	0	0
	Livermore	0	0	0	0	0	0	0	0	0	0	0
	Oakland	0	0	0	0	0	0	0	0	0	0	0
Contra Costa County	Concord	0	0	0	0	0	0	0	0	0	0	0
	Pittsburg	0	0	0	0	0	0	0	0	0	0	0
	Richmond	0	0	0	0	0	0	0	0	0	-	-
	Bethel Island	0	0	0	0	0	0	0	0	0	0	0
Marin County	San Rafael	0	0	0	0	0	0	0	0	0	0	0
Napa County	Napa	0	0	0	0	0	0	0	0	0	0	0
San Francisco	Arkansas St./ Potrero	0	0	0	0	0	0	0	0	0	0	0
	Ellis Street	1	0	0	0	0	0	0	0	0	0	0
San Mateo County	Redwood City	0	0	0	0	0	0	0	0	0	0	0
Santa Clara County	Gilroy	0	0	0	0	0	0	0	-	-	-	-
	San Jose-4th St.	2 (3)	6	2 (5)	4	0	0	0	0	0	0	0
	San Carlos St./ Burbank	-	-	0	0	0	0	0	-	-	-	-
Solano County	Vallejo	1	2	0	0 (1)	0	0	0	0	0	0	0
Sonoma County	Santa Rosa	0	0	0	0	0	0	0	0	0	0	0
AIR DISTRICT DAYS		3 (4)	8	2 (5)	4 (5)	0	0	0	0	0	0	0

*The recorded number of exceedances of the State — as differentiated from the National — Carbon Monoxide 8-Hour Ambient Air Quality Standard is sometimes slightly higher due to prescribed procedures for calculating each. The State Standard is given as 9.0 ppm and is considered to be exceeded when a monitor records a CO 8-hour average level of 9.1 or higher. The National Standard is given as 9 ppm and is considered to be exceeded at a level of 9.5 ppm or higher. In the table above, when the number of days of exceedance in a year differed among the two, the number of days exceeding the State Standard is given in parentheses.

"AIR DISTRICT DAYS" are the number of days in a year that one or more monitoring stations recorded an exceedance of the ambient air quality standard for CO. Air District Days are not usually the sums of the numbers above them in the column because two or more monitoring stations often record exceedances during the same day. More than one exceedance per year, at any one monitoring station, rates a federal classification of "nonattainment" for CO.

- = Monitor not operational.

TABLE C-4
EXCEEDANCES OF THE STATE AND NATIONAL* FINE PARTICULATE MATTER STANDARD
Number Of Days With Maximum 24-Hour Concentration Exceeding 50 micrograms per cubic meter ($\mu g/m^3$)
1988 - 1998

County	Site	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Alameda County	Fremont	-	5	10	14	4	3	3	1	1	1	1
	Livermore	7	13	10	12 (1)	5	3	4	1	1	2	2
	San Leandro	-	-	-	10	2	1	1	0	1	1	0
Contra Costa County	Concord	10	9	6	13	8	2	4	1	1	2	1
	Richmond	-	5	5	9	3	3	3	1	0	-	-
	Bethel Island	14	7	7	10	4	6	3	3	1	2	2
Marin County	San Rafael	2	8	4	10	5	1	4	1	0	2	1
Napa County	Napa	8	9	8	11	5	3	2	1	1	3	1
San Francisco	San Francisco	7	13	12 (1)	15	9	5	6	0	2	0	1
San Mateo County	Redwood City	5	10	8	12	7	5	6	0	0	2	0
Santa Clara County	San Jose-4th St.	14	15	9 (1)	10	13	10	7	4	2	3	3
	Moorpark	8	13	11	13	8	3	4	1	1	3	-
	San Carlos St./ Burbank	-	7	9	14	9	5	6	-	-	-	-
	Tully Road	-	-	11 (1)	11	11	7	7	0	1	3	1
Solano County	Vallejo	-	-	-	-	-	-	1	1	0	3	1
Sonoma County	Santa Rosa	-	-	-	-	-	-	1	0	0	2	1
AIR DISTRICT DAYS		24	21	15 (3)	18 (1)	18	10	9	7	3	4	5

*In instances when the National PM_{10} 24-Hour Standard (150 $\mu g/m^3$) has been exceeded, the number of days of exceedance of the National Standard is given in parentheses.

"AIR DISTRICT DAYS" are the number of days in a year that one or more monitoring stations recorded an exceedance. Air District Days are not usually the sums of the numbers above them in the column because two or more monitoring stations often record exceedances during the same day. PM_{10} is only sampled every sixth day. Actual days over standards can be estimated as six times the number shown.

- = Monitor not operational.

Problems and Trends

Throughout the Bay Area, automobile ownership and use is increasing at a faster rate than population growth. Countering this trend is the move toward cleaner, newer vehicles with fleet turnover and the introduction of cleaner fuels. Overall, projections indicate a net reduction in the emissions of ozone precursors and carbon monoxide, while fine particulate emissions are expected to increase with total miles traveled.

Table C-5 shows projected future emissions of criteria pollutants for the Bay Area for the years 1995, 2000, 2005 and 2010 in terms of total emissions and motor vehicle emissions. Total emissions and the amount and proportion attributable to motor vehicles are expected to decline, especially for reactive organic gases (ROG), nitrogen oxides (NO_x) and carbon monoxide. A small increase is predicted for SO_2 emissions. Most significant is the predicted increase in PM_{10} emissions.

Regionally, the most complex air quality problem has been ozone. Ozone is formed in the atmosphere through a complex series of photochemical reactions involving ROG and NO_x. Because it takes some time for the photochemical reactions to occur, emissions of ROG and NO_x are transported away from their sources and affect ozone concentrations in downwind areas. Motor vehicles account for the majority of the ROG and NO_x emissions. Although the Bay Area's highest ozone levels can fluctuate from year to year depending on weather conditions, ambient ozone standards are exceeded most often in the Santa Clara, Livermore and Diablo valleys.

In contrast to ozone, carbon monoxide (CO) is a more localized concern in the Bay Area, because CO is a nonreactive pollutant with one major source — motor vehicles. Approximately 70 percent of CO in the Bay Area is generated by motor vehicles. The areas with the highest CO levels typically have been those with high levels of vehicular traffic. CO levels are strongly influenced by meteorological factors such as wind speed and atmospheric stability. High concentrations of CO build up on cold, clear winter nights with no wind. The eight-hour CO standards historically were occasionally exceeded in those parts of the Bay Area subject to a combination of high traffic density and susceptibility to the occurrence of surface-based radiation inversions, during the winter months. The CO standards were last exceeded prior to 1992 in San Francisco, San Jose and Vallejo.

Air pollution problems related to particulate matter also occur during winter months, usually under the same weather conditions that foster CO buildup. Particulate levels in the Bay Area are typically low near the coast and higher inland, with the highest levels in dry, sheltered valleys, such as the Santa Clara, Livermore and Diablo valleys. The major human-generated (anthropogenic) sources in the Bay Area include motor vehicle travel over paved and unpaved roads, demolition and construction activity and woodburning in fireplaces and stoves. Agricultural operations and burning also contribute significantly to particulate concentrations in rural areas. PM_{10} emissions are expected to increase in future years.

TABLE C-5
MOTOR VEHICLE SHARE OF CRITERIA CONTAMINANT EMISSIONS

Total Emissions and On-Road Motor Vehicle Emissions in the Bay Area Air Basin

Tons/Day (Annual Average)

Year	CO	ROG*	NOx	SO_2	PM_{10}**
1995					
Total Emissions	3705	550	624	91	200
Motor Vehicle (MV) Emissions	2952	294	351	8	106
MV as % of Total	80%	54%	56%	9%	53%
2000					
Total Emissions	2615	435	508	99	218
Motor Vehicle Emissions	1853	189	265	4	111
MV as % of Total	71%	44%	52%	4%	51%
2005					
Total Emissions	2051	372	419	103	231
Motor Vehicle Emissions	1265	120	198	4	117
MV as % of Total	62%	32%	47%	4%	51%
2010					
Total Emissions	1763	335	394	107	241
Motor Vehicle Emissions	960	76	163	4	122
MV as % of Total	55%	23%	41%	4%	51%

* Reactive organic gases (anthropogenic — i.e. excluding emissions from natural vegetation).

** Including entrained road dust.

Projections are based on the District *Base Year 1996 Emission Inventory*, using ARB's EMFAC7G.

The major sources of nitrogen oxides (NO_X) are vehicular, residential and industrial fuel combustion. Concentrations of nitrogen dioxide, the most abundant form of ambient NO_X, are highest in the South Bay, where the standard was last exceeded in 1980.

Major sources of ambient sulfur dioxide (SO_2) include activities such as electricity generation, petroleum refining and shipping. The highest levels of SO_2 are recorded by monitoring stations located in northern Contra Costa County, where most of the major sources of SO_2 are located. The SO_2 standard is currently being met throughout the Bay Area, with seasonal maximums rarely exceeding 50 percent of the standard. SO_2 levels at most Bay Area monitoring stations are less than 10 percent of the standard.

Emissions Inventory

The District estimates emissions of criteria pollutants from approximately nine hundred source categories. The estimates are based on District permit information for "point sources" (e.g. manufacturing industries, refineries, dry-cleaning plants) plus more generalized estimates for "area sources" (e.g. house heating, use of consumer products) and "mobile sources" (trains, ships and planes, as well as on-road and off-road motor vehicles). Figure C-2 and Table C-5 indicate future projections of emissions for the region. The significant role of mobile sources is highlighted in these charts. More detailed information on individual point sources may be obtained by contacting the District.

The emission inventories and projections assume that the Bay Area will continue to grow as forecast and that all currently adopted control measures will continue. Assumptions underlying the projections include the following:

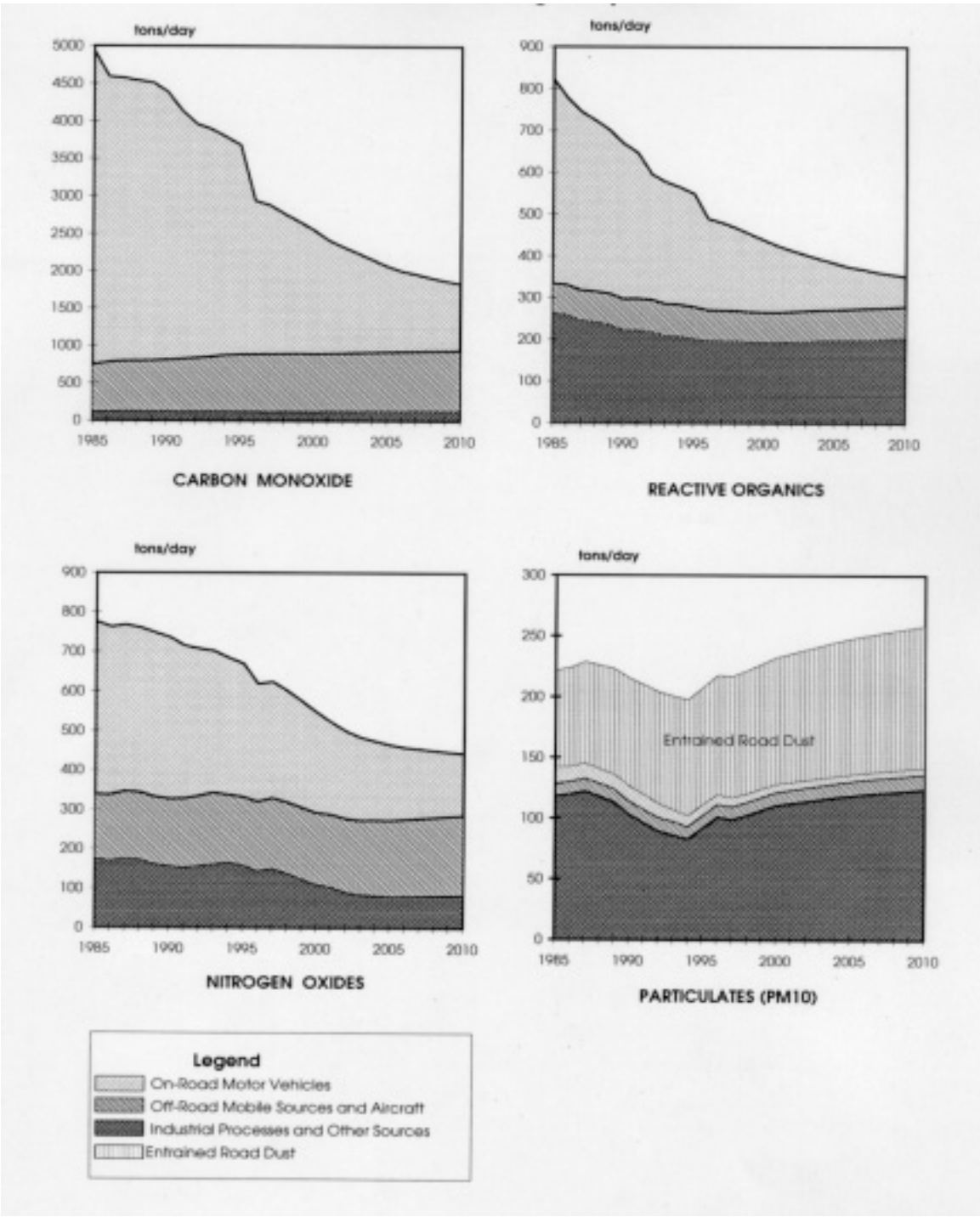
- Population, housing, employment, economic growth and land use development will increase as regionally forecast (ABAG, *Projections '96*).
- New cars will be cleaner than older model vehicles, as required by California regulations.
- The recently improved "Smog Check" program will continue.
- Controls on industry and business will continue.
- Currently implemented transportation control measures will continue.

Lead agencies should be aware that actions which alter these assumptions may also affect progress toward attainment and maintenance of ambient air quality standards.

FIGURE C-2

BAY AREA EMISSION INVENTORY PROJECTIONS 1985-2010
(Base Year 1996)

Annual Average Daily Emissions



Transport of Pollutants

The California Clean Air Act, Section 39610 (a), directs the ARB to "identify each district in which transported air pollutants from upwind areas outside the district cause or contribute to a violation of the ozone standard and to identify the district of origin of transported pollutants." The information regarding the transport of air pollutants from one basin to another was to be quantified to assist interrelated basins in the preparation of plans for the attainment of State ambient air quality standards.

Numerous studies conducted by the ARB have identified air basins that are impacted by pollutants transported from other air basins (as of 1993). Among the air basins affected by air pollution transport from the Bay Area are the North Central Coast Air Basin, the Mountain Counties Air Basin, the San Joaquin Valley Air Basin, and the broader Sacramento Area. The Bay Area was also identified as an area impacted by the transport of air pollutants from the Sacramento area.

Other possible transport corridors being studied by the District and the ARB are from the Bay Area to the Upper Sacramento Valley and from the San Joaquin Valley Air Basin to the Bay Area.

Toxic Air Contaminants

The District has established a number of monitoring stations to track ambient levels of 11 toxic air pollutants: benzene, 1,1,1-trichloroethane (TCA), trichloroethylene (TCE), chloroform (TCM), 1,2-dichloroethane (EDC), 1,2-dibromoethane (EDB), methylene dichloride (DCM), carbon tetrachloride, tetrachloroethylene (perc), vinyl chloride, and toluene. The District is also in the process of establishing a monitoring network to trace 1,3-butadiene. Of the toxics monitored by the District, State ambient air quality standards have been set only for vinyl chloride. (Other toxic substances are regulated or controlled through risk assessment and risk management programs. See Appendix E.)

Because the District's air toxics monitoring program is relatively new, little trend information is available. Based on ARB information, it is expected that benzene and 1,3-butadiene — both generated largely by motor vehicles — will be reduced substantially when reformulated fuels are introduced. These two toxic compounds together account for more than half the background health risk from identified air toxics.

Global Warming and Stratospheric Ozone Depletion

Global warming and stratospheric ozone depletion are issues which have gained increased public attention over the last decade. Unlike emissions of criteria and toxic air pollutants, which have local or regional impacts, emissions contributing to global warming and ozone depletion have a broader, global impact.

Global warming is a process whereby "greenhouse gases" accumulating in the atmosphere contribute to an increase in the temperature of the earth's atmosphere. The principal compounds contributing to global warming are carbon dioxide (CO_2), methane, nitrous oxide, ozone and water vapor. These gases allow visible and ultraviolet light from the sun to pass through the atmosphere, but they prevent heat from escaping back out into space. Among the potential implications of global warming are rising sea levels, climate changes and adverse impacts to agriculture, forestry and natural habitats. In addition, global warming may increase electricity demand for cooling, decrease the availability of hydroelectric power, and affect regional air quality and human health. Like most criteria and toxic pollutants, much of the greenhouse gas production comes from motor vehicles. Greenhouse gas emissions can be reduced to some degree by improved coordination of land use and transportation planning on the city, county and subregional level and other measures to reduce auto use. Energy conservation measures also can contribute to reductions in greenhouse gas emissions.

One group of greenhouse gases, chlorinated fluorocarbons (CFCs) also depletes stratospheric ozone in addition to causing global warming. Ozone in the stratosphere, unlike ground-level ozone, is beneficial. It acts as a solar radiation “screen” reducing the amount of short-wave ultraviolet radiation which can cause skin cancer, damage agricultural crops and increase photochemical smog. By depleting ozone in the upper atmosphere, CFCs not only allow more short-wave ultraviolet radiation to enter the earth's atmosphere, but they are several thousand times more effective than CO_2 in trapping infrared radiation. Since the mid-1930s, CFCs have been used as refrigerants, solvents, and in the production of foam materials. Moreover, CFCs survive in the atmosphere for decades.

National and international agreements have been made to control CFCs and to study air quality problems related to ozone depletion. Recent laws and practices governing repair and recharging of air conditioners and refrigerators have served to reduce CFC emissions. Although local governments alone cannot solve these global problems, some cities in the Bay Area have already demonstrated that local and regional efforts can make a contribution, e.g., banning the sale and commercial use of plastics made with CFCs.

APPENDIX D - CLIMATE, TOPOGRAPHY AND AIR POLLUTION POTENTIAL

Appendix D provides climatological and topographic information about the Bay Area, and explains how these natural factors influence air quality conditions. The first two sections address region-wide conditions relevant to all cities and counties in the Bay Area. The final sections discuss climatological subregions in the Bay Area.

BAY AREA CLIMATE AND TOPOGRAPHY

High Pressure Cell

During the summer, the large-scale meteorological condition that dominates the West Coast is a semipermanent high pressure cell centered over the northeastern Pacific Ocean. This high pressure cell keeps storms from affecting the California coast. Hence, the Bay Area experiences little precipitation in the summer months. Winds tend to blow on shore out of the north/northwest.

The steady northwesterly flow induces upwelling of cold water from below. This upwelling produces a band of cold water off the California coast. When air approaches the California coast, already cool and moisture-laden from its long journey over the Pacific, it is further cooled as it crosses this bank of cold water. This cooling often produces condensation resulting in a high incidence of fog and stratus clouds along the Northern California coast in the summer.

Generally in the winter, the Pacific high weakens and shifts southward, winds tend to flow offshore, upwelling ceases and storms occur. During the winter rainy periods, inversions (layers of warmer air over colder air; see below) are weak or nonexistent, winds are usually moderate and air pollution potential is low. The Pacific high does periodically become dominant however, bringing strong inversions, light winds and high pollution potential.

Topography

Bay Area topography is characterized by complex terrain, consisting of coastal mountain ranges, inland valleys and bays. This complex terrain, especially the higher elevations, distorts the normal wind flow patterns in the Bay Area. The greatest distortion occurs when low-level inversions are present and the air beneath the inversion flows independently of air above the inversion, a condition that is common in the summer time.

The only major break in California's Coast Range occurs in the Bay Area. Here the Coast Range splits into western and eastern ranges. Between the two ranges lies San Francisco Bay. The gap in the western coast range is known as the Golden Gate, and the gap in the eastern coast range is the Carquinez Strait. These gaps allow air to pass into and out of the Bay Area and the Central Valley.

Wind Patterns

During the summer, winds flowing from the northwest are drawn inland through the Golden Gate and over the lower portions of the San Francisco Peninsula. Immediately south of Mount Tamalpais, the northwesterly winds accelerate considerably and come more directly from the west as they stream through the Golden Gate. This channeling of wind through the Golden Gate produces a jet that sweeps eastward and splits off to the northwest toward Richmond and to the southwest toward San Jose when it meets the East Bay hills.

Wind speeds may be strong locally in areas where air is channeled through a narrow opening, such as the Carquinez Strait, the Golden Gate or the San Bruno gap. For example, the average wind speed at San Francisco International Airport in July is about 17 knots (from 3 p.m. to 4 p.m.), compared with only 7 knots at San Jose and less than 6 knots at the Farallon Islands.

The air flowing in from the coast to the Central Valley, called the sea breeze, begins developing at or near ground level along the coast in late morning or early afternoon. As the day progresses, the sea breeze layer deepens and increases in velocity while spreading inland. The depth of the sea breeze depends in large part upon the height and strength of the inversion. If the inversion is low and strong, and hence stable, the flow of the sea breeze will be inhibited and stagnant conditions are likely to result.

In the winter, the Bay Area frequently experiences stormy conditions with moderate to strong winds, as well as periods of stagnation with very light winds. Winter stagnation episodes are characterized by nighttime drainage flows in coastal valleys. Drainage is a reversal of the usual daytime air-flow patterns; air moves from the Central Valley toward the coast and back down toward the Bay from the smaller valleys within the Bay Area.

Temperature

Summertime temperatures in the Bay Area are determined in large part by the effect of differential heating between land and water surfaces. Because land tends to heat up and cool off more quickly than water, a large-scale gradient (differential) in temperature is often created between the coast and the Central Valley, and small-scale local gradients are often produced along the shorelines of the ocean and bays. The temperature gradient near the ocean is also exaggerated, especially in summer, because of the upwelling of cold ocean bottom water along the coast. Thus, on summer afternoons the temperatures at the coast can be 35°F cooler than temperatures 15 to 20 miles inland. At night this contrast usually decreases to less than 10°.

In the winter, the relationship of minimum and maximum temperatures is reversed. During the daytime the temperature contrast between the coast and inland areas is small, whereas at night the variation in temperature is large.

Precipitation

The Bay Area is characterized by moderately wet winters and dry summers. Winter rains account for about 75 percent of the average annual rainfall. The amount of annual precipitation can vary greatly from one part of the Bay Area to another even within short distances. In general, total annual rainfall can reach 40 inches in the mountains, but it is often less than 16 inches in sheltered valleys.

During rainy periods, ventilation (rapid horizontal movement of air and injection of cleaner air) and vertical mixing are usually high, and thus pollution levels tend to be low. However, frequent dry periods do occur during the winter where mixing and ventilation are low and pollutant levels build up.

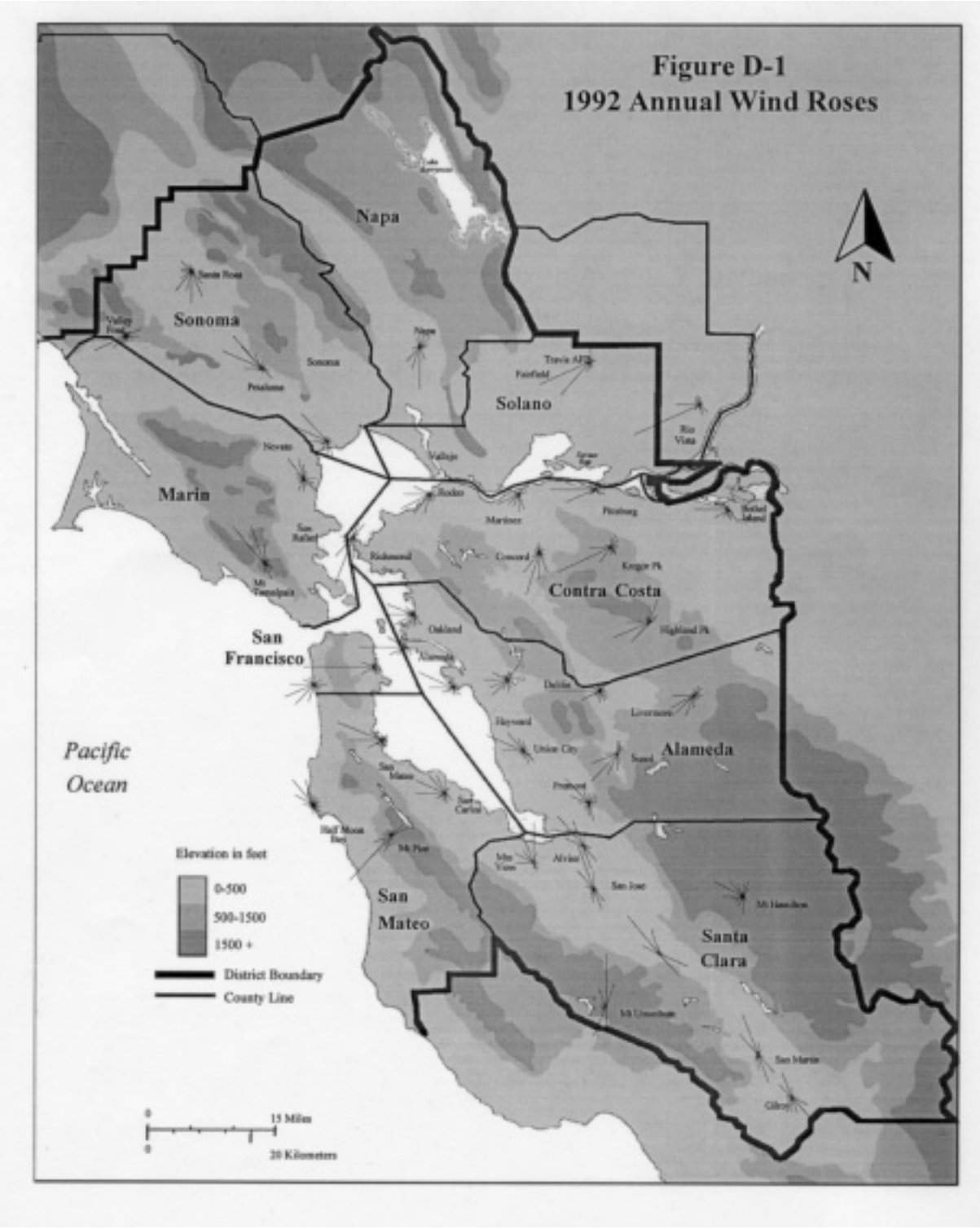
AIR POLLUTION POTENTIAL

The potential for high pollutant concentrations developing at a given location depends upon the quantity of pollutants emitted into the atmosphere in the surrounding area or upwind, and the ability of the atmosphere to disperse the contaminated air. The topographic and climatological factors discussed above influence the atmospheric pollution potential of an area. Atmospheric pollution potential, as the term is used here, is independent of the location of emission sources and is instead a function of factors described below.

Wind Circulation

Low wind speed contributes to the buildup of air pollution because it allows more pollutants to be emitted into the air mass per unit of time. Light winds occur most frequently during periods of low sun (fall and winter, and early morning) and at night. These are also periods when air pollutant emissions from some sources are at their peak, namely, commute traffic (early morning) and wood burning appliances (nighttime). The problem can be compounded in valleys, when weak flows carry the pollutants upvalley during the day, and cold air drainage flows move the air mass downvalley at night. Such restricted movement of trapped air provides little opportunity for ventilation and leads to buildup of pollutants to potentially unhealthful levels.

Wind-roses (Figure D-1) provide useful information for communities that contain industry, landfills or other potentially odorous or noxious land uses. Each wind-rose diagram provides a general indication of the proportion of time that winds blow from each compass direction. The longer the vector length, the greater the frequency of wind occurring from that direction. Such information may be particularly useful in planning buffer zones. For example, sensitive receptors such as residential developments, schools or hospitals are inappropriate uses immediately downwind from facilities that emit toxic or odorous pollutants, unless adequate separation is provided by a buffer zone. Caution should be taken, however, in using wind-roses in planning and environmental review processes. A site on the opposite side of a hill or tall building, even a short distance from a meteorological monitoring station, may experience a significant difference in wind pattern. Figure D-1 is a map of simplified wind roses, composed of data from a number of Bay Area meteorological stations. Lead agencies should consult District meteorologists if more detailed information is needed.


Figure D-1
1992 Annual Wind Roses
N
Napa
Sonoma
Solano
Marin
Contra Costa
San Francisco
Alameda
San Mateo
Santa Clara
Pacific Ocean
Elevation in feet
0-500
500-1500
1500 +
District Boundary
County Line
15 Miles
20 Kilometers

Inversions

An inversion is a layer of warmer air over a layer of cooler air. Inversions affect air quality conditions significantly because they influence the mixing depth, i.e., the vertical depth in the atmosphere available for diluting air contaminants near the ground. The highest air pollutant concentrations in the Bay Area generally occur during inversions.

There are two types of inversions that occur regularly in the Bay Area. One is more common in the summer and fall, while the other is most common during the winter. The frequent occurrence of elevated temperature inversions in summer and fall months acts to cap the mixing depth and consequently limit the depth of air available for dilution. Elevated inversions are caused by subsiding air from the subtropical high pressure zone, and from the cool marine air layer that is drawn into the Bay Area by the heated low pressure region in the Central Valley.

The inversions typical of winter, called radiation inversions, are formed as heat quickly radiates from the earth's surface after sunset, causing the air in contact with it to rapidly cool. Radiation inversions are strongest on clear, low-wind, cold winter nights, allowing the build-up of such pollutants as carbon monoxide and particulate matter. When wind speeds are low, there is little mechanical turbulence to mix the air, resulting in a layer of warm air over a layer of cooler air next to the ground. Mixing depths under these conditions can be as shallow as 50 to 100 meters, particularly in rural areas. Urban areas usually have deeper minimum mixing layers because of heat island effects and increased surface roughness. During radiation inversions downwind transport is slow, the mixing depths are shallow, and turbulence is minimal. All of these factors contribute to increased pollution levels near the ground.

Although each type of inversion is most common during a specific season, either inversion mechanism can occur at any time of the year. Sometimes both occur simultaneously. Moreover, the characteristics of an inversion often change throughout the course of a day. The terrain of the Bay Area also induces significant variations among subregions.

Stability

Stability is defined as the atmosphere's resistance to vertical motions. The more stable the air, the slower the mixing, resulting in increased probability for air pollutants to build up and exceed ambient air quality standards.

The stability of the atmosphere is highly dependent upon the vertical distribution of temperature with height. When the temperature decreases vertically ("lapse rate") at 10 degrees Celsius per 1000 meters, the atmosphere is classified as "neutral stability". When the lapse rate is greater than 10 degrees C per 100 meters, the atmosphere is "unstable". If the lapse rate is less than 10 degrees per 1000 meters, or the temperature increases with height, the atmosphere is "stable". These stabilities have been categorized for use in dispersion models. Stability categories range from "Extremely Unstable" (Stability Class A), through "Neutral" (D), to "Stable" (F).

Unstable conditions can only occur during daytime hours when solar heating warms the lower layers sufficiently. Under A stability conditions, large horizontal wind direction fluctuations occur, along with large vertical mixing. These motions usually only occur midday during

summer months on cloudless days with light winds. Under B stability conditions, wind direction fluctuations and vertical mixing are less pronounced, because the heating is less strong. The fluctuations found during both A and B stability conditions are mostly due to thermal turbulence. Under C stability conditions, the solar insulation is weaker, or the wind speeds are stronger, so that the surface heating is weaker. The horizontal and vertical fluctuations are weaker yet, and are caused by a combination of thermal and mechanical turbulence.

D stability can occur either during the day or at night. Under D stability conditions, the wind speeds are usually strong — greater than 5 meters per second — or the sky is obscured by clouds. Wind direction fluctuations are small, while vertical motions are primarily generated by mechanical turbulence.

Stabilities E and F can only occur at night. The necessary conditions can only occur in the absence of sunlight, and with light to moderate winds. Under these conditions, there is little turbulence because of the atmosphere's resistance to vertical motion. Pollutants emitted into a stable air mass will travel downwind with little dispersion.

Solar Radiation

The frequency of hot, sunny days during the summer months in the Bay Area is another important factor that affects air pollution potential. It is at the higher temperatures that ozone is formed. In the presence of ultraviolet sunlight and warm temperatures, reactive organic gases and oxides of nitrogen react to form secondary photochemical pollutants, including ozone. Because temperatures in many of the Bay Area inland valleys are so much higher than near the coast, the inland areas are especially prone to photochemical air pollution.

In late fall and winter, solar angles are low, resulting in insufficient ultraviolet light and warming of the atmosphere to drive the photochemical reactions. Consequently, ozone concentrations do not reach significant levels in the Bay Area during these seasons.

Sheltered Terrain

The hills and mountains in the Bay Area contribute to the high pollution potential of some areas. During the day, or at night during windy conditions, areas in the lee sides of mountains are sheltered from the prevailing winds, thereby reducing turbulence and downwind transport. At night, when wind speeds are low, the upper atmospheric layers are often decoupled from the surface layers during radiation conditions. If elevated terrain is present, it will tend to block pollutant transport in that direction. Elevated terrain also can create a recirculation pattern by inducing upvalley air flows during the day and reverse downvalley flows during the night, allowing little inflow of fresh air.

The areas having the highest air pollution potential tend to be those that experience the highest temperatures in the summer and the lowest temperatures in the winter. Bay Area coastal areas are exposed to the prevailing marine air and consequently have cooler temperatures in the summer, warmer temperatures in winter, and experience stratus clouds all year. The inland valleys are sheltered from the marine air and consequently experience hotter summers and colder

winters. Thus, the topography of the inland valleys creates conditions conducive to high air pollution potential.

Pollution Potential Related to Emissions

Although air pollution potential is strongly influenced by climate and topography, the air pollution that occurs in a location also depends upon the amount of air pollutant emissions in the surrounding area or transported from more distant places. Air pollutant emissions generally are highest in areas that have high population densities, high motor vehicle use and/or industrialization. However, contaminants created by photochemical processes in the atmosphere, such as ozone, may result in high concentrations many miles downwind from the sources of their precursor chemicals.

CLIMATOLOGICAL SUBREGIONS

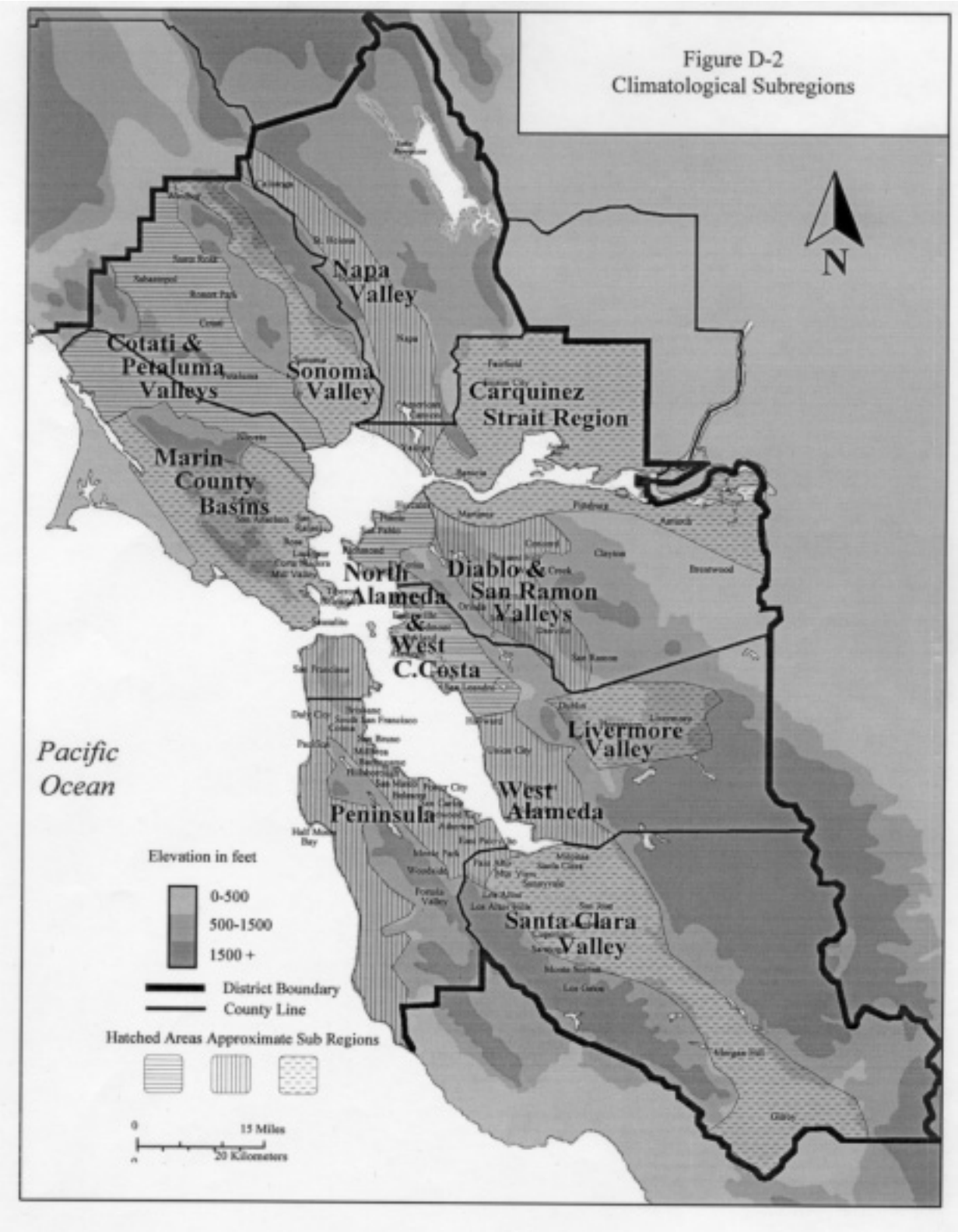
This section discusses the varying climatological and topographic conditions, and the resulting variations in air pollution potential, within inhabited subregions of the Bay Area Air Basin. All urbanized areas of the Bay Area are included in one of 11 climatological subregions. Sparsely inhabited areas are excluded from the subregional designations. Some of the climatological subregions discussed in this appendix overlap county boundaries. Lead Agencies analyzing projects located close to the boundary between subregions may need to examine the characteristics of the neighboring subregions in order to adequately evaluate potential air quality impacts. The 11 subregions are portrayed in Figure D-2.

The information about each subregion includes location, topography and climatological factors relevant to air quality. Where relevant to air quality concerns, more localized subareas within a subregion are discussed. Each subregional section concludes with a discussion of pollution potential resulting from climatological and topographic variables and the major types of air pollutant sources in the subregion.

Carquinez Strait Region

The Carquinez Strait runs from Rodeo to Martinez. It is the only sea-level gap between San Francisco Bay and the Central Valley. The subregion includes the lowlands bordering the strait to the north and south, and includes the area adjoining Suisun Bay and the western part of the Sacramento-San Joaquin Delta as far east as Bethel Island. The subregion extends from Rodeo in the southwest and Vallejo in the northwest to Fairfield on the northeast and Brentwood on the southeast.

Prevailing winds are from the west in the Carquinez Strait. During the summer and fall months, high pressure offshore coupled with low pressure in the Central Valley causes marine air to flow eastward through the Carquinez Strait. The wind is strongest in the afternoon. Afternoon wind speeds of 15 to 20 mph are common throughout the strait region. Annual average wind speeds


Figure D-2
Climatological Subregions
N
Napa Valley
Cotati & Petaluma Valleys
Sonoma Valley
Carquinez Strait Region
Marin County Basins
North Alameda & West C.Costa
Diablo & San Ramon Valleys
Livermore Valley
West Alameda
Peninsula
Santa Clara Valley
Pacific Ocean
Elevation in feet
0-500
500-1500
1500 +
District Boundary
County Line
Hatched Areas Approximate Sub Regions
0
15 Miles
20 Kilometers

are 8 mph in Martinez, and 9 to 10 mph further east. Sometimes atmospheric conditions cause air to flow from the east. East winds usually contain more pollutants than the cleaner marine air from the west. In the summer and fall months, this can cause elevated pollutant levels to move into the central Bay Area through the strait. These high pressure periods are usually accompanied by low wind speeds, shallow mixing depths, higher temperatures and little or no rainfall.

Summer mean maximum temperatures reach about 90° F. in the subregion. Mean minimum temperatures in the winter are in the high 30's. Temperature extremes are especially pronounced in sheltered areas farther from the moderating effects of the strait itself, e.g. at Fairfield.

Many industrial facilities with significant air pollutant emissions — e.g., chemical plants and refineries — are located within the Carquinez Strait Region. The pollution potential of this area is often moderated by high wind speeds. However, upsets at industrial facilities can lead to short-term pollution episodes, and emissions of unpleasant odors may occur at anytime. Receptors downwind of these facilities could suffer more long-term exposure to air contaminants than individuals elsewhere. Consequently, it is important that local governments and other Lead Agencies maintain buffers zones around sources of air pollution sufficient to avoid adverse health and nuisance impacts on nearby receptors. Areas of the subregion that are traversed by major roadways, e.g. Interstate 80, may also be subject to higher local concentrations of carbon monoxide and particulate matter, as well as certain toxic air contaminants such as benzene.

Cotati and Petaluma Valleys

The subregion that stretches from Santa Rosa to the San Pablo Bay is often considered as two different valleys: the Cotati Valley in the north and the Petaluma Valley in the south. To the east, the valley is bordered by the Sonoma Mountains, while to the west is a series of low hills, followed by the Estero Lowlands, which open to the Pacific Ocean. The region from the Estero Lowlands to the San Pablo Bay is known as the Petaluma Gap. This low-terrain area allows marine air to travel into the Bay Area.

Wind patterns in the Petaluma and Cotati Valleys are strongly influenced by the Petaluma Gap, with winds flowing predominantly from the west. As marine air travels through the Petaluma Gap, it splits into northward and southward paths moving into the Cotati and Petaluma valleys. The southward path crosses San Pablo Bay and moves eastward through the Carquinez Strait. The northward path contributes to Santa Rosa's prevailing winds from the south and southeast. Petaluma's prevailing winds are from the northwest.

When the ocean breeze is weak, strong winds from the east can predominate, carrying pollutants from the Central Valley and the Carquinez Strait. During these periods, upvalley flows can carry the polluted air as far north as Santa Rosa.

Winds are usually stronger in the Petaluma Valley than the Cotati Valley because the former is directly in line with the Petaluma Gap. Consequently, Petaluma's climate is similar to areas closer to the coast even though Petaluma is 28 miles from the ocean. Average annual wind speed at the Petaluma Airport is seven mph. The Cotati Valley, being slightly north of the

Petaluma Gap, experiences lower wind speeds. The annual average wind speed in Santa Rosa is five mph.

Air temperatures are very similar in the two valleys. Summer maximum temperatures for this subregion are in the low-to-mid-80's, while winter maximum temperatures are in the high-50's to low-60's. Summer minimum temperatures are around 50 degrees, and winter minimum temperatures are in the high 30's.

Generally, air pollution potential is low in the Petaluma Valley because of its link to the Petaluma Gap and because of its low population density. However, there are two scenarios that could produce elevated pollutant levels: 1) stagnant conditions in the morning hours created when a weak ocean breeze meets a weak bay breeze, and 2) an eastern or southeastern wind pattern in the afternoon brings in pollution from the Carquinez Strait Region and the Central Valley.

The Cotati Valley has a higher pollution potential than does the Petaluma Valley. The Cotati Valley lacks a gap to the sea, contains a larger population and has natural barriers at its northern and eastern ends. There are also industrial facilities in and around Santa Rosa. Both valleys of this subregion are also threatened by increased motor vehicle traffic and the associated air contaminants. Population and motor vehicle use are increasing significantly, and housing costs and the suburbanization of employment are leading to more and longer commutes traversing the subregion.

Diablo and San Ramon Valleys

East of the Coast Range lie the Diablo and San Ramon Valleys. The valleys have a northwest to southeast orientation, with the northern portion known as Diablo Valley and the southern portion as San Ramon Valley. The Diablo Valley is bordered in the north by the Carquinez Strait and in the south by the San Ramon Valley. The San Ramon Valley is long and narrow and extends south from Walnut Creek to Dublin. At its southern end it opens onto the Amador Valley.

The mountains on the west side of these valleys block much of the marine air from reaching the valleys. During the daytime, there are two predominant flow patterns: an upvalley flow from the north and a westerly flow (wind from the west) across the lower elevations of the Coast Range. On clear nights, surface inversions separate the flow of air into two layers: the surface flow and the upper layer flow. When this happens, there are often drainage surface winds which flow downvalley toward the Carquinez Strait.

Wind speeds in these valleys generally are low. Monitoring stations in Concord and Danville report annual average wind speeds of 5 mph. However, winds can increase in the afternoon near San Ramon because it is located at the eastern edge of the Crow Canyon gap. Through this gap, polluted air from cities near the bay travels to the valley in the summer months.

Air temperatures in these valleys are cooler in the winter and warmer in the summer than are temperatures further west, as these valleys are far from the moderating effect of the bay and ocean. Mean summer maximum temperatures are in the low- to mid-80’s. Mean winter minimum temperatures are in the high-30’s to low-40’s.

Pollution potential is relatively high in these valleys. On winter evenings, light winds combined with surface-based inversions and terrain that restricts air flow can cause pollutant levels to build up. San Ramon Valley can experience high pollution concentrations due to motor vehicle emissions and emissions from fireplaces and wood stoves. In the summer months, ozone and ozone precursors are often transported into the valleys from both the central Bay Area and the Central Valley.

Livermore Valley

The Livermore Valley is a sheltered inland valley near the eastern border of the District. The western side of the valley is bordered by 1,000 to 1,500 foot hills with two gaps connecting the valley to the central Bay Area, the Hayward Pass and Niles Canyon. The eastern side of the valley also is bordered by 1,000 to 1,500 foot hills with one major passage to the San Joaquin Valley called the Altamont Pass and several secondary passages. To the north lie the Black Hills and Mount Diablo. A northwest to southeast channel connects the Diablo Valley to the Livermore Valley. The south side of the Livermore Valley is bordered by mountains approximately 3,000 to 3,500 feet high.

During the summer months, when there is a strong inversion with a low ceiling, air movement is weak and pollutants become trapped and concentrated. Maximum summer temperatures in the Livermore Valley range from the high-80's to the low-90's, with extremes in the 100's. At other times in the summer, a strong Pacific high pressure cell from the west, coupled with hot inland temperatures causes a strong onshore pressure gradient which produces a strong, afternoon wind. With a weak temperature inversion, air moves over the hills with ease, dispersing pollutants.

In the winter, with the exception of an occasional storm moving through the area, air movement is often dictated by local conditions. At night and early morning, especially under clear, calm and cold conditions, gravity drives cold air downward. The cold air drains off the hills and moves into the gaps and passes. On the eastern side of the valley the prevailing winds blow from north, northeast and east out of the Altamont Pass. Winds are light during the late night and early morning hours. Winter daytime winds sometimes flow from the south through the Altamont Pass to the San Joaquin Valley. Average winter maximum temperatures range from the high-50's to the low-60's, while minimum temperatures are from the mid-to-high-30's, with extremes in the high teens and low-20's.

Air pollution potential is high in the Livermore Valley, especially for photochemical pollutants in the summer and fall. High temperatures increase the potential for ozone to build up. The valley not only traps locally generated pollutants but can be the receptor of ozone and ozone precursors from San Francisco, Alameda, Contra Costa and Santa Clara counties. On northeasterly wind flow days, most common in the early fall, ozone may be carried west from the San Joaquin Valley to the Livermore Valley.

During the winter, the sheltering effect of the valley, its distance from moderating water bodies, and the presence of a strong high pressure system contribute to the development of strong, surface-based temperature inversions. Pollutants such as carbon monoxide and particulate matter, generated by motor vehicles, fireplaces and agricultural burning, can become

concentrated. Air pollution problems could intensify because of population growth and increased commuting to and through the subregion.

Marin County Basins

Marin County is bounded on the west by the Pacific Ocean, on the east by San Pablo Bay, on the south by the Golden Gate and on the north by the Petaluma Gap. Most of Marin's population lives in the eastern part of the county, in small, sheltered valleys. These valleys act like a series of miniature air basins.

Although there are a few mountains above 1500 feet, most of the terrain is only 800 to 1000 feet high, which usually is not high enough to block the marine layer. Because of the wedge shape of the county, northeast Marin County is further from the ocean than is the southeastern section. This extra distance from the ocean allows the marine air to be moderated by bayside conditions as it travels to northeastern Marin County. In southern Marin the distance from the ocean is short and elevations are lower, resulting in higher incidence of maritime air in that area.

Wind speeds are highest along the west coast of Marin, averaging about 8 to 10 miles per hour. The complex terrain in central Marin creates sufficient friction to slow the air flow. At Hamilton Air Force Base, in Novato, the annual average wind speeds are only 5 mph. The prevailing wind directions throughout Marin County are generally from the northwest.

In the summer months, areas along the coast are usually subject to onshore movement of cool marine air. In the winter, proximity to the ocean keeps the coastal regions relatively warm, with temperatures varying little throughout the year. Coastal temperatures are usually in the high-50's in the winter and the low-60's in the summer. The warmest months are September and October.

The eastern side of Marin County has warmer weather than the western side because of its distance from the ocean and because the hills that separate eastern Marin from western Marin occasionally block the flow of the marine air. The temperatures of cities next to the bay are moderated by the cooling effect of the bay in the summer and the warming effect of the bay in the winter. For example, San Rafael experiences average maximum summer temperatures in the low-80's and average minimum winter temperatures in the low-40’s. Inland towns such as Kentfield experience average maximum temperatures that are two degrees cooler in the winter and two degrees warmer in the summer.

Air pollution potential is highest in eastern Marin County, where most of population is located in semi-sheltered valleys. In the southeast, the influence of marine air keeps pollution levels low. However, as development moves further north, there is greater potential for air pollution to build up because the valleys are more sheltered from the sea breeze. While Marin County does not have many polluting industries, the air quality on its eastern side — especially along the U.S. 101 corridor — may be affected by emissions from increasing motor vehicle use within and through the county.

Napa Valley

The Napa Valley is bordered by relatively high mountains. With an average ridge line height of about 2000 feet, with some peaks approaching 3000 to 4000 feet, these mountains are effective barriers to the prevailing northwesterly winds. The Napa Valley is widest at its southern end and narrows in the north.
During the day, the prevailing winds flow upvalley from the south about half of the time. A strong upvalley wind frequently develops during warm summer afternoons, drawing air in from the San Pablo Bay. Daytime winds sometimes flow downvalley from the north. During the evening, especially in the winter, downvalley drainage often occurs. Wind speeds are generally low, with almost 50 percent of the winds less than 4 mph. Only 5 percent of the winds are between 16 and 18 mph, representing strong summertime upvalley winds and winter storms.

Summer average maximum temperatures are in the low 80's at the southern end of the valley and in the low 90's at the northern end. Winter average maximum temperatures are in the high-50's and low-60's, and minimum temperatures are in the high to mid 30's with the slightly cooler temperatures in the northern end.

The air pollution potential in the Napa Valley could be high if there were sufficient sources of air contaminants nearby. Summer and fall prevailing winds can transport ozone precursors northward from the Carquinez Strait Region to the Napa Valley, effectively trapping and concentrating the pollutants when stable conditions are present. The local upslope and downslope flows created by the surrounding mountains may also recirculate pollutants already present, contributing to buildup of air pollution. High ozone concentrations are a potential problem to sensitive crops such as wine grapes, as well as to human health. The high frequency of light winds and stable conditions during the late fall and winter contribute to the buildup of particulate matter from motor vehicles, agriculture and woodburning in fireplaces and stoves.

Northern Alameda and Western Contra Costa Counties

This climatological subregion stretches from Richmond to San Leandro. Its western boundary is defined by San Francisco Bay and its eastern boundary by the Oakland-Berkeley Hills. The Oakland-Berkeley Hills have a ridge line height of approximately 1500 feet, a significant barrier to air flow. The most densely populated area of the subregion lies in a strip of land between the bay and the lower hills.

In this area, marine air traveling through the Golden Gate, as well as across San Francisco and through the San Bruno Gap, is a dominant weather factor. The Oakland-Berkeley Hills cause the westerly flow of air to split off to the north and south of Oakland, which causes diminished wind speeds. The prevailing winds for most of this subregion are from the west. At the northern end, near Richmond, prevailing winds are from the south-southwest.

Temperatures in this subregion have a narrow range due to the proximity of the moderating marine air. Maximum temperatures in summer average in the mid-70's, with minimums in the mid-50's. Winter highs are in the mid- to high-50's, with lows in the low- to mid-40's.

The air pollution potential is lowest for the parts of the subregion that are closest to the bay, due largely to good ventilation and less influx of pollutants from upwind sources. The occurrence of light winds in the evenings and early mornings occasionally causes elevated pollutant levels.

The air pollution potential at the northern (Richmond) and southern (Oakland, San Leandro) parts of this subregion is marginally higher than communities directly east of the Golden Gate, because of the lower frequency of strong winds.

This subregion contains a variety of industrial air pollution sources. Some industries are quite close to residential areas. The subregion is also traversed by frequently congested major freeways. Traffic and congestion, and the motor vehicle emissions they generate, are increasing.

Peninsula

The peninsula region extends from northwest of San Jose to the Golden Gate. The Santa Cruz Mountains run up the center of the peninsula, with elevations exceeding 2000 feet at the southern end, decreasing to 500 feet in South San Francisco. Coastal towns experience a high incidence of cool, foggy weather in the summer. Cities in the southeastern peninsula experience warmer temperatures and fewer foggy days because the marine layer is blocked by the ridgeline to the west. San Francisco lies at the northern end of the peninsula. Because most of San Francisco's topography is below 200 feet, marine air is able to flow easily across most of the city, making its climate cool and windy.

The blocking effect of the Santa Cruz Mountains results in variations in summertime maximum temperatures in different parts of the peninsula. For example, in coastal areas and San Francisco the mean maximum summer temperatures are in the mid-60's, while in Redwood City the mean maximum summer temperatures are in the low-80's. Mean minimum temperatures during the winter months are in the high-30’s to low-40’s on the eastern side of the Peninsula and in the low 40’s on the coast..

Two important gaps in the Santa Cruz Mountains occur on the peninsula. The larger of the two is the San Bruno Gap, extending from Fort Funston on the ocean to the San Francisco Airport. Because the gap is oriented in the same northwest to southeast direction as the prevailing winds, and because the elevations along the gap are under 200 feet, marine air is easily able to penetrate into the bay. The other gap is the Crystal Springs Gap, between Half Moon Bay and San Carlos. As the sea breeze strengthens on summer afternoons, the gap permits maritime air to pass across the mountains, and its cooling effect is commonly seen from San Mateo to Redwood City.

Annual average wind speeds range from 5 to 10 mph throughout the peninsula, with higher wind speeds usually found along the coast. However, winds on the eastern side of the peninsula are often high in certain areas, such as near the San Bruno Gap and the Crystal Springs Gap.

The prevailing winds along the peninsula's coast are from the west, although individual sites can show significant differences. For example, Fort Funston in western San Francisco shows a southwest wind pattern while Pillar Point in San Mateo County shows a northwest wind pattern. On the east side of the mountains winds are generally from the west, although wind patterns in this area are often influenced greatly by local topographic features.

Air pollution potential is highest along the southeastern portion of the peninsula. This is the area most protected from the high winds and fog of the marine layer. Pollutant transport from upwind sites is common. In the southeastern portion of the peninsula, air pollutant emissions are

relatively high due to motor vehicle traffic as well as stationary sources. At the northern end of the peninsula in San Francisco, pollutant emissions are high, especially from motor vehicle congestion. Localized pollutants, such as carbon monoxide, can build up in "urban canyons". However, winds are generally fast enough to carry the pollutants away before they can accumulate.

Santa Clara Valley

The Santa Clara Valley is bounded by the San Francisco Bay to the north and by mountains to the east, south and west. Temperatures are warm on summer days and cool on summer nights, and winter temperatures are fairly mild. At the northern end of the valley, mean maximum temperatures are in the low-80's during the summer and the high-50's during the winter, and mean minimum temperatures range from the high-50's in the summer to the low-40's in the winter. Further inland, where the moderating effect of the bay is not as strong, temperature extremes are greater. For example, in San Martin, located 27 miles south of the San Jose Airport, temperatures can be more than 10 degrees warmer on summer afternoons and more than 10 degrees cooler on winter nights.

Winds in the valley are greatly influenced by the terrain, resulting in a prevailing flow that roughly parallels the valley's northwest-southeast axis. A north-northwesterly sea breeze flows through the valley during the afternoon and early evening, and a light south-southeasterly drainage flow occurs during the late evening and early morning. In the summer the southern end of the valley sometimes becomes a "convergence zone," when air flowing from the Monterey Bay gets channeled northward into the southern end of the valley and meets with the prevailing north-northwesterly winds.

Wind speeds are greatest in the spring and summer and weakest in the fall and winter. Nighttime and early morning hours frequently have calm winds in all seasons, while summer afternoons and evenings are quite breezy. Strong winds are rare, associated mostly with the occasional winter storm.

The air pollution potential of the Santa Clara Valley is high. High summer temperatures, stable air and mountains surrounding the valley combine to promote ozone formation. In addition to the many local sources of pollution, ozone precursors from San Francisco, San Mateo and Alameda Counties are carried by prevailing winds to the Santa Clara Valley. The valley tends to channel pollutants to the southeast. In addition, on summer days with low level inversions, ozone can be recirculated by southerly drainage flows in the late evening and early morning and by the prevailing northwesterlies in the afternoon. A similar recirculation pattern occurs in the winter, affecting levels of carbon monoxide and particulate matter. This movement of the air up and down the valley increases the impact of the pollutants significantly.

Pollution sources are plentiful and complex in this subregion. The Santa Clara Valley has a high concentration of industry at the northern end, in the Silicon Valley. Some of these industries are sources of air toxics as well as criteria pollutants. In addition, Santa Clara Valley's large population and many work-site destinations generate the highest mobile source emissions of any subregion in the Bay Area.

Sonoma Valley

The Sonoma Valley is west of the Napa Valley. It is separated from the Napa Valley and from the Cotati and Petaluma Valleys by mountains. The Sonoma Valley is long and narrow, approximately 5 miles wide at its southern end and less than a mile wide at the northern end.

The climate is similar to that of the Napa Valley, with the same basic wind characteristics. The strongest upvalley winds occur in the afternoon during the summer and the strongest downvalley winds occur during clear, calm winter nights. Prevailing winds follow the axis of the valley, northwest/southeast, while some upslope flow during the day and downslope flow during the night occurs near the base of the mountains. Summer average maximum temperatures are usually in the high-80's, and summer minimums are around 50 degrees. Winter maximums are in the high-50's to the mid-60's, with minimums ranging from the mid-30's to low-40's.

As in the Napa Valley, the air pollution potential of the Sonoma Valley could be high if there were significant sources of pollution nearby. Prevailing winds can transport locally and non-locally generated pollutants northward into the narrow valley, which often traps and concentrates the pollutants under stable conditions. The local upslope and downslope flows set up by the surrounding mountains may also recirculate pollutants.

However, local sources of air pollution are minor. With the exception of some processing of agricultural goods, such as wine and cheese manufacturing, there is little industry in this valley. Increases in motor vehicle emissions and woodsmoke emissions from stoves and fireplaces may increase pollution as the valley grows in population and as a tourist attraction.

Southwestern Alameda County

This subregion encompasses the southeast side of San Francisco Bay, from Dublin Canyon to north of Milpitas. The subregion is bordered on the east by the East Bay hills and on the west by the bay. Most of the area is flat.

This subregion is indirectly affected by marine air flow. Marine air entering through the Golden Gate is blocked by the East Bay hills, forcing the air to diverge into northerly and southerly paths. The southern flow is directed down the bay, parallel to the hills, where it eventually passes over southwestern Alameda County. These sea breezes are strongest in the afternoon. The further from the ocean the marine air travels, however, the ocean’s effect is diminished. Thus, although the climate in this region is affected by sea breezes, it is affected less so than the regions closer to the Golden Gate.

The climate of southwestern Alameda County is also affected by its close proximity to San Francisco Bay. The bay cools the air with which it comes in contact during warm weather, while during cold weather the bay warms the air. The normal northwest wind pattern carries this air onshore. Bay breezes push cool air onshore during the daytime and draw air from the land offshore at night.

Winds are predominantly out of the northwest during the summer months. In the winter, winds are equally likely to be from the east. Easterly-southeasterly surface flow into southern Alameda

County passes through three major gaps: Hayward/Dublin Canyon, Niles Canyon and Mission Pass. Areas north of the gaps experience winds from the southeast, while areas south of the gaps experience winds from the northeast. Wind speeds are moderate in this subregion, with annual average wind speeds close to the bay at about 7 mph, while further inland they average 6 mph.

Air temperatures are moderated by the subregion's proximity to the bay and to the sea breeze. Temperatures are slightly cooler in the winter and slightly warmer in the summer than East Bay cities to the north. During the summer months, average maximum temperatures are in the mid-70’s. Average maximum winter temperatures are in the high-50's to low-60's. Average minimum temperatures are in the low 40's in winter and mid-50's in the summer.

Pollution potential is relatively high in this subregion during the summer and fall. When high pressure dominates, low mixing depths and bay and ocean wind patterns can concentrate and carry pollutants from other cities to this area, adding to the locally emitted pollutant mix. The polluted air is then pushed up against the East Bay hills. In the wintertime, the air pollution potential in southwestern Alameda county is moderate. Air pollution sources include light and heavy industry, and motor vehicles. Increasing motor vehicle traffic and congestion in the subregion may increase Southwest Alameda County pollution as well as that of its neighboring subregions.

APPENDIX E - TOXIC AIR CONTAMINANTS

Introduction

Toxic air contaminants (TACs) are air pollutants which may lead to serious illness or increased mortality, even when present in relatively low concentrations. Potential human health effects of TACs include birth defects, neurological damage, cancer and death. There are hundreds of different types of TACs, with varying degrees of toxicity. TACs may be produced by a variety of sources, including industrial facilities such as refineries, chemical plants and chrome platers, commercial facilities such as dry cleaners and gasoline stations, and motor vehicles.

District Programs

The District has regulated TACs since the 1980's as a complement to the traditional efforts to reduce emissions of criteria air pollutants. To date, the District's air toxics program has been a risk-based approach, meaning that the decisions over what sources and pollutants to control and the degree to which to control them have been based on the results of health risk assessment. A health risk assessment is an analysis where human health exposure to toxic substances is estimated, and then considered together with information regarding the toxic potency of the substances, to provide quantitative estimates of health risks. (The risk assessments used by the District do not address the possibility of, or adverse health effects resulting from, accidental releases of toxic materials such as a fire or major spill. Review of industry's preparation for, and protection from, accidental releases is performed by emergency response agencies, such as local fire and health departments.) The District's air toxics program consists of three major elements: a program to control emissions from new and modified sources; and two programs directed at existing sources - one with retrofit requirements for categories of sources, and another which is based on facility-specific analyses.

Air Toxics New Source Review

The District reviews new and modified source permit applications in accordance with the District's Risk Management Policy (adopted by the District Board of Directors in 1987). The goal of the program is to prevent any proposed stationary sources from creating new air toxics problems. In addition, benefits are realized when older, more highly polluting sources are replaced with new sources that must meet more stringent control requirements.

The need for, and degree of, emissions control required in toxics new source review is based on the results of health risk screening analysis or health risk assessment. All new/modified permit applications are reviewed for potential health impacts. If any TACs are emitted in amounts that exceed de minimus levels, a risk screening analysis, using computer-modeled estimates of atmospheric dispersion, is completed by District staff. Table E-1 lists the pollutants that trigger the District's risk screening requirements. A project that passes this risk screen is judged to have an insignificant impact on public health. A project that fails the screen does not necessarily have a significant impact, but requires further review. Further review usually consists of more detailed dispersion modeling (including the use of actual meteorological data when applicable), and consideration of other site-specific factors.

TABLE E-1
POLLUTANTS THAT TRIGGER
DISTRICT RISK SCREENING REQUIREMENTS

Carcinogenic Compounds

- Acetaldehyde
- Acrylamide
- Acrylonitrile
- Arsenic and arsenic compounds
- Asbestos
- Benzene
- Benzidine and salts
- Beryllium
- Bis(chloromethyl)ether
- Butadiene, 1,3-
- Cadmium and cadmium compounds
- Carbon tetrachloride
- Chlorinated dibenzodioxins and dibenzofurans (TCDD and TCDF)
- Chloroform
- Chromium (hexavalent)
- Dichlorobenzene, 1,4-
- Dichlorobenzidine, 3,3'-
- Diethylhexylphthalate (DEHP)
- Dioxane, 1,4-
- Epichlorohydrin
- Ethylene dibromide (1,2-dibromoethane)
- Ethylene dichloride (1,2-dichloroethane)
- Ethylene oxide
- Formaldehyde
- Hexachlorobenzene
- Hexachlorocyclohexanes
- Hydrazine
- Methylene chloride
- Methylene dianiline & chloride, 4,4'-
- Nickel and nickel compounds
- Nickel subsulfide
- N-Nitrosodiethylamine
- N-Nitrosodimethylamine
- N-Nitrosodiphenylamine
- N-Nitrosodi-n-butylamine
- N-Nitrosomethylethylamine
- N-Nitrosodi-n-propylamine
- N-Nitrosopyrrolidine
- PCBs
- PAHs (including but not limited to):
  - Benz(a)anthracene
  - Benzo(b)fluoroanthene
  - Benzo(k)fluoroanthene
  - Benzo(a)pyrene
  - Dibenz(a,h)anthracene
  - Ideno(1,2,3-cd)pyrene
- Perchloroethylene (tretrachloroethylene)
- Propylene oxide
- Trichloroethylene
- Trichlorophenol, 2,4,6-
- Urethane
- Vinyl chloride

Noncarcinogenic Compounds

- Acetone
- Acrolein
- Ammonia
- Benzyl chloride
- Bromine and compounds
- Butyl alcohol, tert-
- Carbon disulfide
- Chlorine
- Chlorobenzene
- Chlorofluorocarbons
- Chloropicrin
- Chloroprene
- Chlorotoluene
- Cresol
- Diethylaminoethanol
- Dimethylamine
- Dimethyl phthalate
- Dioctyl phthalate
- Ethyl alcohol (ethanol)
- Ethyl acetate
- Ethyl benzene
- Ethyl chloride
- Freons; (see Chlorofluorocarbons)
- Glycol ethers:
  - 2-ethoxyethanol (Cellosolve)
  - 2-methoxymethanol (Methylcellosolve)
  - 2-butoxyethanol (Butylcellosolve)
- Hexachlorocyclopentadiene
- Hexane, n-
- Hydrogen chloride
- Hydrogen cyanide
- Hydrogen fluoride
- Hydrogen sulfide
- Isocyanates:
  - methylene-bis-phenyliso-cyanate
  - methyl isocyanate
  - toluene diisocyanate
- Isophorone
- Isopropyl alcohol
- Lead, inorganic, and compounds
- Maleic anhydride
- Manganese and compounds
- Mercury and compounds
- Methyl alcohol (methanol)
- Methyl bromide
- Methyl chloroform (TCA)
- Methylethylketone (MEK)
- Methyl mercury
- Methyl methacrylate
- N-Methylpyrrolidone
- Naphthalene
- Nitrobenzene
- Phenol
- Phosgene
- Phosphine
- Phosphorus (white)
- Phthalic anhydride
- Selenium and compounds
- Sodium Hydroxide
- Styrene monomer
- Tetrahydrofuran
- Toluene
- Trichlorobenzene, 1,2,4-
- Tricholorethane, 1,1,1-; (see Methyl cloroform)
- Vapam (Na diethyldithio-carbamate)
- Xylene
- Zinc and compounds

Where risks cannot be reduced below specified health-based significance levels, sources must use the Best Available Control Technology for Toxics, or "T-BACT". The significance level for T-BACT is an individual cancer risk of 1-in-one million, or an ambient concentration above a non-cancer reference exposure level. If the residual health risks, after controls are applied, result in risks that exceed higher significance levels established for the overall acceptability of a project, then other risk reduction measures may be required, or the permits for the proposed source(s) may be denied.

The program has resulted in T-BACT being implemented on a variety of the most significant sources of TACs in the Bay Area. The program also encourages sound land use planning in that, through the risk assessment process, control requirements for sources increase in relation to their proximity to downwind sources.

Retrofit Requirements for Categories of Existing Sources

The primary mechanism for the development of retrofit air toxics control measures in California has been through the Toxic Air Contaminant Act, also referred to as the Tanner Act, adopted by the State legislature in 1983. The Tanner Act establishes a process for the identification of TACs, and for the preparation of retrofit toxic control measures on a Statewide basis. TACs are identified in a scientific review process involving the Air Resources Board (ARB), the Office of Environmental Health Hazard Assessment, and an independent scientific review panel. Once a contaminant is identified as a TAC, control measures, called Airborne Toxic Control Measures (ATCMs), are developed by the ARB. The measures are implemented and enforced by the local air districts, which may adopt the ATCMs as established by ARB, or set more stringent standards.

As of February 1996, 19 compounds have been identified as TACs through the State's scientific review process, and eight statewide ATCMs have been adopted. The first six adopted ATCMs have been adopted into District Rules and have been fully implemented in the Bay Area. These include measures for chrome plating, cooling towers, commercial and hospital sterilizers, medical waste incinerators, paving operations that use serpentine materials, and gasoline stations. The two most recently adopted ATCMs have been adopted as District rules, but final compliance dates have not yet been reached (as of February 1996). These rules address secondary metal melting operations and perchloroethylene dry cleaners.

The District has accelerated the control of air toxics for existing air toxics by supplementing the ATCMs with rules developed locally. Examples of these rules include those covering aeration of contaminated soil and water, marine vessel loading and unloading, and the addition of more stringent requirements for gasoline stations.

In 1990, the federal Clean Air Act was amended creating an ambitious federal air toxics program. In 1992, the State legislature adopted AB 2728 to provide a legal framework for the integration of the existing air toxics programs in California with the new federal program. This legislation required ARB to designate the 189 substances that were listed as Hazardous Air Pollutants in the federal Clean Air Act as TACs without going through the scientific review process. The list of substances designated by the ARB as TACs (as of August 1995) is given in Table E-2.

TABLE E-2
SUBSTANCES DESIGNATED BY ARB AS TOXIC AIR CONTAMINANTS

Chemical Name	CAS No.	Chemical Name	CAS No.
Acetaldehyde	75070	Cresol(o)	95487
Acetamide	60355	Cresol(p)	106445
Acetonitrile	75058	Cresols/Cresylic acid	1319773
Acetophenone	98862	Cumene (Isopropylbenzene)	98828
Acetylaminofluorene(2)	53963	Cyanide Compounds[23]	----
Acrolein	107028	D(2,4), salts and esters	94757
Acrylamide	79061	DDE	3547044
Acrylic acid	79107	Diazomethane	334883
Acrylonitrile	107131	Dibenzofurans	132649
Allylchloride	107051	Dibromo-3-chloropropane(1,2)	96128
Aminobiphenyl(4)	92671	Dibutylphthalate	84742
Aniline	62533	Dichlorobenzene(1,4)(p)	106467
Anisidine(o)	90040	Dichlorobenzidene(3,3)	91941
Antimony Compounds	----	Dichloroethyl ether	
Arsenic Compounds		(Bis(2-chloroethyl)ether)	111444
(inorganic including arsine)	----	Dichloropropene(1,3)	542756
Asbestos	1332214	Dichlorvos	62737
Benzene	71432	Diethanolamine	111422
Benzidine	92875	Diethylaniline(N,N)	
Benzotrichloride	98077	(Dimethylaniline(N,N)	121697
Benzyl chloride	100447	Diethyl sulfate	64675
Beryllium Compounds	----	Dimethoxybenzidine(3,3')	1119904
Biphenyl	192524	Dimethyl aminoazobenzene	60117
Bis(2-ethylhexyl)phthalate (DEHP)	117817	Dimethyl Benzidine(3,3')	119937
Bis(chloromethyl)ether	542881	Dimethyl carbamoyl chloride	79447
Bromoform	75252	Dimethyl formamide	68122
Butadiene(1,3)	106990	Dimethyl hydrazine(1,1)	57147
Cadmium Compounds	----	Dimethyl phthalate	131113
Calcium cyanamide	156627	Dimethyl sulfate	77781
Caprolactam	105602	Dinitro-o-cresol(4,6), and salts	534521
Captan	133062	Dinitrophenol(2,4)	51285
Carbaryl	63252	Dintrotoluene(2,4)	121142
Carbon disulfide	75150	Dioxane(1,4)(1,4-Diethyleneoxide)	123911
Carbon tetrachloride	56235	Diphenylhydrazine(1,2)	122667
Carbonyl sulfide	463581	Epichlorohydrin	
Catechol	120809	(Chloro-2,3-epoxypropane(1))	106898
Chloramben	133904	Epoxybutane(1,2)(1,2-Butylene oxide)	106887
Chlordane	57749	Ethyl acrylate	140885
Chlorine	7782505	Ethyl benzene	100414
Chloroacetic acid	79118	Ethyl carbamate (Urethane)	51796
Chloroacetophenone(2)	532274	Ethyl chloride (Chloroethane)	75003
Chlorobenzene	108907	Ethylene dibromide (1,2-Dibromoethane)	106934
Chlorobenzilate	510156	Ethylene dichloride (1,2-Dichloroethane)	107062
Chloroform	67663	Ethylene glycol	107211
Chloromethyl methyl ether	107302	Ethylene imine (Aziridine)	151564
Chloroprene		Ethylene oxide	75218
(Neoprene; 2-chloro-1,3-butadiene)	126998	Ethylene thiourea	96457
Chromium Compounds	----	Ethylidene dichloride	
Cobalt Compounds	----	(1,1-Dichloroethane)	75343 Coke Oven Emissions
----	Formaldehyde	50000	
Cresol(m)	108394	Glycol ethers[24]	----

[23] X'CN where X = H' or any other group where a formal dissociation may occur, for example KCN or $Ca(CN)_2$.

[24] Includes mono- and di-ethers of ethylene glycol, diethylene glycol and triethylene glycol $R-(OCH_2CH_2)_n-OR'$ where: n = 1,2,or 3 - R = alkyl or aryl groups - R' = R, H, or group which, when removed, yield glycol ethers with the structure: $R-(OCH_2CH)_n-OH$. Polymers are excluded from the glycol category.

TABLE E-2 (CONTINUED)
SUBSTANCES DESIGNATED BY ARB AS TOXIC AIR CONTAMINANTS

Chemical Name	CAS No.	Chemical Name	CAS No.
Heptachlor	76448	Phenylenediamine(p)	106503
Hexachlorobenzene	118741	Phosgene	75445
Hexachlorobutadiene	87683	Phosphine	7803512
Hexachlorocyclopentadiene	77474	Phosphorus	7723140
Hexachloroethane	67721	Pthalic anhydride	85449
Hexamethylene-1,6-disocyanate	822060	Polychlorinated biphenyls (Arochlors)	1336363
Hexamethylphosphoramide	680319	Polycylic Organic Matter[25]	----
Hexane	110543	Propane sultone(1,3)	1120714
Hydrazine	302012	Propiolactone(beta)	57578
Hydrochloric acid	7647010	Propionaldehyde	123386
Hydrogen fluoride (Hydrofluoric acid)	7664393	Propoxur (Baygon)	114261
Hydroquinone	123319	Propylene dichloride	
Isophorone	78591	(1,2-Dichloropropane)	78875
Lead Compounds	----	Propylene oxide	75569
Lindane (all isomers)	58899	Propylenimine(1,2) (2-Methyl aziridine)	75558
Maleic anhydride	108316	Quinoline	91225
Manganese Compounds	----	Quinone (1,4-Cyclohexadienedione)	106514
Mercury Compounds	----	Radionuclides (including radon)[26]	----
Methanol	67561	Selenium Compounds	----
Methoxychlor	72435	Styrene	100425
Methyl bromide (Bromomethane)	74839	Styrene oxide	96093
Methyl chloride (Chloromethane)	74873	Tetrachlorodibenzo-p-dioxin(2,3,7,8)	1746016
Methyl chloroform (1,1,1-Trichloroethane)	71556	Tetrachloroethane(1,1,2,2)	79345
Methyl ethyl ketone (2-Butanone)	78933	Tetrachloroethylene (Perchloroethylene)	127184
Methyl hydrazine	03464	Titanium tetrachloride	7550450
Methyl iodide (Iodomethane)	74884	Toluene	108883
Methyl isobutyl ketone (Hexone)	108101	Toluene diamine(2,4)	
Methyl isocyanate	624839	(2,4-Diaminotoluene)	95807
Methyl methacrylate	80626	Toluene diisocyanate(2,4)	584849
Methyl tert butyl ether	1634044	Toluidine(o)	95534
Methylene bis(2-chloroaniline)(4,4)	101144	Toxaphene (Chlorinated camphene)	8001352
Methylene chloride (Dichloromethane)	75092	Trichlorobenzene(1,2,4)	120821
Methylene diphenyl diisocynate (MDI)	101688	Trichloroethane(1,1,2,)	79005
Methylenedianiline(4,4')	101779	Trichloroethylene	79016
Mineral fibers[27]	----	Trichlorophenol(2,4,5)	95954
Naphthalene	91203	Trichlorophenol(2,4,6)	88062
Nickel Compounds	----	Triethylamine	121448
Nitrobenzene	98953	Trifluralin	1582098
Nitrobiphenyl(4)	92933	Trimethylpentane(2,2,4)	540841
Nitrophenol(4)	100027	Vinyl acetate	108054
Nitropropane(2)	79469	Vinyl bromide	593602
Nitroso-N-methylurea(N)	684935	Vinyl chloride	75014
Nitrosodimethylamine(N)	62759	Vinylidene chloride	
Nitrosomorpholine(N)	59892	(1,1-Dichloroethylene)	75354
Parathion	56382	Xylene(m)	108383
Pentachloronitrobenzene(Quintobenzene)	82688	Xylene(o)	95476
Pentachlorophenol	87865	Xylene(p)	106423
Phenol	108952	Xylenes(mixed)	1330207

[25] Include organic compounds with more than one benzene ring, and which have a boiling point greater than or equal to 100°C.

[26] A type of atom which spontaneously undergoes radioactive decay.

[27] Includes glass microfibers, glass wool fibers, rock wool fibers, and slag wool fibers, each characterized as "respirable" (fiber diameter less than 3.5 micrometers and possessing an aspect ratio (fiber length divided by fiber diameter) greater than 3.

Because of the federal program, the primary source of new air toxics rules in the Bay Area has shifted from the ATCMs developed by ARB to the National Emission Standards for Hazardous Air Pollutants (NESHAPs), developed by the U.S. EPA. (These federal rules are also commonly referred to as MACT standards, because they reflect the Maximum Achievable Control Technology.) A large number of MACT standards are due to be promulgated on a schedule extending through the year 2000. AB 2728 requires the District to implement and enforce all MACT standards, or rules that are at least as stringent.

Air Toxics "Hot Spots" Program

Assembly Bill 2588, the Air Toxics "Hot Spots" Information and Assessment Act, was enacted by the State legislature in 1987. AB 2588 requires plants emitting TACs to prepare inventories of the toxic air emissions from their entire facility. Air districts are then required to prioritize these facilities based on the quantity and toxicity of these emissions, and their proximity to areas where the public may be exposed.

Each facility that is put into a "high priority" category as a result of this review is required to prepare a comprehensive facility-wide health risk assessment. AB 2588 requires that exposed individuals then be notified of any "significant health risks" identified in the health risk assessment. The health risk levels used for public notification in the "hot spots" program are set by each individual air district. In the Bay Area, the District used a maximum individual cancer risk of 10 in one million, or an ambient concentration above a non-cancer reference exposure level, as the threshold of notification.

The first cycle of the District's "hot spots" program was completed in 1991. Out of the 129 "high priority" facilities preparing risk assessments, 30 had risk levels that required public notification. The number of facilities with risks over the notification levels was reduced to 16 in 1992. As of 1995, the number of facilities requiring public notification was 5. These reductions were attributable to efforts to further reduce emissions and to further refine risk assessments. Through 1995, no new high priority facilities had been identified since the original prioritization.

As part of the "hot spots" program, the District also is focusing on "industry-wide" risk assessments, which AB 2588 provides for small businesses that operate in a similar manner. Under the industry-wide program, the District is responsible for the preparation of risk assessments and for performing public notification. Industry-wide studies for gasoline stations and dry cleaners are scheduled for completion in 1996.

In 1992, the State "hot spots" program was amended with the passage of SB 1731. This legislation requires facilities to implement measures to reduce risks below levels determined by the District to be significant within a certain time frame. In 1994, the District took its first regulatory action under SB 1731 with the adoption of a more stringent rule for perchloroethylene dry cleaners. The risk reduction requirements of SB 1731 were incorporated into this rule because many dry cleaners (and in particular those that are located in residential buildings) have been identified with lifetime cancer risks that exceed 100-in-one-million.

APPENDIX F - RESOURCE DOCUMENTS

There is a growing body of research concerning land use and design strategies to reduce automobile use. This appendix identifies selected resources that may be useful to Lead Agencies and other parties interested in pursuing such strategies. This is not intended to be a comprehensive list, but rather a good starting point for those interested in land use-related measures to reduce auto use. Interested parties are encouraged in particular to refer to the report prepared by JHK & Associates for the California Air Resources Board indicated below (Transportation-Related Land Use Strategies to Minimize Motor Vehicle Emission: An Indirect Source Research Study). The report includes an annotated bibliography listing over 150 documents.

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APPENDIX G - GLOSSARY

Acid Deposition -- Conversion of sulfur oxide and nitrogen oxide emissions into acidic compounds which precipitate in rain, snow, fog, or dry particles.

Aerosol -- Particle of solid or liquid matter that can remain suspended in the air because of its small size (generally under one micron).

Air Quality Management District (AQMD) -- Local agency charged with controlling air pollution and attaining air quality standards. The Bay Area Air Quality Management District is the regional AQMD that includes Alameda, Contra Costa, Marin, Napa, San Francisco, San Mateo and Santa Clara Counties and the southern halves of Solano and Sonoma Counties.

Air Resources Board (ARB) -- The State of California agency responsible for air pollution control. Responsibilities include: establishing State ambient air quality standards, setting allowable emission levels for motor vehicles in California and oversight of local air quality management districts.

Area Sources -- Sources of air pollutants that individually emit relatively small quantities of air pollutants, but which cumulatively may emit large quantities of emissions. Examples include water heaters, lawn maintenance equipment and consumer products.

Authority to Construct (A/C) -- A preconstruction permit issued by the District. An A/C typically includes conditions which the applicant must incorporate into facility design, operations, etc. in order to comply with District regulations.

Best Available Control Technology (BACT) -- The most stringent emissions control that has been achieved in practice, identified in a state implementation plan, or found by the District to be technologically feasible and cost-effective for a given class of sources.

California Clean Air Act (CCAA) -- Legislation enacted in 1988 mandating a planning process to attain state ambient air quality standards.

CALINE -- A model developed by the Air Resources Board that calculates carbon monoxide concentrations resulting from motor vehicle use.

Carbon Monoxide (CO) -- A colorless, odorless, toxic gas produced by the incomplete combustion of carbon-containing substances. It is emitted in large quantities by exhaust of gasoline-powered vehicles.

Catalytic Converter -- An air pollution abatement device used primarily on motor vehicles. It removes organic contaminants by oxidizing them into carbon dioxide and water through chemical reaction. May convert nitrogen dioxide to nitrogen and oxygen, as well as promoting other similar reactions.

Chlorofluorocarbons (CFCs) -- A family of inert, nontoxic, and easily liquefied chemicals used in refrigeration, air conditioning, packaging, insulation, or as solvents and aerosol propellants. CFCs drift into the upper atmosphere where their chlorine components destroy stratospheric ozone.

Clean Air Act (CAA) -- Long-standing federal legislation, last amended in 1990, that is the legal basis for the national clean air programs.

Cold Start -- Starting a motor vehicle after the engine has cooled. The duration of time after engine shut-off needed to produce a cold start is typically about an hour for a catalyst equipped vehicle and about four hours for a non-catalyst equipped vehicle.

Conformity -- A requirement in federal law and administrative practice that requires that projects will not be approved if they do not conform with the State Implementation Plan by: causing or contributing to an increase in air pollutant emissions, violating an air pollutant standard, or increasing the frequency of violations of an air pollutant standard.

Criteria Air Pollutants -- Air pollutants for which the federal or State government has established ambient air quality standards, or criteria, for outdoor concentration in order to protect public health. Criteria pollutants include: ozone, carbon monoxide, sulfur dioxide PM_{10} (previously total suspended particulate), nitrogen oxide, and lead.

EMFAC - The computer model developed by the California Air Resources Board to estimate composite on-road motor vehicle emission factors by vehicle class.

Emission Factor -- The amount of a specific pollutant emitted from a specified polluting source per unit quantity of material handled, processed, or burned.

Emission lnventory -- A list of air pollutants emitted into an area's atmosphere, in amounts (commonly tons) per day or year, by type of source.

Environmental Protection Agency (EPA) -- The federal agency responsible for control of air and water pollution, toxic substances, solid waste, and cleanup of contaminated sites.

Exceedance -- A monitored level of concentration of any air contaminant higher than national or state ambient air quality standards.

Hazardous Air Pollutants -- Air pollutants which are not covered by ambient air quality standards but which may reasonably be expected to cause or contribute to serious illness or death (see NESHAPs).

Health Risk Assessment -- An analysis where human exposure to toxic substances is estimated, and considered together with information regarding the toxic potency of the substances, to provide quantitative estimates of health risk.

Hot Spot -- A location where emissions from specific sources may expose individuals and population groups to elevated risks of adverse health effects and contribute to the cumulative health risks of emissions from other sources in the area.

Hot Start - Starting a motor vehicle while the engine is still fully warmed up.

Hydrocarbon -- Any of a vast family of compounds containing carbon and hydrogen in various combinations; found especially in fossil fuels. Some of the hydrocarbon compounds are major air pollutants; they may be active participants in the photochemical process or affect health.

Hydrogen Sulfide (H_2S) -- A gas characterized by "rotten egg" smell, found in the vicinity of oil refineries, chemical plants and sewage treatment plants.

Indirect Sources -- Land-uses and facilities which attract or generate motor vehicle trips and thus result in air pollutant emissions, e.g., shopping centers, office buildings, and airports.

Inversion -- The phenomenon of a layer of warm air over cooler air below. A special problem in polluted areas because this atmospheric structure resists the natural dispersion and dilution of air contaminants.

Level of Service (LOS) -- A transportation planning term for a method of measurement of congestion. The LOS compares actual or projected traffic volume to the maximum capacity of the road under study. LOS ranges from A through F. LOS A describes free flow conditions, while LOS F describes the most congested conditions, up to or over the maximum capacity for which the road was designed.

Mixing Depth -- The expanse in which air rises from the earth and mixes with the air above it until it meets air equal or warmer in temperature -- the inversion cap.

Mobile Source -- Any vehicle that produces air pollution, such as cars, trucks and motorcycles (on road mobile sources) or airplanes, trains and construction equipment (off-road mobile sources).

National Ambient Air Quality Standards (NAAQS) -- Health-based pollutant concentration limits established by EPA that apply to outside air (see Criteria Air Pollutants).

National Emissions Standards for Hazardous Air Pollutants (NESHAPs) -- Emissions standards set by EPA for air pollutants not covered by NAAQS that may cause an increase in deaths or in serious, irreversible, or incapacitating illness.

Nitrogen Oxides (NOx) -- Gases formed in great part from atmospheric nitrogen and oxygen when combustion takes place under conditions of high temperature and high pressure; NOx is a criteria air pollutant.

Non-Attainment Area -- Defined geographic area that does not meet one or more of the Ambient Air Quality Standards for the criteria pollutants designated in the federal Clean Air Act and/or California Clean Air Act.

Organic Compounds -- Large group of chemical compounds that contain carbon. Some types of organic gases, including olefins, aromatics and aldehydes, are highly reactive -- that is, participate in photochemical reactions in the atmosphere to form oxidant.

Ozone (0_3) -- A pungent, colorless, toxic gas. A product of complex photochemical processes, usually in the presence of sunlight. Tropospheric (lower atmosphere) ozone is a criteria air pollutant.

Ozone Depletion -- Destruction of the stratospheric ozone layer (10 to 20 miles above the earth) which shields the earth from ultraviolet radiation. This destruction is caused by the breakdown of certain chlorine and/or bromine-containing compounds (chlorofluorocarbons or halons).

Particulate -- A particle of solid or liquid matter; soot, dust, aerosols, fumes and mists.

Permit to Operate (P/O) -- An operational permit issued yearly by the Air District to industrial sources which emit air contaminants..

Photochemical Process -- The chemical changes brought about by the radiant energy of the sun acting upon various polluting substances. The products are known as photochemical smog.

Pollution Standards Index (PSI) -- A national, standardized system of reporting air pollution levels to the public by assigning them a numerical value.

PM_{10} -- Fine particulate matter (solid or liquid) with an aerodynamic diameter equal to or less than 10 microns. Individual particles of this size are small enough to be inhaled into human lungs; they are not visible to the human eye.

Precursor -- Compounds that change chemically or physically after being emitted into the air and eventually produce air pollutants. For example, organic compounds are precursors for ozone.

Prevention of Significant Deterioration (PSD) -- EPA program in which state and/or federal permits are required that are intended to restrict emissions for new or modified sources in places where air quality is already better than required to meet primary and secondary ambient air quality standards.

Reactive Organic Gases (ROG) -- Classes of organic compounds, especially olefins, substituted aromatics and aldehydes, that react more rapidly in the atmosphere to form photochemical smog or ozone.

Risk Management and Prevention Program (RMPP) -- A program enacted by the State Legislature in 1986 in order to reduce the risk of public exposure to acutely hazardous materials resulting from upsets at industrial and commercial facilities. RMPP analyses identify possible hazards at a facility, estimate potential consequences of an upset to public health and safety, address measures to reduce the chances of an upset, and identify measures for responding to accidents that may occur. The program is usually administered by the county health department or the local fire department.

Sensitive Receptors -- Facilities or land uses that include members of the population that are particularly sensitive to the effects of air pollutants, such as children, the elderly and people with illnesses. Examples include schools, hospitals and residential areas.

State Implementation Plan (SIP) -- EPA-approved state plans for attaining and maintaining federal air quality standards.

Stationary Source -- A fixed, non-mobile source of air pollution, usually at industrial or commercial facilities.

Sulfur Oxides (SO_X) -- Pungent, colorless gases formed primarily by the combustion of sulfur-containing fossil fuels, especially coal and oil. Considered a criteria air pollutant, sulfur oxides may damage the respiratory tract as well as vegetation.

Total Suspended Particulate Matter (TSP) -- Particles of solid or liquid matter -- soot, dust, aerosols, fumes and mist -- up to approximately 30 microns in size. As a criteria pollutant TSP has been replaced by PM_{10}.

Toxic Air Pollutants -- Air pollutants which cause illness or death in relatively small quantities. Non-criteria air contaminants that, upon exposure, ingestion, inhalation, or assimilation into organisms either directly from the environment or indirectly by ingestion through food chains, will cause death, disease, behavioral abnormalities, cancer, genetic mutations, physiological malfunctions, or physical deformations in such organisms or their offspring.

Transportation Control Measures (**TCM**s) -- Measures to reduce congestion and decrease emissions from motor vehicles by reducing vehicle use.

URBEMIS - A computer model developed by the California Air Resources Board to estimate air pollutant emissions from motor vehicle trips associated with land use development.

Volatile Organic Compound (VOC) -- An organic compound that evaporates readily at normal temperatures; a precursor to ozone.

APPENDIX H - REFERENCES

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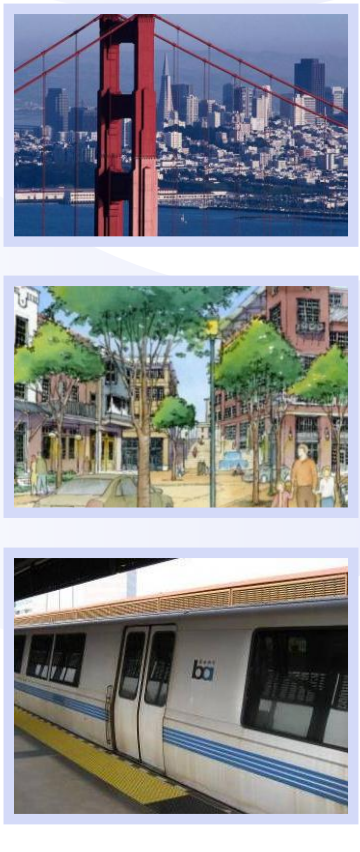
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BAY AREA AIR QUALITY MANAGEMENT DISTRICT

California Environmental Quality Act

Air Quality Guidelines





Updated May 2011

BAY AREA AIR QUALITY MANAGEMENT DISTRICT

California Environmental Quality Act

Air Quality Guidelines

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UPDATED MAY 2011

The following updates were made in May 2011 to the June 2010 CEQA Guidelines:

2: Thresholds of Significance

- In table 2-1, updated the effective date for the risk and hazards threshold for new receptors.
- In section 2.2, clarified that GHG threshold is based on carbon dioxide equivalent emissions and not just CO2.

3: Screening Criteria

- In section 3.2, clarified that the screening values in Table 3-1 may not be applied as screening level sizes for risk and hazard impacts.
- In section 3.3, clarified that the carbon monoxide screening criteria do not apply to stationary source projects.
- In section 3.5.1, clarified that projects with demolition activities that are inconsistent with BAAQMD's Regulation 11, rule: Asbestos Demolition, Renovation, and Manufacturing cannot be screened using the screening level in Table 3-1.

4: Operational-Related Impacts

- In section 4.2.1, page 4-5, clarified that the GHG threshold is based on carbon dioxide equivalent emissions; and clarified use of BGM as preferred model for estimating greenhouse gas emissions from a proposed land use project

5: Local Community Risk and Hazard Impacts

- Updated sections 5.2.6 and 5.2.7 to reflect the updated stationary source, highway, and roadway screening tools made available in May 2011.

6: Local Carbon Monoxide Impacts

- In section 6.1, clarified that the carbon monoxide screening criteria do not apply to stationary source projects and that potential carbon monoxide impacts from stationary sources should be modeled using AERMOD.

8: Assessing and Mitigation Construction-Related Impacts

- In section 8.1.1, removed Table 8-1.

Appendix B: Air Quality Modeling Instructions and Project Examples

- Pages B-11 to B-13, clarified the percent reductions that apply to construction mitigation measures and corrected references to tables and sections in the CEQA Guidelines.

Other minor editorial edits were made throughout the CEQA Guidelines as needed.

BAY AREA AIR QUALITY MANAGEMENT DISTRICT

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ACRONYMS AND ABBREVIATIONS

$\mu g/m^3$	micrograms per cubic meter
AB	Assembly Bill
AB 1807	Tanner Air Toxics Act
AB 2588	Air Toxics Hot Spots Information and Assessment Act of 1987
ABAG	Association of Bay Area Governments
AMS	American Meteorological Society
APS	Alternative Planning Strategy
AQP	Air Quality Plan
ARB	California Air Resources Board
ATCM	air toxics control measures
BAAQMD	Bay Area Quality Management District
BACT	Best Available Control Technology
BMPs	Best Management Practices
CCA	Community Choice Aggregation
CAAQS	California Ambient Air Quality Standards
CALINE4	California Line Source Dispersion Model
CAP	criteria air pollutants
CARE	Community Air Risk Evaluation
CAPCOA	California Air Pollution Control Officers Association
CCAA	California Clean Air Act
CCAR	California Climate Action Registry
CCR	California Code of Regulations
CEC	California Energy Commission
CEQA	California Environmental Quality Act
CalRecycle	The California Department of Resources Recycling and Recovery (formally the California Integrated Waste Management Board)
CFC	Chlorofluorocarbon
CH_4	methane
CHAPIS	Community Health Air Pollution Information System
CO	carbon monoxide
CO Protocol	Carbon Monoxide Protocol
CO_2	Carbon dioxide
CO_2e	carbon dioxide equivalent
CRA	California Resources Agency

DOE	Department of Energy
du	dwelling units
EIR	Environmental Impact Report
EMFAC	On-Road Mobile-Source Emission Factors
EPA	U.S. Environmental Protection Agency
FAR	Floor Area Ratio
FCAA	Federal Clean Air Act
FCAAA	Federal Clean Air Act Amendments of 1990
GHG	greenhouse gas(es)
GRP	General Reporting Protocol
GVW	gross vehicle weight
GWP	global warming potential
H_2S	hydrogen sulfide
HEPA	High Efficiency Particulate Arresting (filter)
HI	Hazard Index
HRA	health risk assessment
HVAC	Heating, Ventilation, and Air Conditioning System
IPCC	Intergovernmental Panel on Climate Change
ISR	Indirect Source Review
ksf	thousand square feet
kwh	Kilowatt hour
lb/acre-day	pound per disturbed acre per day
lb/day	pounds per day
lb/kwh	pounds per kilowatt hour
LCFS	Low-Carbon Fuel Standard
LVW	loaded vehicle weight
MACT	maximum available control technology
mg	million gallons
MMT	million metric tons
mph	miles per hour
MPO	Metropolitan Planning Organizations
MT	metric tons
MTC	Metropolitan Transportation Commission
N_2O	nitrous oxide
NAAQS	National Ambient Air Quality Standards

NESHAP	national emissions standards for hazardous air pollutants
NH_3	mercaptan, ammonia
NOA	Naturally Occurring Asbestos
NOP	Notice of Preparation
NO_X	oxides of nitrogen
OEHHA	Office of Environmental Health Hazard Assessment
OPR	Governor's Office of Planning and Research
PM	particulate matter
PM_{10}	respirable particulate matter with an aerodynamic resistance diameter of 10 micrometers or less
$PM_{2.5}$	fine particulate matter with an aerodynamic resistance diameter of 2.5 micrometers or less
ppm	parts per million
PUC	Public Utilities Commission
RoadMod	Roadway Construction Emissions Model
ROG	reactive organic gases
RTP	Regional Transportation Plan
SB	Senate Bill
SCS	Sustainable Communities Strategy
SF_6	sulfur hexafluoride
SFBAAB	San Francisco Bay Area Air Basin
SIP	State Implementation Plan
SMAQMD	Sacramento Metropolitan Air Quality Management District
SO_2	sulfur dioxide
SP	Service Population
SSIM	Sustainable Systems Integration Model
TAC	toxic air contaminant
T-BACT	Toxic Best Available Control Technology
TBPs	Toxic Best Practices
tpy	tons per year
UC	University of California
URBEMIS	Urban Land Use Emissions Model
VMT	vehicle miles traveled
VT	vehicle trips
yd^3	cubic yards
yr	year

1. INTRODUCTION

1.1. PURPOSE OF GUIDELINES

The purpose of the Bay Area Air Quality Management District (BAAQMD or District) California Environmental Quality Act (CEQA) Guidelines is to assist lead agencies in evaluating air quality impacts of projects and plans proposed in the San Francisco Bay Area Air Basin (SFBAAB). The Guidelines provides BAAQMD-recommended procedures for evaluating potential air quality impacts during the environmental review process consistent with CEQA requirements. These revised Guidelines supersede the BAAQMD's previous CEQA guidance titled *BAAQMD CEQA Guidelines: Assessing the Air Quality Impacts of Projects and Plans* (BAAQMD 1999).

Land development plans and projects have the potential to generate harmful air pollutants that degrade air quality and increase local exposure. The Guidelines contain instructions on how to evaluate, measure, and mitigate air quality impacts generated from land development construction and operation activities. The Guidelines focus on criteria air pollutant, greenhouse gas (GHG), toxic air contaminant, and odor emissions generated from plans or projects.

The Guidelines are intended to help lead agencies navigate through the CEQA process. The Guidelines offer step-by-step procedures for a thorough environmental impact analysis of adverse air emissions due to land development in the Bay Area.

1.1.1. BAAQMD's Role in Air Quality

BAAQMD is the primary agency responsible for assuring that the National and California Ambient Air Quality Standards (NAAQS and CAAQS, respectively) are attained and maintained in the Bay Area. BAAQMD's jurisdiction includes all of Alameda, Contra Costa, Marin, Napa, San Francisco, San Mateo and Santa Clara counties, and the southern portions of Solano and Sonoma counties, as shown in Figure 1-1. The Air District's responsibilities in improving air quality in the region include: preparing plans for attaining and maintaining air quality standards; adopting and enforcing rules and regulations; issuing permits for stationary sources of air pollutants; inspecting stationary sources and responding to citizen complaints; monitoring air quality and meteorological conditions; awarding grants to reduce mobile emissions; implementing public outreach campaigns; and assisting local governments in addressing climate change.

BAAQMD takes on various roles in the CEQA process, depending on the nature of the proposed project, including:

Lead Agency – BAAQMD acts as a lead agency when it has the primary authority to implement or approve a project, such as when it adopts air quality plans for the region, issues stationary source permits, or adopts rules and regulations.

Responsible Agency – BAAQMD acts as a Responsible Agency when it has limited discretionary authority over a portion of a project, but does not have the primary discretionary authority of a lead agency. As a Responsible Agency, BAAQMD may coordinate the environmental review process with the lead agency regarding BAAQMD's permitting process, provide comments to the lead agency regarding potential impacts, and recommend mitigation measures.



Source: ESRI Satellite 2009

Bay Area Air Quality Management District Jurisdictional Boundaries **Figure 1-1**

Commenting Agency – BAAQMD may act as a Commenting Agency when it is not a Lead or Responsible Agency (i.e., it does not have discretionary authority over a project), but when it may have concerns about the air quality impacts of a proposed project or plan. As a Commenting Agency, BAAQMD may review environmental documents prepared for development proposals and plans in the region, such as local general plans, and provide comments to the lead agency regarding the adequacy of the air quality impact analysis, determination of significance, and mitigation measures proposed.

BAAQMD prepared the CEQA Guidelines to assist lead agencies in air quality analysis, as well as to promote sustainable development in the region. The CEQA Guidelines support lead agencies in analyzing air quality impacts and offers numerous mitigation measures and general plan policies to implement smart growth and transit oriented development, minimize construction emissions, and reduce population exposure to air pollution risks.

1.2. GUIDELINE COMPONENTS

The recommendations in the CEQA Guidelines should be viewed as minimum considerations for analyzing air quality impacts. Lead agencies are encouraged to tailor the air quality impact analysis to meet the needs of the local community and may conduct refined analysis that utilize more sophisticated models, more precise input data, innovative mitigation measures, and/or other features. The Guidelines contain the following sections:

Introduction – Chapter 1 provides a summary of the purpose of the Guide, and an overview of BAAQMD responsibilities.

Thresholds of Significance – Chapter 2 outlines the current thresholds or significance for determining the significance of air quality impacts.

Screening Criteria – Chapter 3 provides easy reference tables to determine if your project may have potentially significant impacts requiring a detailed analysis.

Assessing and Mitigating Impacts – Chapters 4 through 9 describe assessment methods and mitigation measures for operational-related, local community risk and hazards, local carbon monoxide (CO), odors, construction-related, and plan-level impacts.

Appendix A – Provides construction assessment tools.

Appendix B – Provides detailed air quality modeling instructions.

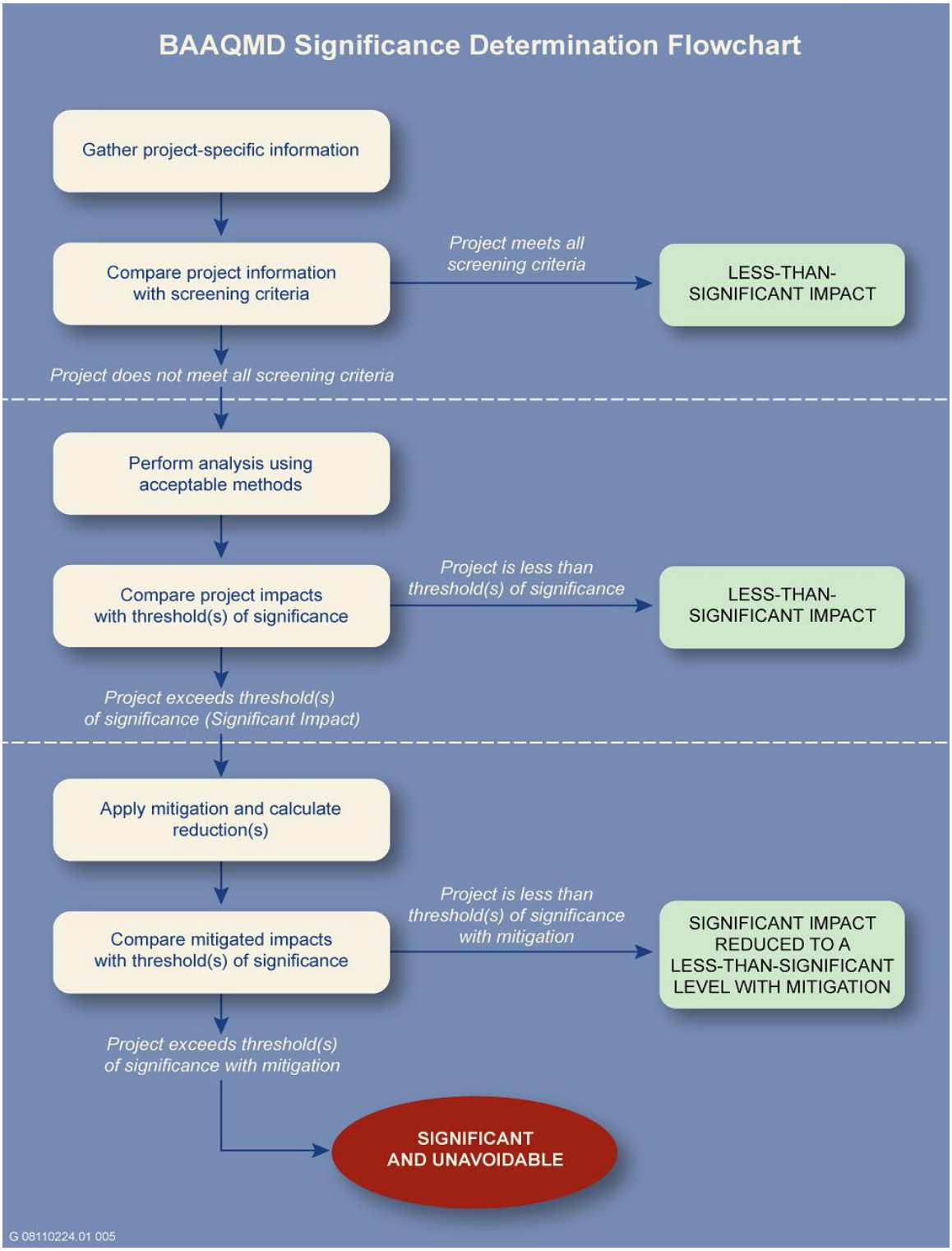
Appendix C – Outlines sample environmental setting information.

Appendix D – Contains justification statements for BAAQMD-adopted thresholds of significance.

Appendix E – Provides a glossary of terms used throughout this guide.

1.2.1. How To Use The Guidelines

Figure 2-1 illustrates general steps for evaluating a project or plan's air quality impacts. The first step is to determine whether the air quality evaluation is for a project or plan. Once identified, the project should be compared with the appropriate construction and operational screening criteria listed in Chapter 2. There are no screening criteria for plans.



General Steps for Determining Significance of Air Quality Impacts **Figure 1-2**



If the project meets the screening criteria and is consistent with the methodology used to develop the screening criteria, then its air quality impacts may be considered less than significant. Otherwise, lead agencies should evaluate potential air quality impacts of projects (and plans) as explained in Chapters 4 through 9. These Chapters describe how to analyze air quality impacts from criteria air pollutants, GHGs, local community risk and hazards, and odors associated with construction activity and operations of a project or plan.

If, after proper analysis, the project or plan's air quality impacts are found to be below the significance thresholds, then the air quality impacts may be considered less than significant. If not, the lead agency should implement appropriate mitigation measures to reduce associated air quality impacts. Lead agencies are responsible for evaluating and implementing all feasible mitigation measures in their CEQA document.

The mitigated project or plan's impacts are then compared again to the significance thresholds. If a project succeeded in mitigating its adverse air quality impacts below the corresponding thresholds, air quality impacts may be considered less than significant. If a project still exceeds the thresholds, the Air District strongly encourages the lead agency to consider project alternatives that could lessen any identified significant impact, including a no project alternative in accordance with CEQA Guidelines section 15126.6(e).

1.2.2. Early Consultation

BAAQMD encourages local jurisdictions and project applicants to address air quality issues as early as possible in the project planning stage. Addressing land use and site design issues while a proposed project is still in the conceptual stage increases opportunities to incorporate project design features to minimize land use compatibility issues and air quality impacts. By the time a project enters the CEQA process, it is usually more costly and time-consuming to redesign the project to incorporate mitigation measures. Early consultation may be achieved by including a formal step in the jurisdiction's development review procedures or simply by discussing air quality concerns at the planning counter when a project proponent makes an initial contact regarding a proposed development. Regardless of the specific procedures a local jurisdiction employs, the objective should be to incorporate features into a project that minimize air quality impacts before significant resources (public and private) have been devoted to the project.

The following air quality considerations warrant particular attention during early consultation between Lead Agencies and project proponents:

1. land use and design measures to encourage alternatives to the automobile, conserve energy and reduce project emissions;
2. land use conflicts and exposure of sensitive receptors to odors, toxics and criteria pollutants; and,
3. applicable District rules, regulations and permit requirements.

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PART I: THRESHOLDS OF SIGNIFICANCE & PROJECT SCREENING

2. THRESHOLDS OF SIGNIFICANCE

The SFBAAB is currently designated as a nonattainment area for state and national ozone standards and national particulate matter ambient air quality standards. SFBAAB's nonattainment status is attributed to the region's development history. Past, present and future development projects contribute to the region's adverse air quality impacts on a cumulative basis. By its very nature, air pollution is largely a cumulative impact. No single project is sufficient in size to, by itself, result in nonattainment of ambient air quality standards. Instead, a project's individual emissions contribute to existing cumulatively significant adverse air quality impacts. If a project's contribution to the cumulative impact is considerable, then the project's impact on air quality would be considered significant.

In developing thresholds of significance for air pollutants, BAAQMD considered the emission levels for which a project's individual emissions would be cumulatively considerable. If a project exceeds the identified significance thresholds, its emissions would be cumulatively considerable, resulting in significant adverse air quality impacts to the region's existing air quality conditions. Therefore, additional analysis to assess cumulative impacts is unnecessary. The analysis to assess project-level air quality impacts should be as comprehensive and rigorous as possible.

Similar to regulated air pollutants, GHG emissions and global climate change also represent cumulative impacts. GHG emissions contribute, on a cumulative basis, to the significant adverse environmental impacts of global climate change. Climate change impacts may include an increase in extreme heat days, higher concentrations of air pollutants, sea level rise, impacts to water supply and water quality, public health impacts, impacts to ecosystems, impacts to agriculture, and other environmental impacts. No single project could generate enough GHG emissions to noticeably change the global average temperature. The combination of GHG emissions from past, present, and future projects contribute substantially to the phenomenon of global climate change and its associated environmental impacts.



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BAAQMD's approach to developing a *Threshold of Significance* for GHG emissions is to identify the emissions level for which a project would not be expected to substantially conflict with existing California legislation adopted to reduce statewide GHG emissions needed to move us towards climate stabilization. If a project would generate GHG emissions above the threshold level, it would be considered to contribute substantially to a cumulative impact, and would be considered significant. Refer to Table 2-1 for a summary of Air Quality CEQA Thresholds and to Appendix D for *Thresholds of Significance* documentation.

Table 2-1
Air Quality CEQA Thresholds of Significance*

Pollutant	Construction-Related	Operational-Related	
Project-Level			
Criteria Air Pollutants and Precursors (Regional)	**Average Daily Emissions (lb/day)**	**Average Daily Emissions (lb/day)**	**Maximum Annual Emissions (tpy)**
ROG	54	54	10
NO_X	54	54	10
PM_{10}	82 (exhaust)	82	15
$PM_{2.5}$	54 (exhaust)	54	10
$PM_{10}/PM_{2.5}$ (fugitive dust)	Best Management Practices	None	
Local CO	None	9.0 ppm (8-hour average), 20.0 ppm (1-hour average)	
GHGs – Projects other than Stationary Sources	None	Compliance with Qualified GHG Reduction Strategy OR 1,100 MT of CO_2e/yr OR 4.6 MT CO_2e/SP/yr (residents+employees)	
GHGs –Stationary Sources	None	10,000 MT of CO_2e/yr	
Risk and Hazards for new sources and receptors (Individual Project)	Same as Operational Thresholds**	Compliance with Qualified Community Risk Reduction Plan OR Increased cancer risk of >10.0 in a million Increased non-cancer risk of > 1.0 Hazard Index (Chronic or Acute) Ambient $PM_{2.5}$ increase: > 0.3 µg/m^3 annual average Zone of Influence: 1,000-foot radius from property line of source or receptor	
Risk and Hazards for new sources and receptors (Cumulative Threshold)	Same as Operational Thresholds**	Compliance with Qualified Community Risk Reduction Plan OR Cancer: > 100 in a million (from all local sources) Non-cancer: > 10.0 Hazard Index (from all local sources) (Chronic) $PM_{2.5}$: > 0.8 µg/m^3 annual average (from all local sources) Zone of Influence: 1,000-foot radius from property line of source or receptor	
Accidental Release of Acutely Hazardous Air Pollutants	None	Storage or use of acutely hazardous materials locating near receptors or new receptors locating near stored or used acutely hazardous materials considered significant	
Odors	None	5 confirmed complaints per year averaged over three years	
Plan-Level			
Criteria Air Pollutants and Precursors	None	1. Consistency with Current Air Quality Plan control measures, and 2. Projected VMT or vehicle trip increase is less than or equal to projected population increase	
GHGs	None	Compliance with Qualified GHG Reduction Strategy OR 6.6 MT CO_2e/SP/yr (residents + employees)	

Table 2-1 Air Quality CEQA Thresholds of Significance*		
Pollutant	**Construction-Related**	**Operational-Related**
Risks and Hazards	None	1. Overlay zones around existing and planned sources of TACs (including adopted Risk Reduction Plan areas) and 2. Overlay zones of at least 500 feet from all freeways and high volume roadways
Accidental Release of Acutely Hazardous Air Pollutants	None	None
Odors	None	Identify the location, and include policies to reduce the impacts, of existing or planned sources of odors
Regional Plans (Transportation and Air Quality Plans)		
GHGs, Criteria Air Pollutants and Precursors, and Toxic Air Contaminants	None	No net increase in emissions

CEQA = California Environmental Quality Act; CO = carbon monoxide; CO_2e = carbon dioxide equivalent; GHGs = greenhouse gases; lb/day = pounds per day; MT = metric tons; NO_X = oxides of nitrogen; $PM_{2.5}$= fine particulate matter with an aerodynamic resistance diameter of 2.5 micrometers or less; PM_{10} = respirable particulate matter with an aerodynamic resistance diameter of 10 micrometers or less; ppm = parts per million; ROG = reactive organic gases; SO_2 = sulfur dioxide; SP = service population; TACs = toxic air contaminants; TBP = toxic best practices; tons/day = tons per day; tpy = tons per year; yr= year; TBD= to be determined.

*It is the Air District's policy that the adopted thresholds apply to projects for which a Notice of Preparation is published, or environmental analysis begins, on or after the applicable effective date. The adopted CEQA thresholds – *except for the risk and hazards thresholds for new receptors* – are effective June 2, 2010. The risk and hazards thresholds for new receptors are effective May 1, 2011.

** The Air District recommends that for construction projects that are less than one year duration, Lead Agencies should annualize impacts over the scope of actual days that peak impacts are to occur, rather than the full year.

2.1. CRITERIA AIR POLLUTANTS AND PRECURSORS – PROJECT LEVEL

Table 2-2 presents the *Thresholds of Significance* for operational-related criteria air pollutant and precursor emissions. These represent the levels at which a project's individual emissions of criteria air pollutants or precursors would result in a cumulatively considerable contribution to the SFBAAB's existing air quality conditions. If daily average or annual emissions of operational-related criteria air pollutants or precursors would exceed any applicable threshold listed in Table 2-2, the proposed project would result in a cumulatively significant impact.

Table 2-2 Thresholds of Significance for Operational-Related Criteria Air Pollutants and Precursors		
Pollutant/Precursor	**Maximum Annual Emissions (tpy)**	**Average Daily Emissions (lb/day)**
ROG	10	54
NO_X	10	54
PM_{10}	15	82
$PM_{2.5}$	10	54
Notes: tpy = tons per year; lb/day = pounds per day; NO_X = oxides of nitrogen; $PM_{2.5}$ = fine particulate matter with an aerodynamic resistance diameter of 2.5 micrometers or lCOess; PM_{10} = respirable particulate matter with an aerodynamic resistance diameter of 10 micrometers or less; ROG = reactive organic gases; tpy = tons per year. Refer to Appendix D for support documentation.		

2.2. GREENHOUSE GASES – PROJECT LEVEL

The *Thresholds of Significance* for operational-related GHG emissions are:

- For land use development projects, the threshold is compliance with a qualified GHG Reduction Strategy (see Section 4.3); or annual emissions less than 1,100 metric tons per year (MT/yr) of CO_2e; or 4.6 MT CO_2e/SP/yr (residents + employees). Land use development projects include residential, commercial, industrial, and public land uses and facilities.

- For stationary-source projects, the threshold is 10,000 metric tons per year (MT/yr) of CO_2e. Stationary-source projects include land uses that would accommodate processes and equipment that emit GHG emissions and would require an Air District permit to operate.

BAAQMD's GHG threshold is defined in terms of carbon dioxide equivalent (CO_2e), a metric that accounts for the emissions from various greenhouse gases based on their global warming potential.

If annual emissions of operational-related GHGs exceed these threshold levels, the proposed project would result in a cumulatively considerable contribution of GHG emissions and a cumulatively significant impact to global climate change.

2.3. LOCAL COMMUNITY RISK AND HAZARD IMPACTS – PROJECT LEVEL

The *Thresholds of Significance* for local community risk and hazard impacts are identified below, which apply to both the siting of a new source and to the siting of a new receptor. Local community risk and hazard impacts are associated with TACs and $PM_{2.5}$ because emissions of these pollutants can have significant health impacts at the local level. If emissions of TACs or $PM_{2.5}$ exceed



any of the threshold listed below, the proposed project would result in a significant impact.

- Non-compliance with a qualified Community Risk Reduction Plan;
- An excess cancer risk level of more than 10 in one million, or a non-cancer (i.e., chronic or acute) hazard index greater than 1.0 would be a significant cumulatively considerable contribution;
- An incremental increase of greater than 0.3 micrograms per cubic meter ($\mu g/m^3$) annual average $PM_{2.5}$ from a single source would be a significant cumulatively considerable contribution.

Cumulative Impacts

A project would have a cumulative considerable impact if the aggregate total of all past, present, and foreseeable future sources within a 1,000 foot radius from the fence line of a source, or from the location of a receptor, plus the contribution from the project, exceeds the following:

- Non-compliance with a qualified Community Risk Reduction Plan; or
- An excess cancer risk levels of more than 100 in one million or a chronic non-cancer hazard index (from all local sources) greater than 10.0; or
- 0.8 $\mu g/m^3$ annual average $PM_{2.5}$.

A lead agency should enlarge the 1,000-foot radius on a case-by-case basis if an unusually large source or sources of risk or hazard emissions that may affect a proposed project is beyond the recommended radius.

2.4. LOCAL CARBON MONOXIDE IMPACTS – PROJECT LEVEL

Table 2-3 presents the *Thresholds of Significance* for local CO emissions, the 1- and 8-hour California Ambient Air Quality Standards (CAAQS) of 20.0 parts per million (ppm) and 9.0 ppm, respectively. By definition, these represent levels that are protective of public health. If a project would cause local emissions of CO to exceed any of the thresholds listed below, the proposed project would result in a significant impact to air quality.

Table 2-3
Thresholds of Significance for Local Carbon Monoxide Emissions

CAAQS Averaging Time	Concentration (ppm)
1-Hour	20.0
8-Hour	9.0
Refer to Appendix D for support documentation.	

2.5. ODOR IMPACTS – PROJECT LEVEL

The *Thresholds of Significance* for odor impacts are qualitative in nature. A project that would result in the siting of a new source or the exposure of a new receptor to existing or planned odor sources should consider the screening level distances and the complaint history of the odor sources:

- Projects that would site a new odor source or a new receptor farther than the applicable screening distance shown in Table 3-3 from an existing receptor or odor source, respectively, would not likely result in a significant odor impact.

- An odor source with five (5) or more confirmed complaints per year averaged over three years is considered to have a significant impact on receptors within the screening distance shown in Table 3-3.

Facilities that are regulated by the CalRecycle agency (e.g. landfill, composting, etc) are required to have Odor Impact Minimization Plans (OIMP) in place and have procedures that establish fence line odor detection thresholds. The Air District recognizes a lead agency's discretion under CEQA to use established odor detection thresholds as thresholds of significance for CEQA review for CalRecycle regulated facilities with an adopted OIMP. Refer to *Chapter 7 Assessing and Mitigating Odor Impacts* for further discussion of odor analysis.

2.6. CONSTRUCTION-RELATED IMPACTS – PROJECT LEVEL

2.6.1. Criteria Air Pollutants and Precursors

Table 2-4 presents the *Thresholds of Significance* for construction-related criteria air pollutant and precursor emissions. If daily average emissions of construction-related criteria air pollutants or precursors would exceed any applicable threshold listed in Table 2-4, the project would result in a significant cumulative impact.



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Table 2-4
Thresholds of Significance for Construction-Related Criteria Air Pollutants and Precursors

Pollutant/Precursor	Daily Average Emissions (lb/day)
ROG	54
NO_X	54
PM_{10}	82*
$PM_{2.5}$	54*
PM_{10}/ $PM_{2.5}$Fugitive Dust	Best Management Practices

* Applies to construction exhaust emissions only.

Notes: CO = carbon monoxide; lb/day = pounds per day; NO_X = oxides of nitrogen; $PM_{2.5}$ = fine particulate matter with an aerodynamic resistance diameter of 2.5 micrometers or less; PM_{10} = respirable particulate matter with an aerodynamic resistance diameter of 10 micrometers or less; ROG = reactive organic gases; SO_2 = sulfur dioxide. Refer to Appendix D for support documentation.

2.6.2. Greenhouse Gases

BAAQMD does not have an adopted *Threshold of Significance* for construction-related GHG emissions. However, the Lead Agency should quantify and disclose GHG emissions that would occur during construction, and make a determination on the significance of these construction-generated GHG emission impacts in relation to meeting AB 32 GHG reduction goals, as required by the Public Resources Code, Section 21082.2. The lead agency is encouraged to incorporate

best management practices to reduce GHG emissions during construction, as feasible and applicable.

2.6.3. Local Community Risk and Hazards

The *Threshold of Significance* for construction-related local community risk and hazard impacts is the same as that for project operations. Construction-related TAC and PM impacts should be addressed on a case-by-case basis, taking into consideration the specific construction-related characteristics of each project and proximity to off-site receptors, as applicable. The Air District recommends that for construction projects that are less than one year duration, Lead Agencies should annualize impacts over the scope of actual days that peak impacts are to occur, rather than the full year.

2.7. THRESHOLDS OF SIGNIFICANCE FOR PLAN-LEVEL IMPACTS

The *Thresholds of Significance* for plans (e.g., general plans, community plans, specific plans, regional plans, congestion management plans, etc.) within the SFBAAB are summarized in Table 2-5 and discussed separately below.

Table 2-5
Thresholds of Significance for Plans

Criteria Air Pollutants and Precursors	Construction: none Operational: Consistency with Current AQP and projected VMT or vehicle trip increase is less than or equal to projected population increase.
GHGs	Construction: none Operational: 6.6 MT CO_2e/SP/yr (residents & employees) or a Qualified GHG Reduction Strategy. This threshold should only be applied to general plans. Other plans, e.g. specific plans, congestion management plans, etc., should use the project-level threshold of 4.6 CO_2e/SP/yr.
Local Community Risk and Hazards	Land use diagram identifies special overlay zones around existing and planned sources of TACs and $PM_{2.5}$, including special overlay zones of at least 500 feet (or Air District-approved modeled distance) on each side of all freeways and high-volume roadways, and plan identifies goals, policies, and objectives to minimize potentially adverse impacts.
Odors	Identify locations of odor sources in plan; identify goals, policies, and objectives to minimize potentially adverse impacts.
Regional Plans (transportation and air quality plans)	No net increase in emissions of GHGs, Criteria Air Pollutants and Precursors, and Toxic Air Contaminants. Threshold only applies to regional transportation and air quality plans.

Notes: AQP = Air Quality Plan; CO_2e = carbon dioxide equivalent; GHGs = greenhouse gases; MT = metric tons; SP = service population; TACs = toxic air contaminants; yr = year; $PM_{2.5}$= fine particulate matter
Refer to Appendix D for support documentation.

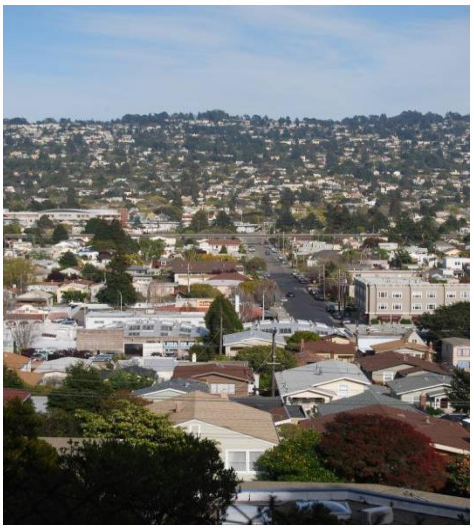
2.7.1. Criteria Air Pollutants and Precursor Emissions

Proposed plans (except regional plans) must show the following over the planning period of the plan to result in a less than significant impact:

- Consistency with current air quality plan control measures.
- A proposed plan's projected VMT or vehicle trips (VT) (either measure may be used) increase is less than or equal to its projected population increase.

2.7.2. Greenhouse Gases

The *Threshold of Significance* for operational-related GHG impacts of plans employs either a GHG efficiency-based metric (per Service Population [SP]), or a GHG Reduction Strategy option, described in Section 4.3.



The *Thresholds of Significance* options for plan level GHG emissions are:

- A GHG efficiency metric of 6.6 MT per SP per year of carbon dioxide equivalent (CO_2e). If annual maximum emissions of operational-related GHGs exceed this level, the proposed plan would result in a significant impact to global climate change.
- Consistency with an adopted GHG Reduction Strategy. If a proposed plan is consistent with an adopted GHG Reduction Strategy that meets the standards described in Section 4.3, the plan would be considered to have a less than significant impact. This approach is consistent with the plan elements described in the State CEQA Guidelines, Section 15183.5.

2.7.3. Local Community Risk and Hazards

The *Thresholds of Significance* for plans with regard to community risk and hazard impacts are:

1. The land use diagram must identify:
    a. Special overlay zones around existing and planned sources of TACs and PM (including adopted risk reduction plan areas); and
    b. Special overlay zones of at least 500 feet (or Air District-approved modeled distance) on each side of all freeways and high-volume roadways.
2. The plan must also identify goals, policies, and objectives to minimize potential impacts and create overlay zones around sources of TACs, PM, and hazards.

2.7.4. Odors

The *Thresholds of Significance* for plans with regard to odor impacts are to identify locations of odor sources in a plan and the plan must also identify goals, policies, and objectives to minimize potentially adverse impacts.

2.7.5. Regional Plans

The *Thresholds of Significance* for regional plans is to achieve a no net increase in emissions of criteria pollutants and precursors, GHG, and toxic air contaminants. This threshold applies only to regional transportation and air quality plans.

3. SCREENING CRITERIA

The screening criteria identified in this section are **not thresholds of significance**. The Air District developed screening criteria to provide lead agencies and project applicants with a conservative indication of whether the proposed project could result in potentially significant air quality impacts. If all of the screening criteria are met by a proposed project, then the lead agency or applicant would not need to perform a detailed air quality assessment of their project's air pollutant emissions. These screening levels are generally representative of new development on greenfield sites without any form of mitigation measures taken into consideration. In addition, the screening criteria in this section do not account for project design features, attributes, or local development requirements that could also result in lower emissions. For projects that are mixed-use, infill, and/or proximate to transit service and local services, emissions would be less than the greenfield type project that these screening criteria are based on.

If a project includes emissions from stationary source engines (e.g., back-up generators) and industrial sources subject to Air District Rules and Regulations, the screening criteria should not be used. The project's stationary source emissions should be analyzed separately from the land use-related indirect mobile- and area-source emissions. Stationary-source emissions are not included in the screening estimates given below and, for criteria pollutants, must be added to the indirect mobile- and area-source emissions generated by the land use development and compared to the appropriate threshold. Greenhouse gas emissions from permitted stationary sources should not be combined with operational emissions, but compared to a separate stationary source greenhouse gas threshold.

3.1. OPERATIONAL-RELATED IMPACTS

3.1.1. Criteria Air Pollutants and Precursors

The screening criteria developed for criteria pollutants and precursors were derived using the default assumptions used by the Urban Land Use Emissions Model (URBEMIS). If the project has sources of emissions not evaluated in the URBEMIS program the screening criteria should not be used. If the project meets the screening criteria in Table 3-1, the project would not result in the generation of operational-related criteria air pollutants and/or precursors that exceed the *Thresholds of Significance* shown in Table 2-2. Operation of the proposed project would result in a less-than-significant cumulative impact to air quality from criteria air pollutant and precursor emissions.

3.1.2. Greenhouse Gases

The screening criteria developed for greenhouse gases were derived using the default emission assumptions in URBEMIS and using off-model GHG estimates for indirect emissions from electrical generation, solid waste and water conveyance. If the project has other significant sources of GHG emissions not accounted for in the methodology described above, then the screening criteria should not be used. Projects below the applicable screening criteria shown in Table 3-1 would not exceed the 1,100 MT of CO_2e/yr GHG threshold of significance for projects other than permitted stationary sources.

If a project, including stationary sources, is located in a community with an adopted qualified GHG Reduction Strategy (see Section 4.3), the project may be considered less than significant if it is consistent with the GHG Reduction Strategy. A project must demonstrate its consistency by identifying and implementing all applicable feasible measures and policies from the GHG Reduction Strategy into the project.

Table 3-1
Criteria Air Pollutants and Precursors and GHG Screening Level Sizes

Land Use Type	Operational Criteria Pollutant Screening Size	Operational GHG Screening Size	Construction Criteria Pollutant Screening Size
Single-family	325 du (NOX)	56 du	114 du (ROG)
Apartment, low-rise	451 du (ROG)	78 du	240 du (ROG)
Apartment, mid-rise	494 du (ROG)	87 du	240 du (ROG)
Apartment, high-rise	510 du (ROG)	91 du	249 du (ROG)
Condo/townhouse, general	451 du (ROG)	78 du	240 du (ROG)
Condo/townhouse, high-rise	511 du (ROG)	92 du	252 du (ROG)
Mobile home park	450 du (ROG)	82 du	114 du (ROG)
Retirement community	487 du (ROG)	94 du	114 du (ROG)
Congregate care facility	657 du (ROG)	143 du	240 du (ROG)
Day-care center	53 ksf (NOX)	11 ksf	277 ksf (ROG)
Elementary school	271 ksf (NOX)	44 ksf	277 ksf (ROG)
Elementary school	2747 students (ROG)	-	3904 students (ROG)
Junior high school	285 ksf (NOX)	-	277 ksf (ROG)
Junior high school	2460 students (NOX)	46 ksf	3261 students (ROG)
High school	311 ksf (NOX)	49 ksf	277 ksf (ROG)
High school	2390 students (NOX)	-	3012 students (ROG)
Junior college (2 years)	152 ksf (NOX)	28 ksf	277 ksf (ROG)
Junior college (2 years)	2865 students (ROG)	-	3012 students (ROG)
University/college (4 years)	1760 students (NOX)	320 students	3012 students (ROG)
Library	78 ksf (NOX)	15 ksf	277 ksf (ROG)
Place of worship	439 ksf (NOX)	61 ksf	277 ksf (ROG)
City park	2613 acres (ROG)	600 acres	67 acres (PM10)
Racquet club	291 ksf (NOX)	46 ksf	277 ksf (ROG)
Racquetball/health	128 ksf (NOX)	24 ksf	277 ksf (ROG)
Quality restaurant	47 ksf (NOX)	9 ksf	277 ksf (ROG)
High turnover restaurant	33 ksf (NOX)	7 ksf	277 ksf (ROG)
Fast food rest. w/ drive thru	6 ksf (NOX)	1 ksf	277 ksf (ROG)
Fast food rest. w/o drive thru	8 ksf (NOX)	1 ksf	277 ksf (ROG)
Hotel	489 rooms (NOX)	83 rooms	554 rooms (ROG)
Motel	688 rooms (NOX)	106 rooms	554 rooms (ROG)
Free-standing discount store	76 ksf (NOX)	15 ksf	277 ksf (ROG)
Free-standing discount superstore	87 ksf (NOX)	17 ksf	277 ksf (ROG)
Discount club	102 ksf (NOX)	20 ksf	277 ksf (ROG)
Regional shopping center	99 ksf (NOX)	19 ksf	277 ksf (ROG)
Electronic Superstore	95 ksf (NOX)	18 ksf	277 ksf (ROG)
Home improvement superstore	142 ksf (NOX)	26 ksf	277 ksf (ROG)
Strip mall	99 ksf (NOX)	19 ksf	277 ksf (ROG)
Hardware/paint store	83 ksf (NOX)	16 ksf	277 ksf (ROG)
Supermarket	42 ksf (NOX)	8 ksf	277 ksf (ROG)
Convenience market (24 hour)	5 ksf (NOX)	1 ksf	277 ksf (ROG)
Convenience market with gas pumps	4 ksf (NOX)	1 ksf	277 ksf (ROG)
Bank (with drive-through)	17 ksf (NOX)	3 ksf	277 ksf (ROG)
General office building	346 ksf (NOX)	53 ksf	277 ksf (ROG)

Table 3-1
Criteria Air Pollutants and Precursors and GHG Screening Level Sizes

Land Use Type	Operational Criteria Pollutant Screening Size	Operational GHG Screening Size	Construction Criteria Pollutant Screening Size
Office park	323 ksf (NOX)	50 ksf	277 ksf (ROG)
Government office building	61 ksf (NOX)	12 ksf	277 ksf (ROG)
Government (civic center)	149 ksf (NOX)	27 ksf	277 ksf (ROG)
Pharmacy/drugstore w/ drive through	49 ksf (NOX)	10 ksf	277 ksf (ROG)
Pharmacy/drugstore w/o drive through	48 ksf (NOX)	10 ksf	277 ksf (ROG)
Medical office building	117 ksf (NOX)	22 ksf	277 ksf (ROG)
Hospital	226 ksf (NOX)	39 ksf	277 ksf (ROG)
Hospital	334 beds (NOX)	84 ksf	337 beds (ROG)
Warehouse	864 ksf (NOX)	64 ksf	259 ksf (NOX)
General light industry	541 ksf (NOX)	121 ksf	259 ksf (NOX)
General light industry	72 acres (NOX)	-	11 acres (NOX)
General light industry	1249 employees (NOX)	-	540 employees (NOX)
General heavy industry	1899 ksf (ROG)	-	259 ksf (NOX)
General heavy industry	281 acres (ROG)	-	11 acres (NOX)
Industrial park	553 ksf (NOX)	65 ksf	259 ksf (NOX)
Industrial park	61 acres (NOX)	-	11 acres (NOX)
Industrial park	1154 employees (NOX)	-	577 employees (NOX)
Manufacturing	992 ksf (NOX)	89 ksf	259 ksf (NOX)

THE SCREENING VALUES IN THIS TABLE CANNOT BE USED AS SCREENING FOR RISK AND HAZARD IMPACTS

Notes: du = dwelling units; ksf = thousand square feet; NO_X = oxides of nitrogen; ROG = reactive organic gases. Screening levels include indirect and area source emissions. Emissions from engines (e.g., back-up generators) and industrial sources subject to Air District Rules and Regulations embedded in the land uses are not included in the screening estimates and must be added to the above land uses.

Refer to Appendix D for support documentation.

Source: Modeled by EDAW 2009.

3.2. COMMUNITY RISK AND HAZARD IMPACTS

Please refer to Chapter 5 for discussion of screening criteria for local community risk and hazard impacts. The screening values in Table 3-1 may not be applied as screening for risk and hazard impacts.

3.3. CARBON MONOXIDE IMPACTS

This preliminary screening methodology provides a conservative indication of whether the implementation of the proposed project would result in CO emissions that exceed the *Thresholds of Significance* shown in Table 2-3. The screening criteria do not apply to proposed stationary source projects.

The proposed project would result in a less-than-significant impact to localized CO concentrations if the following screening criteria is met:

1. Project is consistent with an applicable congestion management program established by the county congestion management agency for designated roads or highways, regional transportation plan, and local congestion management agency plans.
2. The project traffic would not increase traffic volumes at affected intersections to more than 44,000 vehicles per hour.
3. The project traffic would not increase traffic volumes at affected intersections to more than 24,000 vehicles per hour where vertical and/or horizontal mixing is substantially limited (e.g., tunnel, parking garage, bridge underpass, natural or urban street canyon, below-grade roadway).

3.4. ODOR IMPACTS

Table 3-3 presents odor screening distances recommended by BAAQMD for a variety of land uses. Projects that would site a new odor source or a new receptor farther than the applicable screening distance shown in Table 3-3 from an existing receptor or odor source, respectively, would not likely result in a significant odor impact. The odor screening distances in Table 3-3 should not be used as absolute screening criteria, rather as information to consider along with the odor parameters and complaint history. Refer to *Chapter 7 Assessing and Mitigating Odor Impacts* for comprehensive guidance on significance determination.

Table 3-3
Odor Screening Distances

Land Use/Type of Operation	Project Screening Distance
Wastewater Treatment Plant	2 miles
Wastewater Pumping Facilities	1 mile
Sanitary Landfill	2 miles
Transfer Station	1 mile
Composting Facility	1 mile
Petroleum Refinery	2 miles
Asphalt Batch Plant	2 miles
Chemical Manufacturing	2 miles
Fiberglass Manufacturing	1 mile
Painting/Coating Operations	1 mile
Rendering Plant	2 miles
Coffee Roaster	1 mile
Food Processing Facility	1 mile
Confined Animal Facility/Feed Lot/Dairy	1 mile
Green Waste and Recycling Operations	1 mile
Metal Smelting Plants	2 miles
Refer to Appendix D for support documentation.	

Facilities that are regulated by CalRecycle (e.g. landfill, composting, etc.) are required to have Odor Impact Minimization Plans (OIMP) in place and have procedures that establish fence line odor detection thresholds. The Air District recognizes a lead agency's discretion under CEQA to

use established odor detection thresholds as thresholds of significance for CEQA review for CalRecycle regulated facilities with an adopted OIMP.

3.5. CONSTRUCTION-RELATED IMPACTS

3.5.1. Criteria Air Pollutants and Precursors

This preliminary screening provides the lead agency with a conservative indication of whether the proposed project would result in the generation of construction-related criteria air pollutants and/or precursors that exceed the *Thresholds of Significance* shown in Table 2-4.

If all of the following *Screening Criteria* are met, the construction of the proposed project would result in a less-than-significant impact from criteria air pollutant and precursor emissions.

1. The project is below the applicable screening level size shown in Table 3-1; and
2. All *Basic Construction Mitigation Measures* would be included in the project design and implemented during construction; and
3. Construction-related activities would not include any of the following:
    a. Demolition activities inconsistent with District Regulation 11, Rule 2: Asbestos Demolition, Renovation and Manufacturing;
    b. Simultaneous occurrence of more than two construction phases (e.g., paving and building construction would occur simultaneously);
    c. Simultaneous construction of more than one land use type (e.g., project would develop residential and commercial uses on the same site) (not applicable to high density infill development);
    d. Extensive site preparation (i.e., greater than default assumptions used by the Urban Land Use Emissions Model [URBEMIS] for grading, cut/fill, or earth movement); or
    e. Extensive material transport (e.g., greater than 10,000 cubic yards of soil import/export) requiring a considerable amount of haul truck activity.

3.5.2. Community Risk and Hazards

Chapter 5, *Assessing and Mitigating Local Community Risk and Hazard Impacts*, contains information on screening criteria for local risk and hazards.

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PART II: ASSESSING & MITIGATING PROJECT LEVEL IMPACTS

4. OPERATIONAL-RELATED IMPACTS

Operational emissions typically represent the majority of a project's air quality impacts. After a project is built, operational emissions including mobile and area sources, are anticipated to occur continuously throughout the project's lifetime. Operational-related activities, such as driving, use of landscape equipment, and wood burning, could generate emissions of criteria air pollutants, GHG, TACs, and PM. Area sources generally include fuel combustion from space and water heating, landscape maintenance equipment, and fireplaces/stoves, evaporative emissions from architectural coatings and consumer products and unpermitted emissions from stationary sources. This chapter provides recommendations for assessing and mitigating operational-related impacts for individual projects. Recommendations for assessing and mitigating operational-related impacts at the plan-level are discussed in Chapter 9. Chapter 9 also contains guidance for assessing a project's consistency with applicable air quality plans.

When calculating project emissions to compare to the thresholds of significance, lead agencies should account for reductions that would result from state, regional, and local rules and regulations. The Air District also recommends for lead agencies to consider project design features, attributes, or local development requirements as part of the project as proposed and not as mitigation measures. For example, projects that are mixed-use, infill, and/or proximate to transit service and local services, or that provide neighborhood serving commercial and retail services would have substantially lower vehicle trip rates and associated criteria pollutant and GHG emissions than what would be reflected in standard, basin-wide average URBEMIS default trip rates and emission estimates. A project specific transportation study should identify the reductions that can be claimed by projects with the above described attributes. Lead agencies may refer to the California Air Pollution Control Officers Association (CAPCOA) recently released report, *Quantifying Greenhouse Gas Mitigation Measures* for guidance in estimating reductions in standard vehicle trip rates and vehicle miles traveled (VMT) that can be claimed for these land use types when no project specific transportation studies are prepared.

To estimate a project's carbon dioxide equivalent (CO_2e) emissions from direct and indirect emission sources, BAAQMD recommends using the BAAQMD GHG Model (BGM). The Air District developed this model to calculate GHG emissions not included in URBEMIS such as indirect emissions from electricity use and waste and direct fugitive emissions of refrigerants. The BGM is discussed in more detail in Section 4.2 below.

4.1. CRITERIA AIR POLLUTANT AND PRECURSOR EMISSIONS

4.1.1. Significance Determination

Step 1: Comparison of Project Attributes with Screening Criteria

The first step in determining the significance of operational-related criteria air pollutants and precursors is to compare the attributes of the proposed project with the applicable screening criteria listed in Chapter 3. This preliminary screening provides a conservative indication of whether operation of the proposed project would result in the generation of criteria air pollutants and/or precursors that exceed the *Thresholds of Significance* listed in Chapter 2. If all of the screening criteria are met, the operation of the proposed project would result in a less than significant impact to air quality. If the proposed project does not meet all the screening criteria, then project emissions need to be quantified.

Step 2: Emissions Quantification

If a proposed project involves the removal of existing emission sources, BAAQMD recommends subtracting the existing emissions levels from the emissions levels estimated for the new proposed land use. This net calculation is permissible only if the existing emission sources were operational at the time that the Notice of Preparation (NOP) for the CEQA project was circulated or in the absence of an NOP when environmental analysis begins, and would continue if the proposed redevelopment project is not approved. This net calculation is not permitted for emission sources that ceased to operate, or the land uses were vacated and/or demolished, prior to circulation of the NOP or the commencement of environmental analysis. This approach is consistent with the definition of baseline conditions pursuant to CEQA.



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Land Use Development Projects

For proposed land use development projects, BAAQMD recommends using the most current version of URBEMIS (which to date is version 9.2.4) to quantify operational-related criteria air pollutants and precursors. URBEMIS is a modeling tool initially developed by the California Air Resources Board for calculating air pollutant emissions from land use development projects. URBEMIS uses EMFAC emission factors and ITE trip generation rates to calculate ROG, NO_X, carbon monoxide, particulate matter, carbon dioxide, and total vehicle trips. URBEMIS is not equipped for calculating air quality impacts from stationary sources or plans. For land use projects, URBEMIS quantifies emissions from area sources (e.g., natural gas fuel combustion for space and water heating, wood stoves and fireplace combustion, landscape maintenance equipment, consumer products, and architectural coating) and operational-related emissions (mobile sources).

Appendix B contains more detailed instructions for using URBEMIS to model operational emissions.

Stationary-Source Facilities

A stationary source consists of a single emission source with an identified emission point, such as a stack at a facility. Facilities can have multiple emission point sources located on-site and sometimes the facility as a whole is referred to as a stationary source. Major stationary sources are typically associated with industrial processes, such as refineries or power plants. Minor stationary sources are typically land uses that may require air district permits, such as gasoline dispensing stations, and dry cleaning establishments. Examples of other District-permitted stationary sources include back-up diesel generators, boilers, heaters, flares, cement kilns, and other types of combustion equipment, as well as non-combustion sources such as coating or printing operations. BAAQMD is responsible for issuing permits for the construction and operation of stationary sources in order to reduce air pollution, and to attain and maintain the national and California ambient air quality standards in the SFBAAB. Newly modified or constructed stationary sources subject to Air District permitting may be required to implement Best Available Control Technology (BACT), which may include the installation of emissions control equipment or the implementation of administrative practices that would result in the lowest achievable emission rate. Stationary sources may also be required to offset their emissions of criteria air pollutants and precursors to be permitted. This may entail shutting down or augmenting another stationary source at the same facility. Facilities also may purchase an emissions reduction credit to offset their emissions. Any stationary source emissions remaining after the application of BACT and

offsets should be added to the indirect and area source emissions estimated above to arrive at total project emissions.

URBEMIS is not equipped to estimate emissions generated by stationary sources. Instead emissions from stationary sources should be estimated using manual calculation methods in consultation with BAAQMD. When stationary sources will be subject to BAAQMD regulations, the regulation emission limits should be used as emission factors. If BAAQMD emission limits are not applicable, alternative sources of emission factors include: EPA AP-42 emission factors for particular industrial processes, manufacturer specifications for specific equipment, throughput data (e.g., fuel consumption, rate of material feedstock input) and other specifications provided by the project engineer. To the extent possible, BAAQMD recommends that the methodology used to estimate stationary-source emissions be consistent with calculations that would need to be performed to fulfill requirements of the permitting process and provided in the CEQA document.

Step 3: Comparison of Unmitigated Emissions with Thresholds of Significance
Sum the estimated emissions for area, mobile, and stationary sources (if any) for each pollutant as explained above and compare the total average daily and annual emissions of each criteria pollutant and their precursors with the applicable threshold (refer to Table 2-2). If daily average or annual emissions of operational-related criteria air pollutants or precursors do not exceed any of the thresholds, the project would result in a less than significant impact to air quality. If the quantified emissions of operational-related criteria air pollutants or precursors do exceed any applicable threshold, the proposed project would result in a significant impact to air quality and CEQA requires implementation of all feasible mitigation measures.

Step 4: Mitigation Measures and Emission Reductions
Where operational-related emissions exceed applicable threshold, lead agencies are responsible for implementing all feasible mitigation measures to reduce the project's air quality impacts. Section 4.4 contains numerous examples of mitigation measures and associated emission reductions that may be applied to projects. The project's mitigated emission estimates from mitigation measures included in the proposed project or recommended by the lead agency should be quantified and disclosed in the CEQA document.

Step 5: Comparison of Mitigated Emissions with Thresholds of Significance
Compare the total average daily and annual amounts of mitigated criteria air pollutants and precursors with the applicable threshold (refer to Table 4-1). If the implementation of mitigation measures, including off-site mitigation, would reduce all operational-related criteria air pollutants and precursors to levels below the applicable threshold, the impact to air quality would be reduced to a less than significant level. Implementation of mitigation measures means that they are made conditions of project approval and included in a Mitigation Monitoring and Reporting Plan (MMRP). If mitigated levels of any criteria air pollutant or precursor would still exceed the applicable threshold, the impact to air quality would remain significant and unavoidable.

Table 4-1
Example Operational Criteria Air Pollutant and Precursor Emissions Analysis

Step	Emissions Source	Emissions (lb/day or tpy)*			
		ROG	NO_X	PM_{10}	$PM_{2.5}$
2	Area Sources	A	A	A	A
	Mobile Sources	B	B	B	B
	Stationary Sources	C	C	C	C
	Total Unmitigated Emissions	A + B + C = D	A + B + C = D	A + B + C = D	A + B + C = D
	BAAQMD Threshold	54 lb/day or 10 tpy	54 lb/day or 10 tpy	82 lb/day or 15 tpy	54 lb/day or 10 tpy
3	Unmitigated Emissions Exceed BAAQMD Threshold?	Is D > Threshold? (If Yes, significant. Go to step 4. If No, less than significant)			
4	Mitigated Emissions	E	E	E	E
5	Mitigated Emissions Exceed BAAQMD Threshold?	Is E > Threshold? (If Yes, significant and unavoidable. If No, less than significant with mitigation incorporated)			

* Letters "A", "B", and "C" are used to represent numeric values that would be obtained through modeling for area and mobile sources, and by manual calculations for stationary source-emissions. "D" represents the sum of "A", "B", and "C" (i.e., unmitigated emissions). "E" represents mitigated emissions.
Notes: lb/day = pounds per day; NO_X = oxides of nitrogen; $PM_{2.5}$ = fine particulate matter with an aerodynamic resistance diameter of 2.5 micrometers or less; PM_{10} = respirable particulate matter with an aerodynamic resistance diameter of 10 micrometers or less; ROG = reactive organic gases; tpy = tons per year.
Refer to Appendix D for support documentation.

4.2. GREENHOUSE GAS IMPACTS

4.2.1. Significance Determination

Step 1: Comparison of Project Attributes with Screening Criteria
The first step in determining the significance of operational-related GHG emissions is to compare the attributes of the proposed project with the applicable screening criteria (Refer to Chapter 3). If all of the screening criteria are met, the operation of the proposed project would result in a less than significant impact to global climate change. If the proposed project does not meet all the screening criteria, then project emissions need to be quantified.

If a project is located in a community with an adopted qualified GHG Reduction Strategy (described in section 4.3), the project may be considered less than significant if it is consistent with the GHG Reduction Strategy. A project must demonstrate its consistency by identifying and implementing all applicable feasible mandatory and voluntary measures and policies from the GHG Reduction Strategy into the project.

Step 2: Emissions Quantification
For quantifying a project's GHG emissions, BAAQMD recommends that all GHG emissions from a project be estimated, including a project's direct and indirect GHG emissions from operations.

Direct emissions refer to emissions produced from onsite combustion of energy, such as natural gas used in furnaces and boilers, emissions from industrial processes, and fuel combustion from mobile sources. Indirect emissions are emissions produced offsite from energy production and water conveyance due to a project's energy use and water consumption. See Table 4-2 for a list of GHG emission sources and types that should be estimated for projects.



BAAQMD's GHG threshold is defined in terms of carbon dioxide equivalent (CO_2e), a metric that accounts for the emissions from various greenhouse gases based on their global warming potential. For example, one ton of methane has the same contribution to the greenhouse effect as 23 tons of CO_2. Therefore, methane is a much more potent GHG than CO_2. Expressing emissions in CO_2e considers the contributions of all GHG emissions to the greenhouse effect.

Biogenic CO_2 emissions should not be included in the quantification of GHG emissions for a project. Biogenic CO_2 emissions result from materials that are derived from living cells, as opposed to CO_2 emissions derived from fossil fuels, limestone and other materials that have been transformed by geological processes. Biogenic CO_2 contains carbon that is present in organic materials that include, but are not limited to, wood, paper, vegetable oils, animal fat, and food, animal and yard waste.

The GHG emissions from permitted stationary sources should be calculated separately from a project's operational emissions. Permitted stationary sources are subject to a different threshold than land use developments. For example, if a proposed project anticipates having a permitted stationary source on site, such as a back-up generator, the GHG emissions from the generator should not be added to the project's total emissions. The generator's GHG emissions should be calculated separately and compared to the GHG threshold for stationary sources to determine its impact level.

If a proposed project involves the removal of existing emission sources, BAAQMD recommends subtracting the existing emissions levels from the emissions levels estimated for the new proposed land use. This net calculation is permissible only if the existing emission sources were operational at the time that the Notice of Preparation (NOP) for the CEQA project was circulated (or in the absence of an NOP when environmental analysis begins), and would continue if the proposed redevelopment project is not approved. This net calculation is not permitted for emission sources that ceased to operate, or the land uses were vacated and/or demolished, prior to circulation of the NOP or the commencement of environmental analysis. This approach is consistent with the definition of baseline conditions pursuant to CEQA.

BAAQMD Greenhouse Gas Model

BAAQMD's preferred method for quantifying GHG emissions from a project is to use the BAAQMD GHG Model (BGM). The Air District developed this model to calculate GHG emissions not included in URBEMIS such as indirect emissions from electricity use and waste and direct fugitive emissions of refrigerants. BGM quantifies different types of GHG emissions in terms of CO_2e and contains a broad range of GHG reduction strategies that may be applied to projects. BGM also adjusts for state regulations, specifically California's low carbon fuel rules and Pavley regulations.

To use BMG, a project must first be inputted into URBEMIS and then imported into BGM. When using URBEMIS, the same detailed guidance as described for criteria air pollutants should be followed for inputting proposed land use developments. BGM is available for free and

may be downloaded at: http://www.baaqmd.gov/Divisions/Planning-and-Research/CEQA-GUIDELINES.aspx. BGM is run using Microsoft Excel. Refer to the BGM user's manual for detailed instructions on using the model.

Table 4-2 outlines the recommended methodologies for estimating a project's GHG emissions.

Table 4-2
Guidance for Estimating a Project's Operations GHG Emissions

Emission Source	Emission Type	GHG	Methodology
Area Sources (natural gas, hearth, landscape fuel, etc.)	Direct - natural gas and fuel combustion	CO_2, CH_4, N_20	URBEMIS and BGM
Transportation	Direct - fuel combustion	CO_2, CH_4, N_20	URBEMIS and BGM
Electricity consumption	Indirect - electricity	CO_2, CH_4, N_20	BGM
Solid waste landfill (non-biogenic emissions)*	Direct - landfill	CH_4	BGM
Solid waste transport	Indirect - fuel combustion	CO_2, CH_4, N_20	BGM
Water consumption	Indirect - electricity	CO_2, CH_4, N_20	BGM
Wastewater (non-biogenic emissions)*	Indirect - electricity	CO_2, CH_4, N_20	BGM
Industrial process emissions	Direct	CO_2, CH_4, N_20, and refrigerants	BGM and BAAQMD permits**
Fugitive emissions	Direct	CO_2, CH_4, N_20, and refrigerants	BGM
Loss of trees/vegetation	Loss of sequestration	CO_2	BGM

* Biogenic CO_2 emissions should not be included in the quantification of GHG emissions for a project.
** Industrial processes permitted by the Air District must use the methodology provided in BAAQMD rules and regulations. Other industrial process emissions, such as commercial refrigerants, should use the BGM.

CO_2 (carbon dioxide), CH_4 (methane), N_20 (nitrous oxides), and refrigerants (HFCs and PFCs).

In cases where users may need to estimate a project's GHG emissions manually, BAAQMD recommends using ARB's most current Local Government Operations Protocol (LGOP) as appropriate for guidance. The most current LGOP may be downloaded from ARB's website.

Step 3: Comparison of Unmitigated Emissions with Thresholds of Significance
Sum the estimated GHG emissions from area and mobile sources for the build-out year and compare the total annual GHG emissions with the applicable threshold. If annual emissions of operational-related GHGs do not exceed the thresholds, the project would result in a less than significant impact to global climate change. If annual emissions do exceed the thresholds, the proposed project would result in a significant impact to global climate change and will require mitigation measures for emission reductions.

Step 4: Mitigation Measures and Emission Reductions
Where operational-related emissions exceed applicable thresholds, lead agencies are responsible for implementing all feasible mitigation measures to reduce the project's GHG

emissions. Section 4.4 contains recommended mitigation measures. The Air District recommends using the BGM if additional reductions are needed. The air quality analysis should quantify the reduction of emissions associated with any proposed mitigation measures and include this information in the CEQA document.

Step 5: Comparison of Mitigated Emissions with Thresholds of Significance
Compare the total annual amount of mitigated GHGs with the applicable threshold, as demonstrated in Table 4-3. If the implementation of project proposed or required mitigation measures would reduce operational-related GHGs to a level below either the 1,100 MT CO_2e/year or 4.6 MT CO_2e/SP/year threshold, the impact would be reduced to a less than significant level. If mitigated levels still exceed the applicable threshold, the impact to global climate change would be considered significant and unavoidable.

Table 4-3
Example of Operational Greenhouse Gas Emissions Analysis

Step	Emissions Source	Emissions (MT CO_2e/yr)*
2	Area Sources	A
	Mobile Sources	B
	Indirect Sources	C
	Total Unmitigated Emissions	A + B + C = D
	BAAQMD Threshold	1,100 or 4.6 MT CO_2e/yr/SP
3	Unmitigated Emissions Exceed BAAQMD Threshold?	Is D > 1,100/4.6? (If Yes, significant. Go to step 4. If No, less than significant)
4	Mitigated Emissions	E
5	Mitigated Emissions Exceed BAAQMD Threshold?	Is E > 1,100/4.6? (If Yes, significant and unavoidable. If No, less than significant with mitigation incorporated)

* Letters "A", "B", and "C" are used to represent numeric values that would be obtained through modeling for area and mobile sources, and by manual calculations for indirect source-emissions. "D" represents the sum of "A", "B", and "C" (i.e., unmitigated emissions). "E" represents mitigated emissions.
Notes: CO_2e = carbon dioxide equivalent; MT = metric tons; yr = year.
Refer to Appendix D for support documentation.

4.3. GREENHOUSE GAS REDUCTION STRATEGIES

The Air District encourages local governments to adopt a qualified GHG Reduction Strategy that is consistent with AB 32 goals. If a project is consistent with an adopted qualified GHG Reduction Strategy that meets the standards laid out below, it can be presumed that the project will not have significant GHG emission impacts. This approach is consistent with the State CEQA Guidelines, Section 15183.5 (see text in box below).

> *§15183.5. Tiering and Streamlining the Analysis of Greenhouse Gas Emissions.*
>
> *(a) Lead agencies may analyze and mitigate the significant effects of greenhouse gas emissions at a programmatic level, such as in a general plan, a long range development plan, or a separate plan to reduce greenhouse gas emissions. Later project-specific environmental documents may tier from and/or incorporate by reference that existing programmatic review. Project-specific environmental documents may rely on an EIR containing a programmatic analysis of greenhouse gas emissions as provided in section 15152 (tiering), 15167 (staged*

EIRs) 15168 (program EIRs), 15175-15179.5 (Master EIRs), 15182 (EIRs Prepared for Specific Plans), and 15183 (EIRs Prepared for General Plans, Community Plans, or Zoning).

(b) Plans for the Reduction of Greenhouse Gas Emissions. Public agencies may choose to analyze and mitigate significant greenhouse gas emissions in a plan for the reduction of greenhouse gas emissions or similar document. A plan to reduce greenhouse gas emissions may be used in a cumulative impacts analysis as set forth below. Pursuant to sections 15064(h)(3) and 15130(d), a lead agency may determine that a project's incremental contribution to a cumulative effect is not cumulatively considerable if the project complies with the requirements in a previously adopted plan or mitigation program under specified circumstances.

(1) Plan Elements. A plan for the reduction of greenhouse gas emissions should:

(A) Quantify greenhouse gas emissions, both existing and projected over a specified time period, resulting from activities within a defined geographic area;

(B) Establish a level, based on substantial evidence, below which the contribution to greenhouse gas emissions from activities covered by the plan would not be cumulatively considerable;

(C) Identify and analyze the greenhouse gas emissions resulting from specific actions or categories of actions anticipated within the geographic area;

(D) Specify measures or a group of measures, including performance standards, that substantial evidence demonstrates, if implemented on a project-by-project basis, would collectively achieve the specified emissions level;

(E) Establish a mechanism to monitor the plan's progress toward achieving the level and to require amendment if the plan is not achieving specified levels;

(F) Be adopted in a public process following environmental review

(2) Use with Later Activities. A plan for the reduction of greenhouse gas emissions, once adopted following certification of an EIR or adoption of an environmental document, may be used in the cumulative impacts analysis of later projects. An environmental document that relies on a greenhouse gas reduction plan for a cumulative impacts analysis must identify those requirements specified in the plan that apply to the project, and, if those requirements are not otherwise binding and enforceable, incorporate those requirements as mitigation measures applicable to the project. If there is substantial evidence that the effects of a particular project may be cumulatively considerable notwithstanding the project's compliance with the specified requirements in the plan for the reduction of greenhouse gas emissions, an EIR must be prepared for the project.

Standard Elements of a GHG Reduction Strategy

The Air District recommends the Plan Elements in the state CEQA Guidelines as the minimum standard to meet the GHG Reduction Strategy Thresholds of Significance option. A GHG Reduction Strategy may be one single plan, such as a general plan or climate action plan, or could be comprised of a collection of climate action policies, ordinances and programs that have been legislatively adopted by a local jurisdiction. The GHG Reduction Strategy should identify goals, policies and implementation measures that would achieve AB 32 goals for the entire community. Plans with horizon years beyond 2020 should consider continuing the downward reduction path set by AB 32 and move toward climate stabilization goals established in Executive Order S-3-05.

To meet this threshold of significance, a GHG Reduction Strategy must include the following elements (corresponding to the State CEQA Guidelines Plan Elements):

(A) Quantify greenhouse gas emissions, both existing and projected over a specified time period, resulting from activities within a defined geographic area.

A GHG Reduction Strategy must include an emissions inventory that quantifies an existing baseline level of emissions and projected GHG emissions from a business-as-usual, no-plan, forecast scenario of the horizon year. The baseline year is based on the existing growth pattern defined by an existing general plan. The projected GHG emissions are based on the emissions from the existing growth pattern or general plan through to 2020, and if different, the year used for the forecast. If the forecast year is beyond 2020, BAAQMD recommends also doing a forecast for 2020 to establish a trend. The forecast does not include new growth estimates based on a new or draft general plan.

When conducting the baseline emissions inventory and forecast, ARB's business-as-usual 2020 forecasting methodology should be followed to the extent possible, including the following recommended methodology and assumptions:

- The baseline inventory should include one complete calendar year of data for 2008 or earlier. CO_2 must be inventoried across all sectors (residential, commercial, industrial, transportation and waste at a minimum); accounting of CH_4, N_20, SF6, HFC and PFC emission sources can also be included where reliable estimation methodologies and data are available.

- Business-as-usual emissions are projected in the absence of any policies or actions that would reduce emissions. The forecast should include only adopted and funded projects.

- The business-as-usual forecast should project emissions from the baseline year using growth factors specific to each of the different economic sectors.

BAAQMD's *GHG Plan Level Quantification Guidance* contains detailed recommendations for developing GHG emission inventories and projections and for quantifying emission reductions from policies and mitigation measures. This document is available at BAAQMD's website, http://www.baaqmd.gov/Divisions/Planning-and-Research/CEQA-GUIDELINES.aspx.

(B) Establish a level, based on substantial evidence, below which the contribution to GHG emissions from activities covered by the plan would not be cumulatively considerable.

A GHG Reduction Strategy must establish a target that is adopted by legislation that meets or exceeds one of the following options, all based on AB 32 goals:

- Reduce emissions to 1990 level by 2020[1]

- Reduce emissions 15 percent below baseline (2008 or earlier) emission level by 2020[2]

- Meet the plan efficiency threshold of 6.6 MT CO_2e/service population/year

[1] Specified target in AB 32 legislation
[2] From "Climate Change Scoping Plan", Executive Summary page 5

If the target year for a GHG reduction goal exceeds 2020, then the GHG emission reduction target should be in line with the goals outlined in Executive Order S-3-05, and also include an interim goal for 2020.

(C) Identify and analyze the GHG emissions resulting from specific actions or categories of actions anticipated within the geographic area.

A Strategy should identify and analyze GHG reductions from anticipated actions in order to understand the amount of reductions needed to meet its target. Anticipated actions refer to local and state policies and regulations that may be planned or adopted but not implemented. For example, ARB's Scoping Plan contains a number of measures that are planned but not yet implemented. BAAQMD recommends for the Strategy to include an additional forecast analyzing anticipated actions. Element (C), together with (A), is meant to identify the scope of GHG emissions to be reduced through Element (D).

(D) Specify measures or a group of measures, including performance standards that substantial evidence demonstrates, if implemented on a project-by-project basis, would collectively achieve the specified emissions level.

The GHG Reduction Strategy should include mandatory and enforceable measures that impact new development projects, such as mandatory energy efficiency standards, density requirements, transportation demand management policies, etc., as well as existing development. These measures may exist in codes or other policies and may be included in the Strategy by reference.

The GHG Reduction Strategy should include quantification of expected GHG reductions from each identified measure or categories of measures (such as residential energy efficiency measures, bike/pedestrian measures, recycling measures, etc.), including disclosure of calculation methods and assumptions. Quantification should reflect annual GHG reductions and demonstrate how the GHG reduction target will be met. The Strategy should specify which measures apply to new development projects. For assistance in quantifying potential GHG reductions from different mitigation measures, Lead Agencies may refer to CAPCOA's report, *Quantifying Greenhouse Gas Mitigation Measures*.

(E) Monitor the plan's progress

To ensure that all new development projects are incorporating all applicable measures contained within the GHG Reduction Strategy, the Strategy should include an Implementation Plan containing the following:

- Identification of which measures apply to new development projects vs. existing development, discerning between voluntary and mandatory measures.
- Mechanism for reviewing and determining if all applicable mandatory and voluntary measures are being adequately applied to new development projects.
- Identification of implementation steps and parties responsible for ensuring implementation of each action.
- Schedule of implementation identifying near-term and longer-term implementation steps.
- Procedures for monitoring and updating the GHG inventory and reduction measures every 3-5 years before 2020.

- Annual review and reporting to the jurisdiction's governing body on the progress of implementation of individual measures, including assessment of how new development projects have been incorporating Strategy measures. Review should also include an assessment of the implementation of Scoping Plan measures in order to determine if adjustments to local Strategy must be made to account for any shortfalls in Scoping Plan implementation.

(F) Adopt the GHG Reduction Strategy in a public process following environmental review

A GHG Reduction Strategy should undergo an environmental review which may include a negative declaration or EIR.

If the GHG Reduction Strategy consists of a number of different elements, such as a general plan, a climate action plan and/or separate codes, ordinances and policies, each element that is applicable to new development projects would have to complete an environmental review in order to allow tiering for new development projects.

Sustainable Communities Strategy (SCS) or Alternative Planning Strategy

If a project is located within an adopted Sustainable Communities Strategy or Alternative Planning Strategy, the GHG emissions from cars and light duty trucks do not need to be analyzed in the environmental analysis. This approach is consistent with the State CEQA Guidelines, Section 15183.5(c). This approach only applies to certain residential and mixed use projects and transit priority projects as defined in Section 21155 of the State CEQA Guidelines.

Section 15183.5(c): Special Situations. As provided in Public Resources Code sections 21155.2 and 21159.28, environmental documents for certain residential and mixed us projects, and transit priority projects, as defined in section 21155, that are consistent with the general use designation, density, building intensity, and applicable policies specified for the project area in an applicable sustainable communities strategy or alternative planning strategy need not analyze global warming impacts resulting from cars and light duty trucks. A lead agency should consider whether such projects may result in GHG emissions resulting from other source, however, consistent with these Guidelines.

Section 21155: A transit priority project shall (1) contain at least 50 percent residential use, based on total building square footage and, if the project contains between 26 percent and 50 percent nonresidential uses, a floor area ratio of not less than 0.75; (2) provide a minimum net density of at least 20 dwelling units per acre; and (3) be within one-half mile of a major transit stop or high-quality transit corridor included in a regional transportation plan. A major transit stop is as defined in Section 21064.3, except that, for purposes of this section, it also includes major transit stops that are included in the applicable regional transportation plan. For purposes of this section, a high quality transit corridor means a corridor with fixed route bus service with service intervals no longer than 15 minutes during peak commute hours. A project shall be considered to be within on-half mile of a major transit stop or high-quality transit corridor if all parcels within the project have not more than 25 percent of their area farther than one-half mile from the stop or corridor and if not more than 10 percent of the residential units or 100 units, whichever is less, in the project are farther than one-half mile from the stop or corridor.

4.4. MITIGATING OPERATIONAL-RELATED IMPACTS

The following mitigation measures would reduce operational-related emissions of criteria air pollutants, precursors, and GHGs from mobile, area, and stationary sources. Additional mitigation measures may be used, including off-site measures, provided their mitigation efficiency is

justified. Where a range of emission reduction potential is given for a measure, the lead agency should provide justification for the mitigation reduction efficiency assumed for the project. If mitigation does not bring a project back within the threshold requirements, the project could be cumulatively significant and could be approved only with a Statement of Overriding Considerations and a showing that all feasible mitigation measures have been implemented.

Reductions from mitigation measures should be scaled proportionally to their sector of project-generated emissions. For example, if a measure would result in a 50 percent reduction in residential natural gas consumption, but only 20 percent of a project's emissions are associated with natural gas consumption, and only 10 percent of a project's emissions are from residential land uses, then the scaled reduction would equal one percent (50% * 20% * 10% = 1%).

Once all emission reductions are scaled by their applicable sector and land use, they should be added together for the total sum of emission reductions. Once all emission reductions are scaled by their applicable sector and land use, they should be added together for the total sum of emission reductions.

The Air District prefers for project emissions to be reduced to their extent possible onsite. For projects that are not able to mitigate onsite to a level below significance, offsite mitigation measures serve as a feasible alternative. Recent State's CEQA Guidelines amendments allow for offsite measures to mitigate a project's emissions, (Section 15126.4(c)(4)).

In implementing offsite mitigation measures, the lead agency must ensure that emission reductions from identified projects are real, permanent through the duration of the project, enforceable, and are equal to the pollutant type and amount of the project impact being offset. BAAQMD recommends that offsite mitigation projects occur within the nine-county Bay Area in order to reduce localized impacts and capture potential co-benefits. Offsite mitigation for PM and toxics emission reductions should occur within a five mile radius to the project site.

Another feasible mitigation measure the Air District is exploring establishing is an offsite mitigation program to assist lead agencies and project applicants in achieving emission reductions. A project applicant would enter into an agreement with the Air District and pay into an Air District fund. The Air District would commit to reducing the type and amount of emission indentified in the agreement. The Air District would identify, implement, and manage offsite mitigation projects.

The following tables list feasible mitigation measures for consideration in projects. The estimated emission reductions are a work in progress and the Air District will continue to improve guidance on quantifying the mitigation measures.

URBEMIS Mitigation Measures for Operational Mobile Source Emissions

Measure	Sector Reductions	Applicable Pollutants	Sector	Notes	Additional comments
Mix of Uses	-3% to 9%	CAPs, GHGs	Mobile sources	-3 when no housing or employment centers within 1/2 mile	Residential: % reduction is taken from base trips (9.57) and subtracted from ITE trip generation; Nonresidential:
Local serving retail within 1/2 mile of project	2%	CAPs, GHGs	Mobile sources	Uses lower end of reported research to avoid double counting with mix of uses measure	
Transit Service	0% to 15%	CAPs, GHGs	Mobile sources		

URBEMIS Mitigation Measures for Operational Mobile Source Emissions

Measure	Sector Reductions	Applicable Pollutants	Sector	Notes	Additional comments
Bike & Pedestrian	0%–9%	CAPs, GHGs	Mobile sources	Credit is given based on intersection density, sidewalk completeness, and bike network completeness; No reduction if entire area within 1/2 mile is single use	% reduction from ITE trip generation
Affordable Housing	0%–4%	CAPs, GHGs	Mobile sources		
Transportation Demand Management Parking, Transit Passes					
Daily Parking Charge	0%–25%	CAPs, GHGs	Only resident/ employee trips, no visitor/ shopper trips		
Parking Cash-Out	0%–12.5%	CAPs, GHGs		Shoup, Donald. 2005. Parking Cash Out. American Planning Association. Chicago, IL.	
Free Transit Passes	25% of Transit Service Reduction	CAPs, GHGs			
Telecommuting					
Employee Telecommuting Program	1%–100%	CAPs, GHGs	Mobile sources, Worker Trips only		
Compressed Work Schedule 3/36	1%–40%	CAPs, GHGs			
Compressed Work Schedule 4/40	1%–20%	CAPs, GHGs			
Compressed Work Schedule 9/80	1%–10%	CAPs, GHGs			
Other Transportation Demand Measures					
Secure Bike Parking (at least 1 space per 20 vehicle spaces)	At least 3 elements: 1% reduction, plus 5% of the reduction for transit and pedestrian/bike friendliness; At least 5 elements: 2% reduction, plus 10% of the reduction for transit and pedestrian/bike friendliness	CAPs, GHGs	Mobile sources, Worker Trips only		
Showers/Changing Facilities Provided					
Guaranteed Ride Home Program Provided					
Car-Sharing Services Provided					
Information Provided on Transportation Alternatives (Bike Schedules, Maps)					
Dedicated Employee Transportation Coordinator					

URBEMIS Mitigation Measures for Operational Mobile Source Emissions

Measure	Sector Reductions	Applicable Pollutants	Sector	Notes	Additional comments
Carpool Matching Program					
Preferential Carpool/Vanpool Parking					
Parking Supply	0%–50%	CAPs, GHGs	Mobile sources		
On Road Trucks	As input by user in URBEMIS	CAPs, GHGs	Mobile sources		

URBEMIS Mitigation Measures for Operational Area-Source Emissions

Measure	Sector Reductions	Applicable Pollutants	Sector	Notes
Increase Energy Efficiency Beyond Title 24	Same as % improvement over Title 24	CAPs, GHGs	Natural gas sector in URBEMIS for applicable land use only	User should specify baseline year for the Title 24 standards
Electrically powered landscape equipment and outdoor electrical outlets	Same as % of landscape equipment emissions	CAPs, GHGs	Landscape emissions: residential only	
Low VOC architectural coatings	Same as % VOC reduction in applicable coatings (Interior/Exterior)	ROG only	Architectural coating	

NON-URBEMIS Energy Efficiency Mitigation Measures

Measure	Sector Reductions	Applicable Pollutants	Sector	Notes	Additional comments
Plant shade trees within 40 feet of the south side or within 60 feet of the west sides of properties.	30%	GHGs	R,C A/C Electricity	USDA Forest Service, Pacific Northwest Research Station. "California Study Shows Shade Trees Reduce Summertime Electricity Use." Science Daily 7 January 2009. 20 February 2009 <http://www.sciencedaily.com/releases/2009/01/090105150831.htm>.	Electricity-related measures reduce CAPs off-site, but they are not typically quantified as part of a CEQA analysis.
Require cool roof materials (albedo	34%	GHGs	C A/C Electricity	U.S. EPA Cool Roof Product Information,	

NON-URBEMIS Energy Efficiency Mitigation Measures

Measure	Sector Reductions	Applicable Pollutants	Sector	Notes	Additional comments
>= 30)	69%	GHGs	R A/C Electricity	Available: <http://www.epa.gov/heatisland/resources/pdf/CoolRoofsCompendium.pdf>	
Install green roofs	1%	GHGs	R,C A/C Electricity	Reductions are based on the Energy & Atmosphere credits (EA Credit 2) documented in the Leadership in Energy & Environmental Design (LEED), Green Building Rating System for New Constructions and Major Renovations, Version 2.2, October 2005. The reduction assumes that a vegetated roof is installed on a least 50% of the roof area or that a combination high albedo and vegetated roof surface is installed that meets the following standard: (Area of SRI Roof/0.75)+(Area of vegetated roof/0.5) >= Total Roof Area.	
Require smart meters and programmable thermostats	10%	CAPs, GHGs	R, C electricity and natural gas space heating	U. S. Environmental Protection Agency. 2009. Programmable Thermostat. http://www.energystar.gov/ia/new_homes/features/ProgThermostats1-17-01.pdf	
Meet GBC standards in all New construction	17%	GHGs	R electricity	California Energy Commission [CEC] 2007. Impact Analysis 2008 Update to the California Energy Efficiency Standards for Residential and Nonresidential Buildings	
	7%	GHGs	C electricity		
	9%	CAPs, GHGs	R natural gas		
	3%	CAPs, GHGs	C natural gas		
Retrofit existing buildings to meet CA GBC standards	38%	GHGs	R electricity	California Energy Commission [CEC] 2003. Impact Analysis 2005 Update to the California	
	12%	GHGs	C electricity		
	18%	CAPs, GHGs	R natural gas		

NON-URBEMIS Energy Efficiency Mitigation Measures

Measure	Sector Reductions	Applicable Pollutants	Sector	Notes	Additional comments
	12%	CAPs, GHGs	C natural gas	Energy Efficiency Standards for Residential and Nonresidential Buildings; California Energy Commission [CEC] 2007. Impact Analysis 2008 Update to the California Energy Efficiency Standards for Residential and Nonresidential Buildings	
Install solar water heaters	70%	CAPs, GHGs	R natural gas water heating	Energy Star. 2009. Solar Water Heater. http://www.energystar.gov/ia/new_homes/features/WaterHtrs_062906.pdf; Department of Energy. California Energy Commission [CEC] 2007. Impact Analysis 2008 Update to the California Energy Efficiency Standards for Residential and Nonresidential Buildings	Cannot take credit for both solar and tank-less water heater measures
	70%	CAPs, GHGs	C natural gas water heating		
Install tank-less water heaters	35%	CAPs, GHGs	R natural gas water heating	Tankless Water Heater. 2008. Available: <http://www.eere.energy.gov/consumer/your_home/water_heating/index.cfm/mytopic=12820>	
	35%	CAPs, GHGs	C natural gas water heating		
Install solar panels on residential and commercial buildings	100%	GHGs	R, C electricity		

NON-URBEMIS Energy Efficiency Mitigation Measures

Measure	Sector Reductions	Applicable Pollutants	Sector	Notes	Additional comments
100% increase in diversity of land use mix	5%	CAPs, GHGs	Mobile sources	Ewing, Reid, et al. 2001. *Travel and the Built Environment: A Synthesis.* Transportation Research Record 1780. Paper No. 01-3515 as cited in Urban Land Institute. 2008. *Growing Cooler.* ISBN: 978-0-87420-082-2. Washington, DC	
Jobs housing balance	Trip reduction = (1 – (ABS (1.5 * HH – E)/(1.5 * HH + E)) – 0.25) / 0.25 * 0.03; where ABS = absolute value; HH = study area households ; E = study area employment	CAPs, GHGs	Mobile sources	*Nelson/Nygaard Consultants. 2005. Crediting Low-Traffic Developments: Adjusting Site-Level Vehicle Trip Generation Using URBEMIS. Pg 12, (adapted from Criterion and Fehr & Peers, 2001)*	
100% increase in design (i.e., presence of design guidelines for transit oriented development, complete streets standards)	3%	CAPs, GHGs	Mobile sources	Ewing, Reid, et al. 2001. *Travel and the Built Environment: A Synthesis.* Transportation Research Record 1780. Paper No. 01-3515 as cited in Urban Land Institute. 2008. *Growing Cooler.* ISBN: 978-0-87420-082-2. Washington, DC	

NON-URBEMIS Energy Efficiency Mitigation Measures

Measure	Sector Reductions	Applicable Pollutants	Sector	Notes	Additional comments
100% increase in density	5%	CAPs, GHGs	Mobile sources	Ewing, Reid, et al. 2001. *Travel and the Built Environment: A Synthesis.* Transportation Research Record 1780. Paper No. 01-3515 as cited in Urban Land Institute. 2008. *Growing Cooler.* ISBN: 978-0-87420-082-2. Washington, DC	
HVAC duct sealing	30%	GHGs	R,C A/C electricity	Sacramento Metropolitan Utilities District. 2008. Duct Sealing. Available: <http://www.pge.com/myhome/saveenergymoney/rebates/coolheat/duct/index.shtml>.	
Provide necessary infrastructure and treatment to allow use of 50% greywater/ recycled water in residential and commercial uses for outdoor irrigation	SFR: 74%*50% = 37.5% MFR: 58% * 50% = 29% Commercial: 12% * 50% = 6%	GHGs	R electricity (water consumption) C electricity (water consumption)	Department of Water Resources. 2001. Statewide Indoor/Outdoor Split. Accessed December 2, 2008. Available at: <http://www.landwateruse.water.ca.gov/annualdata/urbanwateruse/2001/landuselevels.cfm?use=8>.	
Complete streets (i.e., bike lanes and pedestrian sidewalks on both sides of streets, traffic calming features such as pedestrian bulb-outs, cross-walks, traffic circles, and elimination of physical and psychological barriers (e.g., sound walls and large arterial roadways, respectively).)	1-5%	CAPs, GHGs	Mobile sources	Dierkers, G., E. Silsbe, S. Stott, S. Winkelman, an M. Wubben. 2007. *CCAP Transportation Emissions Guidebook*. Center for Clean Air Policy. Washington, D.C. Available: <http://www.ccap.org/safe/guidebook.php>. as cited in California Air Pollution Control Officers Association (CAPCOA) 2008. *CEQA and Climate Change.*	

NON-URBEMIS Energy Efficiency Mitigation Measures

Measure	Sector Reductions	Applicable Pollutants	Sector	Notes	Additional comments
Maximize interior day light		GHGs	R, C, M		
Increase roof/ceiling insulation		CAPs, GHGs	R, C, M		
Create program to encourage efficiency improvements in rental units		CAPs, GHGs	R		
Install rainwater collection systems in residential and Commercial Buildings		GHGs	R,C,M		
Install low-water use appliances and fixtures		GHGs	R,C,M	California Air Pollution Control Officers Association (CAPCOA) 2008. CEQA and Climate Change.	
Restrict the use of water for cleaning outdoor surfaces/Prohibit systems that apply water to non-vegetated surfaces		GHGs	R,C,M	California Attorney General's Office GHG Reduction Measures	
Implement water-sensitive urban design practices in new construction		GHGs	R,C,M		
NON-URBEMIS Waste Reduction Mitigation Measures					
Provide composting facilities at residential uses		GHGs	R		
Create food waste and green waste curb-side pickup service		GHGs	R,C,M		
Require the provision of storage areas for recyclables and green waste in new construction		GHGs	R,C,M		

Notes: CAPs = Criteria Air Pollutants; GHGs = Greenhouse Gases; ROG = Reactive Organic Gases; R = Residential Development; C = Commercial Development; M = Mixed Use Development; A/C = Air Conditioning; and VOC = Volatile Organic Compounds.

Source: Information compiled by EDAW 2009.

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5. LOCAL COMMUNITY RISK AND HAZARD IMPACTS

The purpose of this Chapter is (1) to recommend methods whereby local community risk and hazard impacts from projects for both new sources and new receptors can be determined based on comparison with applicable thresholds of significance and screening criteria and (2) to recommend mitigation measures for these impacts. This chapter contains the following sections:

Section 5.2 – Presents methods for assessing single-source impacts from either an individual new source or impacts on new receptors from existing individual sources.

Section 5.3 – Discusses methods for assessing cumulative impacts from multiple sources.

Section 5.4 – Discusses methods for mitigating local community risk and hazard impacts.

The recommendations provided in this chapter apply to assessing and mitigating impacts for project-level impacts and related cumulative impacts. Refer to Chapter 9 for recommendations for assessing and mitigating local community risk and hazard impacts at the plan-level.

To assist the lead agency in evaluating air quality impacts at the community scale, *Thresholds of Significance* have been established for local community risks and hazards associated with TACs and $PM_{2.5}$ with respect to siting a new source and/or receptor; as well as for assessing both individual source and cumulative multiple source impacts. These *Thresholds of Significance* focus on $PM_{2.5}$ and TACs because these more so than other emission types pose significant health impacts at the local level as discussed separately below.

5.1. TOXIC AIR CONTAMINANTS

TACs are a defined set of airborne pollutants that may pose a present or potential hazard to human health. A wide range of sources, from industrial plants to motor vehicles, emit TACs. Like $PM_{2.5}$, TAC can be emitted directly and can also be formed in the atmosphere through reactions among different pollutants. The methods presented in this Chapter for assessing local community risk and hazard impacts only include direct TAC emissions, not those formed in the atmosphere.

The health effects associated with TACs are quite diverse and generally are assessed locally, rather than regionally. TACs can cause long-term health effects such as cancer, birth defects, neurological damage, asthma, bronchitis or genetic damage; or short-term acute affects such as eye watering, respiratory irritation (a cough), running nose, throat pain, and headaches. For evaluation purposes, TACs are separated into carcinogens and non-carcinogens based on the nature of the physiological effects associated with exposure to the pollutant. Carcinogens are assumed to have no safe threshold below which health impacts would not occur, and cancer risk is expressed as excess cancer cases per one million exposed individuals, typically over a lifetime of exposure. Non-carcinogenic substances differ in that there is generally assumed to be a safe level of exposure below which no negative health impact is believed to occur. These levels are



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determined on a pollutant-by-pollutant basis. Acute and chronic exposure to non-carcinogens is expressed as a hazard index (HI), which is the ratio of expected exposure levels to an acceptable reference exposure levels.

TACs are primarily regulated through State and local risk management programs. These programs are designed to eliminate, avoid, or minimize the risk of adverse health effects from exposures to TACs. A chemical becomes a regulated TAC in California based on designation by the California Office of Environmental Health Hazard Assessment (OEHHA). As part of its jurisdiction under Air Toxics Hot Spots Program (Health and Safety Code Section 44360(b)(2)), OEHHA derives cancer potencies and reference exposure levels (RELs) for individual air contaminants based on the current scientific knowledge that includes consideration of possible differential effects on the health of infants, children and other sensitive subpopulations, in accordance with the mandate of the Children's Environmental Health Protection Act (Senate Bill 25, Escutia, Chapter 731, Statutes of 1999, Health and Safety Code Sections 39669.5 et seq.). The methodology in this Chapter reflects the approach adopted by OEHHA in May 2009, which considers age sensitivity factors to account for early life stage exposures. The specific toxicity values of each particular TAC as identified by OEHHA are listed in BAAQMD's Regulation 2, Rule 5: New Source Review of Toxic Air Contaminants.

5.1.1. Fine Particulate Matter

$PM_{2.5}$ is a complex mixture of substances that includes elements such as carbon and metals; compounds such as nitrates, organics, and sulfates; and complex mixtures such as diesel exhaust and wood smoke. $PM_{2.5}$ can be emitted directly and can also be formed in the atmosphere through reactions among different pollutants. The methods presented in this Chapter for assessing local community risk and hazard impacts only include direct $PM_{2.5}$ emissions, not those formed in the atmosphere.

Compelling evidence suggests that $PM_{2.5}$ is by far the most harmful air pollutant in the SFBAAB in terms of the associated impact on public health. A large body of scientific evidence indicates that both long-term and short-term exposure to $PM_{2.5}$ can cause a wide range of health effects (e.g., aggravating asthma and bronchitis, causing visits to the hospital for respiratory and cardio-vascular symptoms, and contributing to heart attacks and deaths). BAAQMD recommends characterizing potential health effects from exposure to directly $PM_{2.5}$ emissions through comparison to the applicable *Thresholds of Significance*.

5.1.2. Common Source Types

Common stationary source types of TAC and $PM_{2.5}$ emissions include gasoline stations, dry cleaners, and diesel backup generators, which are subject to BAAQMD permit requirements. The other, often more significant, common source type is on-road motor vehicles on freeways and roads such as trucks and cars, and off-road sources such as construction equipment, ships and trains. Because these common sources are prevalent in many communities, this Chapter focuses on screening tools for the evaluation of associated cumulative community risk and hazard impacts. However, it is important to note that other influential source types do exist (e.g., ports, railyards, and truck distribution centers), but these are often more complex and require more advanced modeling techniques beyond those discussed herein.

5.1.3. Area of Influence

For assessing community risks and hazards, a 1,000 foot radius is recommended around the project property boundary. BAAQMD recommends that any proposed project that includes the siting of a new source or receptor assess associated impacts within 1,000 feet, taking into account both individual and nearby cumulative sources (i.e., proposed project plus existing and foreseeable future projects). Cumulative sources represent the combined total risk values of each individual source within the 1,000-foot evaluation zone. A lead agency should enlarge the 1,000-

foot radius on a case-by-case basis if an unusually large source or sources of risk or hazard emissions that may affect a proposed project is beyond the recommended radius.

The recommended methodology for assessing community risks and hazards from $PM_{2.5}$ and TACs follows a phased approach. Within this approach, more advanced techniques, for both new sources and receptors, which require additional site specific information are presented for each progressive phase to assess risks and hazards. Each phase provides concentrations and risks that are directly comparable to the applicable *Thresholds of Significance*, although it is important to note that the use of more site specific modeling input data produces more accurate results. Also, progression from one phase to the next in a sequential fashion is not necessary and a refined modeling analysis can be conducted at any time.

5.1.4. Impacted Communities

In the Bay Area, there are a number of urban or industrialized communities where the exposure to TACs is relatively high in comparison to others. These same communities are often faced with other environmental and socio-economic hardships that further stress their residents and result in poor health outcomes. To address community risk from air toxics, the Air District initiated the Community Air Risk Evaluation (CARE) program in 2004 to identify locations with high levels of risk from TACs co-located with sensitive populations and use the information to help focus mitigation measures. Through the CARE program, the Air District developed an inventory of TAC emissions for 2005 and compiled demographic and health indicator data. According to the findings of the CARE Program, diesel PM, mostly from on and off-road mobile sources, accounts for over 80 percent of the inhalation cancer risk from TACs in the Bay Area. Figure 5-1 shows the impacted communities as of November 2009, including: the urban core areas of Concord, eastern San Francisco, western Alameda County, Redwood City/East Palo Alto, Richmond/San Pablo, and San Jose. For more information on, and possible revisions to, impacted communities, go to the CARE Program website.

In many cases, air quality conditions in impacted communities result in part from land use and transportation decisions made over many years. BAAQMD believes comprehensive, community-wide strategies will achieve the greatest reductions in emissions of and exposure to TAC and $PM_{2.5}$. BAAQMD strongly recommends that within these impacted areas local jurisdictions develop and adopt Community Risk Reduction Plans, described in Section 5.4. The goal of the Community Risk Reduction Plan is to encourage local jurisdictions to take a proactive approach to reduce the overall exposure to TAC and $PM_{2.5}$ emissions and concentrations from new and existing sources. Local plans may also be developed in other areas to address air quality impacts related to land use decisions and ensure sufficient health protection in the community.

5.2. SINGLE SOURCE IMPACTS

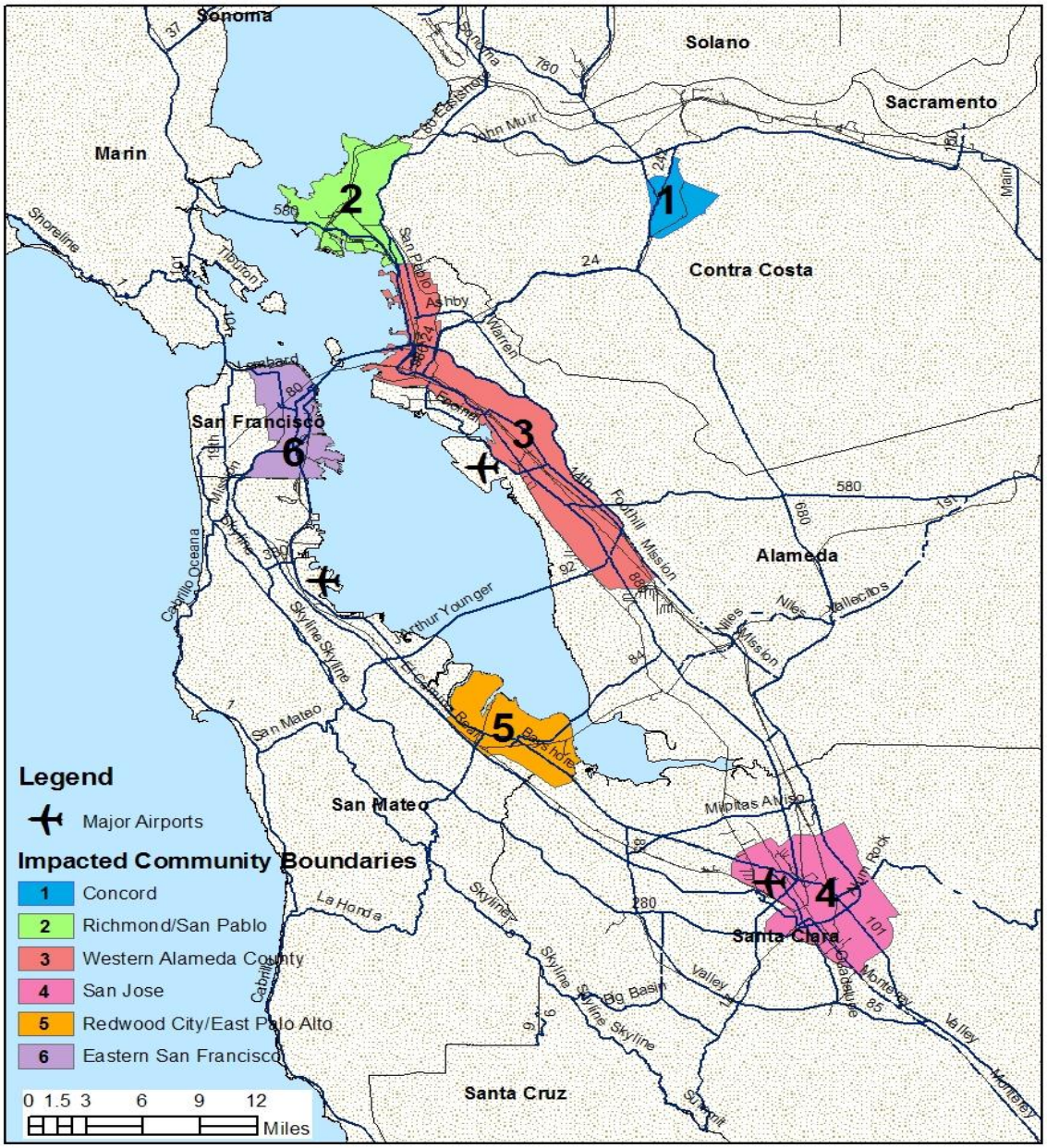
5.2.1. Significance Determination

Lead agencies should determine whether operational-related TAC and $PM_{2.5}$ emissions generated as part of a proposed project would expose existing or new receptors to levels that exceed the following *Thresholds of Significanc*e:

- Non-compliance with a qualified Community Risk Reduction Plan;
- An excess cancer risk level of more than 10 in one million, or a non-cancer (i.e., chronic or acute) risk greater than 1.0 HI from a single source would be a significant cumulatively considerable contribution;
- An incremental increase of greater than 0.3 $\mu g/m^3$ annual average $PM_{2.5}$ from a single source would be a significant cumulatively considerable contribution.

In all areas, but especially within impacted communities identified under BAAQMD's CARE program, the lead agency is encouraged to develop and adopt a Community Risk Reduction Plan. To determine whether an impacted community is located in a jurisdiction, refer to Figure 5-1 and the BAAQMD CARE web page at http://www.baaqmd.gov/CARE/. Please consult with BAAQMD if a more precise map is needed.

Impacted Communities **Figure 5-1**



Source: BAAQMD 2009

Exposure of receptors to substantial concentrations of TACs and $PM_{2.5}$ could occur from the following situations:

1. Siting a new TAC and/or $PM_{2.5}$ source (e.g., diesel generator, truck distribution center, freeway) near existing or planned receptors; and
2. Siting a new receptor near an existing source of TAC and/or $PM_{2.5}$ emissions.

BAAQMD recommendations for evaluating and making a significance determination for each of these situations are discussed separately below.

5.2.2. Siting a New Source

When evaluating whether a new source of TAC and/or $PM_{2.5}$ emissions would adversely affect existing or future proposed receptors, a lead agency should examine:

- the extent to which the new source would increase risk levels, hazard index, and/or $PM_{2.5}$ concentrations at nearby receptors,
- whether the source would be permitted or non-permitted by the BAAQMD, and
- whether the project would implement Best Available Control Technology for Toxics (T-BACT), as determined by BAAQMD.

The incremental increase in cancer and non-cancer (chronic and acute) risk from TACs and $PM_{2.5}$ concentrations at the affected receptors should be assessed. The recommended methodology for assessing community risks and hazards from $PM_{2.5}$ and TACs follows a phased approach, within which progressively more advanced techniques are presented for each phase (Figure 5-2). Each phase provides concentrations and risks that are directly comparable to the applicable threshold, although it is important to note that the use of more site specific modeling input data produces more accurate results. Also, progression from one phase to the next in a sequential fashion is not necessary and a refined modeling analysis can be conducted at any time.

For siting a new source, the first step is to determine the associated emission levels.

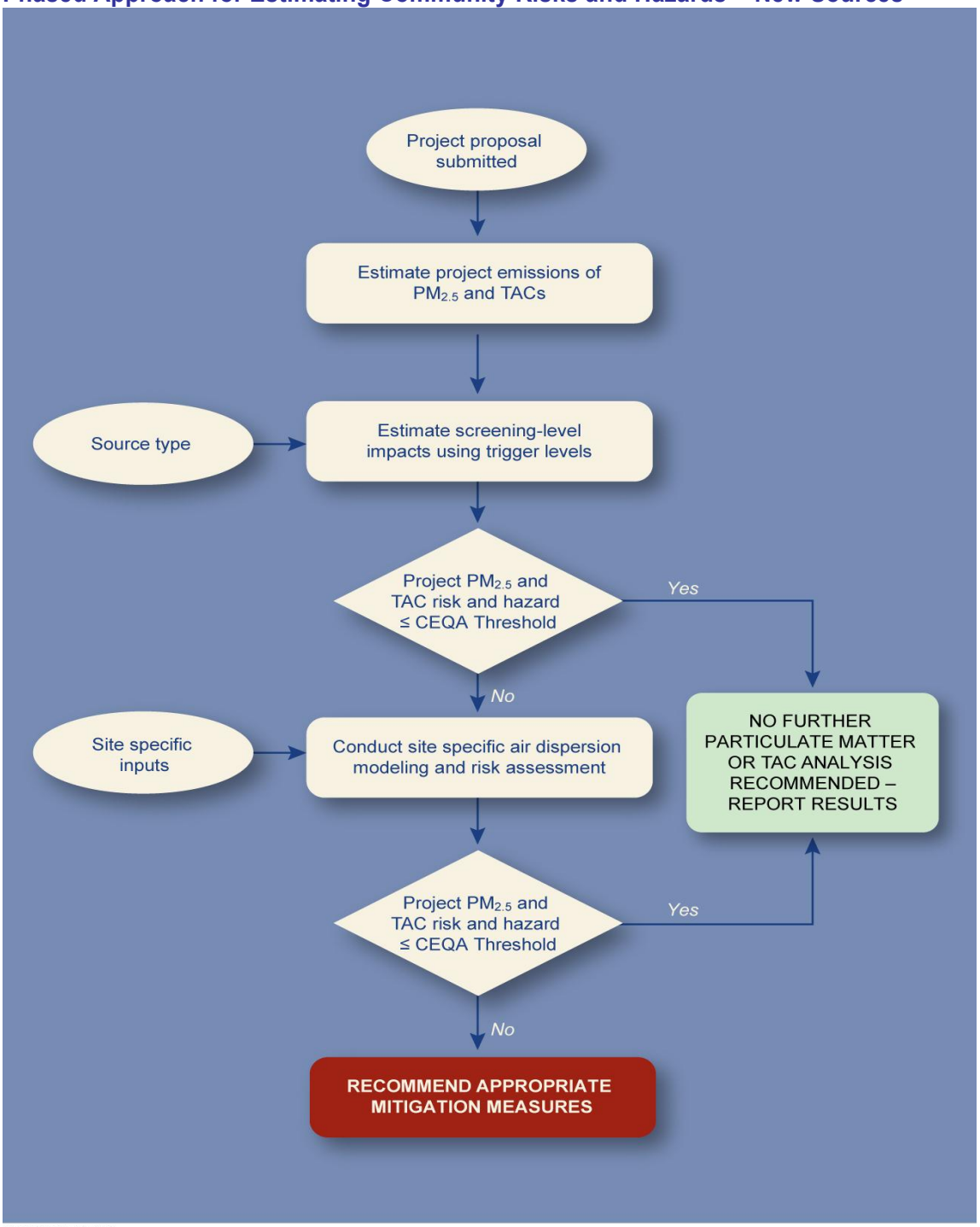
5.2.3. Sources Permitted by BAAQMD

For sources that would be permitted by BAAQMD (e.g., gas stations and back-up diesel generators) the project's type, size, or planned level of use can be used to help estimate $PM_{2.5}$ and TAC emissions. Screening or modeling conducted as part of the permit application can be used to determine cancer and non-cancer risk and $PM_{2.5}$ concentrations for comparing to the applicable threshold. BAAQMD can assist in determining the level of emissions associated with the new source. A lead agency should identify the maximally exposed existing or reasonably foreseeable future receptor.

Requirements of Toxics New Source Review (Regulation 2, Rule 5) will determine whether the project would implement T-BACT.

Figure 5-2

Phased Approach for Estimating Community Risks and Hazards – New Sources



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Concentration estimates of $PM_{2.5}$ from screening or modeling should be compared with the threshold for $PM_{2.5}$. If screening estimates determine $PM_{2.5}$ concentrations from the project would not exceed the thresholds, no further analysis is recommended. If emissions would exceed the thresholds, more refined modeling or mitigation measures to offset emissions should be considered.

5.2.4. Sources Not Requiring a BAAQMD Permit

Some proposed projects would include the operation of non-permitted sources of TAC and/or $PM_{2.5}$ emissions. For instance, projects that would attract high numbers of diesel-powered on-road trucks or use off-road diesel equipment on site, such as a distribution center, a quarry, or a manufacturing facility, would potentially expose existing or future planned receptors to substantial risk levels and/or health hazards.

For sources that would not require permits from BAAQMD (e.g., distribution centers and large retail centers) where emissions are primarily from mobile sources—the number and activity of vehicles and fleet information would be required. The latest version of the State of California's EMFAC model is recommended for estimating emissions from on-road vehicles; the OFFROAD model is recommended for estimating emissions from off-road vehicles. For these types of new sources (not permitted by BAAQMD) screening methods are not currently available and a more refined analysis is necessary.



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If modeling estimates for community risks and hazards determine that local levels associated with the proposed project meet the applicable thresholds, no further analysis is recommended. More details on project screening and recommended protocols for modeling stationary and mobile sources are presented in *Recommended Methods for Screening and Modeling Local Risks and Hazards*. This online companion describes how to use screening tables to determine whether a site specific modeling analysis and risk assessment may be needed. The document also addresses sources that BAAQMD has determined to have negligible impact on health outcomes. It describes the recommended methodology for performing dispersion modeling and estimating emission factors if the project exceeds the thresholds based on the screening analysis; it describes how to calculate the potential cancer risk using age-sensitivity toxicity factors from the concentrations produced from the air modeling analysis; and it provides a sample calculation and the methodology for estimating short term, acute exposures and long term, chronic health impacts. The recommended protocols are consistent with the most current risk assessment methodology used for the BAAQMD's *New Source Review for Toxic Air Contaminants Regulation 2, Rule 5: Toxics New Source Review* and, with few exceptions, follows the California Air Pollution Control Officers Association's (CAPCOA) *Health Risk Assessments for Proposed Land Use Projects* (July 2009).

BAAQMD recommends that all receptors located within a 1,000 foot radius of the project's fence line be assessed for potentially significant impacts from the incremental increase in risks or hazards from the proposed new source. A lead agency should enlarge the 1,000-foot radius on a case-by-case basis if an unusually large source or sources of risk or hazard emissions that may affect a proposed project is beyond the recommended radius.

For new land uses that would host a high number of non-permitted TAC sources, such as a distribution center, the incremental increase in cancer risk should be determined by an HRA using

an acceptable air dispersion model in accordance with BAAQMD's *Recommended Methods for Screening and Modeling Local Risks and Hazards* and/or CAPCOA's guidance document titled *Health Risk Assessments for Proposed Land Use Projects*. A lead agency may consult HRAs that have previously been conducted for similar land uses to determine whether it assesses the incremental increase in cancer risk qualitatively or by performing an HRA. This analysis should account for all TAC and PM emissions generated on the project site, as well as any TAC emissions that would occur near the site as a result of the implementation of the project (e.g., diesel trucks queuing outside an entrance, a high volume of trucks using a road to access a quarry or landfill).

Some proposed projects would include both permitted and non-permitted TAC sources. For instance, a manufacturing facility may include some permitted stationary sources and also attract a high volume of diesel trucks and/or include a rail yard. All sources should be accounted for in the analysis.

5.2.5. Siting a New Receptor

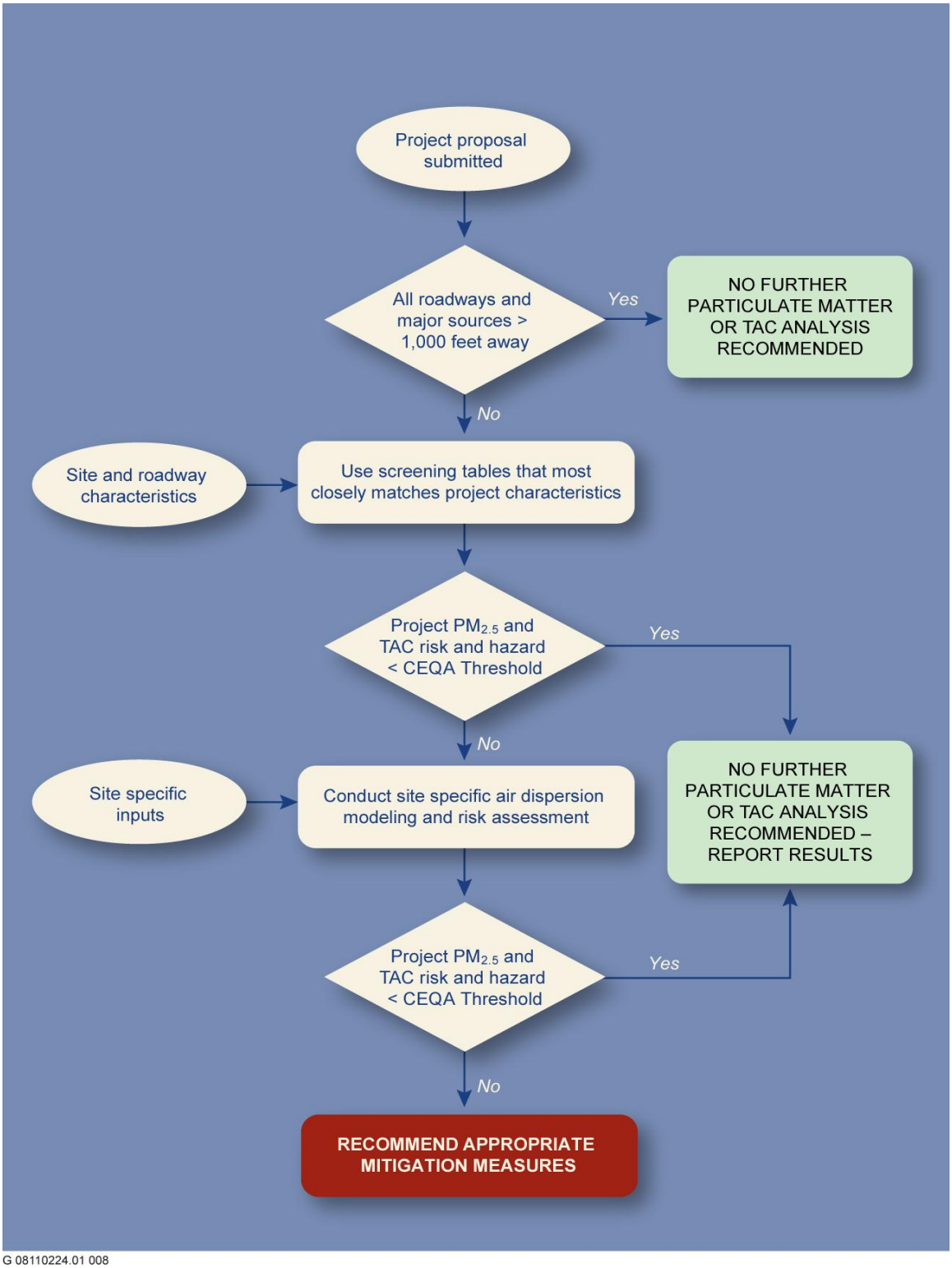
If a project is likely to be a place where people live, play, or convalesce, it should be considered a receptor. It should also be considered a receptor if sensitive individuals are likely to spend a significant amount of time there. Sensitive individuals refer to those segments of the population most susceptible to poor air quality: children, the elderly, and those with pre-existing serious health problems affected by air quality (ARB 2005). Examples of receptors include residences, schools and school yards, parks and play grounds, daycare centers, nursing homes, and medical facilities. Residences can include houses, apartments, and senior living complexes. Medical facilities can include hospitals, convalescent homes, and health clinics. Playgrounds could be play areas associated with parks or community centers.

When siting a new receptor, the existing or future proposed sources of TAC and/or $PM_{2.5}$ emissions that would adversely affect individuals within the planned project should be examined, including:

- the extent to which existing sources would increase risk levels, hazard index, and/or $PM_{2.5}$ concentrations near the planned receptor,
- whether the existing sources are permitted or non-permitted by the BAAQMD, and
- whether there are freeways or major roadways near the planned receptor.

BAAQMD recommends that a lead agency identify all TAC and $PM_{2.5}$ sources located within a 1,000 foot radius of the proposed project site. A lead agency should enlarge the 1,000-foot radius on a case-by-case basis if an unusually large source or sources of risk or hazard emissions that may affect a proposed project is beyond the recommended radius. Permitted sources of TAC and $PM_{2.5}$ should be identified and located as should freeways and major roadways, and other potential sources. To conduct a thorough search, a lead agency should gather all facility data within 1,000 feet of the project site (and beyond where appropriate).

The phased approach for evaluating impacts to new receptors is shown in Figure 5-3.



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Phased Approach for Estimating Community Risks and Hazards – Receptors
Figure 5-3

5.2.6. Stationary Sources Screening Analysis

BAAQMD has developed an online tool containing data for existing permitted, stationary sources of TAC and $PM_{2.5}$ including site locations, UTM coordinates, source type, and screening-level estimates of $PM_{2.5}$ concentrations, cancer risk, and chronic hazard index. The online tool is a Google Earth™ application and may be downloaded for free from the BAAQMD website, http://www.baaqmd.gov/Divisions/Planning-and-Research/CEQA-GUIDELINES/Tools-and-Methodology.aspx. The Google Earth™ files consist of compressed keyhole markup language (kml) files for each of the nine Bay Area counties.

The stationary source screening tool contains all the sources in the Bay Area that have permits to operate and that emit one or more toxic air contaminants. The types of sources include, but are not limited to: refineries, gasoline dispensing facilities, dry cleaners, diesel internal combustion engines, natural gas turbines, crematories, landfills, waste water treatment facilities, hospitals and coffee roasters. The screening tool contains the following information for each source:

- Unique Plant Number for the stationary source used by the District (plant numbers starting with "G" are gasoline dispensing facilities that could be retail or non-retail). Plants are facilities or buildings that require a District permit. Plants are geo-coded and have BAAQMD assigned numbers. Plants can have multiple emission sources.

- The stationary source's plant name.

- Geocoded location for the Plant (Universal Transverse Mercador (UTM) coordinates). Note that the UTM coordinates represent only a single point at a plant, which may not be the point closest to the project. Also, the reference points for the UTM coordinates in the screening table may not be the same for all plants. Potential distance offsets may be as great as 200 meters. To ensure that all relevant plants are included, actual locations of sources should be verified.

- Conservatively estimated $PM_{2.5}$ concentrations, cancer risk, and chronic hazard index due to emissions from a plant are intended for screening purposes only. The screening values do not include acute hazard index since the maximum values for all sources was found to be very minor. Some of the sources may be marked with an asterisk, "*." The estimated risk and hazards for these sources are based on Health Risk Screening Assessments conducted by the District using the most site specific data available. The remaining stationary source risk and hazards impact estimates were derived using conservative modeling parameters and assumptions. The estimated risk and hazard impacts for these sources would be expected to be lower when site-specific Health Risk Screening Assessments are conducted.

The screening-level risk and hazard impacts in the stationary source screening tool do not represent actual impacts. The values are based on worst case assumption scenarios to determine whether or not a refined modeling analysis may be needed. The calculations used in the screening analysis do not include source specific exhaust information such as stack height, exhaust gas exit velocity, exhaust gas temperature, nor do they account for actual distances from receptors. A more refined analysis using source specific exhaust parameters, site specific meteorological data, site specific building dimensions and locations, and actual location of source and receptors is expected to result in lower and more accurate values than those found in the screening tool.

The impacts estimated from a project's screening process and if conducted, modeling analysis, should be summed and compared to the risk and hazards thresholds. If any single project exceeds the single source threshold or the sum of all the sources exceeds the cumulative

thresholds then the lead agency should consider possible mitigations that can reduce potential air quality impacts.

To use the stationary source screening tool, a user would open the county specific kml file, found on BAAQMD's website, where their project is located and identify all the stationary sources within 1,000 feet of the project's boundaries. The Google Earth™ ruler function may be used to measure the distance between stationary sources and the edge of the project boundaries. Users should then select the identified stationary sources to view the estimated $PM_{2.5}$, cancer risk, and chronic hazard index levels estimated for that source.

As an example, Table 5-1 presents a hypothetical location at 19th Avenue and Judah Street in San Francisco and lists the stationary sources within 1,000 feet of the example location. Each row contains entries for a specific existing stationary source and conservative estimates of cancer risk, $PM_{2.5}$ concentration, and chronic hazard index. The risk and hazards for each source should be compared to the appropriate significance thresholds. In Table 5-1 all entries are below the applicable threshold except for the source at 1515 19th Avenue, which has a cancer risk, conservatively estimated at about 58 in a million. In this case, the user may choose to contact BAAQMD staff to learn more about the source and how the risk was estimated and/or opt to conduct site specific modeling for more refined risk and hazard estimates.

Table 5-1
Screening Data for Existing Permitted Stationary Sources*
(within 1,000 feet of the Proposed Project)

EXAMPLE
Proposed Project Location Details:
Address-19th Avenue and Judah Street, San Francisco, CA
Centroid UTMs-E 546090, N 4179460

Plant #	Plant Name	Street Address	City	UTM E	UTM N	Cancer Risk in a million	$PM_{2.5}$ ug/m^3	Chronic Hazard Index	
462	20th Avenue Cleaner	1845 Irving Street	San Francisco	546113	4179490	7.5		0.02	
4672	Sundown Cleaners	1952 Irving Street	San Francisco	546016	4179510	7.5		0.02	
13519	Pacific Bell	1515 19th Avenue	San Francisco	546086	4179240	58.4	0.10	0.10	
2155	Chevron Station #91000	1288 19th Avenue	San Francisco	546052	4179720	5.8		0.03	
8756	ConocoPhillips #251075	1400 19th Avenue	San Francisco	546064	4179490	2.7		0.01	
9266	ConocoPhillips #2611185	1401 19th Avenue	San Francisco	546058	4179500	2.2		0.01	
					Cumulative:	84		0.04	

Source: BAAQMD 2009

*This example provides conservative screening level estimates and does not represent actual risk, hazard index or $PM_{2.5}$ concentrations for the facilities listed.

For detailed information on the methodology and assumptions used in creating the screening tool, and for guidance on conducting site specific modeling see the *Recommended Methods for Screening and Modeling Local Risks and Hazards* report available on the District's website.

5.2.7. On-road Mobile Sources Screening Analysis

BAAQMD developed screening analysis tools for estimating risk and hazard impacts from California highways and surface streets in the Bay Area's nine counties. These tools are available on BAAQMD's website and are discussed individually below.

The highway and roadway screening tools serve as an easy-to-use initial screening process to determine if nearby highway and roadway impacts to a new receptor are below BAAQMD's thresholds of significance. The outcome of the screening may be used to determine whether no further analysis is needed or if a more refined analysis is warranted. BAAQMD recommends the following project screening approach:

1. Determine if the new receptor is at least 1,000 feet from the nearest high volume roadway defined as a freeway or arterial roadway with greater than 10,000 vehicles or 1,000 trucks per day. For new residential developments, the receptor should be placed at the edge of the property boundary. If there are no high volume highway/roadway sources within 1,000 feet of the project, then no further single-source roadway-related air quality evaluation is needed.

2. If the receptor is within the 1,000 foot radius of a nearby highway/roadway that has greater than 10,000 vehicles or 1,000 trucks per day, then the county specific roadway screening tables and the highway screening analysis tool should be used to determine the $PM_{2.5}$ concentrations, cancer risks, and hazards for the project. When two or more highways/roadways are within the1,000 foot radius, sum the contribution from each highway/roadway. If any of the estimates for $PM_{2.5}$ concentration, cancer risk, and hazards exceed the thresholds, then more refined modeling analysis is recommended or the lead agency may choose to implement mitigation measures.

3. For developments that exceed the screening analysis, site specific modeling analysis is recommended following BAAQMD's *Recommended Methods for Screening and Modeling Local Risks and Hazards*.

Highway Screening Analysis

For all state highways in the Bay Area, BAAQMD has developed an online highway screening analysis tool with modeled cancer risk and $PM_{2.5}$ concentrations for each highway link. The online tool consists of Google Earth™ kmz files that may be downloaded from BAAQMD's website, http://www.baaqmd.gov/Divisions/Planning-and-Research/CEQA-GUIDELINES/Tools-and-Methodology.aspx. Estimated risk and hazards impacts are listed for each highway link based on the distance from the edge of a highway's nearest travel lane to the project, AADT count, fleet mix and other modeling parameters specific to that highway link. The estimated risk and hazard impacts are modeled at two different heights, 6 feet and 20 feet. The 6 foot height estimates should be used when receptors are located on the ground floor of a building; and the 20 foot height estimates should be used when receptors are located on the second floor of a building. In each case, the risk and hazard impacts are modeled by distance, from 10 to 1,000 feet on either side of the highway. If a project is located between two highway links or between two distance points, the higher values should be used. If the project is between two distance points in the screening table the cancer risk and $PM_{2.5}$ concentrations may be further refined by linearly interpolating the distance between the project and the highway. See the *Recommended Methods for Screening and Modeling Local Risks and Hazards* report for specific instructions on how to linearly interpolate values. $PM_{2.5}$

As an example, if a proposed project is located 200 feet east of San Pablo Avenue (Highway 123) in Berkeley, and it is known that the ground floor of the project will not house any receptors, the Alameda county ".kmz" file for 20 feet should be downloaded from the BAAQMD website. Once opened in Google Earth™, the closest Highway 123 link to the project should be selected for a summary of the estimated risk and hazard impacts at that highway link. A user would then use the risk and hazard impacts listed at 200 feet east of the freeway in its project analysis. In this case, the highway link table indicates that at 200 feet east of the highway, the PM2.5 concentration is estimated at 0.061 ug/m^3, the cancer risk at 4.524 per million, the chronic hazard index at 0.006, and the acute hazard index at 0.006.

For detailed information on the methodology and assumptions used in creating the screening tool, see the *Recommended Methods for Screening and Modeling Local Risks and Hazards* report available on the District's website.

Roadway Screening Analysis

For major roadways not designated as state highways, BAAQMD developed county-specific screening tables to assess potential impacts for roads with 10,000 to 100,000 annual average daily traffic (AADT). The screening tables present $PM_{2.5}$ concentrations and cancer risk at specific distances away from the edge of the nearest travel lane of a road in relation to the project. These sets of tables correspond to projects located upwind or downwind of the roadway with respect to the prevailing wind direction. Roadways with less than 10,000 vehicles per day are considered minor, low-impact sources and inclusion of these roads in CEQA evaluation is not warranted. In addition, the tables do not include acute or chronic noncancer hazards since the screening values were found to be below the thresholds. The screening tables may be downloaded from the BAAQMD website, http://www.baaqmd.gov/Divisions/Planning-and-Research/CEQA-GUIDELINES/Tools-and-Methodology.aspx. For detailed information on the methodology and assumptions used in creating the screening tables, see the *Recommended Methods for Screening and Modeling Local Risks and Hazards* report available on BAAQMD's website.

When using the roadway screening tables, the lead agency should first gather project information including the county for which the development is proposed and the distance of the project to the nearest roadway. The appropriate cell should be determined by referencing the corresponding county, roadway, and project distance in the tables that most closely matches the project conditions. If the project is predominantly north or south of the roadway, choose the north or south tables. Likewise, if the project is predominantly east or west, choose the east or west tables. If the project is evenly located for example, northeast or southwest of the roadway, select the higher value between either screening tables based on the project distance to the roadway. If the project is between two distances or two AADT values, the cancer risk and $PM_{2.5}$ concentrations may be further refined by linearly interpolating the AADT and distance between the project and the roadway. See *Recommended Methods for Screening and Modeling Local Risks and Hazards* report for specific instructions on how to linearly interpolate values.

Table 5-2 outlines an example using the roadway screening analysis tool. A roadway is located in San Francisco in a north-south direction, has 25,800 vehicles per day, and is approximately 276 feet from the project. To estimate the risks and hazards, the user matches the AADT in the row header with the distance from the project to the roadway in the column header. For cases in which the exact AADT or distances are not estimated in the table, the user should select the higher value between the two estimated values. In Table 5-2, the estimated cancer risk for the example is 2.31 cases per million and the $PM_{2.5}$ concentration is 0.092 ug/m^3.

The values may be further refined to account for the exact roadway AADT and distances by scaling the values in the table. The methodology for scaling values is shown in section 3.1.2 of

the *Recommended Methods for Screening and Modeling Local Risks and Hazards* report available on BAAQMD's website.

Table 5-2. Example Cancer Risk and PM2.5 Estimation for Surface Streets

NORTH-SOUTH DIRECTIONAL ROADWAY							
Annual Average Daily Traffic	Distance East or West of Surface Street - Cancer Risk (per million)						
	10 feet	50 feet	100 feet	200 feet	500 feet	700 feet	1,000 feet
1,000	No analysis required						
5,000							
10,000	2.13	2.10	1.49	0.65	0.36	0.27	0.22
20,000	2.22	2.49	2.22	1.55	0.62	0.51	0.38
30,000	3.37	3.56	3.28	2.31	0.97	0.75	0.55
40,000	4.26	4.46	4.27	3.10	1.33	1.06	0.79
50,000	5.79	6.49	5.78	4.00	1.68	1.33	0.96
60,000	7.81	8.55	7.34	4.76	1.95	1.55	1.15
70,000	9.82	10.60	8.90	5.52	2.22	1.77	1.33
80,000	11.22	12.12	10.17	6.31	2.53	2.02	1.52
90,000	12.63	13.63	11.44	7.10	2.85	2.27	1.71
100,000	14.03	15.15	12.71	7.88	3.17	2.53	1.90

NORTH-SOUTH DIRECTIONAL ROADWAY							
Annual Average Daily Traffic	Distance East or West of Surface Street - PM2.5 Concentration (ug/m^3)						
	10 feet	50 feet	100 feet	200 feet	500 feet	700 feet	1,000 feet
1,000	No analysis required						
5,000							
10,000	0.080	0.063	0.044	0.016	0.012	0.000	0.000
20,000	0.092	0.101	0.092	0.061	0.021	0.016	0.012
30,000	0.129	0.147	0.129	0.092	0.032	0.022	0.017
40,000	0.166	0.193	0.175	0.120	0.051	0.037	0.024
50,000	0.249	0.267	0.239	0.166	0.064	0.050	0.029
60,000	0.341	0.359	0.304	0.198	0.076	0.057	0.039
70,000	0.433	0.451	0.368	0.230	0.087	0.064	0.050
80,000	0.495	0.516	0.421	0.263	0.099	0.074	0.057
90,000	0.557	0.580	0.474	0.296	0.111	0.083	0.064
100,000	0.618	0.645	0.526	0.329	0.124	0.092	0.071

The results of the screening analysis indicate whether new receptors will be exposed to highway/roadway TAC emissions at concentrations exceeding the threshold of significance and whether, a more refined modeling analysis may be needed. If the concentration is less than the thresholds, then no further analysis is required for the single source comparison for roadways. The results of the analysis should be reported in the environmental documentation or staff report that includes a reference to the screening tables used. If the concentrations exceed the thresholds, then the user has the option to conduct a more refined modeling analysis or implement appropriate mitigation measures.

To conduct a more refined modeling analysis, BAAQMD recommends following the methodology in the *Recommended Methods for Screening and Modeling Local Risks and Hazards* report available on BAAQMD's website.

For conducting refined modeling to estimate concentrations from TAC, $PM_{2.5}$, and diesel BAAQMD recommends using the CAL3QHCR model. The CAL3QHCR model can estimate air concentrations at defined receptor locations by processing hourly meteorological data over a year, hourly emissions, and traffic volume. The latest version of the model is available at: http://www.epa.gov/scram001/dispersion_prefrec.htm. For each analysis, the District recommends developing pollutant specific emission factors from EMFAC. As specified in Regulation 2, Rule 5, BAAQMD also recommends that age sensitivity factors be applied to the emissions per year to account for early life-stage exposures. For detailed discussion on this methodology, refer to the *Recommended Methods for Screening and Modeling Local Risks and Hazards* report available on BAAQMD's website.

The risk and hazard levels from the modeling analysis should then be compared with the applicable thresholds. Further assessment may be needed if the thresholds are exceeded, and the lead agency may consider design changes and other mitigation measures as a means of reducing potential risks.

5.3. CUMULATIVE IMPACTS

5.3.1. Significance Determination

A lead agency should examine TAC sources that are located within 1,000 feet of a proposed project site. Sources of TACs include, but are not limited to, land uses such as freeways and high volume roadways, truck distribution centers, ports, rail yards, refineries, chrome plating facilities, dry cleaners using perchloroethylene, and gasoline dispensing facilities. Land uses with permitted sources, such as a landfill or manufacturing plant, may also contain non-permitted TAC and/or $PM_{2.5}$ sources, particularly if they host a high volume of diesel truck activity. A lead agency should determine what the combined risk levels are from all nearby TAC sources in the vicinity of sensitive receptors. Lead agencies should use their judgment to decide if there are large sources outside 1,000 feet that should be included.

A lead agency's analysis should determine whether TAC emissions generated as part of a proposed project would expose off-site receptors to risk levels that exceed BAAQMD's applicable threshold for determining cumulative impacts.

A project would have a significant cumulative impact if the total of all past, present, and foreseeable future sources within a 1,000 foot radius (or beyond where appropriate) from the fence line of a source, or from the location of a receptor, plus the contribution from the project, exceeds the following:

- Non- compliance with a qualified Community Risk Reduction Plan;
- An excess cancer risk levels of more than 100 in one million or a chronic hazard index greater than 10 for TACs; or
- 0.8 $\mu g/m^3$ annual average $PM_{2.5}$.

BAAQMD recommends that cumulative impacts of new sources and new receptors be evaluated as described in Section 5.2, and include the impacts of all individual sources (stationary and on-road mobile) within the 1,000 foot radius. In impacted communities identified under BAAQMD's CARE program, lead agencies are encouraged to develop and adopt a Community Risk Reduction Plan. To determine whether a new source is located in an impacted community, refer to Figure 5-1 and the CARE webpage. See section 5.4 for more information on Community Risk Reduction Plans.

The risk and hazards analysis for assessing potential cumulative impacts should follow the risk screening guidance described in *Recommended Methods for Screening and Modeling Local Risks and Hazards*, which generally follows CAPCOA's guidance document titled *Health Risk Assessments for Proposed Land Use Projects*.

A lead agency should compare the analysis results from TAC emissions with the applicable significance thresholds. BAAQMD's thresholds apply to projects that would site new permitted or non-permitted sources in close proximity to receptors and for projects that would site new sensitive receptors in close proximity to permitted or non-permitted sources of TAC emissions. If a proposed project would not exceed BAAQMD's applicable thresholds then the project would result in a less-than-significant air quality impact. If a project would exceed the applicable thresholds , the proposed project would result in a potentially significant air quality impact and the lead agency should implement all feasible mitigation to reduce the impact (refer to Section 5.5 for mitigating impacts).

If implementation of BAAQMD-recommended mitigation measures for reducing TAC emissions and resultant exposure to health risks would reduce all TAC impacts to levels below the applicable thresholds, TAC impacts would be reduced to a less-than-significant level. If resultant health risk exposure would still exceed the applicable thresholds, the impacts would be considered significant and unavoidable.

5.4. COMMUNITY RISK REDUCTION PLANS

The goal of a Community Risk Reduction Plan is be to bring TAC and $PM_{2.5}$ concentrations for an entire community covered by the Plan down to acceptable levels as identified by the local jurisdiction and approved by the Air District. This approach provides local agencies a proactive alternative to addressing high levels of risk and $PM_{2.5}$ impacts on a project-by-project approach. The Air District has developed detailed guidelines for preparing Community Risk Reduction Plans which can be found BAAQMD's website, http://www.baaqmd.gov/Divisions/Planning-and-Research/CEQA-GUIDELINES.aspx.

Qualified Community Risk Reduction Plans
A qualified Community Risk Reduction Plan adopted by a local jurisdiction should include, at a minimum, the following elements:

(A) Define a planning area;

(B) Include base year and future year emissions inventories of TACs and PM2.5;

(C) Include Air District approved risk modeling of current and future risks;

(D) Establish risk and exposure reduction goals and targets for the community in consultation with Air District staff;

(E) Identify feasible, quantifiable, and verifiable measures to reduce emissions and exposures;

(F) Include procedures for monitoring and updating the inventory, modeling and reduction measures in coordination with Air District staff;

(G) Be adopted in a public process following environmental review.

5.5. MITIGATING LOCAL COMMUNITY RISK AND HAZARD IMPACTS

For stationary sources, please refer to BAAQMD's permit handbook and BACT/T-BACT workbook. For land use projects, BAAQMD is developing community development guidelines to assist lead agencies in identifying mitigation measures to reduce risk and hazard impacts associated with proposed projects. The community development guidelines will contain risk reduction measures with estimated quantified reductions, as well as an analysis worksheet for lead agencies to review as they perform an environmental analysis. The mitigation measures will be helpful in protecting public health for proposed infill and transit-oriented development projects located near TAC sources.

The list below outlines potential mitigation measures for reducing TAC emissions and exposure to sensitive receptors:

1. Increase project distance from freeways and/or major roadways.

2. Redesign the site layout to locate sensitive receptors as far as possible from any freeways, major roadways, or other non-permitted TAC sources (e.g., loading docks, parking lots).

3. Large projects may consider phased development where commercial/retail portions of the project are developed first. This would allow time for CARB's diesel regulations to take effect in reducing diesel emissions along major highways and arterial roadways. Ultimately, lower concentrations would be anticipated along the roads in the near future such that residential development would be impacted by less risk in later phases of development.

4. Projects that propose sensitive receptors adjacent to sources of diesel PM (e.g., freeways, major roadways, rail lines, and rail yards) should consider tiered plantings of trees such as redwood, deodar cedar, live oak and oleander to reduce TAC and PM exposure. This recommendation is based on a laboratory study that measured the removal rates of PM passing through leaves and needles of vegetation. Particles were generated in a wind tunnel and a static chamber and passed through vegetative layers at low wind velocities. Redwood, deodar cedar, live oak, and oleander were tested. The results indicate that all forms of vegetation were able to remove 65–85 percent of very fine particles at wind velocities below 1.5 meters per second, with redwood and deodar cedar being the most effective.

5. Install and maintain air filtration systems of fresh air supply either on an individual unit-by-unit basis, with individual air intake and exhaust ducts ventilating each unit separately, or through a centralized building ventilation system. The ventilation system should be certified to achieve a performance effectiveness, for example, to remove at least 85% of ambient $PM_{2.5}$ concentrations from indoor areas. Air intakes should be located away from emission sources areas, such as major roadways. Users may factor in the amount of time that receptors spend indoors verses out-of-doors to account for air filtration systems in modeling, provided that all assumptions are justified with scientific documentation.

6. Where appropriate, install passive (drop-in) electrostatic filtering systems, especially those with low air velocities (i.e., 1 mph).

7. Require rerouting of nearby heavy-duty truck routes.

8. Enforce illegal parking and/or idling of heavy-duty trucks in vicinity.

6. LOCAL CARBON MONOXIDE IMPACTS



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Emissions and ambient concentrations of CO have decreased dramatically in the SFBAAB with the introduction of the catalytic converter in 1975. No exceedances of the CAAQS or NAAQS for CO have been recorded at nearby monitoring stations since 1991. SFBAAB is currently designated as an attainment area for the CAAQS and NAAQS for CO; however, elevated localized concentrations of CO still warrant consideration in the environmental review process. Occurrences of localized CO concentrations, known as hotspots, are often associated with heavy traffic congestion, which most frequently occur at signalized intersections of high-volume roadways.

6.1. SIGNIFICANCE DETERMINATION

Step 1: Comparison of Project Attributes with Screening Criteria

The first step in determining the significance of CO emissions is to compare the attributes of the proposed project to the applicable S*creening Criteria* (refer to Chapter 3).

This preliminary screening procedure provides a conservative indication of whether the proposed project would result in the generation of CO concentrations that would substantially contribute to an exceedance of the *Thresholds of Significance*. If all of the screening criteria are met, the proposed project would result in a less-than-significant impact to air quality with respect to concentrations of local CO. If the proposed project does not meet all the screening criteria, then CO emissions should be quantified. The screening criteria do not apply to stationary source projects.

Step 2: Emissions Quantification

This section describes recommended methodologies for quantifying concentrations of local CO for proposed transportation projects that do not meet all of the screening criteria. The recommended methodology is to use both the On-Road Mobile-Source Emission Factors (EMFAC) and the California Line Source Dispersion Model (CALINE4) models in accordance with recommendations in the University of California, Davis, Transportation Project-Level Carbon Monoxide Protocol (*CO Protocol*) (Garza, et al. 1997). Proposed stationary source projects should model their potential CO impacts using AERMOD. For specific guidance on using AERMOD, refer to EPA's website, http://www.epa.gov/ttn/scram/dispersion_prefrec.htm#aermod.

Air Quality Models

BAAQMD recommends using the most current version of the EMFAC model to obtain mobile-source emission factors for CO associated with operating conditions that would be representative of the roadway or facility subject to analysis.

Users should input the emission factors and other input parameters into the CALINE4 model to quantify CO concentrations near roadways.

The *CO Protocol* contains detailed methodology for modeling CO impacts.

Input Parameters

The CALINE4 model contains five screens for input data. CALINE4 input parameters are summarized below. For more detailed descriptions see the CALINE4 Users Guide.

Job Parameters

File Name – Name the file (e.g., data file extension) to create the CALINE4 Input file.

Job Title – Provide a name for the modeling scenario (e.g., existing no project, existing plus project).

Run Type – Select the worst-case wind angle.

Aerodynamic Roughness Coefficient – Choose the characteristic (i.e., rural, suburban, central business district, other) that is most representative of the project site.

Model Information – Indicate the unit of measurement (i.e., meters or feet) and inputs the vertical dimension of the project (i.e., altitude above sea level).

Run – Once data input is completed, return to this screen to run the model. Upon running the model, the output will appear as a text file called C4$.out. Save the output file under an appropriate filename for future reference.

Link Geometry

On this screen, input the dimensions (i.e., coordinates) for the roadway intersection that is the subject of the analysis.

Link Name – Input names for each roadway segment.

Link Type – Indicate the character of the roadway segment (i.e., at-grade, depressed, fill, bridge, parking lot).

Endpoint Coordinates (X_1, X_2, Y_1, Y_2) – Input the dimensions (i.e., coordinates) of the roadway segments as though the intersection were oriented at point of origin X = 0, Y = 0 on a Cartesian coordinate system. Roadway segments approaching the intersection from the west side of the screen (if north is treated as "up", or the top of the screen) would have negative X coordinate endpoints. Similarly, roadway segments approaching the intersection from the south would have negative Y coordinate endpoints.

Link Height – Indicate the vertical dimension of the roadway segment. If the roadway segment is at-grade, should set this parameter to zero. If the roadway segment is depressed, enter a negative value for this parameter.

Mixing Zone Width – The Mixing Zone is defined as the width of the roadway, plus three meters on either side. The minimum allowable value is 10 meters, or 32.81 feet.

Canyon/Bluff (Mix Left/Right) – Set these features to zero.

Link Activity

Traffic Volume – Input hourly traffic volumes applicable to each roadway segment.

Emission Factor – Input the CO emission factor (in units of grams/mile) obtained from EMFAC for the applicable vehicle speed class reflecting operating conditions for the affected intersection.

Run Conditions

Wind Speed – Input 0.5 meters per second to represent worst-case conditions.

Wind Direction – Set parameter to zero. Select "Worst-Case Wind Angle" as the "Run Type" on the "Job Parameters" screen, so this field will be overridden by the model.

Wind Direction Standard Deviation – Use a wind direction standard deviation of 5 degrees to represent worst-case conditions.

Atmospheric Stability Class – Use Stability Class 4 (i.e., class D) to represent average conditions in the SFBAAB.

Mixing Height – Indicate the vertical dimension over which vertical mixing may occur. In most situations, input 300 meters, approximately the height of the atmospheric boundary layer. If the roadway subject to analysis is a bridge underpass, tunnel, or other situation where vertical mixing would be limited, indicates the height of the structure that would hamper vertical mixing (in units of meters).

Ambient Temperature – Indicate the average temperature of the project site during the time of day at which maximum daily traffic volume would occur (in degrees Celsius). A temperature of 7.2 degrees Celsius is recommended.

Ambient Pollutant Concentration – Enter 0 in this field to determine the contribution of CO from the roadway subject to analysis. Add the roadway-related CO concentration to ambient CO levels outside of the CALINE4 model, as discussed later in this section.

Receptor Positions

Receptor Name – Input names for each receptor.

Receptor Coordinates (X, Y, Z) – Input receptor coordinates in a manner similar to the "Link Coordinates" on the "Link Geometry" screen. Locate receptors at three and seven meters from the intersection in all directions from the intersection, in accordance with the recommendations of the *CO Protocol*. The Receptor Coordinates are oriented in the same Cartesian coordinate system as the roadway segment "Link Coordinates." Receptors located to the southwest of the intersection would have negative X and Y coordinates. The Z dimension should be assigned the coordinate of 1.8 meters (5.9 feet); the approximate breathing height of a receptor located adjacent to the roadway.

This screen also contains a window that shows a map of the link and receptor coordinates in the X, Y plane.

Model Output

CALINE4 output includes estimated 1-hour CO concentrations in units of ppm at the receptor locations input into the model. Note the highest concentrations at each of the three meter and seven meter receptor distances from the roadway.

Background Concentrations

Ambient 1-hour CO concentrations can be obtained from ARB air quality monitoring station data and 8-hour concentrations from EPA. Users should obtain the CO monitoring data recorded at the monitoring station nearest the project site. According to the *CO Protocol*, select the second highest concentration recorded during the last two years to represent the ambient CO concentration in the project area.

Estimated Localized CO Concentrations

Users should sum the highest modeled 1-hour CO concentration in units of ppm obtained from CALINE4 to ambient (background) 1-hour CO concentrations in ppm obtained from ARB. This represents the modeled worst-case 1-hour CO concentration near the affected roadway.

Persistence Factor – multiply the highest 1-hour CO concentration estimated by CALINE4 by a persistence factor of 0.7, as recommended in the CO Protocol, to obtain the estimated 8-hour CO concentration.

Add the estimated 8-hour CO concentration (ppm) obtained in the previous step to the ambient 8-hour CO concentration obtained from EPA (ppm). This represents the modeled worst-case 8-hour CO concentration near the affected roadway.

Step 3: Comparison of Unmitigated Emissions with Thresholds of Significance

Following quantification of local CO emissions in accordance with the recommended methods, compare the total modeled worst-case 1-hour and 8-hour CO concentrations with the applicable threshold. If the modeled concentrations do not exceed any of the *Thresholds of Significance*, the project would result in a less-than-significant impact to air quality. If modeled concentrations do exceed any applicable threshold, the proposed project would result in a significant impact to air quality with respect to local CO impacts.

Step 4: Mitigation Measures and Emission Reductions

Where local CO emissions exceed applicable threshold, refer to Section 6.2 for recommended mitigation measures and associated emission reductions. Only reduction measures included in the proposed project or recommended as mitigation in a CEQA-compliant document can be included when quantifying mitigated emission levels.

Step 5: Comparison of Mitigated Emissions with Thresholds of Significance

Following quantification of local CO emissions in accordance with the recommended methods, compare the total modeled worst-case 1-hour and 8-hour CO concentrations with the applicable thresholds. If the implementation of recommended mitigation measures reduces all local CO emissions to levels below the applicable thresholds, the impact to air quality would be reduced to a less-than-significant level. If mitigated levels of local CO emissions still exceed the applicable thresholds, the impact to air quality would remain significant and unavoidable.

6.2. MITIGATING LOCAL CARBON MONOXIDE IMPACTS

The following section describes recommended mitigation measures for reducing local CO impacts to air quality. Consider implementation of the following measures, as feasible, for reducing project-generated traffic volumes and associated CO emissions at affected intersections. Actual emission reductions should be quantified through project-specific transportation modeling.

1. Synchronize traffic signals to improve traffic flow and minimize traffic congestion.

2. Consider additional traffic signals, such as light metering, to relocate congested areas further away from receptors.

3. Improve public transit service to reduce vehicle traffic and increase public transit mode share during peak traffic congestion periods.

4. Improve bicycle and pedestrian infrastructure to reduce vehicle traffic and increase bicycle and pedestrian mode share during peak traffic congestion periods. Improvements may include installing class I or II bike lanes, sidewalks, and traffic calming features.

5. Adjust pedestrian crosswalk signal timing to minimize waiting time for vehicles turning right or otherwise sharing green time with pedestrians. Give pedestrians a head start before traffic signal changes to green.

6. Where pedestrian traffic is high, implement pedestrian crosswalks with multi-directional crossings allowing pedestrians to cross intersections diagonally.

7. Limit heavy-duty truck traffic during peak hours. Designate truck routes that divert truck traffic away from congested intersections.

8. Limit left turns or other maneuvers during peak hours that add to congestion.

9. Limit on-street parking during peak hours to allow for added vehicle capacity.

10. Implement traffic congestion-alleviating mitigation measures as identified by a traffic engineer.

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7. ODOR IMPACTS

Odor impacts could result from siting a new odor source near existing sensitive receptors or siting a new sensitive receptor near an existing odor source. Examples of land uses that have the potential to generate considerable odors include, but are not limited to:

1. Wastewater treatment plants;
2. Landfills;
3. Confined animal facilities;
4. Composting stations;
5. Food manufacturing plants;
6. Refineries; and
7. Chemical plants.

Odors are generally regarded as an annoyance rather than a health hazard. Manifestations of a person's reaction to odors can range from psychological (e.g., irritation, anger, or anxiety) to physiological (e.g., circulatory and respiratory effects, nausea, vomiting, and headache).

The ability to detect odors varies considerably among the population and overall is quite subjective. People may have different reactions to the same odor. An odor that is offensive to one person may be perfectly acceptable to another (e.g., coffee roaster). An unfamiliar odor is more easily detected and is more likely to cause complaints than a familiar one. Known as odor fatigue, a person can become desensitized to almost any odor and recognition only occurs with an alteration in the intensity.

Quality and intensity are two properties present in any odor. The quality of an odor indicates the nature of the smell experience. For instance, if a person describes an odor as flowery or sweet, then the person is describing the quality of the odor. Intensity refers to the strength of the odor. For example, a person may use the word strong to describe the intensity of an odor. Odor intensity depends on the concentration in the air. When an odor sample is progressively diluted, the odor concentration decreases. As this occurs, the odor intensity weakens and eventually becomes so low that the detection or recognition of the odor is quite difficult. At some point during dilution, the concentration of the odor reaches a level that is no longer detectable.

The presence of an odor impact is dependent on a number of variables including:

1. Nature of the odor source (e.g., wastewater treatment plant, food processing plant);
2. Frequency of odor generation (e.g., daily, seasonal, activity-specific);
3. Intensity of odor (e.g., concentration);
4. Distance of odor source to sensitive receptors (e.g., miles);
5. Wind direction (e.g., upwind or downwind); and
6. Sensitivity of the receptor.

The recommendations provided in this chapter only apply to assessing and mitigating odor impacts for individual projects. Please refer to Chapter 9 for recommendations for assessing and mitigating odor impacts at the plan-level.

7.1. SIGNIFICANCE DETERMINATION

Odor impacts could occur from two different situations:

1. Siting a new odor source (e.g., the project includes a proposed odor source near existing sensitive receptors), or
2. Siting a new receptor (e.g., the project includes proposed sensitive receptors near an existing odor source).

Regardless of the situation, BAAQMD recommends completing the following steps to comprehensively analyze the potential for an odor impact.

Step 1: Disclosure of Odor Parameters

The first step in assessing potential odor impacts is to gather and disclose applicable information regarding the characteristics of the buffer zone between the sensitive receptor(s) and the odor source(s), local meteorological conditions, and the nature of the odor source. Consideration of such parameters assists in evaluating the potential for odor impacts as a result of the proposed project. Projects should clearly state the following information in odor analyses, which provide the minimum amount of information required to address potential odor impacts:

1. Type of odor source(s) the project is exposed to or the type of odor source(s) produced by the project (e.g., wastewater treatment plant, landfill, food manufacturing plant);
2. Frequency of odor events generated by odor source(s) (e.g., operating hours, seasonal);
3. Distance and landscape between the odor source(s) and the sensitive receptor(s) (e.g., topography, land features); and
4. Predominant wind direction and speed and whether the sensitive receptor(s) in question are upwind or downwind from the odor source(s).

Step 2: Odor Screening Distances

BAAQMD has developed a list of recommended odor screening distances for specific odor-generating facilities shown in Table 3-3. Projects that would locate sensitive receptor(s) to odor source(s) closer than the screening distances would be considered to result in a potential significant impact. If the proposed project would include the operation of an odor source, the screening distances should also be used to evaluate the potential impact to existing sensitive receptors. Projects that would locate sensitive receptor(s) near odor source(s) further than the screening distances, or vice versa, would be considered to have a sufficient buffer to avoid significant impacts. The odor screening distances in Table 3-3 should not be used as absolute thresholds, rather an indicator to how much further analysis is required. The lead agency should also consider the other parameters listed above in Step 1 and information from Step 3 below to comprehensively evaluate potential odor impacts.

Step 3: Odor Complaint History

The impact of an existing odor source on surrounding sensitive receptors should also be evaluated by identifying the number of confirmed complaints received for that specific odor source.

Facilities that are regulated by CalRecycle (e.g. landfill, composting, etc.) are required to have Odor Impact Minimization Plans (OIMP) in place and have procedures that establish fence line odor detection thresholds. The Air District recognizes a lead agency's discretion under CEQA to use established odor detection thresholds as thresholds of significance for CEQA review for CalRecycle regulated facilities with an adopted OIMP.

If the proposed project would be located near an existing odor source, lead agencies should contact BAAQMD to obtain the odor complaints over the past 3 years for the source in question. Then calculate the annual average confirmed odor complaints filed for the source. BAAQMD considers a source to have a substantial number of odor complaints if the complaint history includes five or more confirmed complaints per year averaged over a 3-year period. Also, disclose the distance at which receptors were affected by the existing odor source. As discussed in Step 1, describe the topography and landscape between the receptors and the odor source. These distances and landscaping should then be compared with the distance and landscape that would separate the proposed project and the odor source.

If the proposed project would locate an odor source, first identify the location of potential sensitive receptors (i.e., distance, upwind/downwind) with respect to the project site. If the proposed odor source does not have any existing or planned sensitive receptors within the screening distances shown in Table 3-3, it may be considered less than significant for odor impacts. To evaluate how implementation of the proposed source project would affect identified sensitive receptors contact BAAQMD to obtain odor complaints in the region for facilities similar in size and type of odor produced in the past 3 years. These surrogate odor complaints should be evaluated for their distance from source to receptor, and then compared with the distance from the proposed project to receptors. Odor complaints from the surrogate odor source are considered substantial if the complaint history includes more than five confirmed complaints per year averaged over a 3-year period.

BAAQMD considers a substantial number of odor complaints, specifically, more than five confirmed complaints per year averaged over the past three years as the indication of an odor impact. As discussed above, the lead agency should compare the odor parameters (i.e., distance and wind direction) associated with the odor complaints that have been filed with those of the proposed project. Similar to the odor screening distances, odor complaints should not be used as an absolute threshold, but evidence to support a significance determination.

Step 4: Significance Determination

An odor source with five or more confirmed complaints per year averaged over three years is considered to have a significant impact. BAAQMD recognizes that there is not one piece of information that can solely be used to determine the significance of an odor impact. The factors (i.e., Step 1 through 3) discussed above could enhance the potential for a significant odor impact or help prevent the potential for a significant odor impact. For example, a project that would be located near an existing odor source may not discover any odor complaints for the existing odor source. It is possible that factors such as a small number of existing nearby receptors, predominate wind direction blowing away from the existing receptors, and/or seasonality of the odor source has prevented any odor complaints from being filed about the existing odor source. The results of each of the steps above should be clearly disclosed in the CEQA document. Projects should use the collective information from Steps 1 through 3 to qualitatively evaluate the potential for a significant odor impact. The lead agency should clearly state the reasoning for the significance determination using information from Steps 1 through 3 to support the determination.

7.2. MITIGATING ODOR IMPACTS

BAAQMD considers appropriate land use planning the primary method to mitigate odor impacts. Providing a sufficient buffer zone between sensitive receptors and odor sources should be considered prior to analyzing implementation of odor mitigation technology. Projects that would include potential sensitive receptors should consider the odor parameters, discussed in Step 1 above, during the planning process to avoid siting receptors near odor sources. Similarly, projects

that would include an odor source should consider the location of nearby existing sensitive receptors that could be affected by the project.

The source types for which mitigation has been provided below have been selected based on the nature of the odors produced as a result of their operational activities. These land use types are those most likely to result in odor impacts if sensitive receptors are located in close proximity. This should not be considered an exhaustive list and due to the subjective nature of odor impacts, there is no formulaic method to assess if odor mitigation is sufficient. In determining whether the implementation of mitigation would reduce the potential odor impact to a less-than-significant level, rely on the information obtained through the steps above.

7.2.1. Wastewater Treatment Plant

Main odor sources for wastewater treatment plants typically are the headworks area where the wastewater enters the facility and large solids and grit are removed, the primary clarifiers where suspended solids are removed, and the aeration basins when poor mixing characteristics lead to inadequate dissolved oxygen levels. Lead agencies should consider applying the following odor mitigation measures to wastewater treatment plants.

1. Activated Carbon Filter/Carbon adsorption
2. Biofiltration/Bio Trickling Filters
3. Fine Bubble Aerator
4. Hooded Enclosures
5. Wet and Dry Scrubbers
6. Caustic and Hypochlorite Chemical Scrubbers
7. Ammonia Scrubber
8. Energy Efficient Blower System
9. Thermal Oxidizer
10. Capping/Covering Storage Basins and Anaerobic Ponds
11. Mixed Flow Exhaust
12. Wastewater circulation technology
13. Exhaust stack and vent location with respect to receptors

7.2.2. Landfill/Recycling/Composting Facilities

Odors generated from landfills and composting facilities are typically associated with methane production from the anaerobic decomposition of waste. Lead agencies should consider applying the mitigation measures below to reduce and treat methane in facilities. Landfill projects should also implement best management practices to avoid and minimize the creation of anaerobic conditions.

1. Passive Gas Collection
2. Active Gas Collection
3. Flaring or energy production/utilization
4. Vegetation Growth on Landfill Cover
5. Cover/Cap Landfill
6. Odor Neutralizing Spray
7. Negative aeration for compost facilities
8. Turning and mixing of compost piles

Facilities that are regulated by CalRecycle (e.g. landfill, composting, etc.) are required to have Odor Impact Minimization Plans (OIMP) in place and have procedures that establish fence line odor detection thresholds. The Air District recognizes a lead agency's discretion under CEQA to use established odor detection thresholds as thresholds of significance for CEQA review for CalRecycle regulated facilities with an adopted OIMP.

7.2.3. Petroleum Refinery

Odors generated from materials and processes associated with petroleum refineries include, but are not limited to, H_2S, SO_2, mercaptan, ammonia (NH_3), and petroleum coke. Installing the following current and feasible odor mitigation measures for petroleum refineries should be considered.

1. Water Injections to Hydrocracking Process
2. Vapor recovery system
3. Injection of masking odorants into process streams
4. Flare meters and controls
5. Wastewater circulation technology for Aerated Ponds
6. Exhaust stack and vent location with respect to receptors
7. Thermal oxidizers
8. Carbon absorption
9. Biofiltration/Bio Trickling Filters

7.2.4. Chemical Plant

Chemical plants can generate a variety of different odors (e.g., acrylates, phenols, and styrene) as a result of process emissions. The range of odor mitigation measures required for chemical plants may vary substantially depending on the type of odors produced. The odor mitigation measures could be applied to chemical plants.

1. Wet scrubbers (50–90 percent efficiency)
2. Catalytic oxidation (99 percent efficiency)
3. Thermal oxidation (90–99 percent efficiency)
4. Carbon adsorption (95 percent efficiency)
5. Exhaust stack and vent location with respect to receptors



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7.2.5. Food Services

Restaurants, especially fast food restaurants, can generate substantial sources of odors as a result of cooking processes and waste disposal. Char broilers, deep-fryers, and ovens tend to produce food odors that can be considered offensive to some people. The food waste produced by restaurants can putrefy if not properly managed, which can also produce objectionable odors. The follow mitigation measures are management practices and odor technology that can be used to reduce the amount odors generated by food services.

1. Integral grease filtration system or grease removal system
2. Baffle filters
3. Electrostatic precipitator
4. Water cooling/cleaning unit
5. Disposable pleated or bag filters

6. Activated carbon filters
7. Oxidizing pellet beds
8. Incineration
9. Catalytic conversion
10. Proper packaging and frequency of food waste disposal
11. Exhaust stack and vent location with respect to receptors

In conclusion, odor impacts can also be minimized, contained, or prevented by implementing technologies and design measures at the source, or through planning-based measures. Where odor sources and receptors cannot be physically separated to a degree where impacts would be minimized to less-than-significant level, disclosures of odor sources to prospective tenants of sensitive land uses should be used. Mitigation for odors that is both effective and feasible should be selected on a case-by-case basis.

8. CONSTRUCTION-RELATED IMPACTS

Construction-related activities are those associated with the building of a single project or projects that are part of an adopted plan. Construction activities are typically short-term or temporary in duration; however, project-generated emissions could represent a significant impact with respect to air quality and/or global climate change. Construction-related activities generate criteria air pollutants including carbon monoxide (CO), sulfur dioxide (SO_2), particulate matter (PM_{10}, and $PM_{2.5}$); precursor emissions such as, reactive organic gases (ROG) and oxides of nitrogen (NO_X); and GHGs from exhaust, fugitive dust, and off-gas emissions. Sources of exhaust emissions could include on-road haul trucks, delivery trucks, worker commute motor vehicles, and off-road heavy-duty equipment. Sources of fugitive dust emissions could include construction-related activities such as soil disturbance, grading, and material hauling. Sources of off-gas emissions could include asphalt paving and the application of architectural coatings.

The recommendations provided in this chapter only apply to assessing and mitigating construction-related impacts for individual projects. Construction-related assumptions and project-specific information assumed in CEQA analyses should accompany the quantitative analysis described below. Refer to Chapter 9 for recommendations for assessing and mitigating construction-related impacts at the plan level.

8.1. CRITERIA AIR POLLUTANTS AND PRECURSORS

8.1.1. Significance Determination

Step 1: Comparison of Project Attributes with Screening Criteria

The first step in determining the significance of construction-related criteria air pollutants and precursors is to compare the attributes of the proposed project with the applicable screening criteria listed in Chapter 3. If all of the screening criteria are met, construction of the proposed project would result in a less-than-significant impact to air quality (this does not apply to toxic air contaminants). If not, than construction emissions should be quantified.



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Step 2: Emissions Quantification

BAAQMD recommends using URBEMIS to quantify construction emissions for proposed land use development projects and the Roadway Construction Emissions Model (RoadMod) for proposed linear projects such as, new roadway, roadway widening, or pipeline installation. The most current URBEMIS (currently version 9.2.4) should be used for emission quantification. Table 8-3 outlines summary guidelines for using URBEMIS. Refer to Appendix B for detailed instructions for modeling construction-generated emissions using URBEMIS and RoadMod.

Step 3: Comparison of Unmitigated Emissions with Thresholds of Significance

Following quantification of project-generated construction-related emissions, the total average daily emissions of each criteria pollutant and precursor should be compared with the applicable thresholds. If construction-related emissions have been quantified using multiple models or model runs, sum the criteria air pollutants and precursor levels from each where said activities would

overlap. In cases where the exact timing of construction activities is not known, sum any phases that could overlap to be conservative. For fugitive dust significance, verify that the project incorporates all the *Basic Construction Mitigation Measures* for dust control in Table 8-1.

If daily average emissions of construction-related criteria air pollutants or precursors would not exceed any of the thresholds, the project would result in a less-than-significant impact to air quality. If daily average emissions of construction-related criteria air pollutants or precursors would exceed any applicable thresholds, the proposed project would result in a significant impact to air quality and would require mitigation measures for emission reductions.

Step 4: Mitigation and Emission Reductions

For all proposed projects, BAAQMD recommends the implementation of all *Basic Construction Mitigation Measures* (Table 8.1) whether or not construction-related emissions exceed applicable thresholds. In addition, all projects must implement any applicable air toxic control measures (ATCM). For example, projects that have the potential to disturb asbestos (from soil or building material) must comply with all the requirements of ARB's ATCM for Construction, Grading, Quarrying, and Surface Mining Operations. Only reduction measures included in the proposed project's description or recommended as mitigation in a CEQA-compliant environmental document can be included when quantifying mitigated emission levels. Refer to Appendix B for detailed instructions on how to use URBEMIS to quantify the effects of construction emissions mitigation measures.

Step 5: Comparison of Mitigated (Basic Mitigation) Emissions with Thresholds of Significance

Following quantification of project-generated construction-related emissions, compare the total average daily amount of mitigated (with implementation of *Basic Construction Mitigation Measures)* criteria air pollutants and precursors with the applicable thresholds. If the implementation of BAAQMD-recommended *Basic Construction Mitigation Measures* would reduce all construction-related criteria air pollutants and precursors to levels below the applicable thresholds, the impact to air quality would be less than significant. If emissions of any criteria air pollutant or precursor would exceed the applicable thresholds, the impact to air quality would be significant.

Step 6: Implement Additional Construction Mitigation Measures

BAAQMD recommends that all proposed projects, where construction-related emissions would exceed the applicable thresholds, implement the *Additional Construction Mitigation Measures* (Table 8-2). The methodology for quantifying reductions of fugitive PM dust, exhaust, and off gas emissions associated with the implementation of these mitigation measures is described in Appendix B.

Step 7: Comparison of Mitigated Emissions with Thresholds of Significance

Following quantification of project-generated construction-related emissions in accordance with the BAAQMD-recommended methods, compare the total average daily amount of mitigated (with *Additional Construction Mitigation Measures* implemented) criteria air pollutants and precursors with the applicable thresholds. If the implementation of additional mitigation measures would reduce all construction-related criteria air pollutants and precursors to levels below the applicable thresholds, the impact to air quality would be reduced to a less-than-significant level. If mitigated levels of any criteria air pollutant or precursor still exceed the applicable thresholds, the impact to air quality would remain significant and unavoidable.

8.1.2. Mitigating Criteria Air Pollutants and Precursors

Basic Construction Mitigation Measures

For all proposed projects, BAAQMD recommends implementing all the *Basic Construction Mitigation Measures,* listed in Table 8-1, to meet the best management practices threshold for fugitive dust, and whether or not construction-related emissions exceed applicable thresholds. Appendix B provides guidance on quantifying mitigated emission reductions using URBEMIS and RoadMod.

Table 8-1
Basic Construction Mitigation Measures Recommended for ALL Proposed Projects

1. All exposed surfaces (e.g., parking areas, staging areas, soil piles, graded areas, and unpaved access roads) shall be watered two times per day.
2. All haul trucks transporting soil, sand, or other loose material off-site shall be covered.
3. All visible mud or dirt track-out onto adjacent public roads shall be removed using wet power vacuum street sweepers at least once per day. The use of dry power sweeping is prohibited.
4. All vehicle speeds on unpaved roads shall be limited to 15 mph.
5. All roadways, driveways, and sidewalks to be paved shall be completed as soon as possible. Building pads shall be laid as soon as possible after grading unless seeding or soil binders are used.
6. Idling times shall be minimized either by shutting equipment off when not in use or reducing the maximum idling time to 5 minutes (as required by the California airborne toxics control measure Title 13, Section 2485 of California Code of Regulations [CCR]). Clear signage shall be provided for construction workers at all access points.
7. All construction equipment shall be maintained and properly tuned in accordance with manufacturer's specifications. All equipment shall be checked by a certified visible emissions evaluator.
8. Post a publicly visible sign with the telephone number and person to contact at the lead agency regarding dust complaints. This person shall respond and take corrective action within 48 hours. The Air District's phone number shall also be visible to ensure compliance with applicable regulations.

Additional Construction Mitigation Measures

BAAQMD recommends that all proposed projects, where construction-related emissions would exceed the applicable thresholds, implement the *Additional Construction Mitigation Measures* listed in Table 8-2. Appendix B contains more detailed guidance on emission reductions by source type (i.e., fugitive dust and exhaust) for quantification in URBEMIS and RoadMod.



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Table 8-2
Additional Construction Mitigation Measures Recommended for Projects with Construction Emissions Above the Threshold

1. All exposed surfaces shall be watered at a frequency adequate to maintain minimum soil moisture of 12 percent. Moisture content can be verified by lab samples or moisture probe.
2. All excavation, grading, and/or demolition activities shall be suspended when average wind speeds exceed 20 mph.
3. Wind breaks (e.g., trees, fences) shall be installed on the windward side(s) of actively disturbed areas of construction. Wind breaks should have at maximum 50 percent air porosity.
4. Vegetative ground cover (e.g., fast-germinating native grass seed) shall be planted in disturbed areas as soon as possible and watered appropriately until vegetation is established.
5. The simultaneous occurrence of excavation, grading, and ground-disturbing construction activities on the same area at any one time shall be limited. Activities shall be phased to reduce the amount of disturbed surfaces at any one time.
6. All trucks and equipment, including their tires, shall be washed off prior to leaving the site.
7. Site accesses to a distance of 100 feet from the paved road shall be treated with a 6 to 12 inch compacted layer of wood chips, mulch, or gravel.
8. Sandbags or other erosion control measures shall be installed to prevent silt runoff to public roadways from sites with a slope greater than one percent.
9. Minimizing the idling time of diesel powered construction equipment to two minutes.
10. The project shall develop a plan demonstrating that the off-road equipment (more than 50 horsepower) to be used in the construction project (i.e., owned, leased, and subcontractor vehicles) would achieve a project wide fleet-average 20 percent NO_X reduction and 45 percent PM reduction compared to the most recent ARB fleet average. Acceptable options for reducing emissions include the use of late model engines, low-emission diesel products, alternative fuels, engine retrofit technology, after-treatment products, add-on devices such as particulate filters, and/or other options as such become available.
11. Use low VOC (i.e., ROG) coatings beyond the local requirements (i.e., Regulation 8, Rule 3: Architectural Coatings).
12. Requiring that all construction equipment, diesel trucks, and generators be equipped with Best Available Control Technology for emission reductions of NOx and PM.
13. Requiring all contractors use equipment that meets CARB's most recent certification standard for off-road heavy duty diesel engines.

Assessing Mitigation Measures

Table 8-3 provides a summary of BAAQMD recommendations for assessing construction-related impacts and mitigation measures using URBEMIS. See Appendix B for additional guidance.

Table 8-3
URBEMIS Guidance for Assessing Construction-Related Impacts

URBEMIS Construction Input Parameter	Guidance Principle
Land Use Type and Size	• Select most applicable land use type. • Use the appropriate land use units.
Construction Schedule	• Use the earliest possible commencement date(s) if project-specific information is unknown. • Overlap phases that will or have the potential to occur simultaneously. • Check the selected number of work days per week to ensure an accurate number of construction work days for each phase.
Demolition Phase	• Use a separate demolition URBEMIS run if the land use size to be developed differs from the land use size to be demolished. • Demolition fugitive dust is based on maximum daily volume of building to be demolished. • Demolition construction equipment is based on acres of land use to be demolished (in *Enter Land Use Data* module).
Site Grading Phase	• Site grading construction equipment is based on maximum daily acres disturbed. • Enter project-specific maximum daily acres disturbed if known, otherwise URBEMIS assumes the maximum daily amount of acres disturbed is 25 percent of total acres disturbed.
Site Grading Fugitive Dust	• Select the appropriate fugitive dust quantification methodology based on the amount and type of project-specific information available. • The more specific grading information available will result in more accurate quantification of PM emissions.
Asphalt Paving Phase	• Acres to be asphalt paved are based on land use type and size (in *Enter Land Use Data* module). • Asphalt paving construction equipment is based on total acres to be paved. • Assumes asphalt paving occurs at equal rate throughout phase. • Account for excess asphalt paving requirements of project beyond default assumptions by adjusting the acres to be paved.
Architectural Coatings	• Assumes architectural coating operations occur at equal rate throughout phase.
Basic Construction Mitigation Measures	• All projects must implement Basic Construction Mitigation Measures, including those below the construction screening levels. • Use surrogate URBEMIS mitigation to account for Basic Construction Mitigation Measures' emission reductions.
Additional Construction Mitigation Measures	• Projects with construction emissions that exceed the thresholds are required to implement Additional Construction Mitigation Measures. • Use surrogate URBEMIS mitigation to account for Additional Construction Mitigation Measures' emission reductions.
Other	• For all construction phases, the more specific information available will result in more accurate emissions quantification. • When a specific construction schedule is unknown, all phases that could potentially overlap should be added to calculate maximum daily emissions.

8.2. GREENHOUSE GASES

BAAQMD does not have an adopted *Threshold of Significance* for construction-related GHG emissions. However, lead agencies should quantify and disclose GHG emissions that would occur during construction, and make a determination on the significance of these construction-generated GHG emission impacts in relation to meeting AB 32 GHG reduction goals. BAAQMD recommends using URBEMIS for proposed land use development projects and RoadMod for proposed projects that are linear in nature. Sources of construction-related GHGs include exhaust, for which the same detailed guidance as described for criteria air pollutants and precursors should be followed.

Lead agencies are encouraged to incorporate best management practices to reduce GHG emissions during construction, as applicable. Best management practices may include, but are not limited to: using alternative fueled (e.g., biodiesel, electric) construction vehicles/equipment of at least 15 percent of the fleet; using local building materials of at least 10 percent; and recycling or reusing at least 50 percent of construction waste or demolition materials.

8.3. TOXIC AIR CONTAMINANTS

BAAQMD recommends that the same community risk and hazard *Threshold of Significance* for project operations be applied to construction. However, BAAQMD suggests associated impacts should be addressed on a case-by-case basis, taking into consideration the specific construction-related characteristics of each project and proximity to off-site receptors, as applicable. BAAQMD recommends that for construction projects that are less than one year duration, lead agencies should annualize impacts over the scope of actual days that peak impacts are to occur, rather than the full year.

BAAQMD has developed guidance for estimating risk and hazards impacts entitled *Recommended Methods for Screening and Modeling Local Risks and Hazards* which also includes recommendations for mitigation of significant risk and hazards impacts. BAAQMD has also developed a Construction Risk Calculator model that provides distances from a construction site, based on user-provided project date, where the risk impacts are estimated to be less than significant; sensitive receptors located within these distances would be considered to have potentially significant risk and hazards impacts from construction. The Construction Risk Calculator will be available on BAAQMD's website, http://www.baaqmd.gov/Divisions/Planning-and-Research/CEQA-GUIDELINES.aspx.

8.3.1. Diesel Particulate Matter

Construction-related activities could result in the generation of TACs, specifically diesel PM, from on-road haul trucks and off-road equipment exhaust emissions. Due to the variable nature of construction activity, the generation of TAC emissions in most cases would be temporary, especially considering the short amount of time such equipment is typically within an influential distance that would result in the exposure of sensitive receptors to substantial concentrations. Concentrations of mobile-source diesel PM emissions are typically reduced by 70 percent at a distance of approximately 500 feet (ARB 2005). In addition, current models and methodologies for conducting health risk assessments are associated with longer-term exposure periods of 9, 40, and 70 years, which do not correlate well with the temporary and highly variable nature of construction activities. This results in difficulties with producing accurate estimates of health risk. Additionally, the implementation of the *Basic Construction Mitigation Measures* (table 8-1), which is recommended for all proposed projects, would also reduce diesel PM exhaust emissions.

However, these variability issues associated with construction do not necessarily minimize the significance of possible impacts.

The analysis should disclose the following about construction-related activities:

1. Types of off-site receptors and their proximity to construction activity within approximately 1,000 feet;
2. Duration of construction period;
3. Quantity and types of diesel-powered equipment;
4. Number of hours equipment would be operated each day;
5. Location(s) of equipment use, distance to nearest off-site sensitive receptors, and orientation with respect to the predominant wind direction;
6. Location of equipment staging area; and
7. Amount of on-site diesel-generated $PM_{2.5}$ exhaust (assuming that all on-site diesel $PM_{2.5}$ exhaust is diesel PM) if mass emission levels from construction activity are estimated.

In cases where construction-generated emissions of diesel PM are anticipated to occur in close proximity to sensitive receptors for extended periods of time, lead agencies are encouraged to consult with BAAQMD.

8.3.2. Demolition and Renovation of Asbestos-Containing Materials

Demolition of existing buildings and structures would be subject to BAAQMD Regulation 11, Rule 2 (Asbestos Demolition, Renovation, and Manufacturing). BAAQMD Regulation 11, Rule 2 is intended to limit asbestos emissions from demolition or renovation of structures and the associated disturbance of asbestos-containing waste material generated or handled during these activities. The rule addresses the national emissions standards for asbestos along with some additional requirements. The rule requires the lead agency and its contractors to notify BAAQMD of any regulated renovation or demolition activity. This notification includes a description of structures and methods utilized to determine whether asbestos-containing materials are potentially present. All asbestos-containing material found on the site must be removed prior to demolition or renovation activity in accordance with BAAQMD Regulation 11, Rule 2, including specific requirements for surveying, notification, removal, and disposal of material containing asbestos. Therefore, projects that comply with Regulation 11, Rule 2 would ensure that asbestos-containing materials would be disposed of appropriately and safely. By complying with BAAQMD Regulation 11, Rule 2, thereby minimizing the release of airborne asbestos emissions, demolition activity would not result in a significant impact to air quality.

Because BAAQMD Regulation 11, Rule 2 is in place, no further analysis about the demolition of asbestos-containing materials is needed in a CEQA document. BAAQMD does recommend that CEQA documents acknowledge and discuss BAAQMD Regulation 11, Rule 2 to support the public's understanding of this issue.

8.3.3. Naturally Occurring Asbestos

Naturally occurring asbestos (NOA) was identified as a TAC in 1986 by ARB. NOA is located in many parts of California and is commonly associated with ultramafic rocks, according to the California Department of Geology's special publication titled Guidelines for Geologic Investigations of Naturally Occurring Asbestos in California. Asbestos is the common name for a group of naturally occurring fibrous silicate minerals that can separate into thin but strong and durable fibers. Ultramafic rocks form in high-temperature environments well below the surface of the earth. By the time they are exposed at the surface by geologic uplift and erosion, ultramafic rocks may be partially to completely altered into a type of metamorphic rock called serpentinite.

Sometimes the metamorphic conditions are right for the formation of chrysotile asbestos or tremolite-actinolite asbestos in the bodies of these rocks, along their boundaries, or in the soil.

For individuals living in areas of NOA, there are many potential pathways for airborne exposure. Exposures to soil dust containing asbestos can occur under a variety of scenarios, including children playing in the dirt; dust raised from unpaved roads and driveways covered with crushed serpentine; grading and earth disturbance associated with construction activity; quarrying; gardening; and other human activities. For homes built on asbestos outcroppings, asbestos can be tracked into the home and can also enter as fibers suspended in the air. Once such fibers are indoors, they can be entrained into the air by normal household activities, such as vacuuming (as many respirable fibers will simply pass through vacuum cleaner bags).

People exposed to low levels of asbestos may be at elevated risk (e.g., above background rates) of lung cancer and mesothelioma. The risk is proportional to the cumulative inhaled dose (quantity of fibers), and also increases with the time since first exposure. Although there are a number of factors that influence the disease-causing potency of any given asbestos (such as fiber length and width, fiber type, and fiber chemistry), all forms are carcinogens.

8.3.4. Mitigating Naturally Occurring Asbestos

BAAQMD enforces CARB's ATCM which regulates NOA emissions from grading, quarrying, and surface mining operations at sites which contain ultramafic rock. The provisions that cover these operations are found specifically in the California Code of Regulations, Section 93105. The ATCM for Construction, Grading, Quarrying and Surface Mining Operations was signed into State law on July 22, 2002, and became effective in the SFBAAB on November 19, 2002. The purpose of this regulation is to reduce public exposure to NOA from construction and mining activities that emit or re-suspend dust which may contain NOA.

The ATCM requires regulated operations engaged in road construction and maintenance activities, construction and grading operations, and quarrying and surface mining operations in areas where NOA is likely to be found, to employ the best available dust mitigation measures to reduce and control dust emissions. Tables 8-1 and 8-2 list a number of dust mitigation measures for construction.

BAAQMD's NOA program requires that the applicable notification forms from the Air District's website be submitted by qualifying operations in accordance with the procedures detailed in the ATCM Inspection Guidelines Policies and Procedures. The lead agency should reference BAAQMD's ATCM Policies and Procedures to determine which NOA Notification Form is applicable to the proposed project (NOA Notification Forms).

Using the geologic map of the SFBAAB (Geologic Map), the lead agency should discuss whether a proposed project would be located in "areas moderately likely to contain NOA." If a project would not involve earth-disturbing construction activity in one of these areas or would not locate receptors in one of these areas then it can be assumed that the project would not have the potential to expose people to airborne asbestos particles.

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PART III: ASSESSING & MITIGATING PLAN LEVEL IMPACTS

9. PLAN-LEVEL IMPACTS



Long range plans (e.g., general plan, redevelopment plans, specific plans, area plans, community plans, regional plans, congestion management plans, etc.) present unique challenges for assessing impacts. These plans often contain development strategies for 20-year, or longer, time horizons. They can also provide for a wide range of potential land uses and densities that accommodate all types of development. General plan updates and large specific plans nearly always require the lead agency to prepare an Environmental Impact Report (EIR). Due to the SFBAAB's nonattainment status for ozone and PM, and the cumulative impacts of growth on air quality, these plans almost always have significant, unavoidable adverse air quality impacts. CEQA requires the lead agency to evaluate individual as well as cumulative impacts of general plans, and all feasible mitigation measures must be incorporated within the proposed plan to reduce significant air quality impacts.

This chapter provides guidance on methods to evaluate air quality and climate change impacts of long-range plans prepared within the SFBAAB pursuant to CEQA. The term *general and area plan* refers broadly to discretionary planning activities which may include, but are not limited to the following: general plans, redevelopment plans, specific plans, area plans, community plans, congestion management plans, and annexations of lands and service areas. General and area plans are often subject to program-level analysis under CEQA, as opposed to project-level analysis. As a general principle, the guidance offered within this chapter should be applied to discretionary, program-level planning activities; whereas the project-level guidance offered in other chapters should be applied to individual project-specific approvals, such as a proposed development project.

Air quality impacts from future development pursuant to general or area plans can be divided into construction-related impacts and operational-related impacts. Construction-related impacts are associated with construction activities likely to occur in conjunction with future development allocated by the plan. Operational-related impacts are associated with continued and future operation of developed land uses, including increased vehicle trips and energy use.

Please note that the plan-level approach described here differs for greenhouse gas (GHG) impact assessments. BAAQMD recommends that when assessing GHG impacts for plans other than regional plans (transportation and air quality plans) and general plans, such as specific plans and area plans, the appropriate thresholds and methodology is the same as project-level GHG impact assessments described in Chapter 4.

Regional plan (transportation and air quality plans) impacts also are assessed differently because of their unique characteristics (regional plans do not establish land use designations) and are subject to a threshold of "no net increase in emissions."

9.1. CRITERIA AIR POLLUTANTS AND PRECURSOR EMISSIONS

To meet the *Threshold of Significance* for operational-related criteria air pollutant and precursor impacts for plans (other than regional plans), a proposed plan must satisfy the following criteria:

- Consistency with current air quality plan (AQP) control measures (this requirement applies to project-level as well as plan-level analyses).
- A proposed plan's projected VMT or vehicle trips (VT) (either measure may be used) increase is less than or equal to its projected population increase.

Air Quality Plan Control Measures

For this threshold, an air quality plan refers to clean air plans, state implementation plans (SIPS), ozone plans, and other potential air quality plans developed by BAAQMD. To date, the Air District's most current plan is the 2010 Clean Air Plan.

The following approach for incorporating current AQP control measures into a plan is also applicable for determining a project's consistency with an air quality plan. CEQA requires lead agencies to determine whether a project is consistent with all applicable air quality plans. In addition, the State CEQA Guidelines sample Environmental Checklist Form (Appendix G), poses the question: "Would the project conflict with or obstruct implementation of the applicable air quality plan?"

BAAQMD recommends that the agency approving a project where an air quality plan consistency determination is required analyze the project with respect to the following questions. If all the questions are concluded in the affirmative, and those conclusions are supported by substantial evidence, BAAQMD considers the project consistent with air quality plans prepared for the Bay Area.

1. Does the project support the primary goals of the AQP?

The primary goals of the 2010 Bay Area Clean Air Plan (CAP), the current AQP to date, are to:

- Attain air quality standards;
- Reduce population exposure and protecting public health in the Bay Area; and
- Reduce greenhouse gas emissions and protect the climate.

Any project (i.e. project or plan) that would not support these goals would not be considered consistent with the 2010 CAP. The recommended measure for determining project support of these goals is consistency with District-approved CEQA thresholds of significance. Therefore, if approval of a project would not result in significant and unavoidable air quality impacts, after the application of all feasible mitigation, the project would be considered consistent with the 2010 CAP.

2. Does the project include applicable control measures from the AQP?

Agencies approving projects should require that they include all air quality plan control measures that can feasibly be incorporated into the project design or applied as mitigation, or justify the reasons, supported by substantial evidence, why a measure or measures are not incorporated into the project. Projects that incorporate all feasible air quality plan control measures are considered consistent with the 2010 CAP.

The 2010 CAP contains 55 control measures aimed at reducing air pollution in the Bay Area. Along with the traditional stationary, area, mobile source and transportation control measures, the 2010 CAP contains a number of new control measures designed to protect the climate and promote mixed use, compact development to reduce vehicle emissions and exposure to pollutants from stationary and mobile sources. BAAQMD encourages project developers and lead agencies to incorporate these Land Use and Local Impact (LUM) measures and Energy and Climate measures (ECM) into proposed project designs and plan elements.

Refer to Volume II of the 2010 CAP Control Measure for a list of all the control measures and implementation guidance.

3. Does the project disrupt or hinder implementation of any AQP control measures?

If approval of a project would not cause the disruption, delay or otherwise hinder the implementation of any air quality plan control measure, it would be considered consistent with the 2010 CAP. Examples of how a project may cause the disruption or delay of control measures include a project that precludes an extension of a transit line or bike path, or proposes excessive parking beyond parking requirements.

Projected VMT and Population Growth

A proposed plan must demonstrate that its projected VMT or vehicle trips (VT) (either measure may be used) is less than or equal to its projected population increase to be considered to have a less than significant impact on criteria air pollutants and precursor emissions.

9.2. GREENHOUSE GASES

California's legislative mandate (AB 32) is to reduce total projected 2020 GHG emissions to 1990 levels, a reduction of approximately 30 percent. To achieve this target, future development must be planned and implemented in the most GHG-efficient manner possible. GHG-efficient development reduces vehicle miles traveled by supporting compact, dense, mixed-use, pedestrian- and bicycle-friendly, transit oriented development. State, regional and local agencies are strongly encouraged to address GHG emissions when updating and/or adopting long-range plans. For local jurisdictions, the general plan is perhaps the best venue for addressing GHG emissions in making meaningful progress toward attaining AB 32 goals while addressing CEQA requirements.



If a long-range plan includes goals, policies, performance standards, and implementation measures achieving GHG emission reductions that can be shown to meet and/or exceed AB 32 mandates, as outlined in Section 4.3, subsequent projects consistent with the plan could be relieved of performing GHG analysis as part of their CEQA compliance.

The threshold for operational-related GHG impacts of plans employs either a GHG efficiency-based metric of 6.6 MT per SP per year of carbon dioxide equivalent (CO_2e), or a GHG Reduction Strategy option. Unlike the other plan-level thresholds that apply to the different plans

mentioned in Section 9 above, the GHG efficiency threshold may only be applied to general plans. A lead agency may also determine that this threshold is appropriate for a GHG Reduction Strategy's 2020 milestone target. GHG Reduction Strategies using this threshold with horizon years beyond 2020 should consider horizon-year goals consistent with climate stabilization predictions identified in the Governor's Executive Order S-03-05, and include an interim goal for 2020..

Step 1. GHG Reduction Strategy Approach

A general plan would be assumed to have a less than significant impact related to GHG emissions if the lead agency has a qualified GHG Reduction Strategy that is referenced and or integrated within the general plan. See Section 4.3 for qualifying criteria for a qualified GHG Reduction Strategy.

If the lead agency does not have a qualified GHG Reduction Strategy meeting established criteria, refer to Step 2.

Step 2. GHG Efficiency Approach – Emissions Quantification



BAAQMD recommends quantifying community-wide GHG emissions from a general plan through development of a GHG emissions inventory and projections report. The emissions inventory should be conducted for a base year at or before the current year of the plan; and should follow published ARB protocols for municipal and community-wide inventories (when available). The base year inventory should be expressed in terms of metric tons CO_2e emissions and account for municipal and community-wide emission sectors applicable in the jurisdiction such as, transportation, commercial, residential, water use and treatment, solid waste, and agriculture. BAAQMD's *GHG Plan Level Quantification Guidance* contains detailed recommendations for developing GHG emission inventories and projections. This document is available at BAAQMD's website, http://www.baaqmd.gov/Divisions/Planning-and-Research/CEQA-GUIDELINES.aspx.

Section 4.3 contains additional guidance on preparing a GHG emissions inventory and projections report for a qualified GHG Reduction Strategy that should be applied to general plans as well. A range of tools and resources are available to assist lead agencies in completing inventories, including the Air District's *GHG Plan Level Quantification Guidance*, Intergovernmental Panel on Climate Change (IPCC) Emissions Inventory Guidelines, the California Climate Action Registry's General Reporting Protocol and ICLEI's Clean Air and Climate Protection (CACP) model. In all instances where regional, statewide or national data sources are available, BAAQMD recommends that local data be used if available and more accurate.

Step 3. Prepare Greenhouse Gas Emissions Projections

BAAQMD recommends preparing a community-wide GHG emission projection to identify the expected levels of GHG emissions for: 1) 2020 (i.e., the AB 32 benchmark year), and 2) the projected year of the plan build out. Two projections should be prepared for each year:

- A projection reflecting existing conditions (e.g., business-as-usual), and

- A projection that accounts for proposed policies, programs, and plans included within the general plan that would reduce GHG emissions from build-out of the plan.

The first projection should be used as the basis for evaluation of the no project alternative in the plan's EIR. The second projection should be used as the basis for evaluation of the proposed project. Additional projections corresponding to plan alternatives considered within the EIR should also be prepared and included within the EIR's alternatives analysis. Examples of policies, performance standards and implementation measures are included in Section 9.6.

Where possible, emission projections should account for population and employment growth rates published by ABAG, VMT growth rates available from MTC, energy consumption growth rates available from California Energy Commission (CEC) planned expansions of municipal infrastructure or services, and anticipated statewide legislative requirements or mandates (e.g., Renewable Energy Portfolio, Green Building Code Standards, on-road vehicle emission regulations).

A range of GIS-based planning models are available that can assist lead agencies in completing projections, including Index, PLACE3S, UPlan, and the Sustainable Systems Integration Model (SSIM). The projection should be expressed in metric tons CO_2e emissions, and include the expected municipal and community-wide emissions across all sectors evaluated in the base year inventory.

BAAQMD encourages lead agencies to prepare similar projections for 2050 (the Executive Order S-03-05 benchmark year). As we approach the 2020 timeframe, BAAQMD will reevaluate this significance threshold to better represent progress toward 2050 goals. The lead agency should use the projected build-out emissions profile of the general or area plan as a benchmark to ensure that adoption of the plan would not preclude attainment of 2050 goals.

Step 4. Determine Planned Population and Employment Levels and Service Population

State law requires that general and area plans identify the planned density and intensity of land uses for all lands within the planning area established by the lead agency. These measures of density (typically dwelling units/acre) and intensity (typically floor-area ratios) are often translated into expected population and employment levels for estimating traffic impacts associated with the proposed plan. Most demand-based transportation models use population and employment to determine trip generation. Measures of population and employment are typically available for general and area plans. In evaluating GHG impacts, estimates of the number of residents and jobs anticipated in the general or area plan are required for 2020, the build-out year of the proposed plan, the no project alternative, and additional alternatives the lead agency is evaluating in the environmental review.

Service population (SP) is an efficiency-based measure used by BAAQMD to estimate the development potential of a general or area plan. SP is determined by adding the number of residents to the number of jobs estimated for a given point in time. For purposes of evaluating GHG impacts, SP estimates are required for 2020 and for the build-out year of the proposed plan.

Step 5. Compare Service Population to 2020 GHG Projections and Thresholds of Significance

The lead agency should divide the 2020 GHG emissions inventory by 2020 SP estimates to determine the per-SP emissions associated with the proposed general or area plan, the no project alternative, and additional alternatives the lead agency is evaluating. The lead agency should then compare these per-SP emissions to the significance thresholds identified in Chapter 2 (refer to Table 9-1).

Table 9-1 Example Plan-level Greenhouse Gas Emissions Analysis			
Step	**Emissions Source**	**Year**	**Emissions (MT CO2e/yr)***
2	GHG Emissions Inventory (Community-wide and municipal)	Base year (e.g., 2007)	A
3	GHG Emissions Projections	2020	B
		GP Buildout (e.g., 2030)	C
4	Projected Service Population (population + employment)	SP	
	GHG/SP (2020)	B/SP (MT CO_2e/SP/yr)	
5	BAAQMD GHG/SP Threshold	6.6 (MT CO_2e/SP/yr)	
	Is B/SP > 6.6? (If Yes, Significant. Proceed to Step 6. If No, less than significant).		
*Letters "A", "B", and "C" are used to represent numeric values that would be obtained through conducting a community-wide emissions inventory and projections. Notes: CO_2e = carbon dioxide equivalent; MT = metric tons; yr = year, P = population, SP = service population. Refer to Appendix D for support documentation.			

If the estimated per-SP emissions exceed identified thresholds, the general or area plan would be considered to have a significant impact with respect to GHG emissions, and mitigation would be required.

Step 6. Mitigation Measures

General or area plans found to have a significant impact should implement all feasible mitigation measures to reduce impacts. Refer to Section 9.5 for examples of appropriate mitigation measures for operational impacts relative to GHG emissions. Mitigation measures identified through the environmental review process must be made into binding and enforceable policies and implementation programs within the long range plan.

9.3. LOCAL COMMUNITY RISK AND HAZARD IMPACTS

For general and area plans to have a less-than-significant impact with respect to potential toxic air contaminants (TACs), special overlay zones need to be established around existing and proposed land uses that emit TACs. Special overlay zones should be included in proposed plan policies, land use maps, and implementing ordinances.



The *Thresholds of Significance* for plans with regard to community risk and hazard impacts are:

1. The land use diagram must identify:

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a. Special overlay zones around existing and planned sources of TACs;

b. Special overlay zones of at least 500 feet (or Air District-approved modeled distance) on each side of all freeways and high-volume roadways.

2. The plan must also identify goals, policies, and objectives to minimize potential impacts and create overlay zones for sources of TACs and receptors.

ARB's Land Use Handbook offers advisory recommendations for locating sensitive receptors near uses associated with TACs, such as freeways and high-traffic roads, commercial distribution centers, rail yards, ports, refineries, chrome platers, dry cleaners, gasoline stations, and other industrial facilities, to reduce exposure of sensitive populations. The lead agency should refer to this handbook when evaluating whether the proposed general or area plan includes adequate buffer distances between TAC sources and sensitive receptors.

9.3.1. Community Risk Reduction Plans

The goal of a Community Risk Reduction Plan (CRRP) would be to bring TAC and $PM_{2.5}$ concentrations for the entire community covered by the Plan down to acceptable levels as identified by the local jurisdiction and approved by the Air District. This approach provides local agencies a proactive alternative to addressing communities with high levels of risk on a project-by-project approach.

A qualified Community Risk Reduction Plan adopted by a local jurisdiction should include, at a minimum, the following elements:

(A) Define a planning area;

(B) Include base year and future year emissions inventories of TACs and PM2.5;

(C) Include Air District–approved risk modeling of current and future risks;

(D) Establish risk and exposure reduction goals and targets for the community in consultation with BAAQMD staff;

(E) Identify feasible, quantifiable, and verifiable measures to reduce emissions and exposures;

(F) Include procedures for monitoring and updating the inventory, modeling and reduction measures in coordination with Air District staff; and

(G) Be adopted in a public process following environmental review.

Refer to Chapter 5 for additional guidance on preparing a CRRP. BAAQMD has also developed the *Community Risk Reduction Plan Methodology* guidance document, which can found at http://www.baaqmd.gov/Divisions/Planning-and-Research/CEQA-GUIDELINES.aspx.

9.4. ODOR IMPACTS

For plans to have a less-than-significant impact, a plan must identify the location of existing and planned odor sources in the plan area. The plan must also include policies to reduce potential odor impacts in the plan area.

9.5. REGIONAL PLANS

Regional plans must demonstrate a no net increase in emissions to satisfy the *Threshold of Significance* for operational-related criteria air pollutant and precursor impacts, GHGs, and toxic air contaminants.

Regional plans include the Regional Transportation Plan prepared by the Metropolitan Transportation Commission (MTC) and air quality plans prepared by the Air District. In order to meet this threshold, these agencies must compare the regional plan's baseline emissions with its projected future emissions. This approach requires two comparative analyses:

a. Compare existing (base year) emissions with projected future year plus project emissions (base year/project comparison);

b. Compare projected future year emissions without the project with projected future year emissions plus the project (no project/project comparison).

A regional plan is considered less than significant if each scenario demonstrates that no net increase in emissions of criteria air pollutants and precursors, GHGs, and toxic air contaminants will occur.

9.6. MITIGATING PLAN-LEVEL IMPACTS

Plans often have significant, unavoidable adverse air quality impacts due to the SFBAAB's nonattainment status and the cumulative impacts of growth on air quality. In addition, plans generally have long-term planning horizons of twenty years or more. For these reasons, it is essential for plans to incorporate all feasible strategies and measures to reduce air quality impacts. Mitigation measures for plans are often broad in scope due to the long timeframe and comprehensive nature of general and area plan policies and programs.

This section contains mitigation measures recommended for plans prepared within the SFBAAB. Measures are identified by state-required general plan element, planning issue, development phase, and type of air quality impact. Proposed plans should incorporate mitigation measures applicable to their elements and planning issues.



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Plans are the appropriate place to establish community-wide air quality policies that reinforce regional air quality plans. Plans present opportunities to establish requirements for new construction, future development, and redevelopment projects within a community that will ensure new or revised plans do not inhibit attainment of state and national air quality standards and actually assist in improving local and regional air quality. Binding, enforceable mitigation measures identified through the environmental review process should be incorporated as policies and implementation programs within the plan to the

greatest extent feasible. Ideally, air quality related goals, policies, performance measures and standards should be incorporated within the context of the proposed project itself, rather than introduced as corrective actions within the proposed project's EIR. The list below is not intended to serve as an exhaustive list. The Air District also recommends that Lead Agencies refer to CAPCOA's reports, *Model Policies for Greenhouse Gases in General Plans* (June 2009) for additional guidance (http://www.capcoa.org/modelpolicies/CAPCOA-ModelPolicies-6-12-09-915am.pdf) and *Quantifying GHG Mitigation Measures*.

9.6.1. Land Use Element

Urban Form

Mitigation Measure or General/Area Plan Policy	Construction				Operational			
	CAPs	GHGs	TACs	Odors	CAPs	GHGs	TACs	Odors
Create and enhance landscaped greenway, trail, and sidewalk connections between neighborhoods, commercial areas, activity centers, and parks.					X	X		
Adopt policies supporting infill development					X	X		
Ensure that proposed land uses are supported by a multi-modal transportation system and that the land uses themselves support the development of the transportation system.					X	X		
Designate a central city core for high-density and mixed-use development.					X	X		
Discourage high intensity office and commercial uses from locating outside of designated centers or downtowns, or far from residential areas and transit stations.					X	X		
Provide financial incentives and density bonuses to entice development within the designated central city.					X	X		
Provide public education about benefits of well-designed, higher-density housing and relationships between land use and transportation.					X	X		

Compact Development

Mitigation Measure or General/Area Plan Policy	Construction				Operational			
	CAPs	GHGs	TACs	Odors	CAPs	GHGs	TACs	Odors
Achieve a jobs/housing balance or improve the jobs/housing ratio within the plan area.					X	X		
Create incentives to attract mixed-use projects to older commercial and industrial areas.					X	X		
Adopt incentives for the concurrent development of retail, office, and residential land uses within mixed-use projects or areas. Require mixed-use development to include ground-floor retail.					X	X		
Provide adaptive re-use alternatives to demolition of historic buildings. Provide incentives to prevent demolition of historic buildings.	X	X			X	X		
Facilitate lot consolidation that promotes integrated development with improved pedestrian and vehicular access.					X	X		
Reinvest in existing neighborhoods and promote infill development as a					X	X		

preference over new, greenfield development.								
Ensure that new development finances the full cost of expanding public infrastructure and services to provide an economic incentive for incremental expansion.					X	X		
Require new developments to extend sewer and water lines from existing systems or to be in conformance with a master sewer and water plan.	X	X			X	X		

Transit-oriented Design

Mitigation Measure or General/Area Plan Policy	Construction				Operational			
	CAPs	GHGs	TACs	Odors	CAPs	GHGs	TACs	Odors
Require all development projects proposed within 2,000 feet of an existing or planned light rail transit, commuter rail, express bus, or transit corridor stop, to incorporate site design measures that enhance the efficiency of the transit system.					X	X		
Develop transit/pedestrian-oriented design guidelines. Identify and designate appropriate sites during general plan updates and amendments.					X	X		
Plan areas within ¼-mile of locations identified as transit hubs and commercial centers for higher density development.					X	X		

Sustainable Development

Mitigation Measure or General/Area Plan Policy	Construction				Operational			
	CAPs	GHGs	TACs	Odors	CAPs	GHGs	TACs	Odors
Ensure new construction complies with California Green Building Code Standards and local green building ordinances.					X	X		
Promote re-use of previously developed property, construction materials, and/or vacant sites within a built-up area.					X	X		
Avoid development of isolated residential areas near hillsides or other areas where such development would require significant infrastructure investment or adversely impact biological resources.						X		
Require orientation of buildings to maximize passive solar heating during cool seasons, avoid solar heat gain during hot periods, enhance natural ventilation, and promote effective use of daylight. Orientation should optimize opportunities for on-site solar generation.					X	X		
Provide land area zoned for commercial and industrial uses to support a mix of retail, office, professional, service, and manufacturing businesses.					X	X		
Provide permitting incentives for energy efficient and solar building projects.					X	X		
Develop a joint powers agreement or other legal instrument that provides incentive for counties to discourage urban commercial development in unincorporated areas and promote urban infill and redevelopment projects.					X	X		

Activity Centers

Mitigation Measure or General/Area Plan Policy	Construction				Operational			
	CAPs	GHGs	TACs	Odors	CAPs	GHGs	TACs	Odors
Provide pedestrian amenities, traffic-calming features, plazas and public areas, attractive streetscapes, shade trees, lighting, and retail stores at activity centers.					X	X		
Provide for a mix of complementary retail uses to be located together to create activity centers and commercial districts serving adjacent neighborhoods.					X	X		
Permit upper-story residential and office uses in neighborhood shopping areas.					X	X		
Provide pedestrian links between commercial districts and neighborhoods.					X	X		
Provide benches, streetlights, public art, and other amenities in activity centers to attract pedestrians.					X	X		

Green Economy and Businesses

Mitigation Measure or General/Area Plan Policy	Construction				Operational			
	CAPs	GHGs	TACs	Odors	CAPs	GHGs	TACs	Odors
Work with businesses to encourage employee transit subsidies and shuttles from transit stations.					X	X		
Encourage businesses to participate in local green business programs.					X	X		
Offer incentives to attract businesses to city core and infill areas.					X	X		
Work to attract green businesses and promote local green job training programs.					X	X		
Support regional collaboration to strengthen the green economy.					X	X		
Provide outreach and education to local businesses on energy, waste, and water conservation benefits and cost savings.					X	X		
Support innovative energy technology companies.					X	X		

9.6.2. Circulation Element

Local Circulation

Mitigation Measure or General/Area Plan Policy	Construction				Operational			
	CAPs	GHGs	TACs	Odors	CAPs	GHGs	TACs	Odors
Create or reinforce a grid street pattern with small block sizes and maintain high connectivity within the roadway network.					X	X		
Implement circulation improvements that reduce vehicle idling, such as signal timing systems and controlled intersections.					X	X	X	
Consider alternatives such as increasing public transit or improving bicycle or pedestrian travel routes before funding transportation improvements that increase VMT.					X	X		
Require payment of transportation impact fees and/or roadway and transit improvements as a condition upon new development.					X	X		
Minimize use of cul-de-sacs and incomplete roadway segments.					X	X		
Actively promote walking as a safe mode of local travel, particularly for children attending local schools.					X	X		
Consult with school districts, private schools, and other operators to coordinate local busing, to expand ride-sharing programs, and to replace older diesel buses with low or zero emission vehicles.					X	X	X	
Evaluate all busing options as a preferential strategy to roadway improvements in the vicinity of schools to ease congestion.					X	X		
Establish public/private partnerships to develop satellite and neighborhood work centers for telecommuting.					X	X		
Employ traffic calming methods such as median landscaping and provision of bike or transit lanes to slow traffic, improve roadway capacity, and address safety issues.					X	X		
Support the use of electric vehicles where appropriate. Provide electric recharge facilities.					X	X		

Regional Transportation

Mitigation Measure or General/Area Plan Policy	Construction				Operational			
	CAPs	GHGs	TACs	Odors	CAPs	GHGs	TACs	Odors
Ensure that submittals of transportation improvement projects to be included in regional transportation plans (RTP, RTIP, CMP, etc.) are consistent with the air quality goals and policies of the general plan.					X	X		
Consult with adjacent jurisdictions to address the impacts of regional development patterns on the circulation system.					X	X		
Adopt a (or implement the existing) Transportation Demand Management Ordinance.					X	X		
Create financing programs for the purchase or lease of vehicles used in employer ride sharing programs.					X	X		
Consult with adjacent jurisdictions to maintain adequate service levels at shared intersections and to provide adequate capacity on regional routes for through traffic.					X	X		
Work to provide a strong paratransit system that promotes the mobility of all residents and educate residents about local mobility choices.					X	X		
Designate sites for park-and-ride lots. Consider funding of the park and ride lots as mitigation during CEQA review of residential development projects.					X	X		
Consult with appropriate transportation agencies and major employers to establish express buses and vanpools to increase the patronage of park and ride lots.					X	X		
Allow developers to reach agreements with auto-oriented shopping center owners to use commercial parking lots as park-and-ride lots and multimodal transfer sites.					X	X		

Parking

Mitigation Measure or General/Area Plan Policy	Construction				Operational			
	CAPs	GHGs	TACs	Odors	CAPs	GHGs	TACs	Odors
Reduce parking for private vehicles while increasing options for alternative transportation.					X	X		
Eliminate minimum parking requirements for new development.					X	X		
Establish commercial district parking fees.					X	X		
Require that parking is paid for separately and is not included in rent for residential or commercial space.					X	X		
Encourage parking sharing between different land uses.					X	X		
Encourage businesses to offer parking cash-outs to employees.					X	X		
Encourage parking assessment districts.					X	X		
Encourage car-share and bike-share programs and dedicated parking spaces in new development.					X	X		
Support preferential parking for low emission and carpool vehicles					X	X		

Bicycles and Pedestrians

Mitigation Measure or General/Area Plan Policy	Construction				Operational			
	CAPs	GHGs	TACs	Odors	CAPs	GHGs	TACs	Odors
Provide safe and convenient pedestrian and bicycle connections to and from activity centers, commercial districts, offices, neighborhoods, schools, other major activity centers.					X	X		
Ensure that non-motorized transportation systems are connected and not interrupted by impassable barriers, such as freeways.					X	X		
Provide pedestrian pathways that are well-shaded and pleasantly landscaped to encourage use.					X	X		
Consult with transit providers to increase the number of bicycles that can be accommodated on buses.					X	X		
Provide crosswalks and sidewalks along streets that are accessible for people with disabilities and people who are physically challenged.					X	X		
Prohibit on-street parking to reduce bicycle/automobile conflicts in appropriate target areas.					X	X		
Prohibit projects that impede bicycle and walking access.					X	X		
Retrofit abandoned rail corridors as segments of a bikeway and pedestrian trail system.					X	X		
Require commercial developments and business centers to include bicycle amenities in building such as bicycle racks, showers, and lockers.					X	X		

Regional Rail Transit

Mitigation Measure or General/Area Plan Policy	Construction				Operational			
	CAPs	GHGs	TACs	Odors	CAPs	GHGs	TACs	Odors
Support regional rail service and consult with rail operators to expand services.					X	X		
Create activity centers and transit-oriented development projects near transit stations.					X	X		

Local and Regional Bus Transit

Mitigation Measure or General/Area Plan Policy	Construction				Operational			
	CAPs	GHGs	TACs	Odors	CAPs	GHGs	TACs	Odors
Give funding preference to investment in public transit over investment in infrastructure for private automobile traffic.					X	X		
Establish a local shuttle service to connect neighborhoods, commercial centers, and public facilities to rail transit.					X	X		
Empower seniors and those with physical disabilities who desire maximum personal freedom and independence of lifestyle with unimpeded access to public transportation.					X	X		
Provide transit shelters that are comfortable, attractive, and accommodate transit riders. Ensure that shelters provide shade, route information, benches and lighting.					X	X		
Design all arterial and collector streets planned as transit routes to allow for the efficient operation of public transit.					X	X		
Require transit providers to coordinate intermodal time schedules					X	X		

9.6.3. Conservation Element

Municipal Operations

Mitigation Measure or General/Area Plan Policy	Construction				Operational			
	CAPs	GHGs	TACs	Odors	CAPs	GHGs	TACs	Odors
Replace existing City vehicles with ultra-low or zero emission vehicles and purchase new low emission vehicles.					X	X		
Require that all new government buildings, and all major renovations and additions, meet identified green building standards.					X	X		
Install cost-effective renewable energy systems on all city buildings and purchase remaining electricity from renewable sources.					X	X		
Support the use of teleconferencing in lieu of city/county employee travel to conferences and meetings when feasible.					X	X		
Require city/county departments to set up telecommuting programs as part of their trip reduction strategies.					X	X		
Require environmentally responsible government purchasing. Require or give preference to products that reduce or eliminate indirect GHG emissions.						X		
Investigate the feasibility of using solar (photovoltaic) street lights instead of conventional street lights to conserve energy.					X	X		
Support investment in cost-effective land use and transportation modeling and geographic information system technology.					X	X	X	X
Install LED lighting for all traffic light systems.						X		
Implement a timed traffic light system to reduce idling.					X	X		

Air Quality – Sensitive Receptors

Mitigation Measure or General/Area Plan Policy	Construction				Operational			
	CAPs	GHGs	TACs	Odors	CAPs	GHGs	TACs	Odors
Develop and adopt a comprehensive Community Risk Reduction Plan that includes: baseline inventory of TAC and $PM_{2.5}$ emissions from all sources, emissions reduction targets, and enforceable emission reduction strategies and performance measures. Community Risk Reduction Plan to include enforcement and monitoring tools to ensure regular review of progress toward the emission reduction targets, report progress to the public and responsible agencies, and revise the plan as appropriate.			X				X	
Require residential development projects and projects categorized as sensitive receptors to be located an adequate distance from existing and potential sources of TACs and odors.				X			X	X
Require new air pollution point sources such as, but not limited to, industrial, manufacturing, and processing facilities to be located an adequate distance from residential areas and other sensitive receptors.	X		X	X	X		X	X
Consult with BAAQMD to identify TAC sources and determine the need for and requirements of a health risk assessment for proposed developments.			X	X			X	X
Consult with project proponents during the pre-application review process to avoid inappropriate uses at affected sites and during the environmental review process for general plan amendments and general plan updates.					X		X	X
Require project proponents to prepare health risk assessments in accordance with BAAQMD-recommended procedures as part of environmental review when the proposed project has associated air-toxic emissions.			X				X	
Designate adequate industrial land in areas downwind and well-separated from sensitive uses.							X	X
Designate non-sensitive land uses for areas surrounding industrial sites.					X		X	X
Protect vacant industrial sites from encroachment by residential or other sensitive uses through appropriate zoning.					X		X	X
Require indoor air quality equipment, such as enhanced air filters, to be installed at schools, residences, and other sensitive receptor uses located near pollution sources.							X	X
Quantify the existing and added health risks to new sensitive receptors or for new sources.							X	
Utilize pollution absorbing trees and vegetation in buffer areas.					X	X	X	

Air Quality – PM_{10} and Dust Control

Mitigation Measure or General/Area Plan Policy	Construction				Operational			
	CAPs	GHGs	TACs	Odors	CAPs	GHGs	TACs	Odors
Include PM_{10} control measures as conditions of approval for subdivision maps, site plans, and grading permits.	X				X			
Minimize vegetation removal required for fire prevention.	X				X			
Require alternatives to discing, such as mowing, to the extent feasible. Where vegetation removal is required for aesthetic or property maintenance purposes, encourage or require alternatives to discing.	X	X			X	X		
Require subdivision designs and site planning to minimize grading and use landform grading in hillside areas.	X							
Condition grading permits to require that graded areas be stabilized from the completion of grading to commencement of construction.	X							
Require all access roads, driveways, and parking areas serving new commercial and industrial development to be constructed with materials that minimize particulate emissions and are appropriate to the scale and intensity of use.	X							
Develop a street cleaning program aimed at removing heavy silt loadings from roadways that result from sources such as storm water runoff and construction sites.	X				X			
Pave shoulders and pave or landscape medians. Curb and gutter installation may provide additional benefits where paving is contiguous to the curb.	X	X			X	X		

Water Conservation

Mitigation Measure or General/Area Plan Policy	Construction				Operational			
	CAPs	GHGs	TACs	Odors	CAPs	GHGs	TACs	Odors
Require residential remodels and renovations to improve plumbing fixture and fixture-fitting water efficiency by an established amount above the California Building Standards Code water efficiency standards.		X						
Provide water use audits to identify conservation opportunities and financial incentives for adopting identified efficiency measures.		X						
Require use of native and drought-tolerant plants, proper soil preparation, and efficient irrigation systems for landscaping.		X				X		
Maximize use of native, low-water plants for landscaping of areas adjacent to sidewalks or other impermeable surfaces.		X				X		
Increase use of recycled and reclaimed water for landscaping projects.		X				X		
Adopt a water-efficient landscaping ordinance and implement the Bay-Friendly Landscaping Guidelines established by StopWaste.org.						X		
Provide public water conservation education.						X		
Reduce pollutant runoff from new development through use of Best Management Practices.	X	X	X		X	X	X	
Minimize impervious surfaces and associated urban runoff pollutants in new development and reuse projects.	X	X	X		X	X	X	
Utilize permeable surfaces and green roof technologies where appropriate.					X	X	X	

Energy Conservation

Mitigation Measure or General/Area Plan Policy	Construction				Operational			
	CAPs	GHGs	TACs	Odors	CAPs	GHGs	TACs	Odors
Conduct energy efficiency audits of existing buildings by checking, repairing, and readjusting heating, ventilation, air conditioning, and lighting, water heating equipment, insulation and weatherization. Offer financial incentives for adoption of identified efficiency measures.		X				X		
Require implementation of energy-efficient design features in new development, including appropriate site orientation, exceedance of Title 24, use of light color roofing and building materials, and use of evergreen and wind-break trees to reduce heating and cooling fuel consumption.		X				X		
Adopt residential and commercial energy efficiency retrofit ordinances that require upgrades as a condition of issuing permits for renovations or additions, and on the sale of residences and buildings.		X				X		
Facilitate cooperation between neighboring development projects to use on-site renewable energy supplies or combined heat and power co-generation facilities.		X				X		
Develop a comprehensive renewable energy financing and informational program for residential and commercial uses.		X				X		
Partner with community services agencies to fund energy efficiency projects for low income residents.		X				X		
Encourage the installation of energy efficient fireplaces in lieu of normal open-hearth fireplaces. Prohibit installation of wood burning devices.	X	X			X	X		
Provide natural gas lines or electrical outlets to backyards to encourage the use of natural gas or electric barbecues, and electric gardening equipment.	X				X			
Implement Community Choice Aggregation (CCA) for renewable electricity generation.		X				X		

Solid Waste

Mitigation Measure or General/Area Plan Policy	Construction				Operational			
	CAPs	GHGs	TACs	Odors	CAPs	GHGs	TACs	Odors
Achieve established local and regional waste-reduction and diversion goals. Adopt more stringent waste reduction goals.		X				X		
Establish programs that enable residents to donate or recycle surplus furniture, old electronics, clothing, and other household items.		X				X		
Establish methane recovery in local landfills and wastewater treatment plants to generate electricity.		X				X		
Participate or initiate a composting program for restaurants and residences.						X		
Implement recycling programs for businesses and construction waste.	X	X			X	X		
Prohibit styrofoam containers and plastic bag use by businesses.					X	X		

9.6.4. Open Space Element

Community Forestry

Mitigation Measure or General/Area Plan Policy	Construction				Operational			
	CAPs	GHGs	TACs	Odors	CAPs	GHGs	TACs	Odors
Require inclusion of low VOC-emitting street trees and landscaping for all development projects.		X				X		
Require that trees larger than a specified diameter that are removed to accommodate development must be replaced at a set ratio.		X				X		
Provide adequate funding to manage and maintain the existing community forest, including sufficient funds for tree planting, pest control, scheduled pruning, and removal and replacement of dead trees.		X				X		
Provide public education regarding the benefits of street trees and the community forest.		X				X		

Sustainable Agriculture

Mitigation Measure or General/Area Plan Policy	Construction				Operational			
	CAPs	GHGs	TACs	Odors	CAPs	GHGs	TACs	Odors
Require agricultural practices be conducted in a manner that minimizes harmful effects on soils, air and water quality, and marsh and wildlife habitat. Sustainable agricultural practices should be addressed in the Qualified GHG Reduction Strategy to address climate change effects if relevant.	X	X			X	X		
Preserve forested areas, agricultural lands, wildlife habitat and corridors, wetlands, watersheds, groundwater recharge areas and other open spaces that provide carbon sequestration benefits.	X	X			X	X		
Establish a mitigation program for establishing conservation areas. Impose mitigation fees on development of such lands and use funds generated to protect existing, or create replacement, conservation areas.	X	X			X	X		
Require no-till farming, crop rotation, cover cropping, and residue farming.	X	X			X	X		
Require the use of appropriate vegetation within urban-agricultural buffer areas.		X				X		
Protect grasslands from conversion to non-agricultural uses.	X	X			X	X		
Support energy production activities that are compatible with agriculture, including biogas, wind and solar.		X				X		
Allow alternative energy projects in areas zoned for agriculture or open space where consistent with primary uses.		X				X		
Provide spaces within the community suitable for farmers markets.						X		
Promote local produce and garden programs at schools.						X		

Parks and Recreation

Mitigation Measure or General/Area Plan Policy	Construction				Operational			
	CAPs	GHGs	TACs	Odors	CAPs	GHGs	TACs	Odors
Expand and improve community recreation amenities including parks, pedestrian trails and connections to regional trail facilities.						X		
Require payment of park fees and/or dedication and provision of parkland, recreation facilities and/or multi-use trails as a condition upon new development.		X				X		
Encourage development of pocket parks in neighborhoods. Improve equal accessibility to park space across communities.		X				X		
Encourage joint use of parks with schools and community centers and facilities.		X				X		

9.6.5. Housing Element

Affordable Housing

Mitigation Measure or General/Area Plan Policy	Construction				Operational			
	CAPs	GHGs	TACs	Odors	CAPs	GHGs	TACs	Odors
Ensure a portion of future residential development is affordable to low and very low income households.		X				X		
Target local funds, including redevelopment and Community Development or Energy Efficiency Block Grant resources, to assist affordable housing developers in incorporating energy efficient designs and features.						X		
Adopt minimum residential densities in areas designated for transit-oriented, mixed use development to ensure higher density in these areas.					X	X		
Consult with the Housing Authority, transit providers, and developers to facilitate construction of low-income housing developments that employ transit-oriented and pedestrian-oriented design principles.					X	X		
Offer density-bonus incentives for projects that provide for infill, mixed use, and higher density residential development.					X	X		

9.6.6. Safety Element

Traffic Safety

Mitigation Measure or General/Area Plan Policy	Construction				Operational			
	CAPs	GHGs	TACs	Odors	CAPs	GHGs	TACs	Odors
Facilitate traffic safety for motorists and pedestrians through proper street design and traffic monitoring.					X	X		
Require traffic control devices, crosswalks, and pedestrian-oriented lighting within design of streets, sidewalks, trails, and school routes.					X	X		

A. CONSTRUCTION ASSESSMENT TOOLS

High Level Haulage Input Worksheet
High Level of Detail Fugitive Dust Quantification Method

Instructions: When using the *High Level of Detail* quantificaiton method to calculate fugitive dust emissions from cut/fill activities, BAAQMD recommends using this worksheet to calculate the on- and off-site haulage inputs for URBEMIS. If a project would involve both on-site and off-site cut/fill operations, the user should create two separate High Level Haulage Input Worksheets (i.e., one worksheet calculation for on-site and one for off-site).

Project Name:

Grading Activity/Phase:

User inputs
Input to use in URBEMIS
Calculation (do not change)

Cut/Fill Operations

Description	Amount	Units	Notes
Total Cut/Fill Volume	1,800	cubic yards	Enter information
Months of Activity	2	months	Enter information
Days of Activity	44	days	
Daily Cut/Fill Volume	40.91	cubic yards/day	

Soil Density by Soil Type and Condition

Soil Type	Bulk Density (grams/cubic centimeter)	Density (pounds/cubic yard)	Density (tons/cubic yard)
Sandy	1.69	2,849	1.42
Loamy Coarse-Loamy	1.63	2,747	1.37
Loamy Fine-Loamy	1.60	2,697	1.35
Loamy Coarse-Silty	1.60	2,697	1.35
Loamy Fine-Silty	1.54	2,596	1.30
Clayey 25-25% clay	1.49	2,511	1.26
Clayey >45% clay	1.39	2,343	1.17

Source: U.S. Department of Agriculture, Natural Resources Conservation Service, 2007. National Soil Survey Handbook, title 430-VI. [Online] Available at <http://soils.usda.gov/technical/handbook/>.

URBEMIS 2007 Ton-Mile Calculation

Description	Amount	Units	Notes
Soil Type	Loamy Coarse-Loamy		Use drop-down menu to select soil type. Assume Sandy unless project-specific soil type is known.
Soil Density	1.37	tons/cubic yard	Enter project specific soil density if known
Haul Distance (Round Trip On-Site)	0.04	miles	Enter distance
Ton-Mile per Day	2.25	ton-miles/day	

Notes:
On-site ton-mile assumes cut/fill volume is moved by scrapers.
Off-site ton-mile assumes cut/fill volume is moved by haul trucks.

URBEMIS Construction Modeling Data Needs/Requests

1) Construction Schedule
   Land use type and size to be developed
   Commencement and buildout date
   Duration and start date for each construction phase (e.g., demolition, grading, building construction)
   Identify any potential or planned overlap in phases

   Note: If project will be built out in multiple phases, provide information above for each phase.

2) Demolition
   Commencement date and duration of activities
   Total volume to be demolished
   Maximum daily volume to be demolished
   Haul truck capacity and distance to disposal site (URBEMIS defaults provided)
   Demolition equipment required (URBEMIS defaults provided)

   Note: URBEMIS estimates demolition construction equipment based on the land use being developed.

3) Grading (Mass and Fine)
   Commencement date and duration of activities
   Maximum daily acres disturbed (URBEMIS defaults provided)
   Volume of material to be cut and/or filled (cubic yards)
   Volume of material to be exported and/or exported (cubic yards)
   Construction equipment required

   Note: URBEMIS estimates grading construction equipment based on maximum daily acres disturbed.

4) Fugitive Dust
   A) Method 1 (Default)
      Maximum daily acres disturbed (URBEMIS defaults provided)

   B) Method 2 (Low Level of Detail)
      Duration of cut/fill operations
      Volume of material to be cut and/or filled (cubic yards)
      Origin of soil material (i.e., on-site or off-site)

   C) Method 3 (Medium Level of Detail)
      Duration of cut/fill operations
      Number of scrapers or haul trucks operating per day
      Hours of operation for each scraper or haul truck (scraper hours and haul truck hours)

   D) Method 4 (High Level of Detail)
      Duration of cut/fill operations
      Volume of material to be cut and/or filled (cubic yards)
      Bulk density of material (i.e., tons per cubic yard)
      Round trip distance required to move materials on-site (on-site miles only)

5) Asphalt Paving
   Commencement date and duration of activities
   Total acres to be paved
   Construction equipment required

   Note: URBEMIS estimates asphalt paving construction equipment based on total acres to be paved.

6) Architectural Coatings
   Commencement date and duration of activities

B. AIR QUALITY MODELING INSTRUCTIONS (URBEMIS)

This section provides detailed instructions for and examples of air quality modeling of operational and construction-related emissions pursuant to the methodological recommendations in this guide.

OPERATIONAL-RELATED EMISSIONS

URBEMIS Input Parameters

URBEMIS provides default values for Bay Area specific modeling parameters. Users may use the default values or provide project specific information when possible for more accurate emission quantification. BAAQMD-recommended input parameters and data requirements along with general URBEMIS user information for each operational-related activity are described below. Refer to the URBEMIS User's Guide and the BAAQMD Greenhouse Gas Model User's Manual (referred to collectively as the "User's Guide" below) for more detailed information.

Table B-1
URBEMIS Input Parameters for Operation Emissions

Operational Input Parameters	Guidance Principle
Air District	Bay Area Air District
Analysis Year	Earliest possible year when project would be operational
Land Use Type and Units	Based on project description
Trip Rate	From project traffic study, local trip rates, or ITE Trip Generation Manual
Project Location	Urban
Road Dust	Category should not be turned off but can be modified if project information is known
Pass-by Trips	See User's Guide for further instructions
Double Counting Correction	See User's Guide for further instructions
Percentage of Land Uses using Natural Gas	100 percent for both residential and nonresidential development
Persons per Residential Unit (Consumer Products)	Based on estimated number of residents
All Other URBEMIS Inputs	Use default values, unless project-specific data is available. See User's Guide for further instructions[1]

[1] The rationale for changing default values should be disclosed in the CEQA document

Land Use Type and Size

Choose each individual land use type (e.g., single family housing, apartment high rise, regional shopping center, or office park) that is most applicable to the proposed development project in the *Enter Land Use Data* module and enter the size of the project (e.g., acres, thousand square feet [ksf], students, dwelling units [du], rooms, pumps, rooms, or employees). Ensure that the unit type for the project-specific data is consistent with the unit type selected in URBEMIS. By default, URBEMIS estimates the trip generation rates for each land use type based on equations included in the ITE Trip Generation Manual. The trip rate represents the number of daily trips generated by a particular land use type by size. Override the default trip rate if project-specific data is available from the transportation analysis.

URBEMIS estimates the trip rate differently for residential land use types than for non-residential land use types. For residential land use types, URBEMIS adjusts the default trip rate based on residential density (i.e., dwelling units/residential acre). Overriding the default value for the number of acres for a residential land use type would automatically result in a change in the trip rate value. If both the number of acres and the trip rates for a residential development are known, enter the unit amount for the land use first, then adjust the acreage second, and then adjust the trip rate last. Select the *Submit* button after completing the *Enter Land Use Data* module.

For nonresidential land use types, URBEMIS uses a default trip rate value that is directly based on the unit amount entered into the *Enter Land Use Data* module. URBEMIS also assumes a Floor Area Ratio (FAR) of 0.5 for all nonresidential uses. The FAR is the ratio of the total floor area of a building to the size of the parcel on which it is located. Override the value in the acres data field based on the FAR for the proposed nonresidential land uses. URBEMIS does not adjust the default trip rate if the acre value is adjusted.

The *Enter Land Use Data* module includes a default worker commute trip percentage for all nonresidential land use types, which is used to estimate percentages of other commercial trip types in the *Enter Operational Data* module. The *Enter Land Use Data* module also contains default percentages of primary, diverted, and pass-by trips for all land use types, residential and non-residential. Primary trips are trips made for the specific purpose of visiting the generator and URBEMIS assumes that primary trips travel a full trip length; pass-by trips are trips made as intermediate stops on the way from an origin to another trip destination; and diverted-linked trips are trips attracted from the traffic volume on roadways in the vicinity of the generator but which require a diversion from that roadway to another roadway to gain access to the site. Pass-by and diverted-linked trips are assigned a shorter trip distance than primary trips. URBEMIS assumes that pass-by trips result in virtually no extra travel, with an assumed trip length of 0.1 mile. Diverted-linked trip lengths are assumed to equal 25 percent of the primary trip length. URBEMIS allows users to edit these data fields. URBEMIS incorporates this information for estimation of mobile-source emissions only if the check box for the Pass-by Trips category in the *Enter Operational Data* module is selected. When not selected, URBEMIS assumes all trips are primary trips. BAAQMD recommends reviewing the User's Guide for more information about when to use this feature. Additional discussion about pass-by trips is provided under the *Enter Operational Data* module guidance below.

When estimating emissions for a type of land use that is not listed in URBEMIS, select a similar land use type or add a new land use type on the Blank tab of the *Enter Land Use Data* module. When selecting a similar nonresidential land use type as a proxy, consider the worker commute trip percentage and the primary, diverted, and pass-by trip values. The name of the land use type is unimportant and can be overridden with new text if desired. BAAQMD recommends using one of the types of residential land uses listed in URBEMIS as a proxy when analyzing any type of unique residential project.

For unique nonresidential types of land uses, BAAQMD recommends either using another nonresidential land use type as a proxy or using a Blank land use type. If a new land use type is analyzed using a row on the Blank tab of the *Enter Land Use Data* module, enter a trip rate as URBEMIS does not provide default trip rate on the Blank tab. BAAQMD recommends using a trip rate from the ITE Trip Generation Manual, if an appropriate trip rate is available. If an applicable trip generation rate is not available, the lead agency should make a good faith effort to derive a trip generation rate for the proposed project.

Operational Data

The *Enter Operational Data* module allows users to estimate vehicle exhaust emissions from trips (and associated VMT) generated by a project. The module consists of seven operational

parameter categories including *Year & Vehicle Fleet*, *Trip Characteristics*, *Temperature Data*, *Variable Starts*, *Road Dust*, *Pass-by Trips*, and *Double-Counting Correction*. The first five operational categories are all needed to calculate vehicle exhaust emissions and cannot be turned off. Three of the seven operational categories can be turned off: *Road Dust*, *Pass-by Trips*, and *Double-Counting Correction*.

Guidance regarding each of the operational categories is provided below. In general, most of the default values for these seven source categories do not need to be changed, except where otherwise noted.

Year & Vehicle Fleet

The *Year & Vehicle Fleet* category allows users to specify the operational year for the project. Use the earliest possible year when the project would be operational to estimate worst-case operational emissions. Be aware that changing the project start year also changes the vehicle fleet mix. The default fleet mix values (i.e., *Fleet %, Vehicle Type*, *Non-Catalyst*, *Catalyst*, *Diesel*) are based on values from EMFAC using the year and the location of the project that is specified when users creates a new project in URBEMIS. The fleet mix should be modified only if it is known that the fleet mix for a project would be different from the average vehicle fleet mix in the project area. In that situation, select *Keep Current Fleet Mix When Changing Years*. Changes to the fleet mix data should be based on information provided by the transportation analysis and/or assumptions that are disclosed in the CEQA document. For instance, the fleet mix of motor vehicle trips generated by a school project would likely consist of a higher percentage of school buses and a lower percentage of motor homes and motorcycles than the URBEMIS average.

Trip Characteristics

The *Trip Characteristics* category includes trip data such as average speed, trip percentages, urban and rural trip lengths for different trip types. The trip percentages for home-based trips can be modified; however, it is not possible to modify the same for commercial-based trips, which URBEMIS calculates using the worker commute trip percentage entered in the *Enter Land Use Data* module. URBEMIS uses either the urban or rural trip length values depending on whether *Urban Project* or *Rural Project* is selected on the same screen. In general, the *Urban Project* option should be selected for most land use development projects under BAAQMD's jurisdiction. The trip length values can be changed if supported by information produced in a transportation analysis and/or reasonable assumptions about the project. For instance, the trip length for a proposed school might be adjusted according to the spatial distribution of the households that would be served by that school, particularly if the majority of trip generation would consist of parents driving their children to the school.

In addition to trip rate adjustments based on residential density, URBEMIS allows for modifications to vehicle trips based on other project characteristics. If specific project information is available for any land use type it should be reflected in the URBEMIS inputs. The table "URBEMIS Measures – Operational (Mobile-source) Measures" in Section 4.2 lists available measures to alter the trip rate to better reflect specific conditions. For example, if a project includes access to transit, URBEMIS trip rates can be adjusted between 0% and 15%. A 15% reduction in vehicle trips due to transit access would only be appropriate for a project that offers access to exceptional transit service. See the User's Guide for further instructions on all adjustments. Lead agencies must discuss and justify their reductions with substantial evidence.

Temperature Data

The *Temperature Data* category contains default ambient winter and summer temperature values which are used to estimate winter and summer emissions, respectively. The default temperature values in these data fields are specific to SFBAAB and should only be modified in consultation with BAAQMD.

Variable Starts
The *Variable Starts* parameter category shows the percentage of vehicles in several time classes (minutes since the vehicle engine was turned off) for the six trip types defined in the *Trip Characteristics* parameter category. This information is derived from the applicable EMFAC file and should only be modified in consultation BAAQMD.

Road Dust
The *Road Dust* parameter category allows users to specify the distribution of vehicle travel between paved and unpaved roads. This category is used to calculate entrained road dust emissions due to vehicle travel on paved and unpaved surfaces. Do not turn this category off, and users can adjust the percentage of travel on paved and unpaved roads if detailed project information is known.

Pass-by Trips
The *Pass-by Trips* parameter category can only be turned on or off. When selected, this category divides all the project-generated trips into primary, pass-by, and diverted-linked trips (entered as percentages in *Enter Land Use Data* module). When this category is not selected, URBEMIS assumes 100 percent of the project-generated trips are primary trips. Pass-by trips are trips made as intermediate stops on the way from an origin to a primary trip destination. URBEMIS accounts for these trips by setting the trip length to 0.1 miles for each pass-by trip. These trips are most important for retail and commercial land uses, such as gas stations and fast food restaurants. This option is not applicable to all land use types. For example, most of the trips to and from a *Warehouse* are typically expected to be primary trips and the *Pass-by Trips* option should not be used. This category check box should not be selected unless the percentage of pass-by trips is supported by a transportation analysis or a set of reasonable assumptions discussed in the CEQA document. If the trip length values in the *Trip Characteristics* category or the trip rate values in the Enter Land Use Data module are overwritten using information provided by a transportation analysis, be aware of whether the traffic data incorporated the occurrence of pass-by trips. If the *Pass-By Trips* checkbox is selected then the lead agency should discuss its reasoning for assuming that some of the project-generated vehicle trips would be considered pass-by trips.

Double-Counting Correction
The *Double-Counting Correction* parameter category is designed to account for internal trips between residential and nonresidential land uses. The *Double-Counting Correction* is applicable to mixed-use projects that include both residential and nonresidential land use types in the *Enter Land Use Data* module. For example, a residential trip and a retail trip generated by a mixed-use project may be the same trip. Users have the option of entering the number of internal trips between residential and nonresidential land uses in the *Enter the gross internal trip* as desired. The value entered represents the number of internal trips that would not be included in the emissions estimate. This category should not be used unless the transportation analysis or local transportation studies contain data to support the correction factor. In some cases, the transportation analysis may report project-specific trip generation that is already corrected for internal trips. Consult with a traffic engineer to determine the appropriate method to account for internal trips. The *Double-Counting Correction* checkbox should not be selected if detailed project information is unknown.

Area Source
The *Enter Area Source Data* module allows users to adjust the five area-source emission categories including, natural gas fuel combustion, hearth fuel combustion, landscape fuel combustion, consumer products, and architectural coatings. The natural gas, hearth, and landscape maintenance categories relate to on-site fuel combustion and the consumer products and architectural coatings categories address on-site evaporative emissions.

Guidance regarding each of the area-source categories is provided below. In general, most of the default values for these five source categories do not need to be changed except where otherwise noted in this guide.

Natural Gas Fuel Combustion
Parameters in the *Natural Gas Fuel Combustion* category are used to estimate the natural gas combustion emissions from space and water heating. On the *Natural Gas* tab the default percentage for land uses using natural gas should be changed to 100 percent for both residential and nonresidential land use types, as is representative of most development projects in the SFBAAB, unless project-specific data is available. Similarly, do not override the default natural gas usage values unless project-specific data is available.

Hearth Fuel Combustion
The *Hearth Fuel Combustion* category consists of separate tabs for *Hearth Percentages*, *Wood Stoves*, *Wood Fireplaces*, *Natural Gas Fireplaces*, and *Natural Gas Emission Factors*. Each of the tabs is discussed separately below.

- *Hearth Percentages*
  The parameters on the *Hearth Percentages* tab are applicable only to projects that include residential units. The default percentages should be used for the wood stoves, wood fireplaces, and wood stoves unless project-specific information is available. URBEMIS does not estimate emissions from any hearth types for nonresidential land use types.

- *Wood Stoves*
  On the *Wood Stoves* tab, the default percent values for the types of wood stoves (i.e., *Noncatalytic*, *Catalytic*, *Conventional*, and *Pellet*) should be changed in accordance with District Regulation 6, Rule 3, which allows only EPA-certified wood burning fireplaces and pellet stoves in new construction projects. The values for *Wood Burned*, *Wood Stove Usage*, and *Pounds in a Cord of Wood* should not be changed unless project-specific information is available.

- *Wood Fireplaces*
  The *Wood Fireplaces* tab is similar to the *Wood Stoves* tab. The emission factors on this tab cannot be modified. The values for *Wood Burned*, *Wood Stove Usage*, and *Pounds in a Cord of Wood* should not be changed unless project-specific information is available. District Regulation 6, Rule 3 allows only EPA-certified wood burning fireplaces in new construction projects.

- *Natural Gas Fireplaces*
  The values in the data fields on the *Natural Gas Fireplaces* tab should only be modified in the case that project-specific information is available that supports overriding default values.

- *Natural Gas Emission Factors*
  The emission factors contained in the *Natural Gas Emission Factors* tab cannot be modified. These values are used to estimate emissions from natural gas combustion in fireplaces/stoves and, according to the URBEMIS User's Guide, are based on U.S. Environmental Protection Agency Air Pollutant (AP-42) emission factors.

Landscape Fuel Combustion
The *Landscape Fuel Combustion* source category calculates on-site emissions from landscaping equipment such as lawn mowers, leaf blowers, chain saws, and hedge trimmers that are powered by internal combustion engines. On this tab, only adjust the value for the year being analyzed. The year entered into this field should be the earliest year when the project could become fully

operational. Landscaping emissions are estimated for the summer period only. URBEMIS uses emission rates from ARB's OFFROAD model to estimate of landscape maintenance equipment emissions.

Consumer Products
The *Consumer Products* source category is only relevant to projects that include residential land use types. The *Pounds of ROG (per person)* value should not be adjusted in this category. The persons per residential unit data field should be adjusted based on the estimated number of residents that would be supported by the proposed project, if available. The value should be consistent with the number of residents divided by the number of residential units.

Architectural Coating
Do not make changes to the values in the *Architectural Coating* source category without consulting BAAQMD.

EXAMPLE PROJECT OPERATIONAL-RELATED EMISSIONS CALCULATION

Description
The Example Project would develop a multi-story, mixed-use building that includes 40 units of residential condominium apartments, 50,000 square feet (or "50 thousand square feet" [ksf]) of offices and 35 ksf of retail land uses on an undeveloped 4.0-acre site. All of the residential condominium apartments would have natural gas lines for space heating but half of the units would be referred to as "suites" and include natural gas fireplaces. The regular apartments would not have natural gas fireplaces. Project construction would last two years beginning in 2010 and the project would be fully operational by 2013.

Screening Analysis
In the Land Use Module of URBEMIS (*Enter Land Use Data*) the corresponding Land Use Types of the proposed development would be Apartment High Rise units, General Office Building, and Strip Mall.

When each of the Land Use Types (i.e., Apartment High Rise units, General Office Building, and Strip Mall) is considered individually, their respective sizes would not exceed any of the District's Operational Screening Criteria (Table 3-1). However, because the project would contain more than one land use type, the operational screening levels cannot be used to assess the project's operational emissions, as explained in the discussion about the screening levels earlier in this guidance. The lead agency would be required to perform a detailed estimation of operational emissions using URBEMIS.

Emissions Quantification
When entering the proposed land uses into the Land Use Module, URBEMIS estimates the number of Acres for each Land Use Type assuming that each land use type would be constructed on separate lots. Using default values URBEMIS would assume this Example Project is 4.56 total acres (i.e., 0.65 acres for Apartment High Rise, 2.30 acres for General Office Building, and 1.61 acres for Strip Mall). For mixed-use and/or multi-level developments, the user should adjust the Acres for each of the proposed land uses such that the combined total acreage of all land use types is equal to the actual combined total size of the proposed project site (i.e., 4.0 acres, in this example) prior to running the model.

URBEMIS estimates the Trip Rate differently for residential land use types than for non-residential land use types. For residential land use types, URBEMIS adjusts the default Trip Rate based on residential density (i.e., dwelling units/residential acre). Therefore, overriding the default

value for the number of Acres assumed by URBEMIS for a residential land use type would automatically result in a change to the value assumed in the Trip Rate data field. If both the number of Acres and the Trip Rate for a residential development are known, the user should adjust the Acres field first, then adjust the Trip Rate field, and then click the Submit button. For nonresidential Land Use Types, URBEMIS uses a default value for in the Trip Rate data field that is directly based on the Unit Amt entered into the Land Use Module. The trip rates used by URBEMIS are based on standard rates from the ITE Trip Generation Manual. URBEMIS also assumes a Floor Area Ratio (FAR) of 0.5 for all nonresidential land use types. The FAR is the ratio of the total floor area of a building to the size of the parcel on which it is located. The user should override the value in the Acres data field based on the actual FAR for the development, as appropriate.

In the Area Source Module, Hearth Fuel Combustion category, the user should change the data fields for Wood Stoves, Wood Fireplaces, Natural Gas Fireplaces, and None (% w/o any hearth option) on the Hearth Percentages tab to 0, 0, 50, and 50, respectively to match the project description. In the Landscape Fuel Combustion source category the Year being Analyzed data field should be changed to 2013.

In the Operational Module the year data field in the Year & Vehicle Fleet category page should also be changed to 2013.

Lastly, the estimated daily and annual emissions of criteria air pollutants and precursors should be compared to the District's thresholds of significance (Table 2-2). If the daily or annual emissions would exceed the thresholds of significance, operational emissions would be considered significant and all feasible mitigation measures should be implemented to reduce these emissions.

CONSTRUCTION-RELATED EMISSIONS

Land Use Development Projects

URBEMIS includes a module (*Enter Construction Data*) that quantifies emissions from the following construction-related activity phases: demolition, mass and fine grading ("grading"), trenching, asphalt paving, building construction, and the application of architectural coatings.

URBEMIS Input Parameters

BAAQMD recommends input parameters and data requirements along with general URBEMIS user information for each construction-related activity phase below. Refer to the URBEMIS User's Manual for more detailed information. Appendix A contains a *Construction Data Needs Form* template that can be used to assist with requesting and gathering project-specific information.

Land Use Type and Size

Choose each individual land use type (e.g., single family housing, apartment high rise, regional shopping center, or office park) that is most applicable to the proposed development project in the *Enter Land Use Data* module and enter the size of the project (e.g., acres, thousand square feet [ksf], students, dwelling units [du], rooms, pumps, rooms, or employees). For several of the land use types, various size units are available (e.g., ksf and acres); ensure that the unit type for the project-specific data is consistent with the unit type selected in URBEMIS.

Schedule

The project schedule typically provides the number of months or days required for the completion of each construction-related activity phase (e.g., grading, building construction, asphalt paving), as well as the total duration of project construction. Where project-specific information is

available, modify URBEMIS default assumptions in *Click to Add, Delete, or Modify Phases* under the *Enter Construction Data* module. In this module, add or delete construction activities, add multiple similar construction activities (e.g., three grading phases), as well as overlap any construction activities as necessary. The URBEMIS default assumption for the number of work days per week is five, which inherently assumes that construction-related activities would only occur during weekdays, not on weekends. This can be altered if project-specific data is available in *Click to Add, Delete, or Modify Phases* under the construction phase setting *Work Days/Week.* For projects with specific phasing information (i.e., duration of each construction phase), but no definite construction commencement date, the earliest feasible start date should be used to be conservative. In addition, when project-specific information is not known, assume some overlap of construction phases (e.g., overlap of grading and asphalt paving activities or asphalt paving and building construction activities) to also be conservative. Please note that URBEMIS quantifies annual emissions on a calendar year basis (i.e., January to December) rather than the year-long period (running yearly average from the start date of construction) with the maximum amount of emissions.

Demolition

URBEMIS quantifies exhaust and fugitive PM dust emissions from demolition activities in the *Demolition Phase* within the *Enter Construction Data* module. Information to quantify emissions from this activity phase includes:

1. Duration of demolition (work days/week, phase start and end dates);
2. Total volume of building to be demolished (width, length, and height);
3. Maximum daily volume of building to be demolished (width, length, and height);
4. Haul truck capacity (cubic yards [yd^3]);
5. Haul truck trip length to disposal site (round trip miles); and
6. Off-road equipment requirements (number and type of equipment).

URBEMIS contains default assumptions for haul truck capacity (yd^3 per truck) and round trip distance (miles), if project-specific information is not available. URBEMIS also contains default assumptions for off-road equipment requirements. URBEMIS bases these on the size(s) of the proposed land use type(s) in the *Enter Land Use Data* module to estimate the off-road equipment requirements. In other words, URBEMIS assumes the size of the land use to be demolished is equal to the land use that would be developed. If the size(s) and/or type(s) of the land use(s) to be demolished are different from the land use(s) to be developed, create a separate URBEMIS run to quantify demolition emissions. Input the size and type of land use(s) for the different demolition building space versus the proposed building space in the *Enter Land Use Data* module for the separate URBEMIS run and only include the *Demolition* phase within the *Enter Construction Data* module.

Site Grading (Mass and Fine)

URBEMIS quantifies exhaust and fugitive PM dust emissions from grading activities in the *Site Grading* phase within the *Enter Construction Data* module. Information to quantify emissions from this activity phase includes, where applicable:

1. Duration of grading (work days/week, phase start and end dates);
2. Total acreage to be graded (acres);
3. Maximum daily acreage disturbed (acres per day);
4. Type and amount of cut/fill activities (yd^3 per day on- or off-site);
5. Description of soil hauling (amount of soil import/export [yd^3], haul truck capacity [yd^3 per truck], round trips per day, round trip distance [miles]); and

6. Off-road grading equipment requirements (number and type of equipment).

URBEMIS default assumptions for the total acreage to be graded and the maximum daily acreage disturbed are shown in the *Daily Acreage* tab within the *Site Grading* phase. Under the default settings, URBEMIS assumes that the maximum daily acreage disturbed is equivalent to 25 percent of the total acreage to be graded. Override this default assumption if more specific project information is available. The *Site Grading* phase consists of separate tabs for *Daily Acreage*, as mentioned above, *Fugitive Dust*, *Soil Hauling*, and *Site Grading Equipment*. Due to the differences in methodology and level of information required, each is discussed separately below.

Fugitive Dust
URBEMIS quantifies fugitive PM dust emissions in the *Site Grading* phase under the *Fugitive Dust* tab. URBEMIS provides four different levels of detail from which to select (i.e., default, low, medium, and high), described below.

Default: This method involves the use of the *Default Emission Rate* quantification methodology in the *Fugitive Dust* tab for which fugitive PM dust emissions are based on an emission rate (pound per disturbed acre per day [lb/acre-day]). This method should only be used when no project-specific information is known, or when no cut/fill activities would occur. Use the selection of the worst-case emission rate (i.e., 38.2 lb/acre-day) for extensive site preparation activities (e.g., cut/fill) where the exact type and amount (e.g., yd^3 per day on- or off-site) are not known, and selection of the average emission rate (i.e., 10 lb/acre-day) otherwise. The average emission rate would be used for projects that involve typical site grading activities, but no cut/fill or earthmoving activities.

Low: The *Low Level of Detail* quantification method should be used when cut/fill activities would occur and the amount of on-site and off-site cut/fill is known. Input the type and amount of cut/fill activities (yd^3 per day on- or off-site). On-site cut/fill activities involve soil movement within the boundaries of the project site via scrapers or graders, while off-site cut/fill activities involve soil movement outside of the boundaries of the project site via haul trucks. Projects that require off-site cut/fill should also enter the appropriate amount of soil import/export in the *Soil Hauling* tab, as discussed in more detail below.

Medium: The *Medium Level of Detail* quantification method should be used when cut/fill activities would occur and the required number of activity hours per day for on-site scrapers and off-site haul trucks is known. Input the number of hours per day for on-site scraper and off-site haul trucks conducting cut/fill activities. Input the total number of scraper-hours and/or haul truck-hours that are anticipated to occur per day. For example, if two scrapers would operate for eight hours per day each and three haul trucks would operate for four hours per day each, enter 16 for the *Onsite Scraper* parameter (i.e., 2 scrapers × 8 hours) and 12 for the *Offsite Haul* parameter (i.e., 3 haul trucks × 4 hours). Similar to the *Low Level of Detail* quantification method, on-site cut/fill activities involve soil movement within the boundaries of the project site via scrapers or graders, while off-site cut/fill activities involve soil movement outside of the boundaries of the project site via haul trucks. Projects that require off-site cut/fill should also enter the appropriate amount of soil import/export in the *Soil Hauling* tab, as discussed in more detail below.

High: The *High Level of Detail* quantification method should be used when cut/fill activities would occur and details about soil haulage is known. Input data on the amount of on- and off-site haulage (ton-miles per day) based on the total volume of cut/fill (yd^3), duration of the cut/fill activities (work days), density of soil being moved (tons per yd^3), and the scraper or haul truck round-trip distance (miles). A *High Level Haulage Input* worksheet that can be used to assist with

determining the amount of on- and off-site haulage (ton-miles per day) required for this method is contained in Appendix A.

Soil Hauling
URBEMIS quantifies entrained PM road dust and exhaust emissions from soil hauling in the *Soil Hauling* tab within the *Site Grading* phase. Information requirements include the amount of soil import/export (yd^3), round trips per day, round trip distance (miles), and haul truck capacity (yd^3 per truck). For round trip distance and haul truck capacity, URBEMIS provides default assumptions of 20 yd^3 per truck and 20 miles, respectively. Override the default assumptions if the project specific values are known.

Grading Equipment
URBEMIS quantifies exhaust emissions from on-site heavy-duty equipment in the *Site Grading Equipment* tab within the *Site Grading* phase. Information requirements include the type of equipment and quantity or amount, along with horsepower, load factor, and hours of operation per work day. URBEMIS provides default assumptions for all of these, primarily based on the amount of maximum daily acreage disturbed shown in the *Daily Acreage* tab. If project-specific grading equipment is known, click on the *All Checks Off* button and input the number for each type of equipment to be used for the project. Note that although the *All Checks Off* button will allow users to override the URBEMIS default equipment assumptions in the *Amount Model Uses* column, make sure to delete the previous URBEMIS default equipment selections prior to entering the project-specific equipment information.

Asphalt Paving
URBEMIS quantifies off-gas and exhaust emissions from asphalt paving activities in the *Paving* tab within the *Enter Construction Data* module. Information to quantify emissions from this activity phase includes the duration of asphalt paving (work days/week, phase start and end dates), total acreage to be paved, and off-road equipment requirements. URBEMIS includes default assumptions for the amount of asphalt to be paved based on the size of the proposed land use type(s) in the *Enter Land Use Data* module. Account for the size of project features (e.g., parking structure, roadways, and large hardtop fields) that would require asphalt paving in excess of default assumptions (i.e., standard site access and parking spaces) within the *Total Acreage to be Paved with Asphalt* parameter.

Architectural Coating
URBEMIS quantifies off-gas emissions from the application of architectural coatings in the *Arch Coating* tab within the *Enter Construction Data* module. Information to quantify emissions from this phase include the duration of activities (i.e., work days/week, phase start and end dates). URBEMIS includes default parameters for the volatile organic compound content per liter of coating based on BAAQMD's Regulation 8, Rule 3: Architectural Coating.

Construction Mitigation Measures
BAAQMD recommends that all proposed projects implement the *Basic Construction Mitigation Measures* listed in Table 8-1regardless of the significance determination. Where construction-related emissions would exceed the thresholds, the *Additional Construction Mitigation Measures* in Table 8-2 should be implemented. The methodology for quantifying criteria air pollutant and precursor emission reductions from fugitive PM dust and exhaust emissions are discussed below.

Fugitive Particulate Matter Dust Emissions
For quantification of fugitive PM dust-related *Basic Construction Mitigation Measures* in URBEMIS, select the *Mitigation* option in the *Enter Construction Data* module for the *Site Grading* phase. For *Site Grading Soil Disturbance Mitigation*, select (turn on) the soil stabilizing measure titled *Water exposed surfaces* along with the two times daily option without altering the default

percent reduction. For *Unpaved Roads Mitigation*, select the measure titled *Reduce speed on unpaved roads to less than 15 mph* without altering the default percent reduction. URBEMIS assumes that fugitive PM dust emissions from soil disturbance activities and travel on unpaved roads account for approximately 79 percent and 21 percent of total the fugitive PM dust emissions, respectively. URBEMIS will apply an approximate 53 percent reduction to total fugitive PM dust emissions for implementing the *Basic Construction Mitigation Measures* 1 through 5 in Table 8-1.

To account for the implementation of the *Additional Construction Mitigation Measures* 1 through 8, alter the default percent reduction to 63 percent, which would result in a total reduction of 75 percent in fugitive PM dust emissions. For *Site Grading Soil Disturbance Mitigation* select (turn on) the soil stabilizing measure titled *Equipment loading/unloading*.

In RoadMod, select water trucks to account for the implemented of the Basic Construction Mitigation Measures. Roadmod assumes an inherent 50 percent reduction in fugitive PM dust emissions when water trucks are selected.

Apply an additional 50 percent reduction to the fugitive PM dust emissions contained in the *Emission Estimates* tab of RoadMod to account for the implementation of the *Additional Construction Mitigation Measures* 1 through 8. The resulting total percent reduction from fugitive PM dust emissions would be 75 percent (i.e., 1 – (0.5 × 0.5)). The resultant amount of fugitive PM dust emissions should be added to the average daily mitigated exhaust PM emissions (methodology described below) to calculate the total amount of mitigated PM_{10} and $PM_{2.5}$ emissions.

Exhaust Emissions

A 5 percent reduction could be applied for NO_X, PM_{10}, and $PM_{2.5}$ to account for implementing measures 6 and 7 in the *Basic Construction Mitigation Measures.* For quantification in URBEMIS, select the *Mitigation* option in the *Enter Construction Data* module for the *Site Grading*, *Building Construction,* and *Asphalt Paving* phases, as applicable to the proposed project. Then for the *Off-Road Equipment Mitigation*, select (turn on) the measure titled *Use aqueous diesel fuel* and alter the default percent reduction for each.

To estimate exhaust emission reductions related to measure 10 in the *Additional Construction Mitigation Measures*, turn on the measure titled *Use aqueous diesel fuel* and alter the default percent reduction values to 20 percent for NO_X and 45 percent for PM_{10}, and $PM_{2.5}$. For the *Off-Road Equipment Mitigation* select (turn on) the measure titled *Diesel particulate filter* and alter the default percent reductions as listed in measure 10.

RoadMod does not calculate emission reductions associated with the implementation of the exhaust-related *Basic Construction Mitigation Measures*. To quantify the exhaust-related emission reductions associated with the implementation of the *Basic Construction Mitigation Measures*, rely on the information and data contained in the *Data Entry* and *Emission Estimates* tabs in RoadMod. Reductions in exhaust emissions should be quantified separately for each phase (i.e., Grubbing/Land Clearing, Grading/Excavation, Drainage/Utilities/ Sub-Grade, and Paving). First isolate the exhaust emissions from off-road (e.g., heavy-duty) equipment for each phase. Table B-1 below provides a cell reference for the *Data Entry* tab of RoadMod to assist with the identification and isolation of such emissions.

Once isolated, a 5 percent reduction could be applied to account for implementing measures 6 and 7 in the *Basic Construction Mitigation Measures* for NO_X, PM_{10}, and $PM_{2.5}$.

Emission reductions should be estimated by multiplying the total emissions for each compound by the anticipated emission reduction applicable for that compound to estimate the mitigated amount of emissions reductions.

Apply a 20 percent reduction for NO_X and a 45 percent reduction for PM_{10} and $PM_{2.5}$ to account for implementation of Measure 9 in the *Additional Construction Mitigation Measure*. To quantify the other exhaust-related emission reductions associated with the implementation of the *Additional Construction Mitigation Measures*, follow the same methodology described above for applying the reductions associated with the implementation of the *Basic Construction Mitigation Measures*.

Off-Gas Emissions

For quantification of off-gas-related *Additional Construction Mitigation Measures* (measure 11) first select the *Mitigation* option in the *Enter Construction Data* module for the *Architectural Coating* phase. Then select (turn on) the measures applicable to the proposed project and alter the default percent reduction as appropriate.

Linear Projects

For proposed projects that are linear in nature (e.g., road or levee construction, pipeline installation, transmission lines), use the most current version of Sacramento Metropolitan Air Quality Management District's (SMAQMD) Road Construction Emissions Model (RoadMod) to quantify construction-related criteria air pollutants and precursors. Similar to URBEMIS, RoadMod quantifies fugitive PM dust, exhaust, and off-gas emissions from the following construction-related activity phases: grubbing/land clearing, grading/excavation, drainage/utilities/sub-grade, and paving. Use RoadMod in accordance with the user instructions and default assumptions unless project-specific information is available. The default assumptions are applicable to projects located within the SFBAAB. Also, URBEMIS inherently accounts for the on-site construction of roadways and the installation of project infrastructure. If the proposed project involves off-site improvements that are linear in nature (e.g., roadway widening), use RoadMod in addition to URBEMIS to determine total emissions.

Table B-1
Roadway Construction Emissions Model
Cell Reference for Unmitigated Off-Road Equipment Emissions

Linear Construction Phase	NO_X	PM_{10}	$PM_{2.5}$
Grubbing/Land Clearing	G155	H155	I155
Grading/Excavation	G195	H195	I195
Drainage/Utilities/Sub-Grade	G235	H235	I235
Paving	G275	H275	I275

Notes: NO_X = oxides of nitrogen; $PM_{2.5}$ = fine particulate matter with an aerodynamic resistance diameter of 2.5 micrometers or less; PM_{10} = respirable particulate matter with an aerodynamic resistance diameter of 10 micrometers or less.
Cell references refer to the *Data Entry* tab from the SMAQMD Road Construction Emissions Model.
Source: SMAQMD 2009.

NO_X Emission Reduction
Emissions of NO_X (lb/day) × (1 – [NO_X percent reduction])

PM_{10} Emission Reduction
Emissions of PM_{10} (lb/day) × (1 – [PM_{10} percent reduction])

$PM_{2.5}$ Emission Reduction
Emissions of $PM_{2.5}$ (lb/day) × ([1 – [$PM_{2.5}$ percent reduction])

Users should use the *Emission Estimates* tab to calculate the total mitigated amount of emissions for each phase of construction. The total NO_X, PM_{10}, and $PM_{2.5}$ exhaust emissions for each phase are contained in cells E6 to E9, H6 to H9, and K6 to K9, respectively. To calculate the total amount of mitigated emissions, first subtract the unmitigated off-road equipment exhaust emissions from the total exhaust emissions to calculate total emissions without inclusion of off-road equipment exhaust emissions. Then, add the mitigated off-road exhaust emissions (calculated with the method described above) to the remaining emissions to calculate the total emissions with mitigated off-road construction equipment exhaust emissions. For PM_{10} and $PM_{2.5}$, add the mitigated exhaust emissions with the mitigated fugitive PM dust emissions (calculated by RoadMod) to calculate the total amount of mitigated PM_{10} and $PM_{2.5}$ emissions.

EXAMPLE PROJECT CONSTRUCTION-RELATED EMISSIONS CALCULATION

Description

This Example Project proposes development of 100 single-family residential units over a 2-year period. The project site would be approximately 33 acres (URBEMIS default assumption) and require an undetermined volume of fill materials to be imported to the site. In addition, the project would involve construction of a new access road to serve the development.

Screening Analysis

The project size is less than the construction screening level for single-family residential uses listed in Table 3-4. However, because the project includes the import of fill to the site, the construction screening levels cannot be used to address construction emissions. Therefore, a detailed quantitative analysis of construction-generated NO_X emissions should be performed using URBEMIS to estimate NO_X generated by construction of the residential units and using the RoadMod to estimate NO_X emissions from construction of the new access road.

Emissions Quantification

The size and type of land use proposed (i.e., single family housing) should be entered into the Land Use Module in URBEMIS. In this case, the project's total acres are equal to the default URBEMIS assumption and no override is necessary in the Acres data field. Modeling the construction emissions associated with single-family residential units in URBEMIS requires detailed information about the construction schedule (e.g., commencement date, types of construction activities required, and length of construction activities).

The fugitive PM dust emissions associated with fill activities should be estimated using the Fugitive Dust tab of the Mass Site Grading phase. For use of the Low Level of Detail quantification method, the volume of fill activities should be divided by the number of days that fill activities would occur. For example, if the project would require up to 20,000 yd^3 of fill materials to be imported over a minimum of 40 work days, the user should enter 500 (i.e., 20,000 yd^3 ÷ 40 days) into the Amount of Offsite Cut/Fill (cubic yards/day) data field. In addition, users should also input the total volume of fill materials to be imported into the Total Amount of Soil to Import (cubic yards) data field in the Soil Hauling tab. Off-road construction equipment for grading activities is estimated by URBEMIS based on the Maximum Daily Acreage Disturbed data field.

URBEMIS estimates the types and quantities of construction equipment in the Building Construction phase to develop the proposed project. For the Asphalt Paving phase, URBEMIS assumes the project requires asphalt paving for 25% of the total site. If more specific information can be provided, then user should turn off the Reset acreage with land use changes button in the Off Gas Emissions tab and override the Total Acreage to be Paved with Asphalt data field.

Due to the linear nature of the new access road to the project, daily mass emissions associated with its construction should be quantified using RoadMod. Users should obtain basic project information for the new access road and enter the information into the Data Entry tab of RoadMod. If project-specific information is not available RoadMod estimates the construction schedule for the road and the equipment used in each construction phase.

For analysis of the project's total average daily emissions, users should add emissions of each respective pollutant associated with development of the single-family residential units with the respective emissions associated with construction of the access road where construction activities are anticipated to overlap in the construction schedule. The average daily emissions of each pollutant that would occur throughout the entire construction period should be identified and compared with the District's threshold of significance. If the emissions would exceed the threshold of significance, construction emissions would be considered significant and all feasible mitigation measures to reduce emissions should be implemented.

The user should keep in mind that the District's numeric thresholds for construction emissions apply to exhaust emissions only. BAAQMD recommends implementation *of Basic Construction Mitigation Measures* to reduce fugitive dust emissions for all projects, and *Additional Construction Mitigation Measures* to reduce fugitive dust emissions for significant projects.

C. SAMPLE AIR QUALITY SETTING

The Bay Area Air Quality Management District (BAAQMD) is the regional air quality agency for the San Francisco Bay Area Air Basin (SFBAAB), which comprises all of Alameda, Contra Costa, Marin, Napa, San Francisco, San Mateo, and Santa Clara counties, the southern portion of Sonoma, and the southwestern portion of Solano County. Air quality in this area is determined by such natural factors as topography, meteorology, and climate, in addition to the presence of existing air pollution sources and ambient conditions. These factors along with applicable regulations are discussed below.

C.1.1. Climate, Topography, Air Pollution Potential

The SFBAAB is characterized by complex terrain, consisting of coastal mountain ranges, inland valleys, and bays, which distort normal wind flow patterns. The Coast Range splits resulting in a western coast gap, Golden Gate, and an eastern coast gap, Carquinez Strait, which allow air to flow in and out of the SFBAAB and the Central Valley.

The climate is dominated by the strength and location of a semi-permanent, subtropical high-pressure cell. During the summer, the Pacific high pressure cell is centered over the northeastern Pacific Ocean resulting in stable meteorological conditions and a steady northwesterly wind flow. Upwelling of cold ocean water from below to the surface because of the northwesterly flow produces a band of cold water off the California coast. The cool and moisture-laden air approaching the coast from the Pacific Ocean is further cooled by the presence of the cold water band resulting in condensation and the presence of fog and stratus clouds along the Northern California coast.

In the winter, the Pacific high-pressure cell weakens and shifts southward resulting in wind flow offshore, the absence of upwelling, and the occurrence of storms. Weak inversions coupled with moderate winds result in a low air pollution potential.

High Pressure Cell

During the summer, the large-scale meteorological condition that dominates the West Coast is a semi-permanent high pressure cell centered over the northeastern Pacific Ocean. This high pressure cell keeps storms from affecting the California coast. Hence, the SFBAAB experiences little precipitation in the summer months. Winds tend to blow on shore out of the north/northwest.

The steady northwesterly flow induces upwelling of cold water from below. This upwelling produces a band of cold water off the California coast. When air approaches the California coast, already cool and moisture-laden from its long journey over the Pacific, it is further cooled as it crosses this bank of cold water. This cooling often produces condensation resulting in a high incidence of fog and stratus clouds along the Northern California coast in the summer.

Generally in the winter, the Pacific high weakens and shifts southward, winds tend to flow offshore, upwelling ceases and storms occur. During the winter rainy periods, inversions (layers of warmer air over colder air; see below) are weak or nonexistent, winds are usually moderate and air pollution potential is low. The Pacific high does periodically become dominant, bringing strong inversions, light winds and high pollution potential.

Topography

The topography of the SFBAAB is characterized by complex terrain, consisting of coastal mountain ranges, inland valleys and bays. This complex terrain, especially the higher elevations, distorts the normal wind flow patterns in the SFBAAB. The greatest distortion occur when low-level inversions are present and the air beneath the inversion flows independently of air above the inversion, a condition that is common in the summer time.

The only major break in California's Coast Range occurs in the SFBAAB. Here the Coast Range splits into western and eastern ranges. Between the two ranges lies San Francisco Bay. The gap in the western coast range is known as the Golden Gate, and the gap in the eastern coast range is the Carquinez Strait. These gaps allow air to pass into and out of the SFBAAB and the Central Valley.

Wind Patterns

During the summer, winds flowing from the northwest are drawn inland through the Golden Gate and over the lower portions of the San Francisco Peninsula. Immediately south of Mount Tamalpais, the northwesterly winds accelerate considerably and come more directly from the west as they stream through the Golden Gate. This channeling of wind through the Golden Gate produces a jet that sweeps eastward and splits off to the northwest toward Richmond and to the southwest toward San Jose when it meets the East Bay hills.

Wind speeds may be strong locally in areas where air is channeled through a narrow opening, such as the Carquinez Strait, the Golden Gate or the San Bruno gap. For example, the average wind speed at San Francisco International Airport in July is about 17 knots (from 3 p.m. to 4 p.m.), compared with only 7 knots at San Jose and less than 6 knots at the Farallon Islands.

The air flowing in from the coast to the Central Valley, called the sea breeze, begins developing at or near ground level along the coast in late morning or early afternoon. As the day progresses, the sea breeze layer deepens and increases in velocity while spreading inland. The depth of the sea breeze depends in large part upon the height and strength of the inversion. If the inversion is low and strong, and hence stable, the flow of the sea breeze will be inhibited and stagnant conditions are likely to result.

In the winter, the SFBAAB frequently experiences stormy conditions with moderate to strong winds, as well as periods of stagnation with very light winds. Winter stagnation episodes are characterized by nighttime drainage flows in coastal valleys. Drainage is a reversal of the usual daytime air-flow patterns; air moves from the Central Valley toward the coast and back down toward the Bay from the smaller valleys within the SFBAAB.

Temperature

Summertime temperatures in the SFBAAB are determined in large part by the effect of differential heating between land and water surfaces. Because land tends to heat up and cool off more quickly than water, a large-scale gradient (differential) in temperature is often created between the coast and the Central Valley, and small-scale local gradients are often produced along the shorelines of the ocean and bays. The temperature gradient near the ocean is also exaggerated, especially in summer, because of the upwelling of cold ocean bottom water along the coast. On summer afternoons the temperatures at the coast can be 35°F cooler than temperatures 15 to 20 miles inland. At night this contrast usually decreases to less than 10°.

In the winter, the relationship of minimum and maximum temperatures is reversed. During the daytime the temperature contrast between the coast and inland areas is small, whereas at night the variation in temperature is large.

Precipitation

The SFBAAB is characterized by moderately wet winters and dry summers. Winter rains account for about 75 percent of the average annual rainfall. The amount of annual precipitation can vary greatly from one part of the SFBAAB to another even within short distances. In general, total annual rainfall can reach 40 inches in the mountains, but it is often less than 16 inches in sheltered valleys.

During rainy periods, ventilation (rapid horizontal movement of air and injection of cleaner air) and vertical mixing are usually high, and thus pollution levels tend to be low. However, frequent dry periods do occur during the winter where mixing and ventilation are low and pollutant levels build up.

Air Pollution Potential

The potential for high pollutant concentrations developing at a given location depends upon the quantity of pollutants emitted into the atmosphere in the surrounding area or upwind, and the ability of the atmosphere to disperse the contaminated air. The topographic and climatological factors discussed above influence the atmospheric pollution potential of an area. Atmospheric pollution potential, as the term is used here, is independent of the location of emission sources and is instead a function of factors described below.

Wind Circulation

Low wind speed contributes to the buildup of air pollution because it allows more pollutants to be emitted into the air mass per unit of time. Light winds occur most frequently during periods of low sun (fall and winter, and early morning) and at night. These are also periods when air pollutant emissions from some sources are at their peak, namely, commute traffic (early morning) and wood burning appliances (nighttime). The problem can be compounded in valleys, when weak flows carry the pollutants upvalley during the day, and cold air drainage flows move the air mass downvalley at night. Such restricted movement of trapped air provides little opportunity for ventilation and leads to buildup of pollutants to potentially unhealthful levels.

Wind-roses provide useful information for communities that contain industry, landfills or other potentially odorous or noxious land uses. Each wind-rose diagram provides a general indication of the proportion of time that winds blow from each compass direction. The longer the vector length, the greater the frequency of wind occurring from that direction. Such information may be particularly useful in planning buffer zones. For example, sensitive receptors such as residential developments, schools or hospitals are inappropriate uses immediately downwind from facilities that emit toxic or odorous pollutants, unless adequate separation is provided by a buffer zone. Caution should be taken in using wind-roses in planning and environmental review processes. A site on the opposite side of a hill or tall building, even a short distance from a meteorological monitoring station, may experience a significant difference in wind pattern. Consult BAAQMD meteorologists if more detailed wind circulation information is needed.

Inversions

An inversion is a layer of warmer air over a layer of cooler air. Inversions affect air quality conditions significantly because they influence the mixing depth, i.e., the vertical depth in the atmosphere available for diluting air contaminants near the ground. The highest air pollutant concentrations in the SFBAAB generally occur during inversions.

There are two types of inversions that occur regularly in the SFBAAB. One is more common in the summer and fall, while the other is most common during the winter. The frequent occurrence of elevated temperature inversions in summer and fall months acts to cap the mixing depth, limiting the depth of air available for dilution. Elevated inversions are caused by subsiding air from the subtropical high pressure zone, and from the cool marine air layer that is drawn into the SFBAAB by the heated low pressure region in the Central Valley.

The inversions typical of winter, called radiation inversions, are formed as heat quickly radiates from the earth's surface after sunset, causing the air in contact with it to rapidly cool. Radiation inversions are strongest on clear, low-wind, cold winter nights, allowing the build-up of such pollutants as carbon monoxide and particulate matter. When wind speeds are low, there is little mechanical turbulence to mix the air, resulting in a layer of warm air over a layer of cooler air next

to the ground. Mixing depths under these conditions can be as shallow as 50 to 100 meters, particularly in rural areas. Urban areas usually have deeper minimum mixing layers because of heat island effects and increased surface roughness. During radiation inversions downwind transport is slow, the mixing depths are shallow, and turbulence is minimal, all factors which contribute to ozone formation.

Although each type of inversion is most common during a specific season, either inversion mechanism can occur at any time of the year. Sometimes both occur simultaneously. Moreover, the characteristics of an inversion often change throughout the course of a day. The terrain of the SFBAAB also induces significant variations among subregions.

Solar Radiation

The frequency of hot, sunny days during the summer months in the SFBAAB is another important factor that affects air pollution potential. It is at the higher temperatures that ozone is formed. In the presence of ultraviolet sunlight and warm temperatures, reactive organic gases and oxides of nitrogen react to form secondary photochemical pollutants, including ozone.

Because temperatures in many of the SFBAAB inland valleys are so much higher than near the coast, the inland areas are especially prone to photochemical air pollution.

In late fall and winter, solar angles are low, resulting in insufficient ultraviolet light and warming of the atmosphere to drive the photochemical reactions. Ozone concentrations do not reach significant levels in the SFBAAB during these seasons.

Sheltered Terrain

The hills and mountains in the SFBAAB contribute to the high pollution potential of some areas. During the day, or at night during windy conditions, areas in the lee sides of mountains are sheltered from the prevailing winds, thereby reducing turbulence and downwind transport. At night, when wind speeds are low, the upper atmospheric layers are often decoupled from the surface layers during radiation conditions. If elevated terrain is present, it will tend to block pollutant transport in that direction. Elevated terrain also can create a recirculation pattern by inducing upvalley air flows during the day and reverse downvalley flows during the night, allowing little inflow of fresh air.

The areas having the highest air pollution potential tend to be those that experience the highest temperatures in the summer and the lowest temperatures in the winter. The coastal areas are exposed to the prevailing marine air , creating cooler temperatures in the summer, warmer temperatures in winter, and stratus clouds all year. The inland valleys are sheltered from the marine air and experience hotter summers and colder winters. Thus, the topography of the inland valleys creates conditions conducive to high air pollution potential.

Pollution Potential Related to Emissions

Although air pollution potential is strongly influenced by climate and topography, the air pollution that occurs in a location also depends upon the amount of air pollutant emissions in the surrounding area or transported from more distant places. Air pollutant emissions generally are highest in areas that have high population densities, high motor vehicle use and/or industrialization. These contaminants created by photochemical processes in the atmosphere, such as ozone, may result in high concentrations many miles downwind from the sources of their precursor chemicals.

Climatological Subregions

This section discusses the varying climatological and topographic conditions, and the resulting variations in air pollution potential, within inhabited subregions of the SFBAAB. All urbanized areas of the SFBAAB are included in one of 11 climatological subregions. Sparsely inhabited

areas are excluded from the subregional designations. Some of the climatological subregions discussed in this appendix overlap county boundaries. The Lead Agencies analyzing projects located close to the boundary between subregions may need to examine the characteristics of the neighboring subregions to adequately evaluate potential air quality impacts.

The information about each subregion includes location, topography and climatological factors relevant to air quality. Where relevant to air quality concerns, more localized subareas within a subregion are discussed. Each subregional section concludes with a discussion of pollution potential resulting from climatological and topographic variables and the major types of air pollutant sources in the subregion.

Carquinez Strait Region

The Carquinez Strait runs from Rodeo to Martinez. It is the only sea-level gap between the Bay and the Central Valley. The subregion includes the lowlands bordering the strait to the north and south, and includes the area adjoining Suisun Bay and the western part of the Sacramento-San Joaquin Delta as far east as Bethel Island. The subregion extends from Rodeo in the southwest and Vallejo in the northwest to Fairfield on the northeast and Brentwood on the southeast.

Prevailing winds are from the west in the Carquinez Strait. During the summer and fall months, high pressure offshore coupled with low pressure in the Central Valley causes marine air to flow eastward through the Carquinez Strait. The wind is strongest in the afternoon. Afternoon wind speeds of 15 to 20 mph are common throughout the strait region. Annual average wind speeds are 8 mph in Martinez, and 9 to 10 mph further east. Sometimes atmospheric conditions cause air to flow from the east. East winds usually contain more pollutants than the cleaner marine air from the west. In the summer and fall months, this can cause elevated pollutant levels to move into the central SFBAAB through the strait. These high pressure periods are usually accompanied by low wind speeds, shallow mixing depths, higher temperatures and little or no rainfall.

Summer mean maximum temperatures reach about 90° F. in the subregion. Mean minimum temperatures in the winter are in the high 30's. Temperature extremes are especially pronounced in sheltered areas farther from the moderating effects of the strait itself, e.g. at Fairfield.

Many industrial facilities with significant air pollutant emissions — e.g., chemical plants and refineries — are located within the Carquinez Strait Region. The pollution potential of this area is often moderated by high wind speeds. However, upsets at industrial facilities can lead to short-term pollution episodes, and emissions of unpleasant odors may occur at anytime. Receptors downwind of these facilities could suffer more long-term exposure to air contaminants than individuals elsewhere., It is important that local governments and other Lead Agencies maintain buffers zones around sources of air pollution sufficient to avoid adverse health and nuisance impacts on nearby receptors. Areas of the subregion that are traversed by major roadways, e.g. Interstate 80, may also be subject to higher local concentrations of carbon monoxide and particulate matter, as well as certain toxic air contaminants such as benzene.

Cotati and Petaluma Valleys

The subregion that stretches from Santa Rosa to the San Pablo Bay is often considered as two different valleys: the Cotati Valley in the north and the Petaluma Valley in the south. To the east, the valley is bordered by the Sonoma Mountains, while to the west is a series of low hills, followed by the Estero Lowlands, which open to the Pacific Ocean. The region from the Estero Lowlands to the San Pablo Bay is known as the Petaluma Gap. This low-terrain area allows marine air to travel into the SFBAAB.

Wind patterns in the Petaluma and Cotati Valleys are strongly influenced by the Petaluma Gap, with winds flowing predominantly from the west. As marine air travels through the Petaluma Gap, it splits into northward and southward paths moving into the Cotati and Petaluma valleys. The

southward path crosses San Pablo Bay and moves eastward through the Carquinez Strait. The northward path contributes to Santa Rosa's prevailing winds from the south and southeast. Petaluma's prevailing winds are from the northwest.

When the ocean breeze is weak, strong winds from the east can predominate, carrying pollutants from the Central Valley and the Carquinez Strait. During these periods, upvalley flows can carry the polluted air as far north as Santa Rosa.

Winds are usually stronger in the Petaluma Valley than the Cotati Valley because the former is directly in line with the Petaluma Gap. Petaluma's climate is similar to areas closer to the coast even though Petaluma is 28 miles from the ocean. Average annual wind speed at the Petaluma Airport is seven mph. The Cotati Valley, being slightly north of the Petaluma Gap, experiences lower wind speeds. The annual average wind speed in Santa Rosa is five mph.

Air temperatures are very similar in the two valleys. Summer maximum temperatures for this subregion are in the low-to-mid-80's, while winter maximum temperatures are in the high-50's to low-60's. Summer minimum temperatures are around 50 degrees, and winter minimum temperatures are in the high 30's.

Generally, air pollution potential is low in the Petaluma Valley because of its link to the Petaluma Gap and because of its low population density. There are two scenarios that could produce elevated pollutant levels: 1) stagnant conditions in the morning hours created when a weak ocean breeze meets a weak bay breeze, and 2) an eastern or southeastern wind pattern in the afternoon brings in pollution from the Carquinez Strait Region and the Central Valley.

The Cotati Valley has a higher pollution potential than does the Petaluma Valley. The Cotati Valley lacks a gap to the sea, contains a larger population and has natural barriers at its northern and eastern ends. There are also industrial facilities in and around Santa Rosa. Both valleys of this subregion are also threatened by increased motor vehicle traffic and the associated air contaminants. Population and motor vehicle use are increasing significantly, and housing costs and the suburbanization of employment are leading to more and longer commutes traversing the subregion.

Diablo and San Ramon Valleys

East of the Coast Range lay the Diablo and San Ramon Valleys. The valleys have a northwest to southeast orientation, with the northern portion known as Diablo Valley and the southern portion as San Ramon Valley. The Diablo Valley is bordered in the north by the Carquinez Strait and in the south by the San Ramon Valley. The San Ramon Valley is long and narrow and extends south from Walnut Creek to Dublin. At its southern end it opens onto the Amador Valley.

The mountains on the west side of these valleys block much of the marine air from reaching the valleys. During the daytime, there are two predominant flow patterns: an upvalley flow from the north and a westerly flow (wind from the west) across the lower elevations of the Coast Range. On clear nights, surface inversions separate the flow of air into two layers: the surface flow and the upper layer flow. When this happens, there are often drainage surface winds which flow downvalley toward the Carquinez Strait.

Wind speeds in these valleys generally are low. Monitoring stations in Concord and Danville report annual average wind speeds of 5 mph. Winds can increase in the afternoon near San Ramon because it is located at the eastern edge of the Crow Canyon gap. Through this gap, polluted air from cities near the Bay travels to the valley in the summer months.

Air temperatures in these valleys are cooler in the winter and warmer in the summer than are temperatures further west, as these valleys are far from the moderating effect of the Bay and

ocean. Mean summer maximum temperatures are in the low- to mid-80's. Mean winter minimum temperatures are in the high-30's to low-40's.

Pollution potential is relatively high in these valleys. On winter evenings, light winds combined with surface-based inversions and terrain that restricts air flow can cause pollutant levels to build up. San Ramon Valley can experience high pollution concentrations due to motor vehicle emissions and emissions from fireplaces and wood stoves. In the summer months, ozone and ozone precursors are often transported into the valleys from both the central SFBAAB and the Central Valley.

Livermore Valley

The Livermore Valley is a sheltered inland valley near the eastern border of SFBAAB. The western side of the valley is bordered by 1,000 to 1,500 foot hills with two gaps connecting the valley to the central SFBAAB, the Hayward Pass and Niles Canyon. The eastern side of the valley also is bordered by 1,000 to 1,500 foot hills with one major passage to the San Joaquin Valley called the Altamont Pass and several secondary passages. To the north lie the Black Hills and Mount Diablo. A northwest to southeast channel connects the Diablo Valley to the Livermore Valley. The south side of the Livermore Valley is bordered by mountains approximately 3,000 to 3,500 feet high.

During the summer months, when there is a strong inversion with a low ceiling, air movement is weak and pollutants become trapped and concentrated. Maximum summer temperatures in the Livermore Valley range from the high-80's to the low-90's, with extremes in the 100's. At other times in the summer, a strong Pacific high pressure cell from the west, coupled with hot inland temperatures causes a strong onshore pressure gradient which produces a strong, afternoon wind. With a weak temperature inversion, air moves over the hills with ease, dispersing pollutants.

In the winter, with the exception of an occasional storm moving through the area, air movement is often dictated by local conditions. At night and early morning, especially under clear, calm and cold conditions, gravity drives cold air downward. The cold air drains off the hills and moves into the gaps and passes. On the eastern side of the valley the prevailing winds blow from north, northeast and east out of the Altamont Pass. Winds are light during the late night and early morning hours. Winter daytime winds sometimes flow from the south through the Altamont Pass to the San Joaquin Valley. Average winter maximum temperatures range from the high-50's to the low-60's, while minimum temperatures are from the mid-to-high-30's, with extremes in the high teens and low-20's.

Air pollution potential is high in the Livermore Valley, especially for photochemical pollutants in the summer and fall. High temperatures increase the potential for ozone to build up. The valley not only traps locally generated pollutants but can be the receptor of ozone and ozone precursors from San Francisco, Alameda, Contra Costa and Santa Clara counties. On northeasterly wind flow days, most common in the early fall, ozone may be carried west from the San Joaquin Valley to the Livermore Valley.

During the winter, the sheltering effect of the valley, its distance from moderating water bodies, and the presence of a strong high pressure system contribute to the development of strong, surface-based temperature inversions. Pollutants such as carbon monoxide and particulate matter, generated by motor vehicles, fireplaces and agricultural burning, can become concentrated. Air pollution problems could intensify because of population growth and increased commuting to and through the subregion.

Marin County Basins

Marin County is bounded on the west by the Pacific Ocean, on the east by San Pablo Bay, on the south by the Golden Gate and on the north by the Petaluma Gap. Most of Marin's population lives in the eastern part of the county, in small, sheltered valleys. These valleys act like a series of miniature air basins.

Although there are a few mountains above 1500 feet, most of the terrain is only 800 to 1000 feet high, which usually is not high enough to block the marine layer. Because of the wedge shape of the county, northeast Marin County is further from the ocean than is the southeastern section. This extra distance from the ocean allows the marine air to be moderated by bayside conditions as it travels to northeastern Marin County. In southern Marin the distance from the ocean is short and elevations are lower, resulting in higher incidence of maritime air in that area.

Wind speeds are highest along the west coast of Marin, averaging about 8 to 10 miles per hour. The complex terrain in central Marin creates sufficient friction to slow the air flow. At Hamilton Air Force Base, in Novato, the annual average wind speeds are only 5 mph. The prevailing wind directions throughout Marin County are generally from the northwest.

In the summer months, areas along the coast are usually subject to onshore movement of cool marine air. In the winter, proximity to the ocean keeps the coastal regions relatively warm, with temperatures varying little throughout the year. Coastal temperatures are usually in the high-50's in the winter and the low-60's in the summer. The warmest months are September and October.

The eastern side of Marin County has warmer weather than the western side because of its distance from the ocean and because the hills that separate eastern Marin from western Marin occasionally block the flow of the marine air. The temperatures of cities next to the Bay are moderated by the cooling effect of the Bay in the summer and the warming effect of the Bay in the winter. For example, San Rafael experiences average maximum summer temperatures in the low-80's and average minimum winter temperatures in the low-40’s. Inland towns such as Kentfield experience average maximum temperatures that are two degrees cooler in the winter and two degrees warmer in the summer.

Air pollution potential is highest in eastern Marin County, where most of population is located in semi-sheltered valleys. In the southeast, the influence of marine air keeps pollution levels low. As development moves further north, there is greater potential for air pollution to build up because the valleys are more sheltered from the sea breeze. While Marin County does not have many polluting industries, the air quality on its eastern side — especially along the U.S. 101 corridor — may be affected by emissions from increasing motor vehicle use within and through the county.

Napa Valley

The Napa Valley is bordered by relatively high mountains. With an average ridge line height of about 2000 feet, with some peaks approaching 3000 to 4000 feet, these mountains are effective barriers to the prevailing northwesterly winds. The Napa Valley is widest at its southern end and narrows in the north.

During the day, the prevailing winds flow upvalley from the south about half of the time. A strong upvalley wind frequently develops during warm summer afternoons, drawing air in from the San Pablo Bay. Daytime winds sometimes flow downvalley from the north. During the evening, especially in the winter, downvalley drainage often occurs. Wind speeds are generally low, with almost 50 percent of the winds less than 4 mph. Only 5 percent of the winds are between 16 and 18 mph, representing strong summertime upvalley winds and winter storms.

Summer average maximum temperatures are in the low 80's at the southern end of the valley and in the low 90's at the northern end. Winter average maximum temperatures are in the high-

50's and low-60's, and minimum temperatures are in the high to mid 30's with the slightly cooler temperatures in the northern end.

The air pollution potential in the Napa Valley could be high if there were sufficient sources of air contaminants nearby. Summer and fall prevailing winds can transport ozone precursors northward from the Carquinez Strait Region to the Napa Valley, effectively trapping and concentrating the pollutants when stable conditions are present. The local upslope and downslope flows created by the surrounding mountains may also recirculate pollutants already present, contributing to buildup of air pollution. High ozone concentrations are a potential problem to sensitive crops such as wine grapes, as well as to human health. The high frequency of light winds and stable conditions during the late fall and winter contribute to the buildup of particulate matter from motor vehicles, agriculture and wood burning in fireplaces and stoves.

Northern Alameda and Western Contra Costa Counties

This climatological subregion stretches from Richmond to San Leandro. Its western boundary is defined by the Bay and its eastern boundary by the Oakland-Berkeley Hills. The Oakland-Berkeley Hills have a ridge line height of approximately 1500 feet, a significant barrier to air flow. The most densely populated area of the subregion lies in a strip of land between the Bay and the lower hills.

In this area, marine air traveling through the Golden Gate, as well as across San Francisco and through the San Bruno Gap, is a dominant weather factor. The Oakland-Berkeley Hills cause the westerly flow of air to split off to the north and south of Oakland, which causes diminished wind speeds. The prevailing winds for most of this subregion are from the west. At the northern end, near Richmond, prevailing winds are from the south-southwest.

Temperatures in this subregion have a narrow range due to the proximity of the moderating marine air. Maximum temperatures during summer average in the mid-70's, with minimums in the mid-50's. Winter highs are in the mid- to high-50's, with lows in the low- to mid-40's.

The air pollution potential is lowest for the parts of the subregion that are closest to the bay, due largely to good ventilation and less influx of pollutants from upwind sources. The occurrence of light winds in the evenings and early mornings occasionally causes elevated pollutant levels.

The air pollution potential at the northern (Richmond) and southern (Oakland, San Leandro) parts of this subregion is marginally higher than communities directly east of the Golden Gate, because of the lower frequency of strong winds.

This subregion contains a variety of industrial air pollution sources. Some industries are quite close to residential areas. The subregion is also traversed by frequently congested major freeways. Traffic and congestion, and the motor vehicle emissions they generate, are increasing.

Peninsula

The peninsula region extends from northwest of San Jose to the Golden Gate. The Santa Cruz Mountains run up the center of the peninsula, with elevations exceeding 2000 feet at the southern end, decreasing to 500 feet in South San Francisco. Coastal towns experience a high incidence of cool, foggy weather in the summer. Cities in the southeastern peninsula experience warmer temperatures and fewer foggy days because the marine layer is blocked by the ridgeline to the west. San Francisco lies at the northern end of the peninsula. Because most of San Francisco's topography is below 200 feet, marine air is able to flow easily across most of the city, making its climate cool and windy.

The blocking effect of the Santa Cruz Mountains results in variations in summertime maximum temperatures in different parts of the peninsula. For example, in coastal areas and San Francisco

the mean maximum summer temperatures are in the mid-60's, while in Redwood City the mean maximum summer temperatures are in the low-80's. Mean minimum temperatures during the winter months are in the high-30's to low-40's on the eastern side of the Peninsula and in the low 40's on the coast.

Two important gaps in the Santa Cruz Mountains occur on the peninsula. The larger of the two is the San Bruno Gap, extending from Fort Funston on the ocean to the San Francisco Airport. Because the gap is oriented in the same northwest to southeast direction as the prevailing winds, and because the elevations along the gap are less than 200 feet, marine air is easily able to penetrate into the bay. The other gap is the Crystal Springs Gap, between Half Moon Bay and San Carlos. As the sea breeze strengthens on summer afternoons, the gap permits maritime air to pass across the mountains, and its cooling effect is commonly seen from San Mateo to Redwood City.

Annual average wind speeds range from 5 to 10 mph throughout the peninsula, with higher wind speeds usually found along the coast. Winds on the eastern side of the peninsula are often high in certain areas, such as near the San Bruno Gap and the Crystal Springs Gap.

The prevailing winds along the peninsula's coast are from the west, although individual sites can show significant differences. For example, Fort Funston in western San Francisco shows a southwest wind pattern while Pillar Point in San Mateo County shows a northwest wind pattern. On the east side of the mountains winds are generally from the west, although wind patterns in this area are often influenced greatly by local topographic features.

Air pollution potential is highest along the southeastern portion of the peninsula. This is the area most protected from the high winds and fog of the marine layer. Pollutant transport from upwind sites is common. In the southeastern portion of the peninsula, air pollutant emissions are relatively high due to motor vehicle traffic as well as stationary sources. At the northern end of the peninsula in San Francisco, pollutant emissions are high, especially from motor vehicle congestion. Localized pollutants, such as carbon monoxide, can build up in "urban canyons." Winds are generally fast enough to carry the pollutants away before they can accumulate.

Santa Clara Valley

The Santa Clara Valley is bounded by the Bay to the north and by mountains to the east, south and west. Temperatures are warm on summer days and cool on summer nights, and winter temperatures are fairly mild. At the northern end of the valley, mean maximum temperatures are in the low-80's during the summer and the high-50's during the winter, and mean minimum temperatures range from the high-50's in the summer to the low-40's in the winter. Further inland, where the moderating effect of the Bay is not as strong, temperature extremes are greater. For example, in San Martin, located 27 miles south of the San Jose Airport, temperatures can be more than 10 degrees warmer on summer afternoons and more than 10 degrees cooler on winter nights.

Winds in the valley are greatly influenced by the terrain, resulting in a prevailing flow that roughly parallels the valley's northwest-southeast axis. A north-northwesterly sea breeze flows through the valley during the afternoon and early evening, and a light south-southeasterly drainage flow occurs during the late evening and early morning. In the summer the southern end of the valley sometimes becomes a "convergence zone," when air flowing from the Monterey Bay gets channeled northward into the southern end of the valley and meets with the prevailing north-northwesterly winds.

Wind speeds are greatest in the spring and summer and weakest in the fall and winter. Nighttime and early morning hours frequently have calm winds in all seasons, while summer afternoons and

evenings are quite breezy. Strong winds are rare, associated mostly with the occasional winter storm.

The air pollution potential of the Santa Clara Valley is high. High summer temperatures, stable air and mountains surrounding the valley combine to promote ozone formation. In addition to the many local sources of pollution, ozone precursors from San Francisco, San Mateo and Alameda Counties are carried by prevailing winds to the Santa Clara Valley. The valley tends to channel pollutants to the southeast. In addition, on summer days with low level inversions, ozone can be recirculated by southerly drainage flows in the late evening and early morning and by the prevailing northwesterlies in the afternoon. A similar recirculation pattern occurs in the winter, affecting levels of carbon monoxide and particulate matter. This movement of the air up and down the valley increases the impact of the pollutants significantly.

Pollution sources are plentiful and complex in this subregion. The Santa Clara Valley has a high concentration of industry at the northern end, in the Silicon Valley. Some of these industries are sources of air toxics as well as criteria air pollutants. In addition, Santa Clara Valley's large population and many work-site destinations generate the highest mobile source emissions of any subregion in the SFBAAB.

Sonoma Valley

The Sonoma Valley is west of the Napa Valley. It is separated from the Napa Valley and from the Cotati and Petaluma Valleys by mountains. The Sonoma Valley is long and narrow, approximately 5 miles wide at its southern end and less than a mile wide at the northern end.

The climate is similar to that of the Napa Valley, with the same basic wind characteristics. The strongest upvalley winds occur in the afternoon during the summer and the strongest downvalley winds occur during clear, calm winter nights. Prevailing winds follow the axis of the valley, northwest/southeast, while some upslope flow during the day and downslope flow during the night occurs near the base of the mountains. Summer average maximum temperatures are usually in the high-80's, and summer minimums are around 50 degrees. Winter maximums are in the high-50's to the mid-60's, with minimums ranging from the mid-30's to low-40's.

As in the Napa Valley, the air pollution potential of the Sonoma Valley could be high if there were significant sources of pollution nearby. Prevailing winds can transport local and nonlocally generated pollutants northward into the narrow valley, which often traps and concentrates the pollutants under stable conditions. The local upslope and downslope flows set up by the surrounding mountains may also recirculate pollutants.

However, local sources of air pollution are minor. With the exception of some processing of agricultural goods, such as wine and cheese manufacturing, there is little industry in this valley. Increases in motor vehicle emissions and woodsmoke emissions from stoves and fireplaces may increase pollution as the valley grows in population and as a tourist attraction.

Southwestern Alameda County

This subregion encompasses the southeast side of San Francisco Bay, from Dublin Canyon to north of Milpitas. The subregion is bordered on the east by the East Bay hills and on the west by the bay. Most of the area is flat.

This subregion is indirectly affected by marine air flow. Marine air entering through the Golden Gate is blocked by the East Bay hills, forcing the air to diverge into northerly and southerly paths. The southern flow is directed down the bay, parallel to the hills, where it eventually passes over southwestern Alameda County. These sea breezes are strongest in the afternoon. The further from the ocean the marine air travels, the more the ocean’s effect is diminished. Although the

climate in this region is affected by sea breezes, it is affected less so than the regions closer to the Golden Gate.

The climate of southwestern Alameda County is also affected by its close proximity to San Francisco Bay. The Bay cools the air with which it comes in contact during warm weather, while during cold weather the Bay warms the air. The normal northwest wind pattern carries this air onshore. Bay breezes push cool air onshore during the daytime and draw air from the land offshore at night.

Winds are predominantly out of the northwest during the summer months. In the winter, winds are equally likely to be from the east. Easterly-southeasterly surface flow into southern Alameda County passes through three major gaps: Hayward/Dublin Canyon, Niles Canyon and Mission Pass. Areas north of the gaps experience winds from the southeast, while areas south of the gaps experience winds from the northeast. Wind speeds are moderate in this subregion, with annual average wind speeds close to the Bay at about 7 mph, while further inland they average 6 mph.

Air temperatures are moderated by the subregion's proximity to the Bay and to the sea breeze. Temperatures are slightly cooler in the winter and slightly warmer in the summer than East Bay cities to the north. During the summer months, average maximum temperatures are in the mid-70's. Average maximum winter temperatures are in the high-50's to low-60's. Average minimum temperatures are in the low 40's in winter and mid-50's in the summer.

Pollution potential is relatively high in this subregion during the summer and fall. When high pressure dominates, low mixing depths and Bay and ocean wind patterns can concentrate and carry pollutants from other cities to this area, adding to the locally emitted pollutant mix. The polluted air is then pushed up against the East Bay hills. In the wintertime, the air pollution potential in southwestern Alameda County is moderate. Air pollution sources include light and heavy industry, and motor vehicles. Increasing motor vehicle traffic and congestion in the subregion may increase Southwest Alameda County pollution as well as that of its neighboring subregions.

C.1.2. Existing Ambient Air Quality: Criteria Air Pollutants

The California Air Resources Board (ARB) and the U.S. Environmental Protection Agency (EPA) currently focus on the following air pollutants as indicators of ambient air quality: ozone, particulate matter (PM), nitrogen dioxide (NO_2), CO, sulfur dioxide (SO_2), and lead. Because these are the most prevalent air pollutants known to be deleterious to human health and extensive health-effects criteria documents are available, they are commonly referred to as "criteria air pollutants." Sources and health effects of the criteria air pollutants are summarized in Table C.2. Current state and federal air quality standards are available at http://www.arb.ca.gov/research/aaqs/aaqs2.pdf and designations are available at http://www.arb.ca.gov/desig/desig.htm. See Table C.1 for current attainment status.

Table C.1
Ambient Air Quality Standards and Designations

Pollutant	Averaging Time	California		National Standards[a]		
		Standards[b, c]	Attainment Status[d]	Primary[c,e]	Secondary[c,f]	Attainment Status[g]
Ozone	1-hour	0.09 ppm (180 µg/m^3)	N (Serious)	–[h]	Same as Primary Standard	–[h]
	8-hour	0.070 ppm (137 µg/m^3)	–	0.075 ppm (147 µg/m^3)		N
Carbon Monoxide (CO)	1-hour	20 ppm (23 mg/m^3)	A	35 ppm (40 mg/m^3)	–	U/A
	8-hour	9 ppm (10 mg/m^3)		9 ppm (10 mg/m^3)		
Nitrogen Dioxide (NO_2)	Annual Arithmetic Mean	0.030 ppm (57 µg/m^3)	–	0.053 ppm (100 µg/m^3)	Same as Primary Standard	U/A
	1-hour	0.18 ppm (339 µg/m^3)	A	–		–
Sulfur Dioxide (SO_2)	Annual Arithmetic Mean	–	–	0.030 ppm (80 µg/m^3)	–	A
	24-hour	0.04 ppm (105 µg/m^3)	A	0.14 ppm (365 µg/m^3)	–	
	3-hour	–	–	–	0.5 ppm (1300 µg/m^3)	
	1-hour	0.25 ppm (655 µg/m^3)	A	–	–	–
Respirable Particulate Matter (PM_{10})	Annual Arithmetic Mean	20 µg/m^3	N	–[h]	Same as Primary Standard	U
	24-hour	50 µg/m^3		150 µg/m^3		
Fine Particulate Matter ($PM_{2.5}$)	Annual Arithmetic Mean	12 µg/m^3	N	15 µg/m^3	Same as Primary Standard	N[j]
	24-hour	–	–	35 µg/m^3		
Lead[i]	30-day Average	1.5 µg/m^3	A	–	–	–
	Calendar Quarter	–	–	1.5 µg/m^3	Same as Primary Standard	–

Table C.1
Ambient Air Quality Standards and Designations

Pollutant	Averaging Time	California		National Standards[a]		
		Standards[b, c]	Attainment Status[d]	Primary[c,e]	Secondary[c,f]	Attainment Status[g]
Sulfates	24-hour	25 µg/m^3	A	**No National Standards**		
Hydrogen Sulfide	1-hour	0.03 ppm (42 µg/m^3)	U			
Vinyl Chloride[i]	24-hour	0.01 ppm (26 µg/m^3)	–			
Visibility-Reducing Particle Matter	8-hour	Extinction coefficient of 0.23 per kilometer —visibility of 10 miles or more (0.07—30 miles or more for Lake Tahoe) because of particles when the relative humidity is less than 70%.	U			

[a] National standards (other than ozone, PM, and those based on annual averages or annual arithmetic means) are not to be exceeded more than once a year. The ozone standard is attained when the fourth highest 8-hour concentration in a year, averaged over 3 years, is equal to or less than the standard. The PM_{10} 24-hour standard is attained when 99% of the daily concentrations, averaged over 3 years, are equal to or less than the standard. The $PM_{2.5}$ 24-hour standard is attained when 98% of the daily concentrations, averaged over 3 years, are equal to or less than the standard. Contact the EPA for further clarification and current federal policies.

[b] California standards for ozone, CO (except Lake Tahoe), SO_2 (1- and 24-hour), NO_2, PM, and visibility-reducing particles are values that are not to be exceeded. All others are not to be equaled or exceeded. CAAQS are listed in the Table of Standards in Section 70200 of Title 17 of the California Code of Regulations.

[c] Concentration expressed first in units in which it was promulgated [i.e., parts per million (ppm) or micrograms per cubic meter (µg/m^3)]. Equivalent units given in parentheses are based upon a reference temperature of 25°C and a reference pressure of 760 torr. Most measurements of air quality are to be corrected to a reference temperature of 25°C and a reference pressure of 760 torr; ppm in this table refers to ppm by volume, or micromoles of pollutant per mole of gas.

[d] Unclassified (U): a pollutant is designated unclassified if the data are incomplete and do not support a designation of attainment or nonattainment.
Attainment (A): a pollutant is designated attainment if the state standard for that pollutant was not violated at any site in the area during a 3-year period.
Nonattainment (N): a pollutant is designated nonattainment if there was a least one violation of a state standard for that pollutant in the area.
Nonattainment/Transitional (NT): is a subcategory of the nonattainment designation. An area is designated nonattainment/transitional to signify that the area is close to attaining the standard for that pollutant.

[e] National Primary Standards: The levels of air quality necessary, with an adequate margin of safety, to protect the public health.

[f] National Secondary Standards: The levels of air quality necessary to protect the public welfare from any known or anticipated adverse effects of a pollutant.

[g] Nonattainment (N): any area that does not meet (or that contributes to ambient air quality in a nearby area that does not meet) the national primary or secondary ambient air quality standard for the pollutant.
Attainment (A): any area that meets the national primary or secondary ambient air quality standard for the pollutant.
Unclassifiable (U): any area that cannot be classified on the basis of available information as meeting or not meeting the national primary or secondary ambient air quality standard for the pollutant.

[h] The 1-hour ozone NAAQS was revoked on June 15, 2005 and the annual PM_{10} NAAQS was revoked in 2006.

[i] ARB has identified lead and vinyl chloride as toxic air contaminants with no threshold of exposure for adverse health effects determined. These actions allow for the implementation of control measures at levels below the ambient concentrations specified for this pollutant.

[j] U.S EPA lowered the 24-hour $PM_{2.5}$ standard from 65 µg/m^3 to 35 µg/m^3 in 2006. EPA issued attainment status designations for the 35 µg/m^{3}standard on December 22, 2008. EPA has designated the Bay Area as nonattainment for the 35 µg/m^3 $PM_{2.5}$ standard. The EPA designation will be effective 90 days after publication of the regulation in the Federal Register.

Table C.2
Common Sources of Health Effects for Criteria Air Pollutants

Pollutants	Sources	Health Effects
Ozone	Atmospheric reaction of organic gases with nitrogen oxides in sunlight	Aggravation of respiratory and cardiovascular diseases; reduced lung function; increased cough and chest discomfort
Fine Particulate Matter (PM_{10} and $PM_{2.5}$)	Stationary combustion of solid fuels; construction activities; industrial processes; atmospheric chemical reactions	Reduced lung function; aggravation of respiratory and cardiovascular diseases; increases in mortality rate; reduced lung function growth in children
Nitrogen Dioxide (NO_2)	Motor vehicle exhaust; high temperature stationary combustion; atmospheric reactions	Aggravation of respiratory illness
Carbon Monoxide (CO)	Incomplete combustion of fuels and other carbon-containing substances, such as motor vehicle exhaust; natural events, such as decomposition of organic matter	Aggravation of some heart diseases; reduced tolerance for exercise; impairment of mental function; birth defects; death at high levels of exposure
Sulfur Dioxide (SO_2)	Combination of sulfur-containing fossil fuels; smelting of sulfur-bearing metal ore; industrial processes	Aggravation of respiratory diseases; reduced lung function
Lead	Contaminated soil	Behavioral and hearing disabilities in children; nervous system impairment

Source: South Coast Air Quality Management District 2005; EPA 2009; EDAW 2009

Ozone, or smog, is not emitted directly into the environment, but is formed in the atmosphere by complex chemical reactions between ROG and NO_X in the presence of sunlight. Ozone formation is greatest on warm, windless, sunny days. The main sources of NO_X and ROG, often referred to as ozone precursors, are combustion processes (including motor vehicle engines) the evaporation of solvents, paints, and fuels, and biogenic sources. Automobiles are the single largest source of ozone precursors in the SFBAAB. Tailpipe emissions of ROG are highest during cold starts, hard acceleration, stop-and-go conditions, and slow speeds. They decline as speeds increase up to about 50 mph, then increase again at high speeds and high engine loads. ROG emissions associated with evaporation of unburned fuel depend on vehicle and ambient temperature cycles. Nitrogen oxide emissions exhibit a different curve; emissions decrease as the vehicle approaches 30 mph and then begin to increase with increasing speeds.

Ozone levels usually build up during the day and peak in the afternoon hours. Short-term exposure can irritate the eyes and cause constriction of the airways. Besides causing shortness of breath, it can aggravate existing respiratory diseases such as asthma, bronchitis and emphysema. Chronic exposure to high ozone levels can permanently damage lung tissue. Ozone can also damage plants and trees, and materials such as rubber and fabrics.

Particulate Matter refers to a wide range of solid or liquid particles in the atmosphere, including smoke, dust, aerosols, and metallic oxides. Respirable particulate matter with an aerodynamic diameter of 10 micrometers or less is referred to as PM_{10}. $PM_{2.5}$ includes a subgroup of finer particles that have an aerodynamic diameter of 2.5 micrometers or less. Some particulate matter,

such as pollen, is naturally occurring. In the SFBAAB most particulate matter is caused by combustion, factories, construction, grading, demolition, agricultural activities, and motor vehicles. Extended exposure to particulate matter can increase the risk of chronic respiratory disease. PM_{10} is of concern because it bypasses the body's natural filtration system more easily than larger particles, and can lodge deep in the lungs. The EPA and the state of California revised their PM standards several years ago to apply only to these fine particles. $PM_{2.5}$ poses an increased health risk because the particles can deposit deep in the lungs and contain substances that are particularly harmful to human health. Motor vehicles are currently responsible for about half of particulates in the SFBAAB. Wood burning in fireplaces and stoves is another large source of fine particulates.

Nitrogen Dioxide (NO_2) is a reddish-brown gas that is a by-product of combustion processes. Automobiles and industrial operations are the main sources of NO_2. Aside from its contribution to ozone formation, nitrogen dioxide can increase the risk of acute and chronic respiratory disease and reduce visibility. NO_2 may be visible as a coloring component of a brown cloud on high pollution days, especially in conjunction with high ozone levels.

Carbon Monoxide (CO) is an odorless, colorless gas. It is formed by the incomplete combustion of fuels. The single largest source of CO in the SFBAAB is motor vehicles. Emissions are highest during cold starts, hard acceleration, stop-and-go driving, and when a vehicle is moving at low speeds. New findings indicate that CO emissions per mile are lowest at about 45 mph for the average light-duty motor vehicle and begin to increase again at higher speeds. When inhaled at high concentrations, CO combines with hemoglobin in the blood and reduces the oxygen-carrying capacity of the blood. This results in reduced oxygen reaching the brain, heart and other body tissues. This condition is especially critical for people with cardiovascular diseases, chronic lung disease or anemia, as well as fetuses. Even healthy people exposed to high CO concentrations can experience headaches, dizziness, fatigue, unconsciousness, and even death.

Sulfur Dioxide (SO_2) is a colorless acid gas with a pungent odor. It has potential to damage materials and it can have health effects at high concentrations. It is produced by the combustion of sulfur-containing fuels, such as oil, coal and diesel. SO_2 can irritate lung tissue and increase the risk of acute and chronic respiratory disease.

Lead is a metal found naturally in the environment as well as in manufactured products. The major sources of lead emissions have historically been mobile and industrial sources. As a result of the phase-out of leaded gasoline, metal processing is currently the primary source of lead emissions. The highest levels of lead in air are generally found near lead smelters. Other stationary sources are waste incinerators, utilities, and lead-acid battery manufacturers.

Twenty years ago, mobile sources were the main contributor to ambient lead concentrations in the air. In the early 1970s, the EPA set national regulations to gradually reduce the lead content in gasoline. In 1975, unleaded gasoline was introduced for motor vehicles equipped with catalytic converters. The EPA banned the use of leaded gasoline in highway vehicles in December 1995. As a result of the EPA's regulatory efforts to remove lead from gasoline, emissions of lead from the transportation sector and levels of lead in the air decreased dramatically.

Monitoring Data

The BAAQMD operates a regional air quality monitoring network that regularly measures the concentrations of the five major criteria air pollutants. Air pollutant monitoring data is available at http://www.arb.ca.gov/adam/welcome.html. Air quality conditions in the SFBAAB have improved significantly since the BAAQMD was created in 1955. Ambient concentrations and the number of days on which the region exceeds standards have declined dramatically. Neither State nor

national ambient air quality standards of these chemicals have been violated in recent decades for nitrogen dioxide, sulfur dioxide, sulfates, lead, hydrogen sulfide, and vinyl chloride.

Emissions Inventory

The BAAQMD estimates emissions of criteria air pollutants from approximately nine hundred source categories. The estimates are based on BAAQMD permit information for stationary sources (e.g., manufacturing industries, refineries, dry-cleaning operations), plus more generalized estimates for area sources (e.g., space heating, landscaping activities, use of consumer products) and mobile sources (e.g., trains, ships and planes, as well as on-road and off-road motor vehicles). BAAQMD emissions inventory data is available at http://www.arb.ca.gov/ei/maps/statemap/dismap.htm.

C.1.2. Existing Ambient Air Quality: Toxic Air Contaminants

In addition to the criteria air pollutants listed above, another group of pollutants, commonly referred to as toxic air contaminants (TACs) or hazardous air pollutants can result in health effects that can be quite severe. Many TACs are confirmed or suspected carcinogens, or are known or suspected to cause birth defects or neurological damage. Secondly, many TACs can be toxic at very low concentrations. For some chemicals, such as carcinogens, there are no thresholds below which exposure can be considered risk-free.

Industrial facilities and mobile sources are significant sources of TACs. The electronics industry, including semiconductor manufacturing, has the potential to contaminate both air and water due to the highly toxic chlorinated solvents commonly used in semiconductor production processes. Sources of TACs go beyond industry. Various common urban facilities also produce TAC emissions, such as gasoline stations (benzene), hospitals (ethylene oxide), and dry cleaners (perchloroethylene). Automobile exhaust also contains TACs such as benzene and 1,3-butadiene. Most recently, diesel particulate matter was identified as a TAC by the ARB. Diesel PM differs from other TACs in that it is not a single substance but rather a complex mixture of hundreds of substances. BAAQMD research indicates that mobile-source emissions of diesel PM, benzene, and 1,3-butadiene represent a substantial portion of the ambient background risk from TACs in the SFBAAB.

C.1.3. Greenhouse Gases and Global Climate Change

Unlike emissions of criteria and toxic air pollutants, which have local or regional impacts, emissions of greenhouse gases (GHGs) that contribute to global warming or global climate change have a broader, global impact. Global warming is a process whereby GHGs accumulating in the atmosphere contribute to an increase in the temperature of the earth's atmosphere. The principal GHGs contributing to global warming are carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), and fluorinated compounds. The primary GHGs of concern are summarized in Table C.3. These gases allow visible and ultraviolet light from the sun to pass through the atmosphere, but they prevent heat from escaping back out into space. Among the potential implications of global warming are rising sea levels, and adverse impacts to water supply, water quality, agriculture, forestry, and habitats. In addition, global warming may increase electricity demand for cooling, decrease the availability of hydroelectric power, and affect regional air quality and public health. Like most criteria and toxic air pollutants, much of the GHG production comes from motor vehicles. GHG emissions can be reduced to some degree by improved coordination of land use and transportation planning on the city, county, and subregional level, and other measures to reduce automobile use. Energy conservation measures also can contribute to reductions in GHG emissions.

Table C.3 Examples of Greenhouse Gases	
Gas	**Sources**
Carbon dioxide (CO_2)	Fossil fuel combustion in stationary and point sources; emission sources includes burning of oil, coal, gas.
Methane (CH_4)	Incomplete combustion in forest fires, landfills, and leaks in natural gas and petroleum systems, agricultural activities, coal mining, wastewater treatment, and certain industrial processes.
Nitrous oxide (N_2O)	Fossil fuel combustion in stationary and point sources; other emission sources include agricultural soil management, animal manure management, sewage treatment, adipic acid production, and nitric acid production.
Chlorofluorocarbon (CFC), and Hydro-chlorofluorocarbon (HCFC)	Agents used in production of foam insulation; other sources include air conditioners, refrigerators, and solvents in cleaners.
Sulfur hexafluoride (SF_6)	Electric insulation in high voltage equipment that transmits and distributes electricity, including circuit breakers, gas-insulated substations, and other switchgear used in the transmission system to manage the high voltages carried between generating stations and customer load centers.
Perfluorocarbons (PFC's)	Primary aluminum production and semiconductor manufacturing.
Source: EPA 2009	

California Greenhouse Gas Emissions Inventory

Emissions of GHGs contributing to global climate change are attributable in large part to human activities associated with the transportation, industrial/manufacturing, utility, residential, commercial and agricultural sectors. In California, the transportation sector is the largest emitter of GHGs, followed by electricity generation. Emissions of CO_2 are byproducts of fossil fuel combustion. CH_4, a highly potent GHG, results from off-gassing (the release of chemicals from nonmetallic substances under ambient or greater pressure conditions) is largely associated with agricultural practices and landfills. N_2O is also largely attributable to agricultural practices and soil management. CO_2 sinks, or reservoirs, include vegetation and the ocean, which absorb CO_2 through sequestration and dissolution, respectively, two of the most common processes of CO_2 sequestration.

California produced 474 million gross metric tons (MMT) of CO_2 equivalent (CO_2e) averaged over the period from 2002-2004. CO_2e is a measurement used to account for the fact that different GHGs have different potential to retain infrared radiation in the atmosphere and contribute to the greenhouse effect. This potential, known as the global warming potential (GWP) of a GHG, is dependent on the lifetime, or persistence, of the gas molecule in the atmosphere. For example, one ton of CH_4 has the same contribution to the greenhouse effect as approximately 23 tons of CO_2. Therefore, CH_4 is a much more potent GHG than CO_2. Expressing emissions in CO_2e takes the contributions of all GHG emissions to the greenhouse effect and converts them to a single unit equivalent to the effect that would occur if only CO_2 were being emitted.

Combustion of fossil fuel in the transportation sector was the single largest source of California's GHG emissions in 2002-2004, accounting for 38 percent of total GHG emissions in the state. This sector was followed by the electric power sector (including both in-state and out-of-state sources) (18 percent) and the industrial sector (21 percent).

California Greenhouse Gas Emissions Projections

The 1990 GHG emissions limit is approximately 430 MMT CO_2e, which must be met in California by 2020 per the requirements of AB 32 (discussed below in the Regulatory Setting). ARB's GHG inventory for all emissions sectors would require an approximate 28 percent reduction in GHG emissions from projected 2020 forecasts to meet the target emissions limit (equivalent to levels in 1990) established in AB 32. The AB 32 Scoping Plan, discussed further below, is ARB's plan for meeting this mandate.

C.1.4. Existing Ambient Air Quality: Odors and Dust

Other air quality issues of concern in the SFBAAB include nuisance impacts of odors and dust. Objectionable odors may be associated with a variety of pollutants. Common sources of odors include wastewater treatment plants, landfills, composting facilities, refineries and chemical plants. Similarly, nuisance dust may be generated by a variety of sources including quarries, agriculture, grading and construction. Odors rarely have direct health impacts, but they can be very unpleasant and can lead to anger and concern over possible health effects among the public. Each year the BAAQMD receives thousands of citizen complaints about objectionable odors. Dust emissions can contribute to increased ambient concentrations of PM_{10}, and can also contribute to reduced visibility and soiling of exposed surfaces.

REGULATORY SETTING

Air quality with respect to criteria air pollutants and TACs within the SFBAAB is regulated by such agencies as the BAAQMD, ARB, and EPA. Each of these agencies develops rules, regulations, policies, and/or goals to attain the goals or directives imposed through legislation. Although the EPA regulations may not be superseded, both state and local regulations may be more stringent.

C.1.5. Criteria Air Pollutants

Federal Air Quality Regulations

U.S. Environmental Protection Agency

At the federal level, EPA has been charged with implementing national air quality programs. EPA's air quality mandates are drawn primarily from the Federal Clean Air Act (FCAA), which was enacted in 1963. The FCAA was amended in 1970, 1977, and 1990.

The FCAA required EPA to establish primary and secondary NAAQS, which are available at http://www.arb.ca.gov/research/aaqs/aaqs2.pdf. The FCAA also required each state to prepare an air quality control plan referred to as a State Implementation Plan (SIP). The Federal Clean Air Act Amendments of 1990 (FCAAA) added requirements for states with nonattainment areas to revise their SIPs to incorporate additional control measures to reduce air pollution. The SIP is periodically modified to reflect the latest emissions inventories, planning documents, and rules and regulations of the air basins as reported by their jurisdictional agencies. EPA has responsibility to review all state SIPs to determine conformation to the mandates of the FCAAA and determine if implementation will achieve air quality goals. If the EPA determines a SIP to be inadequate, a Federal Implementation Plan (FIP) may be prepared for the nonattainment area that imposes additional control measures. Failure to submit an approvable SIP or to implement the plan within the mandated timeframe may result in sanctions being applied to transportation funding and stationary air pollution sources in the air basin.

State Air Quality Regulations

In 1992 and 1993, the California Air Resources Board (CARB) requested delegation of authority for the implementation and enforcement of specified New Source Performance Standards

(NSPS) and National Emission Standards for Hazardous Air Pollutants (NESHAPS) to the following local agencies: Bay Area and South Coast Air Quality Management Districts (AQMDs). EPA's review of the State of California's laws, rules, and regulations showed them to be adequate for the implementation and enforcement of these federal standards, and EPA granted the delegations as requested.

California Air Resources Board

ARB is the agency responsible for coordination and oversight of state and local air pollution control programs in California and for implementing the California Clean Air Act (CCAA), which was adopted in 1988. The CCAA requires that all air districts in the state endeavor to achieve and maintain the CAAQS by the earliest practical date. The act specifies that districts should focus particular attention on reducing the emissions from transportation and area-wide emission sources, and provides districts with the authority to regulate indirect sources.

ARB is primarily responsible for developing and implementing air pollution control plans to achieve and maintain the NAAQS. The ARB is primarily responsibility for statewide pollution sources and produces a major part of the SIP. Local air districts are still relied upon to provide additional strategies for sources under their jurisdiction. The ARB combines this data and submits the completed SIP to EPA.

Other ARB duties include monitoring air quality (in conjunction with air monitoring networks maintained by air pollution control and air quality management districts), establishing CAAQS (which in many cases are more stringent than the NAAQS), determining and updating area designations and maps, and setting emissions standards for new mobile sources, consumer products, small utility engines, and off-road vehicles.

Transport of Pollutants

The California Clean Air Act, Section 39610 (a), directs the ARB to “identify each district in which transported air pollutants from upwind areas outside the district cause or contribute to a violation of the ozone standard and to identify the district of origin of transported pollutants.” The information regarding the transport of air pollutants from one basin to another was to be quantified to assist interrelated basins in the preparation of plans for the attainment of State ambient air quality standards. Numerous studies conducted by the ARB have identified air basins that are impacted by pollutants transported from other air basins (as of 1993). Among the air basins affected by air pollution transport from the SFBAAB are the North Central Coast Air Basin, the Mountain Counties Air Basin, the San Joaquin Valley Air Basin, and the Sacramento Valley Air Basin. The SFBAAB was also identified as an area impacted by the transport of air pollutants from the Sacramento region.

Local Air Quality Regulations

Bay Area Air Quality Management District

The BAAQMD attains and maintains air quality conditions in the SFBAAB through a comprehensive program of planning, regulation, enforcement, technical innovation, and promotion of the understanding of air quality issues. The clean air strategy of the BAAQMD includes the preparation of plans for the attainment of ambient air quality standards, adoption and enforcement of rules and regulations concerning sources of air pollution, and issuance of permits for stationary sources of air pollution. The BAAQMD also inspects stationary sources of air pollution and responds to citizen complaints, monitors ambient air quality and meteorological conditions, and implements programs and regulations required by the FCAA, FCAAA, and the CCAA.

In 2009, the BAAQMD released the update to its CEQA Guidelines. This is an advisory document that provides the lead agency, consultants, and project applicants with uniform procedures for

addressing air quality in environmental documents. The handbook contains the following applicable components:

1. Criteria and thresholds for determining whether a project may have a significant adverse air quality impact;
2. Specific procedures and modeling protocols for quantifying and analyzing air quality impacts;
3. Methods available to mitigate air quality impacts;
4. Information for use in air quality assessments and environmental documents that will be updated more frequently such as air quality data, regulatory setting, climate, topography.

Air Quality Plans

As stated above, the BAAQMD prepares plans to attain ambient air quality standards in the SFBAAB. The BAAQMD prepares ozone attainment plans (OAP) for the national ozone standard and clean air plans (CAP) for the California standard both in coordination with the Metropolitan Transportation Commission and the Association of Bay Area Governments (ABAG).

With respect to applicable air quality plans, the BAAQMD prepared the *2010 Clean Air Plan* to address nonattainment of the national 1-hour ozone standard in the SFBAAB. The purpose of the 2010 Clean Air Plan is to:

1. Update the Bay Area 2005 Ozone Strategy in accordance with the requirements of the California Clean Air Act to implement "all feasible measures" to reduce ozone;
2. Consider the impacts of ozone control measures on particulate matter (PM), air toxics, and greenhouse gases in a single, integrated plan;
3. Review progress in improving air quality in recent years;
4. Establish emission control measures to be adopted or implemented in the 2009-2012 timeframe.

Similarly, the BAAQMD prepared the 2010 Clean Air Plan to address nonattainment of the CAAQS.

C.1.6. Toxic Air Contaminants

TACs, or in federal parlance under the FCAA, HAPs, are pollutants that result in an increase in mortality, a serious illness, or pose a present or potential hazard to human health. Health effects of TACs may include cancer, birth defects, and immune system and neurological damage.

TACs can be separated into carcinogens and noncarcinogens based on the nature of the physiological degradation associated with exposure to the pollutant. For regulatory purposes, carcinogens are assumed to have no safe threshold below which health impacts will not occur. Noncarcinogenic TACs differ in that there is a safe level in which it is generally assumed that no negative health impacts would occur. These levels are determined on a pollutant-by-pollutant basis.

It is important to understand that TACs are not considered criteria air pollutants and thus are not specifically addressed through the setting of ambient air quality standards. Instead, the EPA and ARB regulate HAPs and TACs, respectively, through statutes and regulations that generally require the use of the maximum or best available control technology (MACT and BACT) to limit emissions. These in conjunction with additional rules set forth by the BAAQMD establish the regulatory framework for TACs.

Federal Hazardous Air Pollutant Program

Title III of the FCAAA requires the EPA to promulgate national emissions standards for hazardous air pollutants (NESHAPs). The NESHAP may differ for major sources than for area sources of HAPs (major sources are defined as stationary sources with potential to emit more than 10 tons per year [TPY] of any HAP or more than 25 TPY of any combination of HAPs; all other sources are considered area sources). The emissions standards are to be promulgated in two phases. In the first phase (1992–2000), the EPA developed technology-based emission standards designed to produce the maximum emission reduction achievable. These standards are generally referred to as requiring MACT. These federal rules are also commonly referred to as MACT standards, because they reflect the Maximum Achievable Control Technology. For area sources, the standards may be different, based on generally available control technology. In the second phase (2001–2008), the EPA is required to promulgate health risk–based emissions standards where deemed necessary to address risks remaining after implementation of the technology-based NESHAP standards. The FCAAA required the EPA to promulgate vehicle or fuel standards containing reasonable requirements that control toxic emissions, at a minimum to benzene and formaldehyde. Performance criteria were established to limit mobile-source emissions of toxics, including benzene, formaldehyde, and 1,3-butadiene. In addition, §219 required the use of reformulated gasoline in selected U.S. cities (those with the most severe ozone nonattainment conditions) to further reduce mobile-source emissions.

State Toxic Air Contaminant Programs

California regulates TACs primarily through the Tanner Air Toxics Act (AB 1807) and the Air Toxics Hot Spots Information and Assessment Act of 1987 (AB 2588). The Tanner Act sets forth a formal procedure for ARB to designate substances as TACs. This includes research, public participation, and scientific peer review before ARB can designate a substance as a TAC. To date, ARB has identified over 21 TACs, and adopted the EPA's list of HAPs as TACs. Most recently, diesel exhaust particulate was added to the ARB list of TACs. Once a TAC is identified, ARB's then adopts an Airborne Toxics Control Measure for sources that emit that particular TAC. If there is a safe threshold for a substance at which there is no toxic effect, the control measure must reduce exposure below that threshold. If there is no safe threshold, the measure must incorporate TBACT to minimize emissions. None of the TACs identified by ARB have a safe threshold.

The Hot Spots Act requires that existing facilities that emit toxic substances above specified level:

1. Prepare a toxic emission inventory;
2. Prepare a risk assessment if emissions are significant;
3. Notify the public of significant risk levels;
4. Prepare and implement risk reduction measure.

ARB has adopted diesel exhaust control measures and more stringent emission standards for various on-road mobile sources of emissions, including transit buses, and off-road diesel equipment (e.g., tractors, generators). In February 2000, ARB adopted a new public transit bus fleet rule and emission standards for new urban buses. These new rules and standards provide for 1) more stringent emission standards for some new urban bus engines beginning with 2002 model year engines, 2) zero-emission bus demonstration and purchase requirements applicable to transit agencies, and 3) reporting requirements with which transit agencies must demonstrate compliance with the urban transit bus fleet rule. Upcoming milestones include the low sulfur diesel fuel requirement, and tighter emission standards for heavy-duty diesel trucks (2007) and off-road diesel equipment (2011) nationwide. Over time, the replacement of older vehicles will result in a vehicle fleet that produces substantially less TACs than under current conditions. Mobile-source emissions of TACs (e.g., benzene, 1-3-butadiene, diesel PM) have been reduced

significantly over the last decade, and will be reduced further in California through a progression of regulatory measures [e.g., Low Emission Vehicle/Clean Fuels and Phase II reformulated gasoline regulations) and control technologies. With implementation of ARB's Risk Reduction Plan, it is expected that diesel PM concentrations will be reduced by 75% in 2010 and 85% in 2020 from the estimated year 2000 level. Adopted regulations are also expected to continue to reduce formaldehyde emissions from cars and light-duty trucks. As emissions are reduced, it is expected that risks associated with exposure to the emissions will also be reduced.

Local Air Quality Regulations

Bay Area Air Quality Management District

The BAAQMD has regulated TACs since the 1980s. At the local level, air pollution control or management districts may adopt and enforce ARB's control measures. Under BAAQMD Regulation 2-1 (General Permit Requirements), Regulation 2-2 (New Source Review), and Regulation 2-5 (New Source Review), all nonexempt sources that possess the potential to emit TACs are required to obtain permits from BAAQMD. Permits may be granted to these operations if they are constructed and operated in accordance with applicable regulations, including new source review standards and air toxics control measures. The BAAQMD limits emissions and public exposure to TACs through a number of programs. The BAAQMD prioritizes TAC-emitting stationary sources based on the quantity and toxicity of the TAC emissions and the proximity of the facilities to sensitive receptors. In addition, the BAAQMD has adopted Regulation 11 Rules 2 and 14, which address asbestos demolition renovation, manufacturing, and standards for asbestos containing serpentine.

C.1.7. Greenhouse Gases and Global Climate Change

Federal Greenhouse Gas Regulations

Supreme Court Ruling

The U.S. Environmental Protection Agency (EPA) is the Federal agency responsible for implementing the Clean Air Act (CAA). The U.S. Supreme Court ruled in its decision in *Massachusetts et al. v. Environmental Protection Agency* et al. ([2007] 549 U.S. 05-1120), issued on April 2, 2007, that carbon dioxide (CO_2) is an air pollutant as defined under the CAA, and that EPA has the authority to regulate emissions of GHGs.

EPA Actions

In response to the mounting issue of climate change, EPA has taken actions to regulate, monitor, and potentially reduce GHG emissions.

Mandatory Greenhouse Gas Reporting Rule

On September 22, 2009, EPA issued a final rule for mandatory reporting of GHGs from large GHG emissions sources in the United States. In general, this national reporting requirement will provide EPA with accurate and timely GHG emissions data from facilities that emit 25,000 metric tons or more of CO2 per year. This publically available data will allow the reporters to track their own emissions, compare them to similar facilities, and aid in identifying cost effective opportunities to reduce emissions in the future. Reporting is at the facility level, except that certain suppliers of fossil fuels and industrial greenhouse gases along with vehicle and engine manufacturers will report at the corporate level. An estimated 85% of the total U.S. GHG emissions, from approximately 10,000 facilities, are covered by this final rule.

Proposed Endangerment and Cause or Contribute Findings for Greenhouse Gases under the Clean Air Act

On April 23, 2009, EPA published their Proposed Endangerment and Cause or Contribute Findings for Greenhouse Gases under the CCA (Endangerment Finding) in the Federal Register. The Endangerment Finding is based on Section 202(a) of the CAA, which states that the Administrator (of EPA) should regulate and develop standards for "emission[s] of air pollution from any class of classes of new motor vehicles or new motor vehicle engines, which in [its] judgment cause, or contribute to, air pollution which may reasonably be anticipated to endanger public health or welfare." The proposed rule addresses Section 202(a) in two distinct findings. The first addresses whether or not the concentrations of the six key GHGs (i.e., carbon dioxide [CO_2], methane [CH_4], nitrous oxide [N_2O], hydrofluorocarbons [HFCs], perflurorocarbons [PFCs], and sulfur hexafluoride [SF_6]) in the atmosphere threaten the public health and welfare of current and future generations. The second addresses whether or not the combined emissions of GHGs from new motor vehicles and motor vehicle engines contribute to atmospheric concentrations of GHGs and to the threat of climate change.

The Administrator proposed the finding that atmospheric concentrations of GHGs endanger the public health and welfare within the meaning of Section 202(a) of the CCA. The evidence supporting this finding consists of human activity resulting in "high atmospheric levels" of GHG emissions, which are very likely responsible for increases in average temperatures and other climatic changes. Furthermore, the observed and projected results of climate change (e.g., higher likelihood of heat waves, wild fires, droughts, sea level rise, higher intensity storms) are a threat to the public health and welfare. Therefore, GHGs were found to endanger the public health and welfare of current and future generations.

The Administrator also proposed the finding that GHG emissions from new motor vehicles and motor vehicle engines are contributing to air pollution, which is endangering public health and welfare. The proposed finding cites that in 2006, motor vehicles were the second largest contributor to domestic GHG emissions (24 percent of total) behind electricity generation. Furthermore, in 2005, the U.S. was responsible for 18 percent of global GHG emissions. Therefore, GHG emissions from motor vehicles and motor vehicle engines were found to contribute to air pollution that endangers public health and welfare.

State Greenhouse Gas Regulations

Assembly Bill 1493 (2002)

In 2002, then-Governor Gray Davis signed Assembly Bill (AB) 1493. AB 1493 requires that ARB develop and adopt, by January 1, 2005, regulations that achieve "the maximum feasible reduction of greenhouse gases emitted by passenger vehicles and light-duty trucks and other vehicles determined by ARB to be vehicles whose primary use is noncommercial personal transportation in the state."

To meet the requirements of AB 1493, in 2004 ARB approved amendments to the California Code of Regulations (CCR) adding GHG emissions standards to California's existing standards for motor vehicle emissions. Amendments to CCR Title 13, Sections 1900 and 1961 (13 CCR 1900, 1961), and adoption of Section 1961.1 (13 CCR 1961.1) require automobile manufacturers to meet fleet-average GHG emissions limits for all passenger cars, light-duty trucks within various weight criteria, and medium-duty passenger vehicle weight classes (i.e., any medium-duty vehicle with a gross vehicle weight rating less than 10,000 pounds that is designed primarily for the transportation of persons), beginning with the 2009 model year. For passenger cars and light-duty trucks with a loaded vehicle weight (LVW) of 3,750 pounds or less, the GHG emission limits for the 2016 model year are approximately 37percent lower than the limits for the first year of the regulations, the 2009 model year. For light-duty trucks with LVW of 3,751 pounds to gross vehicle

weight (GVW) of 8,500 pounds, as well as medium-duty passenger vehicles, GHG emissions would be reduced approximately 24 percent between 2009 and 2016.

In December 2004, a group of car dealerships, automobile manufacturers, and trade groups representing automobile manufacturers filed suit against ARB to prevent enforcement of 13 CCR Sections 1900 and 1961 as amended by AB 1493 and 13 CCR 1961.1 (*Central Valley Chrysler-Jeep et al. v. Catherine E. Witherspoon, in Her Official Capacity as Executive Director of the California Air Resources Board, et al.*). The auto-makers' suit in the U.S. District Court for the Eastern District of California, contended California's implementation of regulations that, in effect, regulate vehicle fuel economy violates various federal laws, regulations, and policies.

On December 12, 2007, the Court found that if California receives appropriate authorization from EPA (the last remaining factor in enforcing the standard), these regulations would be consistent with and have the force of federal law, thus, rejecting the automakers' claim. This authorization to implement more stringent standards in California was requested in the form of a CAA Section 209, subsection (b) waiver in 2005. Since that time, EPA failed to act on granting California authorization to implement the standards. Governor Schwarzenegger and Attorney General Edmund G. Brown filed suit against EPA for the delay. In December 2007, EPA Administrator Stephen Johnson denied California's request for the waiver to implement AB 1493. Johnson cited the need for a national approach to reducing GHG emissions, the lack of a "need to meet compelling and extraordinary conditions", and the emissions reductions that would be achieved through the Energy Independence and Security Act of 2007 as the reasoning for the denial.

The state of California filed suit against EPA for its decision to deny the CAA waiver. The recent change in presidential administration directed EPA to reexamine its position for denial of California's CAA waiver and for its past opposition to GHG emissions regulation. California received the waiver, notwithstanding the previous denial by EPA, on June 30, 2009.

Assembly Bill 32 (2006), California Global Warming Solutions Act

In September 2006, the governor of California signed AB 32 (Chapter 488, Statutes of 2006), the California Global Warming Solutions Act of 2006, which enacted Sections 38500–38599 of the California Health and Safety Code. AB 32 requires the reduction of statewide GHG emissions to 1990 levels by 2020. This equates to an approximate 15 percent reduction compared to existing statewide GHG emission levels or a 30 percent reduction from projected 2020 "business as usual" emission levels. The required reduction will be accomplished through an enforceable statewide cap on GHG emissions beginning in 2012.

To effectively implement the statewide cap on GHG emissions, AB 32 directs ARB to develop and implement regulations that reduce statewide GHG emissions generated by stationary sources. Specific actions required of ARB under AB 32 include adoption of a quantified cap on GHG emissions that represent 1990 emissions levels along with disclosing how the cap was quantified, institution of a schedule to meet the emissions cap, and development of tracking, reporting, and enforcement mechanisms to ensure that the state achieves the reductions in GHG emissions needed to meet the cap.

In addition, AB 32 states that if any regulations established under AB 1493 (2002) cannot be implemented then ARB is required to develop additional, new regulations to control GHG emissions from vehicles as part of AB 32.

AB 32 Climate Change Scoping Plan

In December 2008, ARB adopted its *Climate Change Scoping Plan*, which contains the main strategies California will implement to achieve reduction of approximately 169 million metric tons (MMT) of CO_2e, or approximately 30% from the state's projected 2020 emission level of 596 MMT of CO_2e under a business-as-usual scenario (this is a reduction of 42 MMT CO_2e, or almost 10%,

from 2002-2004 average emissions). The *Scoping Plan* also includes ARB-recommended GHG reductions for each emissions sector of the state's GHG inventory. The Scoping Plan calls for the largest reductions in GHG emissions to be achieved by implementing the following measures and standards:

- improved emissions standards for light-duty vehicles (estimated reductions of 31.7 MMT CO_2e);
- the Low-Carbon Fuel Standard (15.0 MMT CO_2e);
- energy efficiency measures in buildings and appliances and the widespread development of combined heat and power systems (26.3 MMT CO_2e); and
- a renewable portfolio standard for electricity production (21.3 MMT CO_2e).

ARB has not yet determined what amount of GHG reductions it recommends from local government operations; however, the *Scoping Plan* does state that land use planning and urban growth decisions will play an important role in the state's GHG reductions because local governments have primary authority to plan, zone, approve, and permit how land is developed to accommodate population growth and the changing needs of their jurisdictions(meanwhile, ARB is also developing an additional protocol for community emissions). ARB further acknowledges that decisions on how land is used will have large impacts on the GHG emissions that will result from the transportation, housing, industry, forestry, water, agriculture, electricity, and natural gas emission sectors. The *Scoping Plan* states that the ultimate GHG reduction assignment to local government operations is to be determined (ARB 2008). With regard to land use planning, the *Scoping Plan* expects approximately 5.0 MMT CO_2e will be achieved associated with implementation of SB 375, which is discussed further below.

Senate Bills 1078 and 107 and Executive Order S-14-08

SB 1078 (Chapter 516, Statutes of 2002) requires retail sellers of electricity, including investor-owned utilities and community choice aggregators, to provide at least 20 percent of their supply from renewable sources by 2017. SB 107 (Chapter 464, Statutes of 2006) changed the target date to 2010. In November 2008 Governor Schwarzenegger signed Executive Order S-14-08, which expands the state's Renewable Energy Standard to 33 percent renewable power by 2020. Governor Schwarzenegger plans to propose legislative language that will codify the new higher standard.

Senate Bill 1368 (2006)

SB 1368 is the companion bill of AB 32 and was signed by Governor Schwarzenegger in September 2006. SB 1368 requires the California Public Utilities Commission (PUC) to establish a greenhouse gas emission performance standard for baseload generation from investor owned utilities by February 1, 2007. The California Energy Commission (CEC) must establish a similar standard for local publicly owned utilities by June 30, 2007. These standards cannot exceed the greenhouse gas emission rate from a baseload combined-cycle natural gas fired plant. The legislation further requires that all electricity provided to California, including imported electricity, must be generated from plants that meet the standards set by the PUC and CEC.

Senate Bill 97 (2007)

SB 97, signed by governor of California in August 2007 (Chapter 185, Statutes of 2007; Public Resources Code, Sections 21083.05 and 21097), acknowledges climate change is a prominent environmental issue that requires analysis under CEQA. This bill directed the Governor's Office of Planning and Research (OPR) to prepare, develop, and transmit to the California Resources Agency by July 1, 2009 guidelines for mitigating GHG emissions or the effects of GHG emissions,

as required by CEQA. The California Resources Agency is required to certify and adopt these guidelines by January 1, 2010.

This bill also removes, both retroactively and prospectively, as legitimate causes of action in litigation any claim of inadequate CEQA analysis of effects of GHG emissions associated with environmental review for projects funded by the Highway Safety, Traffic Reduction, Air Quality and Port Security Bond Act of 2006 (Proposition 1B) or the Disaster Preparedness and Flood Protection Bond Act of 2006 (Proposition 1E). This provision will be repealed by provision of law on January 1, 2010 at that time such projects, if any remain unapproved, will no longer enjoy protection against litigation claims based on failure to adequately address issues related to GHG emissions.

Senate Bill 375 (2008)

SB 375, signed in September 2008, aligns regional transportation planning efforts, regional GHG reduction targets, and land use and housing allocation. As part of the alignment, SB 375 requires Metropolitan Planning Organizations (MPOs) to adopt a Sustainable Communities Strategy (SCS) or Alternative Planning Strategy (APS) which prescribes land use allocation in that MPO's Regional Transportation Plan (RTP). The ARB, in consultation with MPOs, is required to provide each affected region with reduction targets for GHGs emitted by passenger cars and light trucks in the region for the years 2020 and 2035. These reduction targets will be updated every 8 years but can be updated every 4 years if advancements in emissions technologies affect the reduction strategies to achieve the targets. The ARB is also charged with reviewing each MPO's SCS or APS for consistency with its assigned GHG emission reduction targets. If MPOs do not meet the GHG reduction targets, transportation projects located in the MPO boundaries would not be eligible for funding programmed after January 1, 2012.

This bill also extends the minimum time period for the Regional Housing Needs Allocation (RNHA) cycle from 5 years to 8 years for local governments located in an MPO that meets certain requirements. City or County land use policies (e.g., General Plans) are not required to be consistent with the RTP including associated SCSs or APSs. Qualified projects consistent with an approved SCS or APS and categorized as "transit priority projects" would receive incentives under new provisions of CEQA.

Executive Order S-3-05 (2005)

Governor Schwarzenegger signed Executive Order S-3-05 on June 1, 2005 which proclaimed California is vulnerable to the impacts of climate change. The executive order declared increased temperatures could reduce snowpack in the Sierra Nevada Mountains, further exacerbate California's air quality problems, and potentially cause a rise in sea levels. To combat those concerns, the executive order established targets for total GHG emissions which include reducing GHG emissions to the 2000 level by 2010, to the 1990 level by 2020, and to 80 percent below the 1990 level by 2050.

The executive order also directed the secretary of the California Environmental Protection Agency to coordinate a multiagency effort to reduce GHG emissions to the target levels. The secretary will submit biannual reports to the governor and legislature describing progress made toward reaching the emission targets; impacts of global warming on California's resources; and mitigation and adaptation plans to combat impacts of global warming.

To comply with the executive order, the Secretary of the California Environmental Protection Agency created the California Climate Action Team which is made up of members from various state agencies and commissions. The California Climate Action Team released its first report in March 2006 of which proposed achieving the GHG emissions targets by building on voluntary

actions of California businesses and actions by local governments and communities along with continued implementation of state incentive and regulatory programs.

Executive Order S-13-08

Governor Schwarzenegger signed Executive Order S-13-08 on November 14, 2008 which directs California to develop methods for adapting to climate change through preparation of a statewide plan. The executive order directs OPR, in cooperation with the California Resources Agency (CRA), to provide land use planning guidance related to sea level rise and other climate change impacts by May 30, 2009. The order also directs the CRA to develop a state Climate Adaptation Strategy by June 30, 2009 and to convene an independent panel to complete the first California Sea Level Rise Assessment Report. The assessment report is required to be completed by December 1, 2010 and required to include the following four items:

1. Project the relative sea level rise specific to California by taking into account issues such as coastal erosion rates, tidal impacts, El Niño and La Niña events, storm surge, and land subsidence rates;
2. Identify the range of uncertainty in selected sea level rise projections;
3. Synthesize existing information on projected sea level rise impacts to state infrastructure (e.g., roads, public facilities, beaches), natural areas, and coastal and marine ecosystems; and
4. Discuss future research needs relating to sea level rise in California.

Executive Order S-1-07

Governor Schwarzenegger signed Executive Order S-1-07 in 2007 which proclaimed the transportation sector as the main source of GHG emissions in California. The executive order proclaims the transportation sector accounts for over 40 percent of statewide GHG emissions. The executive order also establishes a goal to reduce the carbon intensity of transportation fuels sold in California by a minimum of 10 percent by 2020.

In particular, the executive order established a Low-Carbon Fuel Standard (LCFS) and directed the Secretary for Environmental Protection to coordinate the actions of the CEC, the ARB, the University of California, and other agencies to develop and propose protocols for measuring the "life-cycle carbon intensity" of transportation fuels. This analysis supporting development of the protocols was included in the State Implementation Plan for alternative fuels (*State Alternative Fuels Plan* adopted by CEC on December 24, 2007) and was submitted to ARB for consideration as an "early action" item under AB 32. The ARB adopted the LCFS on April 23, 2009.

Local Greenhouse Gas Regulations

Bay Area Air Quality Management District Climate Protection Program

The BAAQMD established a climate protection program to reduce pollutants that contribute to global climate change and affect air quality in the SFBAAB. The climate protection program includes measures that promote energy efficiency, reduce vehicle miles traveled, and develop alternative sources of energy all of which assist in reducing emissions of GHG and in reducing air pollutants that affect the health of residents. BAAQMD also seeks to support current climate protection programs in the region and to stimulate additional efforts through public education and outreach, technical assistance to local governments and other interested parties, and promotion of collaborative efforts among stakeholders.

D. THRESHOLDS OF SIGNIFICANCE JUSTIFICATION

BAY AREA AIR QUALITY MANAGEMENT DISTRICT

California Environmental Quality Act Guidelines Update

Thresholds of Significance

June 2, 2010

BAY AREA AIR QUALITY MANAGEMENT DISTRICT

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Bay Area Air Quality Management District

Air Quality CEQA Thresholds of Significance

1. INTRODUCTION

Bay Area Air Quality Management District (BAAQMD or Air District) staff analyzed various options for California Environmental Quality Act (CEQA) air quality thresholds of significance for use within BAAQMD's jurisdiction. The analysis and evaluation undertaken by Air District staff is documented in the *Revised Draft Options and Justification Report – California Environmental Quality Act Thresholds of Significance* (Draft Options Report) (BAAQMD October 2009).

Air District staff hosted public workshops in February, April, September and October 2009, and April 2010 at several locations around the Bay Area. Air District staff also hosted additional workshops in each of the nine Bay Area counties specifically designed for, and to solicit input from, local agency staff. In addition, Air District staff met with regional stakeholder groups to discuss and receive input on the threshold options being evaluated. Throughout the course of the public workshops and stakeholder meetings Air District staff received many comments on the various options under consideration. Based on comments received and additional staff analysis, the threshold options and staff-recommended thresholds were further refined. The culmination of this nearly year and a half-long effort was presented in the Proposed Thresholds of Significance Report published on November 2, 2009 as the Air District staff's proposed air quality thresholds of significance.

The Air District Board of Directors (Board) held public hearings on November 18 and December 2, 2009 and January 6, 2010, to receive comments on staff's Proposed Thresholds of Significance (November 2, 2009; revised December 7, 2009). After public testimony and Board deliberations, the Board requested staff to present additional options for risk and hazard thresholds for Board consideration. This Report includes risks and hazards threshold options, as requested by the Board, in addition to staff's previously recommended thresholds of significance. The thresholds presented herein, adopted by the Air District Board of Directors, are intended to replace all of the Air District's currently recommended thresholds. The air quality thresholds of significance, and Board-requested risk and hazard threshold options, are provided in Table 1 at the end of this introduction.

1.1. BAAQMD/CEQA REGULATORY AUTHORITY

The BAAQMD has direct and indirect regulatory authority over sources of air pollution in the San Francisco Bay Area Air Basin (SFBAAB). CEQA requires that public agencies consider the potential adverse environmental impacts of any project that a public agency proposes to carry out, fund or approve. CEQA requires that a lead agency prepare an Environmental Impact Report (EIR) whenever it can be fairly argued (the "fair argument" standard), based on substantial evidence,[3] that a project may have a significant effect[4] on the environment, even if there is

[3] "Substantial evidence" includes facts, reasonable assumptions predicated upon facts, or expert opinions supported by facts, but does not include argument, speculation, unsubstantiated opinion or narrative, evidence that is clearly inaccurate

substantial evidence to the contrary (CEQA Guidelines §15064). CEQA requires that the lead agency review not only a project's direct effects on the environment, but also the cumulative impacts of a project and other projects causing related impacts. When the incremental effect of a project is cumulatively considerable, the lead agency must discuss the cumulative impacts in an EIR. (CEQA Guidelines §15064).

The "fair argument" standard refers to whether a fair argument can be made that a project may have a significant effect on the environment (*No Oil, Inc. v. City of Los Angeles* (1974) 13 Cal.3d 68, 84). The fair argument standard is generally considered a low threshold requirement for preparation of an EIR. The legal standards reflect a preference for requiring preparation of an EIR and for "resolving doubts in favor of environmental review." *Meija v. City of Los Angeles* (2005) 130 Cal. App. 4th 322, 332. "The determination of whether a project may have a significant effect on the environment calls for careful judgment on the part of the public agency involved, based to the extent possible on scientific and factual data." (CEQA Guidelines §15064(b).

In determining whether a project may have a significant effect on the environment, CEQA Guidelines Section 15064.7 provides that lead agencies may adopt and/or apply "thresholds of significance." A threshold of significance is "an identifiable quantitative, qualitative or performance level of a particular environmental effect, non-compliance with which means the effect will normally be determined to be significant by the agency and compliance with which means the effect normally will be determined to be less than significant" (CEQA Guidelines §15064.7).

While thresholds of significance give rise to a presumption of insignificance, thresholds are not conclusive, and do not excuse a public agency of the duty to consider evidence that a significant effect may occur under the fair argument standard. *Meija*, 130 Cal. App. 4th at 342. "A public agency cannot apply a threshold of significance or regulatory standard 'in a way that forecloses the consideration of any other substantial evidence showing there may be a significant effect.'" *Id.* This means that if a public agency is presented with factual information or other substantial evidence establishing a fair argument that a project may have a significant effect on the environment, the agency must prepare an EIR to study those impacts even if the project's impacts fall below the applicable threshold of significance.

Thresholds of significance must be supported by substantial evidence. This Report provides the substantial evidence in support of the thresholds of significance developed by the BAAQMD. If adopted by the BAAQMD Board of Directors, the Air District will recommend that lead agencies within the nine counties of the BAAQMD's jurisdiction use the thresholds of significance in this Report when considering the air quality impacts of projects under their consideration.

1.2. JUSTIFICATION FOR UPDATING CEQA THRESHOLDS

Any analysis of environmental impacts under CEQA includes an assessment of the nature and extent of each impact expected to result from the project to determine whether the impact will be treated as significant or less than significant. CEQA gives lead agencies discretion whether to classify a particular environmental impact as significant. Ultimately, formulation of a standard of significance requires the lead agency to make a policy judgment about where the line should be drawn distinguishing adverse impacts it considers significant from those that are not deemed significant. This judgment must, however, be based on scientific information and other factual data to the extent possible (CEQA Guidelines §15064(b)).

or erroneous, or evidence of social or economic impacts that do not contribute to, or are not caused by, physical impacts on the environment. Cal. Pub. Res. C. §21080(c); *see also* CEQA Guidelines §15384.

[4] A "significant effect" on the environment is defined as a "substantial, or potentially substantial, adverse change in the environment." Cal. Pub. Res. C. §21068; *see also* CEQA Guidelines §15382.

In the sense that advances in science provide new or refined factual data, combined with advances in technology and the gradual improvement or degradation of an environmental resource, the point where an environmental effect is considered significant is fluid over time. Other factors influencing this fluidity include new or revised regulations and standards, and emerging, new areas of concern.

In the ten years since BAAQMD last reviewed its recommended CEQA thresholds of significance for air quality, there have been tremendous changes that affect the quality and management of the air resources in the Bay Area. Traditional criteria air pollutant ambient air quality standards, at both the state and federal levels, have become increasingly more stringent. A new criteria air pollutant standard for fine particulate matter less than 2.5 microns in diameter ($PM_{2.5}$) has been added to federal and state ambient air quality standards. We have found, through technical advances in impact assessment, that toxic air contaminants are not only worse than previously thought from a health perspective, but that certain communities experience high levels of toxic air contaminants, giving rise to new regulations and programs to reduce the significantly elevated levels of ambient toxic air contaminant concentrations in the Bay Area.

In response to the elevated levels of toxic air contaminants in some Bay Area communities, the Air District created the Community Air Risk Evaluation (CARE) Program. Phase 1 of the BAAQMD's CARE program compiled and analyzed a regional emissions inventory of toxic air contaminants (TACs), including emissions from stationary sources, area sources, and on-road and off-road mobile sources. Phase 2 of the CARE Program conducted regional computer modeling of selected TAC species, species which collectively posed the greatest risk to Bay Area residents. In both Phases 1 and 2, demographic data were combined with estimates of TAC emissions or concentrations to identify communities that are disproportionally impacted from high concentrations of TACs. Bay Area Public Health Officers, in discussions with Air District staff and in comments to the Air District's Advisory Council (February 11, 2009, Advisory Council Meeting on Air Quality and Public Health), have recommended that $PM_{2.5}$, in addition to TACs, be considered in assessments of community-scale impacts of air pollution.

Another significant issue that affects the quality of life for Bay Area residents is the growing concern with global climate change. In just the past few years, estimates of the global atmospheric temperature and greenhouse gas concentration limits needed to stabilize climate change have been adjusted downward and the impacts of greenhouse gas emissions considered more dire. Previous scientific assessments assumed that limiting global temperature rise to 2-3°C above pre-industrial levels would stabilize greenhouse gas concentrations in the range of 450-550 parts per million (ppm) of carbon dioxide-equivalent (CO_2e). Now the science indicates that a temperature rise of 2°C would not prevent dangerous interference with the climate system. Recent scientific assessments suggest that global temperature rise should be kept below 2°C by stabilizing greenhouse gas concentrations below 350 ppm CO_2e, a significant reduction from the current level of 385 ppm CO_2e.

For the reasons stated above, and to further the goals of other District programs such as encouraging transit-oriented and infill development, BAAQMD has undertaken an effort to review all of its currently-recommended CEQA thresholds, revise them as appropriate, and develop new thresholds where appropriate. The overall goal of this effort is to develop CEQA significance criteria that ensure new development implements appropriate and feasible emission reduction measures to mitigate significant air quality impacts. The Air District's recommended CEQA significance thresholds have been vetted through a public review process and will be presented to the BAAQMD Board of Directors for adoption.

Table 1 – Air Quality CEQA Thresholds of Significance			
Pollutant	**Construction-Related**	**Operational-Related**	
Project-Level			
Criteria Air Pollutants and Precursors (Regional)	**Average Daily Emissions (lb/day)**	**Average Daily Emissions (lb/day)**	**Maximum Annual Emissions (tpy)**
ROG	54	54	10
NO_X	54	54	10
PM_{10}	82 (exhaust only)	82	15
$PM_{2.5}$	54 (exhaust only)	54	10
$PM_{10}/PM_{2.5}$ (fugitive dust)	Best Management Practices	None	
Local CO	None	9.0 ppm (8-hour average), 20.0 ppm (1-hour average)	
GHGs **Projects other than Stationary Sources**	None	Compliance with Qualified Greenhouse Gas Reduction Strategy OR 1,100 MT of CO_2e/yr OR 4.6 MT CO_2e/SP/yr (residents + employees)	
GHGs **Stationary Sources**	None	10,000 MT/yr	
Risks and Hazards – New Source (All Areas) (Individual Project) **Staff Proposal**	Same as Operational Thresholds*	Compliance with Qualified Community Risk Reduction Plan OR Increased cancer risk of >10.0 in a million Increased non-cancer risk of > 1.0 Hazard Index (Chronic or Acute) Ambient $PM_{2.5}$ increase: > 0.3 µg/m^3 annual average Zone of Influence: 1,000-foot radius from fence line of source or receptor	

Table 1 – Air Quality CEQA Thresholds of Significance		
Pollutant	**Construction-Related**	**Operational-Related**
Risks and Hazards – New Receptor (All Areas) (Individual Project) **Staff Proposal**	Same as Operational Thresholds*	Compliance with Qualified Community Risk Reduction Plan OR Increased cancer risk of >10.0 in a million Increased non-cancer risk of > 1.0 Hazard Index (Chronic or Acute) Ambient $PM_{2.5}$ increase: > 0.3 µg/m^3 annual average Zone of Influence: 1,000-foot radius from fence line of source or receptor
Risks and Hazards (Individual Project) **Tiered Thresholds Option**	Same as Operational Thresholds*	**Impacted Communities:** Siting a New Source Compliance with Qualified Community Risk Reduction Plan OR Increased cancer risk of >5.0 in a million Increased non-cancer risk of > 1.0 Hazard Index (Chronic or Acute) Ambient $PM_{2.5}$ increase: > 0.2 µg/m^3 annual average Zone of Influence: 1,000-foot radius from fence line of source or receptor
Risks and Hazards (Individual Project) **Tiered Thresholds Option** (Continued)	Same as Operational Thresholds*	**Impacted Communities:** Siting a New Receptor **All Other Areas:** Siting a New Source or Receptor Compliance with Qualified Community Risk Reduction Plan OR Increased cancer risk of >10.0 in a million Increased non-cancer risk of > 1.0 Hazard Index (Chronic or Acute) Ambient $PM_{2.5}$ increase: > 0.3 µg/m^3 annual average Zone of Influence: 1,000-foot radius from fence line of source or receptor

Table 1 – Air Quality CEQA Thresholds of Significance		
Pollutant	**Construction-Related**	**Operational-Related**
Risks and Hazards – New Source (All Areas) (Cumulative Thresholds)	Same as Operational Thresholds*	Compliance with Qualified Community Risk Reduction Plan OR Cancer: > 100 in a million (from all local sources) Non-cancer: > 10.0 Hazard Index (from all local sources) (Chronic) $PM_{2.5}$: > 0.8 µg/m^3 annual average (from all local sources) Zone of Influence: 1,000-foot radius from fence line of source or receptor
Risks and Hazards – New Receptor (All Areas) (Cumulative Thresholds)	Same as Operational Thresholds*	Compliance with Qualified Community Risk Reduction Plan OR Cancer: > 100 in a million (from all local sources) Non-cancer: > 10.0 Hazard Index (from all local sources) (Chronic) $PM_{2.5}$: > 0.8 µg/m^3 annual average (from all local sources) Zone of Influence: 1,000-foot radius from fence line of source or receptor
Accidental Release of Acutely Hazardous Air Pollutants	None	Storage or use of acutely hazardous materials locating near receptors or receptors locating near stored or used acutely hazardous materials considered significant
Odors	None	Complaint History—Five confirmed complaints per year averaged over three years
Plan-Level		
Criteria Air Pollutants and Precursors	None	1. Consistency with Current Air Quality Plan control measures 2. Projected VMT or vehicle trip increase is less than or equal to projected population increase

Table 1 – Air Quality CEQA Thresholds of Significance		
Pollutant	**Construction-Related**	**Operational-Related**
GHGs	None	Compliance with Qualified Greenhouse Gas Reduction Strategy (or similar criteria included in a General Plan) OR 6.6 MT CO2e/ SP/yr (residents + employees)
Risks and Hazards	None	1. Overlay zones around existing and planned sources of TACs (including adopted Risk Reduction Plan areas) 2. Overlay zones of at least 500 feet (or Air District-approved modeled distance) from all freeways and high volume roadways
Odors	None	Identify the location of existing and planned sources of odors
Accidental Release of Acutely Hazardous Air Pollutants	None	None
Regional Plans (Transportation and Air Quality Plans)		
GHGs, Criteria Air Pollutants and Precursors, and Toxic Air Contaminants	None	No net increase in emissions

Notes: CO = carbon monoxide; CO_2e = carbon dioxide equivalent; GHGs = greenhouse gases; lb/day = pounds per day; MT = metric tons; NO_X = oxides of nitrogen; $PM_{2.5}$= fine particulate matter with an aerodynamic resistance diameter of 2.5 micrometers or less; PM_{10} = respirable particulate matter with an aerodynamic resistance diameter of 10 micrometers or less; ppm = parts per million; ROG = reactive organic gases; SO_2 = sulfur dioxide; SP = service population; TACs = toxic air contaminants; TBP = toxic best practices; tons/day = tons per day; tpy = tons per year; yr= year.

* Note: The Air District recommends that for construction projects that are less than one year duration, Lead Agencies should annualize impacts over the scope of actual days that peak impacts are to occur, rather than the full year.

2. GREENHOUSE GAS THRESHOLDS

BAAQMD does not currently have an adopted threshold of significance for GHG emissions. BAAQMD currently recommends that lead agencies quantify GHG emissions resulting from new development and apply all feasible mitigation measures to lessen the potentially significant adverse impacts. One of the primary objectives in updating the current CEQA Guidelines is to identify a GHG significance threshold, analytical methodologies, and mitigation measures to ensure new land use development meets its fair share of the emission reductions needed to address the cumulative environmental impact from GHG emissions. GHG emissions contribute, on a cumulative basis, to the significant adverse environmental impacts of global climate change. As reviewed herein, climate change impacts include an increase in extreme heat days, higher ambient concentrations of air pollutants, sea level rise, impacts to water supply and water quality, public health impacts, impacts to ecosystems, impacts to agriculture, and other environmental

impacts. No single land use project could generate enough GHG emissions to noticeably change the global average temperature. The combination of GHG emissions from past, present, and future projects contribute substantially to the phenomenon of global climate change and its associated environmental impacts.

2.1. THRESHOLDS OF SIGNIFICANCE

Project Type	Thresholds
Projects other than Stationary Sources	Compliance with Qualified Greenhouse Gas Reduction Strategy OR 1,100 MT of CO_2e/yr OR 4.6 MT CO_2e/SP/yr (residents + employees)
Stationary Sources	10,000 MT of CO_2e/yr
Plans	Compliance with Qualified Greenhouse Gas Reduction Strategy (or similar criteria included in a General Plan) OR 6.6 MT CO_2e/SP/yr (residents + employees)
Regional Plans (Transportation and Air Quality Plans)	No net increase in GHG emissions

2.2. JUSTIFICATION AND SUBSTANTIAL EVIDENCE SUPPORTING THRESHOLDS

BAAQMD's approach to developing a threshold of significance for GHG emissions is to identify the emissions level for which a project would not be expected to substantially conflict with existing California legislation adopted to reduce statewide GHG emissions. If a project would generate GHG emissions above the threshold level, it would be considered to contribute substantially to a cumulative impact, and would be considered significant. If mitigation can be applied to lessen the emissions such that the project meets its share of emission reductions needed to address the cumulative impact, the project would normally be considered less than significant.

As explained in the District's *Revised Draft Options and Justifications Report* (BAAQMD 2009), there are several types of thresholds that may be supported by substantial evidence and be consistent with existing California legislation and policy to reduce statewide GHG emissions. In determining which thresholds to recommend, Staff studied numerous options, relying on reasonable, environmentally conservative assumptions on growth in the land use sector, predicted emissions reductions from statewide regulatory measures and resulting emissions inventories, and the efficacies of GHG mitigation measures. The thresholds recommended herein were chosen based on the substantial evidence that such thresholds represent quantitative and/or qualitative levels of GHG emissions, compliance with which means that the environmental impact of the GHG emissions will normally not be cumulatively considerable under CEQA. Compliance with such thresholds will be part of the solution to the cumulative GHG emissions problem, rather than hinder the state's ability to meet its goals of reduced statewide GHG emissions. Staff notes that it does not believe there is only one threshold for GHG emissions that can be supported by substantial evidence.

GHG CEQA significance thresholds recommended herein are intended to serve as interim levels during the implementation of the AB 32 Scoping Plan and SB 375, which will occur over time. Until AB 32 has been fully implemented in terms of adopted regulations, incentives, and programs and until SB 375 required plans have been fully adopted, or the California Air Resources Board (ARB) adopts a recommended threshold, the BAAQMD recommends that local agencies in the Bay Area apply the GHG thresholds recommended herein.

If left unchecked, GHG emissions from new land use development in California will result in a cumulatively considerable amount of GHG emissions and a substantial conflict with the State's ability to meet the goals within AB 32. Thus, BAAQMD proposes to adopt interim GHG thresholds for CEQA analysis, which can be used by lead agencies within the Bay Area. This would help lead agencies navigate this dynamic regulatory and technological environment where the field of analysis has remained wide open and inconsistent. BAAQMD's framework for developing a GHG threshold for land development projects that is based on policy and substantial evidence follows.

2.2.1. Scientific and Regulatory Justification

Climate Science Overview

Prominent GHGs contributing to the greenhouse effect are carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons, chlorofluorocarbons, and sulfur hexafluoride. Human-caused emissions of these GHGs in excess of natural ambient concentrations are responsible for intensifying the greenhouse effect and have led to a trend of unnatural warming of the earth's climate, known as global climate change or global warming. It is *extremely unlikely* that global climate change of the past 50 years can be explained without the contribution from human activities (IPCC 2007a).

According to Article 2 of the United Nations Framework Convention on Climate Change (UNFCCC), "Avoiding Dangerous Climate Change" means: *"stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system."* Dangerous climate change defined in the UNFCCC is based on several key indicators including the potential for severe degradation of coral reef systems, disintegration of the West Antarctic Ice Sheet, and shut down of the large-scale, salinity- and thermally-driven circulation of the oceans. (UNFCCC 2009). The global atmospheric concentration of carbon dioxide has increased from a pre-industrial value of about 280 ppm to 379 ppm in 2005 (IPCC 2007a). "Avoiding dangerous climate change" is generally understood to be achieved by stabilizing global average temperatures between 2 and 2.4°C above pre-industrial levels. In order to limit temperature increases to this level, ambient global CO_2 concentrations must stabilize between 350 and 400 ppm (IPCC 2007b).

Executive Order S-3-05

Executive Order S-3-05, which was signed by Governor Schwarzenegger in 2005, proclaims that California is vulnerable to the impacts of climate change. It declares that increased temperatures could reduce the Sierra's snowpack, further exacerbate California's air quality problems, and potentially cause a rise in sea levels. To combat those concerns, the Executive Order established total GHG emission targets. Specifically, emissions are to be reduced to the 2000 level by 2010, the 1990 level by 2020, and to 80 percent below the 1990 level by 2050.

Assembly Bill 32, the California Global Warming Solutions Act of 2006

In September 2006, Governor Arnold Schwarzenegger signed Assembly Bill 32, the California Global Warming Solutions Act of 2006, which set the 2020 greenhouse gas emissions reduction goal into law. AB 32 finds and declares that "Global warming poses a serious threat to the economic well-being, public health, natural resources, and the environment of California." AB 32 requires that statewide GHG emissions be reduced to 1990 levels by 2020, and establishes

regulatory, reporting, voluntary, and market mechanisms to achieve quantifiable reductions in GHG emissions to meet the statewide goal.

In December of 2008, ARB adopted its *Climate Change Scoping Plan* (*Scoping Plan*), which is the State's plan to achieve GHG reductions in California, as required by AB 32 (ARB 2008). The Scoping Plan contains strategies California will implement to achieve a reduction of 169 MMT CO_2e emissions, or approximately 28 percent from the state's projected 2020 emission level of 596 MMT of CO_2e under a business-as-usual scenario (this is a reduction of 42 MMT of CO_2e, or almost 10 percent, from 2002-2004 average emissions), so that the state can return to 1990 emission levels, as required by AB 32.

While the Scoping Plan establishes the policy intent to control numerous GHG sources through regulatory, incentive, and market means, given the early phase of implementation and the level of control that local CEQA lead agencies have over numerous GHG sources, CEQA is an important and supporting tool in achieving GHG reductions overall in compliance with AB 32. In this spirit, BAAQMD is considering the adoption of thresholds of significance for GHG emissions for stationary source and land use development projects.

Senate Bill 375

Senate Bill (SB) 375, signed in September 2008, aligns regional transportation planning efforts, regional GHG reduction targets, and land use and housing allocation. SB 375 requires Metropolitan Planning Organizations (MPOs) to adopt a Sustainable Communities Strategy (SCS) or Alternative Planning Strategy (APS), which will prescribe land use allocation in that MPO's Regional Transportation Plan (RTP). ARB, in consultation with MPOs, will provide each affected region with reduction targets for GHGs emitted by passenger cars and light trucks in the region for the years 2020 and 2035. These reduction targets will be updated every eight years, but can be updated every four years if advancements in emission technologies affect the reduction strategies to achieve the targets. ARB is also charged with reviewing each MPO's SCS or APS for consistency with its assigned targets. If MPOs do not meet the GHG reduction targets, transportation projects would not be eligible for State funding programmed after January 1, 2012. New provisions of CEQA incentivize qualified projects that are consistent with an approved SCS or APS, categorized as "transit priority projects."

The revised District CEQA Guidelines includes methodology consistent with the recently updated State CEQA Guidelines, which provides that certain residential and mixed use projects, and transit priority projects consistent with an applicable SCS or APS need not analyze GHG impacts from cars and light duty trucks (CEQA Guidelines §15183.5(c)).

2.2.2. Project-Level GHG Thresholds

Staff recommends setting GHG significance thresholds based on AB 32 GHG emission reduction goals while taking into consideration emission reduction strategies outlined in ARB's Scoping Plan. Staff proposes two quantitative thresholds for land use projects: a bright line threshold based on a "gap" analysis and an efficiency threshold based on emission levels required to be met in order to achieve AB 32 goals.

Staff also proposes one qualitative threshold for land use projects: if a project complies with a Qualified Greenhouse Gas Reduction Strategy (as defined in Section 2.3.4 below) that addresses the project it would be considered less than significant. As explained in detail in Section 2.3.4 below, compliance with a Qualified Greenhouse Gas Reduction Strategy (or similar adopted policies, ordinances and programs), would provide the evidentiary basis for making CEQA findings that development consistent with the plan would result in feasible, measureable, and verifiable GHG reductions consistent with broad state goals such that projects approved under

qualified Greenhouse Gas Reduction Strategies or equivalent demonstrations would achieve their fair share of GHG emission reductions.

Land Use Projects "Gap-Based" Threshold

Staff took eight steps in developing this threshold approach, which are summarized here and detailed in the sections that follow. It should be noted that the "gap-based approach" used for threshold development is a conservative approach that focuses on a limited set of state mandates that appear to have the greatest potential to reduce land use development-related GHG emissions at the time of this writing. It is also important to note that over time, as the effectiveness of the State's implementation of AB 32 (and SB 375) progresses, BAAQMD will need to reconsider the extent of GHG reductions needed over and above those from the implementation thereof for the discretionary approval of land use development projects. Although there is an inherent amount of uncertainty in the estimated capture rates (i.e., frequency at which project-generated emissions would exceed a threshold and would be subject to mitigation under CEQA) and the aggregate emission reductions used in the gap analysis, they are based on BAAQMD's expertise, the best available data, and use conservative assumptions for the amount of emission reductions from legislation in derivation of the gap (e.g., only adopted legislation was relied upon). This approach is intended to attribute an appropriate share of GHG emission reductions necessary to reach AB 32 goals to new land use development projects in BAAQMD's jurisdiction that are evaluated pursuant to CEQA.

Step 1 Estimate from ARB's statewide GHG emissions inventory the growth in emissions between 1990 and 2020 attributable to "land use-driven" sectors of the emission inventory as defined by OPR's guidance document (*CEQA and Climate Change*). Land use-driven emission sectors include Transportation (On-Road Passenger Vehicles; On-Road Heavy Duty), Electric Power (Electricity; Cogeneration), Commercial and Residential (Residential Fuel Use; Commercial Fuel Use) and Recycling and Waste (Domestic Waste Water Treatment).

Result:1990 GHG emissions were 295.53 MMT CO_2e/yr and projected 2020 business-as-usual GHG emissions would be 400.22 MMT CO_2e/yr; thus a 26.2 percent reduction from statewide land use-driven GHG emissions would be necessary to meet the AB 32 goal of returning to 1990 emission levels by 2020. (See Table 2)

Step 2 Estimate the anticipated GHG emission reductions affecting the same land use-driven emissions inventory sectors associated with adopted statewide regulations identified in the AB 32 Scoping Plan.

Result: Estimated a 23.9 percent reduction can be expected in the land use-driven GHG emissions inventory from adopted Scoping Plan regulations, including AB 1493 (Pavley), LCFS, Heavy/Medium Duty Efficiency, Passenger Vehicle Efficiency, Energy-Efficiency Measures, Renewable Portfolio Standard, and Solar Roofs. (See Table 3)

Step 3 Determine any short fall or "gap" between the 2020 statewide emission inventory estimates and the anticipated emission reductions from adopted Scoping Plan regulations. This "gap" represents additional GHG emission reductions needed statewide from the land use-driven emissions inventory sectors, which represents new land use development's share of the emission reductions needed to meet statewide GHG emission reduction goals.

Result: With the 23.9 percent reductions from AB 32 Scoping Measures, there is a "gap" of 2.3 percent in necessary additional GHG emissions reductions to meet AB 32

goals of a 26.2 percent reduction from statewide land use-driven GHG emissions to return to 1990 levels in 2020. (See Table 2)

Step 4 Determine the percent reduction this "gap" represents in the "land use-driven" emissions inventory sectors from BAAQMD's 2020 GHG emissions inventory. Identify the mass of emission reductions needed in the SFBAAB from land use-driven emissions inventory sectors.

Result: Estimated that a 2.3 percent reduction in BAAQMD's projected 2020 emissions projections requires emissions reductions of 1.6 MMT CO_2e/yr from the land use-driven sectors. (See Table 4)

Step 5 Assess BAAQMD's historical CEQA database (2001-2008) to determine the frequency distribution trend of project sizes and types that have been subject to CEQA over the past several years.

Result: Determined historical patterns of residential, commercial and industrial development by ranges of average sizes of each development type. Results were used in Step 6 below to distribute anticipated Bay Area growth among different future project types and sizes.

Step 6 Forecast new land use development for the Bay Area using DOF/EDD population and employment projections and distribute the anticipated growth into appropriate land use types and sizes needed to accommodate the anticipated growth (based on the trend analysis in Step 5 above). Translate the land use development projections into land use categories consistent with those contained in the Urban Emissions Model (URBEMIS).

Result: Based on population and employment projections and the trend analysis from Step 5 above, forecasted approximately 4,000 new development projects, averaging about 400 projects per year through 2020 in the Bay Area.

Step 7 Estimate the amount of GHG emissions from each land use development project type and size using URBEMIS and post-model manual calculation methods (for emissions not included in URBEMIS). Determine the amount of GHG emissions that can reasonably and feasibly be reduced through currently available mitigation measures ("mitigation effectiveness") for future land use development projects subject to CEQA (based on land use development projections and frequency distribution from Step 6 above).

Result: Based on the information available and on sample URBEMIS calculations, found that mitigation effectiveness of between 25 and 30 percent is feasible.

Step 8 Conduct a sensitivity analysis of the numeric GHG mass emissions threshold needed to achieve the desired emissions reduction (i.e., "gap") determined in Step 4. This mass emission GHG threshold is that which would be needed to achieve the emission reductions necessary by 2020 to meet the Bay Area's share of the statewide "gap" needed from the land use-driven emissions inventory sectors.

Result: The results of the sensitivity analysis conducted in Step 8 found that reductions between about 125,000 MT/yr (an aggregate of 1.3 MMT in 2020) and over 200,000 MT/yr (an aggregate of over 2.0 MMT in 2020) were achievable and feasible. A mass emissions threshold of 1,100 MT of CO_2e/yr would result in approximately 59 percent of all projects being above the significance threshold (e.g., this is approximately the operational GHG emissions that would be associated with a 60 residential unit

subdivision) and must implement feasible mitigation measures to meet CEQA requirements. With an estimated 26 percent mitigation effectiveness, the 1,100 MT threshold would achieve 1.6 MMT CO_2e/yr in GHG emissions reductions.

Detailed Basis and Analysis

Derivation of Greenhouse Gas Reduction Goal

To meet the target emissions limit established in AB 32 (equivalent to levels in 1990), total GHG emissions would need to be reduced by approximately 28 percent from projected 2020 forecasts (ARB 2009a). The AB 32 Scoping Plan is ARB's plan for meeting this mandate (ARB 2008). While the Scoping Plan does not specifically identify GHG emission reductions from the CEQA process for meeting AB 32 derived emission limits, the scoping plan acknowledges that "other strategies to mitigate climate change . . . should also be explored." The Scoping Plan also acknowledges that "Some of the measures in the plan may deliver more emission reductions than we expect; others less . . . and new ideas and strategies will emerge." In addition, climate change is considered a significant environmental issue and warrants consideration under CEQA. SB 97 represents the State Legislature's confirmation of this fact, and it directed the Governor's Office of Planning and Research (OPR) to develop CEQA Guidelines for evaluation of GHG emissions impacts and recommend mitigation strategies. In response, OPR released the *Technical Advisory: CEQA and Climate Change* (OPR 2008), and proposed revisions to the State CEQA guidelines (April 14, 2009) for consideration of GHG emissions. The California Natural Resources Agency adopted the proposed State CEQA Guidelines revisions on December 30, 2009 and the revisions were effective beginning March 18, 2010. It is known that new land use development must also do its fair share toward achieving AB 32 goals (or, at a minimum, should not hinder the State's progress toward the mandated emission reductions).

Foreseeable Scoping Plan Measures Emission Reductions and Remaining "Gap"

Step 1 of the Gap Analysis entailed estimating from ARB's statewide GHG inventory the growth in emissions between 1990 and 2020 attributable to land use driven sectors of the emissions inventory. As stated above, to meet the requirements set forth in AB 32 (i.e., achieve California's 1990-equivalent GHG emissions levels by 2020) California would need to achieve an approximate 28 percent reduction in emissions across all sectors of the GHG emissions inventory compared with 2020 projections. However, to meet the AB 32 reduction goals in the emissions sectors that are related to land use development (e.g., on-road passenger and heavy-duty motor vehicles, commercial and residential area sources [i.e., natural gas], electricity generation/consumption, wastewater treatment, and water distribution/consumption), staff determined that California would need to achieve an approximate 26 percent reduction in GHG emissions from these land use-driven sectors (ARB 2009a) by 2020 to return to 1990 land use emission levels.

Next, in Step 2 of the Gap Analysis, Staff determined the GHG emission reductions within the land use-driven sectors that are anticipated to occur from implementation of the Scoping Plan measures statewide, which are summarized in Table 2 and described below. Since the GHG emission reductions anticipated with the Scoping Plan were not accounted for in ARB's or BAAQMD's 2020 GHG emissions inventory forecasts (i.e., business as usual), an adjustment was made to include (i.e., give credit for) GHG emission reductions associated with key Scoping Plans measures, such as the Renewable Portfolio Standard, improvements in energy efficiency through periodic updates to Title 24, AB 1493 (Pavley) (which recently received a federal waiver to allow it to be enacted in law), the Low Carbon Fuel Standard (LCFS), and other measures. With reductions from these State regulations (Scoping Plan measures) taken into consideration and accounting for an estimated 23.9 percent reduction in GHG emissions, in Step 3 of the Gap Analysis Staff determined that the Bay Area would still need to achieve an additional 2.3 percent reduction from projected 2020 GHG emissions to meet the 1990 GHG emissions goal from the

land-use driven sectors. This necessary 2.3 percent reduction in projected GHG emissions from the land use sector is the "gap" the Bay Area needs to fill to do its share to meet the AB 32 goals. Refer to the following explanation and Tables 2 through 4 for data used in this analysis.

Because the transportation sector is the largest emissions sector of the state's GHG emissions inventory, it is aggressively targeted in early actions and other priority actions in the Scoping Plan including measures concerning gas mileage (Pavley), fuel carbon intensity (LCFS) and vehicle efficiency measures.

Table 2 – California 1990, 2002-2004, and 2020 Land Use Sector GHG[1] (MMT CO_2e/yr)

Sector	1990 Emissions	2002-2004 Average	2020 BAU Emissions Projections	% of 2020 Total
Transportation	**137.98**	**168.66**	**209.06**	**52%**
On-Road Passenger Vehicles	108.95	133.95	160.78	40%
On-Road Heavy Duty	29.03	34.69	48.28	12%
Electric Power	**110.63**	**110.04**	**140.24**	**35%**
Electricity	95.39	88.97	107.40	27%
Cogeneration[2]	15.24	21.07	32.84	8%
Commercial and Residential	**44.09**	**40.96**	**46.79**	**12%**
Residential Fuel Use	29.66	28.52	32.10	8%
Commercial Fuel Use	14.43	12.45	14.63	4%
Recycling and Waste[1]	**2.83**	**3.39**	**4.19**	**1%**
Domestic Wastewater Treatment	2.83	3.39	4.19	1%
TOTAL GROSS EMISSIONS	**295.53**	**323.05**	**400.22**	
% Reduction Goal from Statewide land use driven sectors (from 2020 levels to reach 1990 levels in these emission inventory sectors)			26.2%	
% Reduction from AB32 Scoping Plan measures applied to land use sectors (see Table 3)			-23.9%	
% Reduction needed statewide beyond Scoping Plan measures (Gap)			2.3%	

Notes: MMT CO_2e /yr = million metric tons of carbon dioxide equivalent emissions per year.

[1] Landfills not included. See text.

[2] Cogeneration included due to many different applications for electricity, in some cases provides substantial power for grid use, and because electricity use served by cogeneration is often amenable to efficiency requirements of local land use authorities.

Sources: Data compiled by EDAW and ICF Jones & Stokes from ARB data.

Pavley Regulations. The AB 32 Scoping Plan assigns an approximate 20 percent reduction in emissions from passenger vehicles associated with the implementation of AB 1493. The AB 32 Scoping Plan also notes that "AB 32 specifically states that if the Pavley regulations do not remain in effect, ARB shall implement alternative regulations to control mobile sources to achieve

equivalent or greater reductions of greenhouse gas emissions (HSC §38590)." Thus, it is reasonable to assume full implementation of AB 1493 standards, or equivalent programs that would be implemented by ARB. Furthermore, on April 1, 2010, U.S. EPA and the Department of Transportation's National Highway Safety Administration (NHTSA) announced a joint final rule establishing a national program that will dramatically reduce greenhouse gas emissions and improve fuel economy for new cars and trucks sold in the United States after 2011. Under this national program, automobile manufacturers will be able to build a single light-duty national fleet that satisfies all requirements under both the national program and the standards of California and other states. Nonetheless, BAAQMD may need to revisit this methodology as the federal standards come on line to ensure that vehicle standards are as aggressive as contemplated in development of this threshold.

Table 3 – 2020 Land Use Sector GHG Emission Reductions from State Regulations and AB 32 Measures

Affected Emissions Source	California Legislation	% Reduction from 2020 GHG inventory	End Use Sector (% of Bay Area LU Inventory)	Scaled % Emissions Reduction (credit)
Mobile	AB 1493 (Pavley)	19.7%	On road passenger/light truck transportation (45%)	8.9%
	LCFS	7.2%	On road passenger/light truck transportation (45%)	3.2%
	LCFS	7.2%	On road Heavy/Medium Duty Transportation (5%)	0.4%
	Heavy/Medium Duty Efficiency	2.9%	On road Heavy/Medium Duty Transportation (5%)	0.2%
	Passenger Vehicle Efficiency	2.8%	On road passenger/light truck transportation (45%)	1.3%
Area	Energy-Efficiency Measures	9.5%	Natural gas (Residential, 10%)	1.0%
			Natural gas (Non-residential, 13%)	1.2%
Indirect	Renewable Portfolio Standard	21.0%	Electricity (excluding cogen) (17%)	3.5%
	Energy-Efficiency Measures	15.7%	Electricity (26%)	4.0%
	Solar Roofs	1.5%	Electricity (excluding cogen) (17%)	0.2%
Total credits given to land use-driven emission inventory sectors from Scoping Plan measures				**23.9%**

Notes: AB = Assembly Bill; LCFS = Low Carbon Fuel Standard; SB = Senate Bill; RPS = Renewable Portfolio Standard
Sources: Data compiled by ICF Jones & Stokes.

LCFS. According to the adopted LCFS rule (CARB, April 2009), the LCFS is expected to result in approximately 10 percent reduction in the carbon intensity of transportation fuels. However, a

portion of the emission reductions required from the LCFS would be achieved over the life cycle of transportation fuel production rather than from mobile-source emission factors. Based on CARB's estimate of nearly 16 MMT reductions in on-road emissions from implementation of the LCFS and comparison to the statewide on-road emissions sector, the LCFS is assumed to result in a 7.2 percent reduction compared to 2020 BAU conditions (CARB 2009e).

Table 4 – SFBAAB 1990, 2007, and 2020 Land Use Sector GHG Emissions Inventories and Projections (MMT CO_2e/yr)

Sector	1990 Emissions	2007 Emissions	2020 Emissions Projections	% of 2020 Total[2]
Transportation	**26.1**	**30.8**	**35.7**	**50%**
On-Road Passenger Vehicles	23.0	27.5	32.0	
On-Road Heavy Duty	3.1	3.3	3.7	
Electric Power	**25.1**	**15.2**	**18.2**	**26%**
Electricity	16.5	9.9	11.8	
Cogeneration	8.6	5.3	6.4	
Commercial and Residential	**8.9**	**15.0**	**16.8**	**24%**
Residential Fuel Use	5.8	7.0	7.5	
Commercial Fuel Use	3.1	8.0	9.3	
Recycling and Waste[1]	**0.2**	**0.4**	**0.4**	**1%**
Domestic Waste Water Treatment	0.2	0.4	0.4	
TOTAL GROSS EMISSIONS	**60.3**	**61.4**	**71.1**	
SFBAAB's "Fair Share" % Reduction (from 2020 levels to reach 1990 levels) with AB-32 Reductions (from Table 3)			2.3%	
SFBAAB's Equivalent Mass Emissions Land Use Reduction Target at 2020 (MMT CO2e/yr)			1.6	

Notes: MMT CO_2e /yr = million metric tons of carbon dioxide equivalent emissions per year; SFBAAB = San Francisco Bay Area Air Basin.

[1] Landfills not included.

[2] Percentages do not sum exactly to 100% in table due to rounding.

Sources: Data compiled by EDAW 2009, ICF Jones & Stokes 2009, BAAQMD 2008.

Renewable Portfolio Standard, Energy Efficiency and Solar Roofs. Energy efficiency and renewable energy measures from the Scoping Plan were also included in the gap analysis. The Renewable Portfolio Standard (rules) will require the renewable energy portion of the retail electricity portfolio to be 33 percent in 2020. For PG&E, the dominant electricity provider in the Basin, approximately 12 percent of their current portfolio qualifies under the RPS rules and thus the gain by 2020 would be approximately 21 percent. The Scoping Plan also estimates that energy efficiency gains with periodic improvement in building and appliance energy standards and incentives will reach 10 to 15 percent for natural gas and electricity respectively. The final state measure included in this gap analysis is the solar roof initiative, which is estimated to result in reduction of the overall electricity inventory of 1.5 percent.

Landfill emissions are excluded from this analysis. While land use development does generate waste related to both construction and operations, the California Integrated Waste Management Board (CIWMB) has mandatory diversion requirements that will, in all probability, increase over time to promote waste reductions, reuse, and recycle. The Bay Area has relatively high levels of waste diversion and extensive recycling efforts. Further, ARB has established and proposes to increase methane capture requirements for all major landfills. Thus, at this time, landfill emissions associated with land use development waste generation is not included in the land use sector inventory used to develop this threshold approach.

Industrial stationary sources thresholds were developed separately from the land use threshold development using a market capture approach as described below. However, mobile source and area source emissions, as well as indirect electricity emissions that derive from industrial use are included in the land use inventory above as these particular activities fall within the influence of local land use authorities in terms of the affect on trip generation and energy efficiency.

AB 32 mandates reduction to 1990-equivalent GHG levels by 2020, with foreseeable emission reductions from State regulations and key Scoping Plan measures taken into account, were applied to the land use-driven emission sectors within the SFBAAB (i.e., those that are included in the quantification of emissions from a land use project pursuant to a CEQA analysis [on-road passenger vehicles, commercial and residential natural gas, commercial and residential electricity consumption, and domestic waste water treatment], as directed by OPR in the Technical Advisory: *Climate Change and CEQA* [OPR 2008]). This translates to a 2.3 percent gap in necessary GHG emission reductions by 2020 from these sectors.

Land Use Projects Bright Line Threshold

In Steps 4 and 5 of the gap analysis, Staff determined that applying a 2.3 percent reduction to these land use emissions sectors in the SFBAAB's GHG emissions inventory would result in an equivalent fair share of 1.6 million metric tons per year (MMT/yr) reductions in GHG emissions from new land use development. As additional regulations and legislation aimed at reducing GHG emissions from land use-related sectors become available in the future, the 1.6 MMT GHG emissions reduction goal may be revisited and recalculated by BAAQMD.

In order to derive the 1.6 MMT "gap," a projected development inventory for the next ten years in the SFBAAB was calculated (see Table 4 and *Revised Draft Options and Justifications Report* (BAAQMD 2009)). CO_2e emissions were modeled for projected development in the SFBAAB and compiled to estimate the associated GHG emissions inventory. The GHG (i.e., CO_2e) CEQA threshold level was adjusted for projected land use development that would occur within BAAQMD's jurisdiction over the period from 2010 through 2020.

Projects with emissions greater than the threshold would be required to mitigate to the threshold level or reduce project emissions by a percentage (mitigation effectiveness) deemed feasible by the lead agency under CEQA compared to a base year condition. The base year condition is defined by an equivalent size and character of project with annual emissions using the defaults in URBEMIS and the California Climate Action Registry's General Reporting Protocol for 2008. By this method, land use project mitigation subject to CEQA would help close the "gap" remaining after application of the key regulations and measures noted above supporting overall AB 32 goals.

This threshold takes into account Steps 1-8 of the gap analysis described above to arrive at a numerical mass emissions threshold. Various mass emissions significance threshold levels (i.e., bright lines) could be chosen based on the mitigation effectiveness and performance anticipated to be achieved per project to meet the aggregate emission reductions of 1.6 MMT needed in the

SFBAAB by 2020(see Table 5 and *Revised Draft Options and Justifications Report* (BAAQMD 2009)). Staff recommends a 1,100 MT CO_2e per year threshold. Choosing a 1,100 MT mass emissions significance threshold level (equivalent to approximately 60 single-family units), would result in about 59 percent of all projects being above the significance threshold and having to implement feasible mitigation measures to meet their CEQA obligations. These projects account for approximately 92 percent of all GHG emissions anticipated to occur between now and 2020 from new land use development in the SFBAAB.

Project applicants and lead agencies could use readily available computer models to estimate a project's GHG emissions, based on project specific attributes, to determine if they are above or below the bright line numeric threshold. With this threshold, projects that are above the threshold level, after consideration of emission-reducing characteristics of the project as proposed, would have to reduce their emissions to below the threshold to be considered less than significant.

Table 5 – Operational GHG Threshold Sensitivity Analysis

Option	Mitigation Effectiveness Assumptions		Mass Emission Threshold Level (MT CO_2e/yr)	% of Projects Captured (>threshold)	% of Emissions Captured (> threshold)	Emissions Reduction per year (MT/yr)	Aggregate Emissions Reduction (MMT) at 2020	Threshold Project Size Equivalent (single family dwelling units)
	Performance Standards Applied to All Projects with Emissions < Threshold Level	Mitigation Effectiveness Applied to Emissions > Threshold Level						
1A	N/A	30%	975	60%	93%	201,664	2.0	53
1A	N/A	25%	110	96%	100%	200,108	2.0	66
1A	N/A	30%	1,225	21%	67%	159,276	1.6	67
1A	N/A	26%	1,100	59%	92%	159,877	1.6	60
1A	N/A	30%	2,000	14%	61%	143,418	1.4	109
1A	N/A	25%	1,200	58%	92%	136,907	1.4	66
1A	N/A	30%	3,000	10%	56%	127,427	1.3	164
1A	N/A	25%	1,500	20%	67%	127,303	1.3	82
1B	26%	N/A	N/A	100%	100%	208,594	2.1	N/A[1]
1C	5%	30%	1,900	15%	62%	160,073	1.6	104
1C	10%	25%	1,250	21%	67%	159,555	1.6	68
1C	5%	30%	3,000	10%	56%	145,261	1.5	164
1C	10%	25%	2,000	4%	61%	151,410	1.5	109
1C	10%	30%	10,000	2%	33%	125,271	1.3	547

MMT = million metric tons per year; MT CO_2e/yr = metric tons of carbon dioxide equivalent emissions per year; MT/yr = metric tons per year; N/A = not applicable.

[1] Any project subject to CEQA would trigger this threshold.

Source: Data modeled by ICF Jones& Stokes

Source: Data modeled by ICF Jones & Stokes.

Establishing a "bright line" to determine the significance of a project's GHG emissions impact provides a level of certainty to lead agencies in determining if a project needs to reduce its GHG emissions through mitigation measures and when an EIR is required.

Land Use Projects Efficiency-Based Threshold

GHG efficiency metrics can also be utilized as thresholds to assess the GHG efficiency of a project on a per capita basis (residential only projects) or on a "service population" basis (the sum of the number of jobs and the number of residents provided by a project) such that the project will allow for consistency with the goals of AB 32 (i.e., 1990 GHG emissions levels by 2020). GHG efficiency thresholds can be determined by dividing the GHG emissions inventory goal (allowable emissions), by the estimated 2020 population and employment. This method allows highly efficient projects with higher mass emissions to meet the overall reduction goals of AB 32. Staff believes it is more appropriate to base the land use efficiency threshold on the service population metric for the land use-driven emission inventory. This approach is appropriate because the threshold can be applied evenly to all project types (residential or commercial/retail only and mixed use) and uses only the land use emissions inventory that is comprised of all land use projects. Staff will provide the methodology to calculate a project's GHG emissions in the revised CEQA Guidelines, such as allowing infill projects up to a 50 percent or more reduction in daily vehicle trips if the reduction can be supported by close proximity to transit and support services, or a traffic study prepared for the project.

Table 6 – California 2020 GHG Emissions, Population Projections and GHG Efficiency Thresholds - Land Use Inventory Sectors

Land Use Sectors Greenhouse Gas Emissions Target	295,530,000
Population	44,135,923
Employment	20,194,661
California Service Population (Population + Employment)	64,330,584
AB 32 Goal GHG emissions (metric tons CO_2e)/SP[1]	**4.6**

Notes: AB = Assembly Bill; CO_2e = carbon dioxide equivalent; GHG = greenhouse gas; SP = service population.
[1] Greenhouse gas efficiency levels were calculated using only the "land use-related" sectors of ARB's emissions inventory.
Sources: Data compiled by EDAW 2009, ARB 2009a, DOF 2009, EDD 2009, ICF Jones & Stokes 2009.

Staff proposes a project-level efficiency threshold of 4.6 MT CO_2e/SP, the derivation of which is shown Table 6. This efficiency-based threshold reflects very GHG-efficient projects. As stated previously and below, staff anticipates that significance thresholds (rebuttable presumptions of significance at the project level) will function on an interim basis only until adequate programmatic approaches are in place at the city, county, and regional level that will allow the CEQA streamlining of individual projects. (See State CEQA Guidelines §15183.5 ["Tiering and Streamlining the Analysis of Greenhouse Gas Emissions"]).

2.2.3. Plan-Level GHG Thresholds

Staff proposes using a two step process for determining the significance of proposed plans and plan amendments for GHG. As a first step in assessing plan-level impacts, Staff is proposing that agencies that have adopted a qualified Greenhouse Gas Reduction Strategy (or have incorporated similar criteria in their general plan) and the general plan is consistent with the Greenhouse Gas Reduction Strategy, the general plan would be considered less than significant. In addition, as discussed above for project-level GHG impacts, Staff is proposing an efficiency

threshold to assess plan-level impacts. Staff believes a programmatic approach to limiting GHG emissions is appropriate at the plan-level. Thus, as projects consistent with the Greenhouse Gas Reduction Strategy are proposed, they may be able to tier off the plan and its environmental analysis.

GHG Efficiency Metrics for Plans

For local land use plans, a GHG-efficiency metric (e.g., GHG emissions per unit) would enable comparison of a proposed general plan to its alternatives and to determine if the proposed general plan meets AB 32 emission reduction goals.

AB 32 identifies local governments as essential partners in achieving California's goal to reduce GHG emissions. Local governments have primary authority to plan, zone, approve, and permit how and where land is developed to accommodate population growth and the changing needs of their jurisdiction. ARB has developed the Local Government Operations Protocol and is developing a protocol to estimate community-wide GHG emissions. ARB encourages local governments to use these protocols to track progress in reducing GHG emissions. ARB encourages local governments to institutionalize the community's strategy for reducing its carbon footprint in its general plan. SB 375 creates a process for regional integration of land development patterns and transportation infrastructure planning with the primary goal of reducing GHG emissions from the largest sector of the GHG emission inventory, light duty vehicles.

If the statewide AB 32 GHG emissions reduction context is established, GHG efficiency can be viewed independently from the jurisdiction in which the plan is located. Expressing projected 2020 mass of emissions from land use-related emissions sectors by comparison to a demographic unit (e.g., population and employment) provides evaluation of the GHG efficiency of a project in terms of what emissions are allowable while meeting AB 32 targets.

Two approaches were considered for efficiency metrics. The "service population" (SP) approach would consider efficiency in terms of the GHG emissions compared to the sum of the number of jobs and the number of residents at a point in time. The per capita option would consider efficiency in terms of GHG emissions per resident only. Staff recommends that the efficiency threshold for plans be based on all emission inventory sectors because, unlike land use projects, general plans comprise more than just land use related emissions (e.g. industrial). Further, Staff recommends that the plan threshold be based on the service population metric as general plans include a mix of residents and employees. The Service Population metric would allow decision makers to compare GHG efficiency of general plan alternatives that vary residential and non-residential development totals, encouraging GHG efficiency through improving jobs/housing balance. This approach would not give preference to communities that accommodate more residential (population-driven) land uses than non-residential (employment driven) land uses which could occur with the per capita approach.

A SP-based GHG efficiency metric (see Table 7) was derived from the emission rates at the State level that would accommodate projected population and employment growth under trend forecast conditions, and the emission rates needed to accommodate growth while allowing for consistency with the goals of AB 32 (i.e., 1990 GHG emissions levels by 2020).

Table 7 – California 2020 GHG Emissions, Population Projections and GHG Efficiency Thresholds - All Inventory Sectors	
All Inventory Sectors Greenhouse Gas Emissions Target	426,500,000
Population	44,135,923
Employment	20,194,661
California Service Population (Population + Employment)	64,330,584
AB 32 Goal GHG emissions (metric tons CO_2e)/SP[1]	**6.6**

Notes: AB = Assembly Bill; CO_2e = carbon dioxide equivalent; GHG = greenhouse gas; SP = service population.
[1] Greenhouse gas efficiency levels were calculated using only the "land use-related" sectors of ARB's emissions inventory.
Sources: Data compiled by EDAW 2009, ARB 2009a, DOF 2009, EDD 2009, ICF Jones & Stokes 2009.

If a general plan demonstrates, through dividing the emissions inventory projections (MT CO_2e) by the amount of growth that would be accommodated in 2020, that it could meet the GHG efficiency metrics in this section (6.6 MT CO_2e/SP from all emission sectors, as noted in Table 7), then the amount of GHG emissions associated with the general plan would be considered less than significant, regardless of its size (and magnitude of GHG emissions). In other words, the general plan would accommodate growth in a manner that would not hinder the State's ability to achieve AB 32 goals, and thus, would be less than significant for GHG emissions and their contribution to climate change. The efficiency metric would not penalize well-planned communities that propose a large amount of development. Instead, the SP-based GHG efficiency metric acts to encourage the types of development that BAAQMD and OPR support (i.e., infill and transit-oriented development) because it tends to reduce GHG and other air pollutant emissions overall, rather than discourage large developments for being accompanied by a large mass of GHG emissions. Plans that are more GHG efficient would have no or limited mitigation requirements to help them complete the CEQA process more readily than plans that promote GHG inefficiencies, which will require detailed design of mitigation during the CEQA process and could subject a plan to potential challenge as to whether all feasible mitigation was identified and adopted. This type of threshold can shed light on a well-planned general plan that accommodates a large amount of growth in a GHG-efficient way.

When analyzing long-range plans, such as general plans, it is important to note that the planning horizon will often surpass the 2020 timeframe for implementation of AB 32. Executive Order S-3-05 establishes a more aggressive emissions reduction goal for the year 2050 of 80 percent below 1990 emissions levels. The year 2020 should be viewed as a milestone year, and the general plan should not preclude the community from a trajectory toward the 2050 goal. However, the 2020 timeframe is examined in this threshold evaluation because doing so for the 2050 timeframe (with respect to population, employment, and GHG emissions projections) would be too speculative. Advances in technology and policy decisions at the state level will be needed to meet the aggressive 2050 goals. It is beyond the scope of the analysis tools available at this time to examine reasonable emissions reductions that can be achieved through CEQA analysis in the year 2050. As the 2020 timeframe draws nearer, BAAQMD will need to reevaluate the threshold to better represent progress toward 2050 goals.

2.2.4. Greenhouse Gas Reduction Strategies

Finally, many local agencies have already undergone or plan to undergo efforts to create general or other plans that are consistent with AB 32 goals. The Air District encourages such planning efforts and recognizes that careful upfront planning by local agencies is invaluable to achieving

the state's GHG reduction goals. If a project is consistent with an adopted Qualified Greenhouse Gas Reduction Strategy that addresses the project's GHG emissions, it can be presumed that the project will not have significant GHG emission impacts. This approach is consistent with CEQA Guidelines Sections 15064(h)(3) and 15183.5(b), which provides that a lead agency may determine that a project's incremental contribution to a cumulative effect is not cumulatively considerable if the project will comply with the requirements in a previously approved plan or mitigation program which provides specific requirements that will avoid or substantially lessen the cumulative problem."

A qualified Greenhouse Gas Reduction Strategy (or similar adopted policies, ordinances and programs) is one that is consistent with all of the AB 32 Scoping Plan measures and goals. The Greenhouse Gas Reduction Strategy should identify a land use design, transportation network, goals, policies and implementation measures that would achieve AB 32 goals. Strategies with horizon years beyond 2020 should consider continuing the downward reduction path set by AB 32 and move toward climate stabilization goals established in Executive Order S-3-05.

Qualified Greenhouse Gas Reduction Strategy

A qualified Greenhouse Gas Reduction Strategy adopted by a local jurisdiction should include the following elements as described in the State CEQA Guidelines Section 15183.5. BAAQMD's revised CEQA Guidelines provides the methodology to determine if a Greenhouse Gas Reduction Strategy meets these requirements.

(A) Quantify greenhouse gas emissions, both existing and projected over a specified time period, resulting from activities within a defined geographic area;

(B) Establish a level, based on substantial evidence, below which the contribution to greenhouse gas emissions from activities covered by the plan would not be cumulatively considerable;

(C) Identify and analyze the greenhouse gas emissions resulting from specific actions or categories of actions anticipated within the geographic area;

(D) Specify measures or a group of measures, including performance standards, that substantial evidence demonstrates, if implemented on a project-by-project basis, would collectively achieve the specified emissions level;

(E) Establish a mechanism to monitor the plan's progress toward achieving the level and to require amendment if the plan is not achieving specified levels;

(F) Be adopted in a public process following environmental review.

Local Climate Action Policies, Ordinances and Programs

Air District staff recognizes that many communities in the Bay Area have been proactive in planning for climate change but have not yet developed a stand-alone Greenhouse Gas Reduction Strategy that meets the above criteria. Many cities and counties have adopted climate action policies, ordinances and program that may in fact achieve the goals of AB 32 and a qualified Greenhouse Gas Reduction Strategy. Staff recommends that if a local jurisdiction can demonstrate that its collective set of climate action policies, ordinances and other programs is consistent with AB 32 and State CEQA Guidelines Section 15183.5, includes requirements or feasible measures to reduce GHG emissions and achieves one of the following GHG emission reduction goals,[5] the AB 32 consistency demonstration should be considered equivalent to a qualified Greenhouse Gas Reduction Strategy:

[5] Lead agencies using consistency with their jurisdiction's climate action policies, ordinances and programs as a measure of significance under CEQA Guidelines section 15064(h)(3) and

- 1990 GHG emission levels,
- 15 percent below 2008 emission levels, or
- Meet the plan efficiency threshold of 6.6 MT CO_2e/service population/year.

Qualified Greenhouse Gas Reduction Strategies that are tied to the AB 32 reduction goals would promote reductions on a plan level without impeding the implementation of GHG-efficient development, and would recognize the initiative of many Bay Area communities who have already developed or are in the process of developing a GHG reduction plan. The details required above for a qualified Greenhouse Gas Reduction Strategy (or similar adopted policies, ordinances and programs) would provide the evidentiary basis for making CEQA findings that development consistent with the plan would result in feasible, measureable, and verifiable GHG reductions consistent with broad state goals such that projects approved under qualified Greenhouse Gas Reduction Strategies or equivalent demonstrations would achieve their fair share of GHG emission reductions.

GHG Thresholds for Regional Plans

Regional plans include the Regional Transportation Plan prepared by the Metropolitan Transportation Commission (MTC) and air quality plans prepared by the Air District.

The Regional Transportation Plan (RTP), also called a Metropolitan Transportation Plan (MTP) or Long-Range Transportation Plan is the mechanism used in California by both Metropolitan Planning Organizations (MPOs) and Regional Transportation Planning Agencies (RTPAs) to conduct long-range (minimum of 20 years) planning in their regions. MTC functions as both the regional transportation planning agency, a state designation, and, for federal purposes, as the region's metropolitan planning organization (MPO). As such, it is responsible for regularly updating the Regional Transportation Plan, a comprehensive blueprint for the development of the Bay Area's transportation system that includes mass transit, highway, airport, seaport, railroad, bicycle and pedestrian facilities. The performance of this system affects such public policy concerns as air quality, environmental resource consumption, social equity, "smart growth," economic development, safety, and security. Transportation planning recognizes the critical links between transportation and other societal goals. The planning process requires developing strategies for operating, managing, maintaining, and financing the area's transportation system in such a way as to advance the area's long-term goals.

The Air District periodically prepares and updates plans to achieve the goal of healthy air. Typically, a plan will analyze emissions inventories (estimates of current and future emissions from industry, motor vehicles, and other sources) and combine that information with air monitoring data (used to assess progress in improving air quality) and computer modeling simulations to test future strategies to reduce emissions in order to achieve air quality standards. Air quality plans usually include measures to reduce air pollutant emissions from industrial facilities, commercial processes, motor vehicles, and other sources. Bay Area air quality plans are prepared with the cooperation of MTC, the Association of Bay Area Governments (ABAG) and the Bay Conservation and Development Commission (BCDC).

The threshold of significance for regional plans is no net increase in emissions including greenhouse gas emissions. This threshold serves to answer the State CEQA Guidelines

15183.5(b) should ensure that the policies, ordinances and programs satisfy all of the requirements of that subsection before relying on them in a CEQA analysis.

Appendix G sample question: "Would the project generate greenhouse gas emissions, either directly or indirectly, that may have a significant impact on the environment?"

2.2.5. Stationary Source GHG Threshold

Staff's recommended threshold for stationary source GHG emissions is based on estimating the GHG emissions from combustion sources for all permit applications submitted to the Air District in 2005, 2006 and 2007. The analysis is based only on CO_2 emissions from stationary sources, as that would cover the vast majority of the GHG emissions due to stationary combustion sources in the SFBAAB. The estimated CO_2 emissions were calculated for the maximum permitted amount, i.e. emissions that would be emitted if the sources applying for a permit application operate at maximum permitted load and for the total permitted hours. All fuel types are included in the estimates. For boilers burning natural gas, diesel fuel is excluded since it is backup fuel and is used only if natural gas is not available. Emission values are estimated before any offsets (i.e., Emission Reduction Credits) are applied. GHG emissions from mobile sources, electricity use and water delivery associated with the operation of the permitted sources are not included in the estimates.

It is projected that a threshold level of 10,000 metric tons of CO_2e per year would capture approximately 95 percent of all GHG emissions from new permit applications from stationary sources in the SFBAAB. That threshold level was calculated as an average of the combined CO_2 emissions from all stationary source permit applications submitted to the Air District during the three year analysis period.

Staff recommends this 10,000 MT of CO_2/yr as it would address a broad range of combustion sources and thus provide for a greater amount of GHG reductions to be captured and mitigated through the CEQA process. As documented in the Scoping Plan, in order to achieve statewide reduction targets, emissions reductions need to be obtained through a broad range of sources throughout the California economy and this threshold would achieve this purpose. While this threshold would capture 95 percent of the GHG emissions from new permit applications, the threshold would do so by capturing only the large, significant projects. Permit applications with emissions above the 10,000 MT of CO_2/yr threshold account for less than 10 percent of stationary source permit applications which represent 95 percent of GHG emissions from new permits analyzed during the three year analysis period.

This threshold would be considered an interim threshold and Air District staff will reevaluate the threshold as AB 32 Scoping Plan measures such as cap and trade are more fully developed and implemented at the state level.

2.2.6. Summary of Justification for GHG Thresholds

The bright-line numeric threshold of 1,100 MT CO_2e/yr is a numeric emissions level below which a project's contribution to global climate change would be less than "cumulatively considerable." This emissions rate is equivalent to a project size of approximately 60 single-family dwelling units, and approximately 59 percent of all future projects and 92 percent of all emissions from future projects would exceed this level. For projects that are above this bright-line cutoff level, emissions from these projects would still be less than cumulatively significant if the project as a whole would result in an efficiency of 4.6 MT CO_2e per service population or better for mixed-use projects. Projects with emissions above 1,100 MT CO_2e/yr would still be less than significant if they achieved project efficiencies below these levels. If projects as proposed exceed these levels, they would be required to implement mitigation measures to bring them back below the 1,100 MT CO_2e/yr bright-line cutoff or within the 4.6 MT CO_2e Service Population efficiency threshold. If mitigation did not bring a project back within the threshold requirements, the project would be cumulatively significant and could be approved only with a Statement of Overriding

Considerations and a showing that all feasible mitigation measures have been implemented. Projects' GHG emissions would also be less than significant if they comply with a Qualified Greenhouse Gas Reduction Strategy.

As explained in the preceding analyses of these thresholds, the greenhouse gas emissions from land use projects expected between now and 2020 built in compliance with these thresholds would be approximately 26 percent below BAU 2020 conditions and thus would be consistent with achieving an AB 32 equivalent reduction. The 26 percent reduction from BAU 2020 from new projects built in conformance with these thresholds would achieve an aggregate reduction of approximately 1.6 MMT CO_2e/yr, which is the level of emission reductions from new Bay Area land use sources needed to meet the AB 32 goals, per ARB's Scoping Plan as discussed above.

Projects with greenhouse gas emissions in conformance with these thresholds would not be considered significant for purposes of CEQA. Although the emissions from such projects would add an incremental amount to the overall greenhouse gas emissions that cause global climate change impacts, emissions from projects consistent with these thresholds would not be a "cumulatively considerable" contribution under CEQA. Such projects would not be "cumulatively considerable" because they would be helping to solve the cumulative problem as a part of the AB 32 process.

California's response to the problem of global climate change is to reduce greenhouse gas emissions to 1990 levels by 2020 under AB 32 as a near-term measure and ultimately to 80 percent below 1990 levels by 2050 as the long-term solution to stabilizing greenhouse gas concentrations in the atmosphere at a level that will not cause unacceptable climate change impacts. To implement this solution, the Air Resources Board has adopted a Scoping Plan and budgeted emissions reductions that will be needed from all sectors of society in order to reach the interim 2020 target.

The land-use sector in the Bay Area needs to achieve aggregate emission reductions of approximately 1.6 MMT CO_2e/yr from new projects between now and 2020 to achieve this goal, as noted above, and each individual new project will need to achieve its own respective portion of this amount in order for the Bay Area land use sector as a whole to achieve its allocated emissions target. Building all of the new projects expected in the Bay Area between now and 2020 in accordance with the thresholds that District staff are proposing will achieve the overall appropriate share for the land use sector, and building each individual project in accordance with the thresholds will achieve that individual project's respective portion of the emission reductions needed to implement the AB 32 solution. For these reasons, projects built in conformance with the thresholds will be part of the solution to the cumulative problem, and not part of the continuing problem. They will allow the Bay Area's land use sector to achieve the emission reductions necessary from that sector for California to implement its solution to the cumulative problem of global climate change. As such, even though such projects will add an incremental amount of greenhouse gas emissions, their incremental contribution will be less than "cumulatively considerable" because they are helping to achieve the cumulative solution, not hindering it. Such projects will not be "significant" for purposes of CEQA (see CEQA Guidelines §15064(h)(1)).

The conclusion that land use projects that comply with these thresholds is also supported by CEQA Guidelines Section 15030(a)(3), which provides that a project's contribution to a cumulative problem can be less that cumulatively considerable "if the project is required to implement or fund its fair share of a mitigation measure or measures designed to alleviate the cumulative impact." In the case of greenhouse gas emissions associated with land use projects, achieving the amount of emission reductions below BAU that will be required to achieve the AB 32 goals is the project's "fair share" of the overall emission reductions needed under ARB's scoping plan to reach the overall statewide AB 32 emissions levels for 2020. If a project is

designed to implement greenhouse gas mitigation measures that achieve a level of reductions consistent with what is required from all new land use projects to achieve the land use sector "budget" – *i.e.*, keeping overall project emissions below 1,100 MT CO_2e/yr or ensuring that project efficiency is better than 4.6 MT CO_2e/service population – then it will be implementing its share of the mitigation measures necessary to alleviate the cumulative impact, as shown in the analyses set forth above.

It is also worth noting that this "fair share" approach is flexible and will allow a project's significance to be determined by how well it is designed from a greenhouse gas efficiency standpoint, and not just by the project's size. For example, a large high-density infill project located in an urban core nearby to public transit and other alternative transportation options, and built using state-of-the-art energy efficiency methods and improvements such as solar panels, as well as all other feasible mitigation measures, would not become significant for greenhouse gas purposes (and thus require a Statement of Overriding Considerations in order to be approved) simply because it happened to be a large project. Projects such as this hypothetical development with low greenhouse gas emissions per service population are what California will need in the future in order to do its part in achieving a solution to the problem of global climate change. The determination of significance under CEQA should take these factors into account, and the significance thresholds would achieve this important policy goal. In all, land use sector projects that comply with the GHG thresholds would not be "cumulatively considerable" because they would be helping to solve the cumulative problem as a part of the AB 32 process.

Likewise, new Air District permit applications for stationary sources that comply with the quantitative threshold of 10,000 MT CO_2e/yr would not be "cumulatively considerable" because they also would not hinder the state's ability to solve the cumulative greenhouse gas emissions problem pursuant to AB 32. Unlike the land use sector, the AB 32 Scoping Plan measures, including the cap-and-trade program, provide for necessary emissions reductions from the stationary source sector to achieve AB 32 2020 goals.

While stationary source projects will need to comply with the cap-and-trade program once it is enacted and reduce their emissions accordingly, the program will be phased in over time starting in 2012 and at first will only apply to the very largest sources of GHG emissions. In the mean time, certain stationary source projects, particularly those with large GHG emissions, still will have a cumulatively considerable impact on climate change. The 10,000 MT CO_2e/yr threshold will capture 95 percent of the stationary source sector GHG emissions in the Bay Area. The five percent of emissions that are from stationary source projects below the 10,000 MT CO_2e/yr threshold account for a small portion of the Bay Area's total GHG emissions from stationary sources and these emissions come from very small projects. Such small stationary source projects will not significantly add to the global problem of climate change, and they will not hinder the Bay Area's ability to reach the AB 32 goal in any significant way, even when considered cumulatively. In Air District's staff's judgment, the potential environmental benefits from requiring EIRs and mitigation for these projects would be insignificant. In all, based on staff's expertise, stationary source projects with emissions below 10,000 MT CO_2e/yr will not provide a cumulatively considerable contribution to the cumulative impact of climate change.

3. COMMUNITY RISK AND HAZARD THRESHOLDS

To address community risk from air toxics, the Air District initiated the Community Air Risk Evaluation (CARE) program in 2004 to identify locations with high levels of risk from ambient toxic air contaminants (TAC) co-located with sensitive populations and use the information to help focus mitigation measures. Through the CARE program, the Air District developed an inventory of

TAC emissions for 2005 and compiled demographic and health indicator data. According to the findings of the CARE Program, diesel PM—mostly from on and off-road mobile sources—accounts for over 80 percent of the inhalation cancer risk from TACs in the Bay Area (BAAQMD 2006).

The Air District applied a regional air quality model using the 2005 emission inventory data to estimate excess cancer risk from ambient concentrations of important TAC species, including diesel PM, 1,3-butadiene, benzene, formaldehyde and acetaldehyde. The highest cancer risk levels from ambient TAC in the Bay Area tend to occur in the core urban areas, along major roadways and adjacent to freeways and port activity. Cancer risks in areas along these major freeways are estimated to range from 200 to over 500 excess cases in a million for a lifetime of exposure. Priority communities within the Bay Area – defined as having higher emitting sources, highest air concentrations, and nearby low income and sensitive populations – include the urban core areas of Concord, eastern San Francisco, western Alameda County, Redwood City/East Palo Alto, Richmond/San Pablo, and San Jose.

Fifty percent of BAAQMD's population was estimated to have an ambient background inhalation cancer risk of less than 500 cases in one million, based on emission levels in 2005. Table 8 presents a summary of percentages of the population exposed to varying levels of cancer risk from ambient TACs. Approximately two percent of the SFBAAB population is exposed to background risk levels of less than 200 excess cases in one million. This is in contrast to the upper percentile ranges where eight percent of the SFBAAB population is exposed to background risk levels of greater than 1,000 excess cases per one million. To identify and reduce risks from TAC, this chapter presents thresholds of significance for both cancer risk and non-cancer health hazards.

Table 8 – Statistical Summary of Estimated Population-Weighted Ambient Cancer Risk in 2005

Percentage of Population (Percent below level of ambient risk)	Ambient Cancer Risk (inhalation cancer cases in one million)
92	1,000
90	900
83	800
77	700
63	600
50	500
32	400
13	300
2	200
<1	100

Source: Data compiled by EDAW 2009.

Many scientific studies have linked fine particulate matter and traffic-related air pollution to respiratory illness (Hiltermann et al. 1997, Schikowski et al 2005, Vineis et al. 2007) and premature mortality (Dockery 1993, Pope et al. 1995, Jerrett et al. 2005). Traffic-related air pollution is a complex mix of chemical compounds (Schauer et al. 2006), often spatially correlated

with other stressors, such as noise and poverty (Wheeler and Ben-Shlomo 2005). While such correlations can be difficult to disentangle, strong evidence for adverse health effects of fine particulate matter ($PM_{2.5}$) has been developed for regulatory applications in a study by the U.S, EPA. This study found that a 10 percent increase in $PM_{2.5}$ concentrations increased the non-injury death rate by 10 percent (U.S. EPA 2006).

Public Health Officers for four counties in the San Francisco Bay Area in 2009 provided testimony to the Air District's Advisory Council (February 11, 2009, Advisory Council Meeting on Air Quality and Public Health). Among the recommendations made, was that $PM_{2.5}$, in addition to TACs, be considered in assessments of community-scale impacts of air pollution. In consideration of the scientific studies and recommendations by the Bay Area Health Directors, it is apparent that, in addition to the significance thresholds for local-scale TAC, thresholds of significance are required for near-source, local-scale concentrations of $PM_{2.5}$.

3.1. THRESHOLDS OF SIGNIFICANCE

The thresholds of significance and Board-requested options are presented in this section:

- The **Staff Proposal** includes thresholds for cancer risk, non-cancer health hazards, and fine particulate matter.
- **Tiered Thresholds Option** includes tiered thresholds for new sources in impacted communities. Thresholds for receptors and cumulative impacts are the same as the Staff Proposal.

Proposal/Option	Construction-Related	Operational-Related
Project-Level – Individual Project		
Risks and Hazards – New Source (All Areas) (Individual Project) **Staff Proposal**	Same as Operational Thresholds*	Compliance with Qualified Community Risk Reduction Plan OR Increased cancer risk of >10.0 in a million Increased non-cancer risk of > 1.0 Hazard Index (Chronic or Acute) Ambient $PM_{2.5}$ increase: > 0.3 µg/m^3 annual average Zone of Influence: 1,000-foot radius from fence line of source or receptor

Proposal/Option	Construction-Related	Operational-Related
Risks and Hazards – New Receptor (All Areas) (Individual Project) **Staff Proposal**	Same as Operational Thresholds*	Compliance with Qualified Community Risk Reduction Plan OR Increased cancer risk of >10.0 in a million Increased non-cancer risk of > 1.0 Hazard Index (Chronic or Acute) Ambient $PM_{2.5}$ increase: > 0.3 µg/m^3 annual average Zone of Influence: 1,000-foot radius from fence line of source or receptor
Risks and Hazards (Individual Project) **Tiered Thresholds Option**	Same as Operational Thresholds*	**Impacted Communities:** Siting a New Source Compliance with Qualified Community Risk Reduction Plan OR Increased cancer risk of >5.0 in a million Increased non-cancer risk of > 1.0 Hazard Index (Chronic or Acute) Ambient $PM_{2.5}$ increase: > 0.2 µg/m^3 annual average Zone of Influence: 1,000-foot radius from fence line of source or receptor
	Same as Operational Thresholds*	**Impacted Communities:** Siting a New Receptor **All Other Areas:** Siting a New Source or Receptor Compliance with Qualified Community Risk Reduction Plan OR Increased cancer risk of >10.0 in a million Increased non-cancer risk of > 1.0 Hazard Index (Chronic or Acute) Ambient $PM_{2.5}$ increase: > 0.3 µg/m^3 annual average Zone of Influence: 1,000-foot radius from fence line of source or receptor
Accidental Release of Acutely Hazardous Air Pollutants	None	Storage or use of acutely hazardous materials locating near receptors or receptors locating near stored or used acutely hazardous materials considered significant
Project-Level – Cumulative		

Proposal/Option	Construction-Related	Operational-Related
Risks and Hazards – New Source (All Areas) (Cumulative Thresholds)	Same as Operational Thresholds*	Compliance with Qualified Community Risk Reduction Plan OR Cancer: > 100 in a million (from all local sources) Non-cancer: > 10.0 Hazard Index (from all local sources) (Chronic) $PM_{2.5}$: > 0.8 µg/m^3 annual average (from all local sources) Zone of Influence: 1,000-foot radius from fence line of source or receptor
Risks and Hazards – New Receptor (All Areas) (Cumulative Thresholds)	Same as Operational Thresholds*	Compliance with Qualified Community Risk Reduction Plan OR Cancer: > 100 in a million (from all local sources) Non-cancer: > 10.0 Hazard Index (from all local sources) (Chronic) $PM_{2.5}$: > 0.8 µg/m^3 annual average (from all local sources) Zone of Influence: 1,000-foot radius from fence line of source or receptor
Plan-Level		
Risks and Hazards	None	1. Overlay zones around existing and planned sources of TACs (including adopted Risk Reduction Plan areas). 2. Overlay zones of at least 500 feet (or Air District-approved modeled distance) from all freeways and high volume roadways.
Accidental Release of Acutely Hazardous Air Pollutants	None	None
Regional Plans (Transportation and Air Quality Plans)		
Risks and Hazards	None	No net increase in toxic air contaminants

* Note: The Air District recommends that for construction projects that are less than one year duration, Lead Agencies should annualize impacts over the scope of actual days that peak impacts are to occur, rather than the full year.

3.2. JUSTIFICATION AND SUBSTANTIAL EVIDENCE SUPPORTING THRESHOLDS

The goal of the thresholds is to ensure that no source creates, or receptor endures, a significant adverse impact from any individual project, and that the total of all nearby directly emitted risk and hazard emissions is also not significantly adverse. The thresholds for local risks and hazards from TAC and $PM_{2.5}$ are intended to apply to all sources of emissions, including both permitted stationary sources and on- and off-road mobile sources, such as sources related to construction, busy roadways, or freight movement.

Thresholds for an individual new source are designed to ensure that the source does not contribute to a cumulatively significant impact. Cumulative thresholds for sources recognize that some areas are already near or at levels of significant impact. If within such an area there are receptors, or it can reasonably be foreseen that there will be receptors, then a cumulative significance threshold sets a level beyond which any additional risk is significant.

For new receptors – sensitive populations or the general public – thresholds of significance are designed to identify levels of contributed risk or hazards from existing local sources that pose a significant risk to the receptors. Single-source thresholds for receptors are provided to recognize that within the area defined there can be variations in risk levels that may be significant. Single-source thresholds assist in the identification of significant risks, hazards, or concentrations in a subarea, within the area defined by the selected radius. Cumulative thresholds for receptors are designed to account for the effects of all sources within the defined area.

Cumulative thresholds, for both sources and receptors, must consider the size of the source area, defined by a radius from the proposed project. To determine cumulative impacts from a prescribed zone of influence requires the use of modeling. The larger the radius, the greater the number of sources considered that may contribute to the modeled risk and, until the radius approaches a regional length scale, the greater the expected modeled risk increment. If the area of impact considered were grown to the scale of a city, the modeled risk increment would approach the risk level present in the ambient air.

3.2.1. Scientific and Regulatory Justification

Regulatory Framework for TACs

Prior to 1990, the Clean Air Act required EPA to list air toxics it deemed hazardous and to establish control standards which would restrict concentrations of hazardous air pollutants (HAP) to a level that would prevent any adverse effects "with an ample margin of safety." By 1990, EPA had regulated only seven such pollutants and it was widely acknowledged by that time that the original Clean Air Act had failed to address toxic air emissions in any meaningful way. As a result, Congress changed the focus of regulation in 1990 from a risk-based approach to technology-based standards. Title III, Section 112(b) of the 1990 Clean Air Act Amendment established this new regulatory approach. Under this framework, prescribed pollution control technologies based upon maximum achievable control technology (MACT) were installed without the a priori estimation of the health or environmental risk associated with each individual source. The law listed 188 HAPs that would be subject to the MACT standards. EPA issued 53 standards for 89 different types of major industrial sources of air toxics and eight categories of smaller sources such as dry cleaners. These requirements took effect between 1996 and 2002. Under the federal Title V Air Operating Permit Program, a facility with the potential to emit 10 tons of any toxic air pollutant, or 25 tons per year of any combination of toxic air pollutants, is defined as a major source HAPs. Title V permits include requirements for these facilities to limit toxic air pollutant emissions.

Several state and local agencies adopted programs to address gaps in EPA's program prior to the overhaul of the national program in 1990. California's program to reduce exposure to air toxics was established in 1983 by the Toxic Air Contaminant Identification and Control Act (AB 1807, Tanner 1983) and the Air Toxics "Hot Spots" Information and Assessment Act (AB 2588, Connelly 1987). Under AB 1807, ARB and the Office of Environmental Health Hazard Assessment (OEHHA) determines if a substance should be formally identified as a toxic air contaminant (TAC) in California. OEHHA also establishes associated risk factors and safe concentrations of exposure.

AB 1807 was amended in 1993 by AB 2728, which required ARB to identify the 189 federal hazardous air pollutants as TACs. AB 2588 (Connelly, 1987) supplements the AB 1807 program, by requiring a statewide air toxics inventory, notification of people exposed to a significant health risk, and facility plans to reduce these risks. In September 1992, the "Hot Spots" Act was amended by Senate Bill 1731 which required facilities that pose a significant health risk to the community to reduce their risk through a risk management plan.

Cancer Risk

Cancer risk from TACs is typically expressed in numbers of excess cancer cases per million persons exposed over a defined period of exposure, for example, over an assumed 70 year lifetime. The Air District is not aware of any agency that has established an acceptable level of cancer risk for TACs. However, a range of what constitutes a significant increment of cancer risk from any compound has been established by the U.S. EPA. EPA's guidance for conducting air toxics analyses and making risk management decisions at the facility- and community-scale level considers a range of acceptable cancer risks from one in a million to one in ten thousand (100 in a million). The guidance considers an acceptable range of cancer risk increments to be from one in a million to one in ten thousand. In protecting public health with an ample margin of safety, EPA strives to provide maximum feasible protection against risks to health from HAPs by limiting additional risk to a level no higher than the one in ten thousand estimated risk that a person living near a source would be exposed to at the maximum pollutant concentrations for 70 years. This goal is described in the preamble to the benzene National Emissions Standards for Hazardous Air Pollutants (NESHAP) rulemaking (54 Federal Register 38044, September 14, 1989) and is incorporated by Congress for EPA's residual risk program under Clean Air Act section 112(f).

Regulation 2, Rule 5 of the Air District specifies permit requirements for new and modified stationary sources of TAC. The Project Risk Requirement (2-5-302.1) states that the Air Pollution Control Officer shall deny an Authority to Construct or Permit to Operate for any new or modified source of TACs if the project cancer risk exceeds 10.0 in one million.

Hazard Index for Non-cancer Health Effects

Non-cancer health hazards for chronic and acute diseases are expressed in terms of a hazard index (HI), a ratio of TAC concentration to a reference exposure level (REL), below which no adverse health effects are expected, even for sensitive individuals. As such, OEHHA has defined acceptable concentration levels, and also significant concentration increments, for compounds that pose non-cancer health hazards. If the HI for a compound is less than one, non-cancer chronic and acute health impacts have been determined to be less than significant.

State and Federal Ambient Air Quality Standards for $PM_{2.5}$

The Children's Environmental Health Protection Act (Senate Bill 25), passed by the California state legislature in 1999, requires ARB, in consultation with OEHHA, to "review all existing health-based ambient air quality standards to determine whether, based on public health, scientific literature and exposure pattern data, these standards adequately protect the public, including infants and children, with an adequate margin of safety." As a result of the review requirement, in 2002 ARB adopted an annual average California Ambient Air Quality Standard (CAAQS) for

$PM_{2.5}$ of 12 ug/m^3 that is not to be exceeded (California Code of Regulations, Title 17 § 70200, Table of Standards). The National Ambient Air Quality Standard (NAAQS) established an annual standard for $PM_{2.5}$ (15 ug/m^3) that is less stringent that the CAAQS, but also set a 24-hour average standard (35 ug/m^3), which is not included in the CAAQS (Code of Federal Regulations, Title 40, Part 50.7).

Significant Impact Levels for $PM_{2.5}$

EPA recently proposed and documented alternative options for $PM_{2.5}$ Significant Impact Levels (SILs) (Federal Register 40 CFR Parts 51 and 52, September 21, 2007). The EPA is proposing to facilitate implementation of a $PM_{2.5}$ Prevention of Significant Deterioration (PSD) program in areas attaining the $PM_{2.5}$ NAAQS by developing $PM_{2.5}$ increments, or SILs. These "increments" are maximum increases in ambient $PM_{2.5}$ concentrations ($PM_{2.5}$ increments) allowed in an area above the baseline concentration.

The SIL is a threshold that would be applied to individual facilities that apply for a permit to emit a regulated pollutant in an area that meets the NAAQS. The State and EPA must determine if emissions from that facility will cause the air quality to worsen. If an individual facility projects an increase in emissions that result in ambient impacts greater than the established SIL, the permit applicant would be required to perform additional analyses to determine if those impacts will be more than the amount of the PSD increment. This analysis would combine the impact of the proposed facility when added to all other sources in the area.

The EPA is proposing such values for $PM_{2.5}$ that will be used as screening tools by a major source subject to PSD to determine the subsequent level of analysis and data gathering required for a PSD permit application for emissions of $PM_{2.5}$. The SIL is one element of the EPA program to prevent deterioration in regional air quality and is utilized in the new source review (NSR) process. New source review is required under Section 165 of the Clean Air Act, whereby a permit applicant must demonstrate that emissions from the proposed construction and operation of a facility "will not cause, or contribute to, air pollution in excess of any maximum allowable increase or maximum allowable concentration for any pollutant." The purpose of the SIL is to provide a screening level that triggers further analysis in the permit application process.

For the purpose of NSR, SILs are set for three types of areas: Class I areas where especially clean air is most desirable, including national parks and wilderness areas; Class II areas where there is not expected to be substantial industrial growth; and Class III areas where the highest relative level of industrial development is expected. In Class II and Class III areas, a $PM_{2.5}$ concentration of 0.3, 0.8, and 1 µg/m^3 has been proposed as a SIL. To arrive at the SIL $PM_{2.5}$ option of 0.8 µg/m^3 , EPA scaled an established PM_{10} SILs of 1.0 µg/m^3 by the ratio of emissions of $PM_{2.5}$ to PM_{10} using the EPA's 1999 National Emissions Inventory. To arrive at the SIL option of 0.3 µg/m^3, EPA scaled the PM_{10} SIL of 1.0 µg/m^3 by the ratio of the current Federal ambient air quality standards for $PM_{2.5}$ and PM_{10} (15/50). These options represent what EPA currently considers as a range of appropriate SIL values.

EPA interprets the SIL to be the level of $PM_{2.5}$ increment that represents a "significant contribution" to regional non-attainment. While SIL options were not designed to be thresholds for assessing community risk and hazards, they are being considered to protect public health at a regional level by helping an area maintain the NAAQS. Furthermore, since it is the goal of the Air District to achieve and maintain the NAAQS and CAAQS at both regional and local scales, the SILs may be reasonably be considered as thresholds of significance under CEQA for local-scale increments of $PM_{2.5}$.

Roadway Proximity Health Studies

Several medical research studies have linked near-road pollution exposure to a variety of adverse health outcomes impacting children and adults. Kleinman et al. (2007) studied the potential of roadway particles to aggravate allergic and immune responses in mice. Using mice that were not inherently susceptible, the researchers placed these mice at various distances downwind of State Road 60 and Interstate 5 freeways in Los Angeles to test the effect these roadway particles have on their immune system. They found that within five meters of the roadway, there was a significant allergic response and elevated production of specific antibodies. At 150 meters (492 feet) and 500 meters (1,640 feet) downwind of the roadway, these effects were not statistically significant.

Another significant study (Ven Hee et al. 2009) conducted a survey involving 3,827 participants that aimed to determine the effect of residential traffic exposure on two preclinical indicators of heart failure; left ventricular mass index (LVMI), measured by the cardiac magnetic resonance imaging (MRI), and ejection fraction. The studies classified participants based on the distance between their residence and the nearest interstate highway, state or local highway, or major arterial road. Four distance groups were defined: less than 50 meters (165 feet), 50-100 meters, 101-150 meters, and greater than 150 meters. After adjusting for demographics, behavioral, and clinical covariates, the study found that living within 50 meters of a major roadway was associated with a 1.4 g/m^2 higher LVMI than living more than 150 meters from one. This suggests an association between traffic-related air pollution and increased prevalence of a preclinical predictor of heart failure among people living near roadways.

To quantify the roadway concentrations of $PM_{2.5}$ that contributed to the health impacts reported by Kleinman et al (2007), the Air District modeled the emissions and associated particulate matter concentrations for the roadways studied. To perform the modeling, emissions were estimated for Los Angeles using the EMFAC model and annual average vehicle traffic data taken from Caltrans was used in the roadway model (CAL3QHCR) to estimate the downwind $PM_{2.5}$ concentrations at 50 meters and 150 meters. Additionally, emissions were assumed to occur from 10:00 a.m. to 2:00 p.m. corresponding to the time in which the mice were exposed during the study. The results of the modeling indicate that at 150 meters, where no significant health effects were found, the downwind concentration of $PM_{2.5}$ was 0.78 $\mu g/m^3$, consistent with the proposed EPA SIL option of 0.8 $\mu g/m^3$.

Concentration-Response Function for $PM_{2.5}$

The U.S. EPA reevaluated the relative risk of premature death associated with $PM_{2.5}$ exposure and developed a new relative risk factor (U.S. EPA 2006). This expert elicitation was prepared in support of the characterization of uncertainty in EPA's benefits analyses associated with reductions in exposure to particulate matter pollution. As recommended by the National Academy of Sciences, EPA used expert judgment to better describe the uncertainties inherent in their benefits analysis. Twelve experts participated in the study and provided not just a point estimate of the health effects of PM2.5, but a probability distribution representing the range where they expected the true effect would be. Among the experts who directly incorporated their views on the likelihood of a causal relationship into their distributions, the central (median) estimates of the percent change in all-cause mortality in the adult U.S. population that would result from a permanent 1 µg/m3 drop in annual average PM2.5 concentrations ranged from 0.7 to 1.6 percent. The median of their estimates was 1.0 (% increase per 1 µg/m3 increase in PM2.5), with a 90% confidence interval of 0.3 to 2.0 (medians of their 5^{th} and 95^{th} percentiles, respectively) (BAAQMD 2010).Subsequent to the EPA elicitation, Schwartz et al. (2008) examined the linearity of the concentration-response function of $PM_{2.5}$-mortality and showed that the response function was linear, with health effects clearly continuing below the current U.S. standard of 15 $\mu g/m^3$, and that the effects of changes in exposure on mortality were seen within two years.

San Francisco Ordinance on Roadway Proximity Health Effects

In 2008, the City and County of San Francisco adopted an ordinance (San Francisco Health Code, Article 38 - Air Quality Assessment and Ventilation Requirement for Urban Infill Residential Development, Ord. 281-08, File No. 080934, December 5, 2008) requiring that public agencies in San Francisco take regulatory action to prevent future air quality health impacts from new sensitive uses proposed near busy roadways (SFDPH 2008). The regulation requires that developers screen sensitive use projects for proximity to traffic and calculate the concentration of $PM_{2.5}$ from traffic sources where traffic volumes suggest a potential hazard. If modeled levels of traffic-attributable $PM_{2.5}$ at a project site exceed an action level (currently set at 0.2 $\mu g/m^3$) developers would be required to incorporate ventilation systems to remove 80 percent of $PM_{2.5}$ from outdoor air. The regulation does not place any requirements on proposed sensitive uses if modeled air pollutant levels fall below the action threshold. This ordinance only considers impacts from on-road motor vehicles, not impacts related to construction equipment or stationary sources.

A report with supporting documentation for the ordinance (SFPHD 2008) provided a threshold to trigger action or mitigation of 0.2 $\mu g/m^3$ of $PM_{2.5}$ annual average exposure from roadway vehicles within a 150 meter (492 feet) maximum radius of a sensitive receptor. The report applied the concentration-response function from Jerrett et al. (2005) that attributed 14 percent increase in mortality to a 10 $\mu g/m^3$ increase in $PM_{2.5}$ to estimate an increase in non-injury mortality in San Francisco of about 21 excess deaths per million population per year from a 0.2 $\mu g/m^3$ increment of annual average $PM_{2.5}$.

Distance for Significant Impact

The distance used for the radius around the project boundary should reflect the zone or area over which sources may have a significant influence. For cumulative thresholds, for both sources and receptors, this distance also determines the size of the source area, defined. To determine cumulative impacts from a prescribed zone of influence requires the use of modeling. The larger the radius, the greater the number of sources considered that may contribute to the risk and the greater the expected modeled risk increment. If the area of impact considered were grown to approach the scale of a city, the modeled risk increment would approach the risk level present in the ambient air.

A summary of research findings in ARB's Land Use Compatibility Handbook (ARB 2005) indicates that traffic-related pollutants were higher than regional levels within approximately 1,000 feet downwind and that differences in health-related effects (such as asthma, bronchitis, reduced lung function, and increased medical visits) could be attributed in part to the proximity to heavy vehicle and truck traffic within 300 to 1,000 feet of receptors. In the same summary report, ARB recommended avoiding siting sensitive land uses within 1,000 feet of a distribution center and major rail yard, which supports the use of a 1,000 feet evaluation distance in case such sources may be relevant to a particular project setting. A 1,000 foot zone of influence is also supported by Health & Safety Code §42301.6 (Notice for Possible Source Near School).

Some studies have shown that the concentrations of particulate matter tend to be reduced substantially or can even be indistinguishable from upwind background concentrations at a distance 1,000 feet downwind from sources such as freeways or large distribution centers. Zhu et al. (2002) conducted a systematic ultrafine particle study near Interstate 710, one of the busiest freeways in the Los Angeles Basin. Particle number concentration and size distribution were measured as a function of distances upwind and downwind of the I-710 freeway. Approximately 25 percent of the 12,180 vehicles per hour are heavy duty diesel trucks based on video counts conducted as part of the research. Measurements were taken at 13 feet, 23 feet, 55 feet, 252 feet, 449 feet, and 941 feet downwind and 613 feet upwind from the edge of the freeway. The particle number and supporting measurements of carbon monoxide and black carbon decreased

exponentially and all constituents simultaneously tracked with each other as one moves away from the freeway. Ultrafine particle size distribution changed markedly and its number concentrations dropped dramatically with increasing distance. The study found that ultrafine particle concentrations measured 941 feet downwind of I-710 were indistinguishable from the upwind background concentration.

Impacted Communities

Starting in 2006, the Air District's CARE program developed gridded TAC emissions inventories and compiled demographic information that were used to identify communities that were particularly impacted by toxic air pollution for the purposes of distributing grant and incentive funding. In 2009, the District completed regional modeling of TAC on a one kilometer by one kilometer grid system. This modeling was used to estimate cancer risk and TAC population exposures for the entire District. The information derived from the modeling was then used to update and refine the identification of impacted communities. One kilometer modeling yielded estimates of annual concentrations of five key compounds – diesel particulate matter, benzene, 1,3-butadiene, formaldehyde, and acetaldehyde – for year 2005. These concentrations were multiplied by their respective unit cancer risk factors, as established by OEHHA, to estimate the expected excess cancer risk per million people from these compounds.

Sensitive populations from the 2000 U.S. Census database were identified as youth (under 18) and seniors (over 64) and mapped to the same one kilometer grid used for the toxics modeling. Excess cancers from TAC exposure were determined by multiplying these sensitive populations by the model-estimated excess risk to establish a data set representing sensitive populations with high TAC exposures. TAC emissions (year 2005) were mapped to the one kilometer grid and also scaled by their unit cancer risk factor to provide a data set representing source regions for TAC emissions. Block-group level household income data from the U.S. Census database were used to identify block groups with family incomes where more than 40 percent of the population was below 185 percent of the federal poverty level (FPL). Poverty-level polygons that intersect high (top 50 percent) exposure cells and are within one grid cell of a high emissions cell (top 25 percent) were used to identify impacted areas. Boundaries were constructed along major roads or highways that encompass nearby high emission cells and low income areas. This method identified the following six areas as priority communities: (1) portions of the City of Concord; (2) Western Contra Costa County (including portions of the Cities of Richmond and San Pablo); (3) Western Alameda County along the Interstate-880 corridor (including portions of the Cities of Berkeley, Oakland, San Leandro, San Lorenzo, Hayward; (4) Portions of the City of San Jose. (5) Eastern San Mateo County (including portions of the Cities of Redwood City and East Palo Alto); and (6) Eastern portions of the City of San Francisco.

3.2.2. Construction, Land Use and Stationary Source Risk and Hazard Thresholds

The options for local risk and hazards thresholds of significance are based on U.S. EPA guidance for conducting air toxics analyses and making risk management decisions at the facility and community-scale level. The thresholds consider reviews of recent health effects studies that link increased concentrations of fine particulate matter to increased mortality. The thresholds would apply to both siting new sources and siting new receptors.

For new sources of TACs, thresholds of significance for a single source are designed to ensure that emissions do not raise the risk of cancer or non-cancer health impacts to cumulatively significant levels. For new sources of $PM_{2.5}$, thresholds are designed to ensure that $PM_{2.5}$ concentrations are maintained below state and federal standards in all areas where sensitive receptors or members of the general public live or may foreseeably live, even if at the local- or community-scale where sources of TACs and PM may be nearby.

Project Radius for Assessing Impacts

For a project proposing a new source or receptor it is recommended to assess impacts within 1,000 feet, taking into account both its individual and nearby cumulative sources (i.e. proposed project plus existing and foreseeable future projects). Cumulative sources are the combined total risk values of each individual source within the 1,000-foot evaluation zone. A lead agency should enlarge the 1,000-foot radius on a case-by-case basis if an unusually large source or sources of risk or hazard emissions that may affect a proposed project is beyond the recommended radius.

The 1,000 foot radius is consistent with findings in ARB's Land Use Compatibility Handbook (ARB 2005), the Health & Safety Code §42301.6 (Notice for Possible Source Near School), and studies such as that of Zhu et al (2002) which found that concentrations of particulate matter tend to be reduced substantially at a distance 1,000 feet downwind from sources such as freeways or large distribution centers.

Qualified Community Risk Reduction Plan

Within the framework of these thresholds, proposed projects would be considered to be less than significant if they are consistent with a qualified Community Risk Reduction Plan (CRRP) adopted by the local jurisdiction with enforceable measures to reduce the community risk.

Project proposed in areas where a CRRP has been adopted that are not consistent with the CRRP would be considered to have a significant impact.

Projects proposed in areas where a CRRP has not been adopted and that have the potential to expose sensitive receptors or the general public to emissions-related risk in excess of the thresholds below from any source would be considered to have a significant air quality impact.

The conclusion that land use projects that comply with qualified Community Risk Reduction Plans are less than significant is supported by CEQA Guidelines Sections 15030(a)(3) and 15064(h)(3), which provides that a project's contribution to a cumulative problem can be less that cumulatively considerable if the project is required to implement or fund its fair share of a mitigation measure or measures designed to alleviate the cumulative impact.

Increased Cancer Risk to Maximally Exposed Individual (MEI)

Emissions from a new source or emissions affecting a new receptor would be considered significant where ground-level concentrations of carcinogenic TACs from any source result in an increased cancer risk greater than 10.0 in one million, assuming a 70 year lifetime exposure. Under Board Option 1, within Impacted Communities as defined through the CARE program, the significance level for cancer would be reduced to 5.0 in one million for new sources.

The 10.0 in one million cancer risk threshold for a single source is supported by EPA's guidance for conducting air toxics analyses and making risk management decisions at the facility and community-scale level. It is also the level set by the Project Risk Requirement in the Air District's Regulation 2, Rule 5 new and modified stationary sources of TAC, which states that the Air Pollution Control Officer shall deny an Authority to Construct or Permit to Operate for any new or modified source of TACs if the project risk exceeds a cancer risk of 10.0 in one million.

This threshold for an individual new source is designed to ensure that the source does not contribute a cumulatively significant impact. The justification for the Tiered Thresholds Option threshold of 5.0 in one million for new sources in an impacted community is that in these areas the cancer risk burden is higher than in other parts of the Bay Area; the threshold at which an individual source becomes significant is lower for an area that is already at or near unhealthy levels. However, even without a tiered approach, the recommended thresholds already address the burden of impacted communities via the cumulative thresholds: specifically, if an area has

many existing TAC sources near receptors, then the cumulative threshold will be reached sooner than it would in another area with fewer TAC sources.

The single-source threshold for receptors is provided to address the possibility that within the area defined by the 1,000 foot radius there can be variations in risk levels that may be significant, below the corresponding cumulative threshold. Single-source thresholds assist in the identification of significant risks, hazards, or concentrations in a subarea, within the 1,000 foot radius.

Increased Non-Cancer Risk to MEI

Emissions from a new source or emissions affecting a new receptor would be considered significant where ground-level concentrations of non-carcinogenic TACs result in an increased chronic or acute Hazard Index (HI) from any source greater than 1.0. This threshold is unchanged under Tiered Thresholds Option.

A HI less than 1.0 represents a TAC concentration, as determined by OEHHA that is at a health protective level. While some TACs pose non-carcinogenic, chronic and acute health hazards, if the TAC concentrations result in a HI less than one, those concentrations have been determined to be less than significant.

Increased Ambient Concentration of $PM_{2.5}$

Emissions from a new source or emissions affecting a new receptor would be considered significant where ground-level concentrations of $PM_{2.5}$ from any source would result in an average annual increase greater than 0.3 $\mu g/m^3$. Under Tiered Thresholds Option, within Impacted Communities as defined through the CARE program, the significance level for a $PM_{2.5}$ increment is 0.2 $\mu g/m^3$.

If one applies the concentration-response of the median of the EPA consensus review (EPA 2005, BAAQMD 2010) and attributes a 1 percent increase in mortality to a 1 $\mu g/m^3$ increase in $PM_{2.5}$, one finds an increase in non-injury mortality in the Bay Area of about 20 excess deaths per million per year from a 0.3 $\mu g/m^3$ increment of $PM_{2.5}$. This is consistent with the impacts reported and considered significant by SFDPH (2008) using an earlier study (Jerrett et al. 2005) to estimate the increase in mortality from a 0.2 $\mu g/m^3$ $PM_{2.5}$ increment.

The SFDPH recommended a lower threshold of significance for multiple sources but only considered roadway emissions within a 492 foot radius. This recommendation applies to a single source but considers all types of emissions within 1,000 feet. On balance, the Air District estimates that the SFDPH threshold and this one, in combination with the cumulative threshold for $PM_{2.5}$, will afford similar levels of health protection.

The $PM_{2.5}$ threshold represents the lower range of an EPA proposed Significant Impact Level (SIL). EPA interprets the SIL to be the level of ambient impact that is considered to represent a "significant contribution" to regional non-attainment. While this threshold was not designed to be a threshold for assessing community risk and hazards, it was designed to protect public health at a regional level by helping an area maintain the NAAQS. Since achieving and maintaining state and federal AAQS is a reasonable goal at the local scale, the SIL provides a useful reference for comparison.

This threshold for an individual new source is designed to ensure that the source does not contribute a cumulatively significant impact. The justification for the Tiered Thresholds Option threshold of 0.2 $\mu g/m^3$ for new sources in an impacted community is that these areas have higher levels of diesel particulate matter than do other parts of the Bay Area; the threshold at which an individual source becomes significant is lower for an area that is already at or near unhealthy

levels. However, even without a tiered approach, the recommended thresholds already address the burden of impacted communities via the cumulative thresholds: specifically, if an area has many existing $PM_{2.5}$ sources near receptors, then the cumulative threshold will be reached sooner than it would in another area with fewer $PM_{2.5}$ sources.

The single-source threshold for receptors is provided to address the possibility that within the area defined by the 1,000 foot radius there can be variations in risk levels that may be significant, below the corresponding cumulative threshold. Single-source thresholds assist in the identification of significant risks, hazards, or concentrations in a subarea, within the 1,000 foot radius.

Accidental Release of Acutely Hazardous Air Emissions

The BAAQMD currently recommends, at a minimum, that the lead agency, in consultation with the administering agency of the Risk Management Prevention Program (RMPP), find that any project resulting in receptors being within the Emergency Response Planning Guidelines (ERPG) exposure level 2 for a facility has a significant air quality impact. ERPG exposure level 2 is defined as "the maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to one hour without experiencing or developing irreversible or other serious health effects or symptoms which could impair an individual's ability to take protective action."

Staff proposes continuing with the current threshold for the accidental release of hazardous air pollutants. Staff recommends that agencies consult with the California Emergency Management Agency for the most recent guidelines and regulations for the storage of hazardous materials. Staff proposes that projects using or storing acutely hazardous materials locating near existing receptors, and projects resulting in receptors locating near facilities using or storing acutely hazardous materials be considered significant.

The current Accidental Release/Hazardous Air Emissions threshold of significance could affect all projects, regardless of size, and require mitigation for Accidental Release/Hazardous Air Emissions impacts.

3.2.3. Cumulative Risk and Hazard Thresholds

Qualified Community Risk Reduction Plan

Proposed projects would be considered to be less than significant if they are consistent with a qualified Community Risk Reduction Plan (CRRP) adopted by the local jurisdiction with enforceable measures to reduce the community risk.

Project proposed in areas where a CRRP has been adopted that are not consistent with the CRRP would be considered to have a significant impact.

Projects proposed in areas where a CRRP has not been adopted and that have the potential to expose sensitive receptors or the general public to emissions-related risk in excess of the following thresholds from the aggregate of cumulative sources would be considered to have a significant air quality impact.

The conclusion that land use projects that comply with qualified Community Risk Reduction Plans are less than significant is supported by CEQA Guidelines Sections 15030(a)(3) and 15064(h)(3), which provides that a project's contribution to a cumulative problem can be less that cumulatively considerable if the project is required to implement or fund its fair share of a mitigation measure or measures designed to alleviate the cumulative impact.

Increased Cancer Risk to Maximally Exposed Individual (MEI)
Emissions from a new source or emissions affecting a new receptor would be considered significant where ground-level concentrations of carcinogenic TACs from any source result in an increased cancer risk greater than 100.0 in one million.

The significance threshold of 100 in a million increased excess cancer risk would be applied to the cumulative emissions. The 100 in a million threshold is based on EPA guidance for conducting air toxics analyses and making risk management decisions at the facility and community-scale level. In protecting public health with an ample margin of safety, EPA strives to provide maximum feasible protection against risks to health from hazardous air pollutants (HAPs) by limiting risk to a level no higher than the one in ten thousand (100 in a million) estimated risk that a person living near a source would be exposed to at the maximum pollutant concentrations for 70 years (NESHAP 54 Federal Register 38044, September 14, 1989; CAA section 112(f)). One hundred in a million excess cancer cases is also consistent with the ambient cancer risk in the most pristine portions of the Bay Area based on the District's recent regional modeling analysis.

Increased Non-Cancer Risk to MEI
Emissions from a new source or emissions affecting a new receptor would be considered significant where ground-level concentrations of non-carcinogenic TACs result in an increased chronic Hazard Index from any source greater than 10.0.

The Air District has developed an Air Toxics Hot Spots (ATHS) program that provides guidance for implementing the Air Toxics "Hot Spots" Information and Assessment Act (AB 2588, Connelly, 1987: chaptered in the California Health and Safety Code § 44300, et. al.). The ATHS provides that if the health risks resulting from the facility's emissions exceed significance levels established by the air district, the facility is required to conduct an airborne toxic risk reduction audit and develop a plan to implement measures that will reduce emissions from the facility to a level below the significance level. The Air District has established a non-cancer Hazard Index of ten (10.0) as ATHS mandatory risk reduction levels. The cumulative chronic non-cancer Hazard Index threshold is consistent with the Air District's ATHS program.

Increased Ambient Concentration of $PM_{2.5}$
Emissions from a new source or emissions affecting a new receptor would be considered significant where ground-level concentrations of $PM_{2.5}$ from any source would result in an average annual increase greater than 0.8 $\mu g/m^3$.

If one applies the concentration-response function from the U.S, EPA assessment (U.S. EPA 2006) and attributes a 10 percent increase in mortality to a 10 $\mu g/m^3$ increase in $PM_{2.5}$, one finds an increase in non-injury mortality in the Bay Area of about 50 excess deaths per year from a 0.8 $\mu g/m^3$ increment of $PM_{2.5}$. This is greater than the impacts reported and considered significant by SFDPH (2008) using an earlier study (Jerrett et al. 2005) to estimate the increase in mortality from a 0.2 $\mu g/m^3$ $PM_{2.5}$ increment (SFDPH reported 21 excess deaths per year). However, SFDPH only considered roadway emissions within a 492 foot radius. This threshold applies to all types of emissions within 1,000 feet. In modeling applications for proposed projects, a larger radius results in a greater number of sources considered and higher modeled concentrations. On balance, the Air District estimates that the SFDPH threshold and this one, in combination with the individual source threshold for $PM_{2.5}$, will afford similar levels of health protection.

The cumulative $PM_{2.5}$ threshold represents the middle range of an EPA proposed Significant Impact Level (SIL). EPA interprets the SIL to be the level of ambient impact that is considered to represent a "significant contribution" to regional non-attainment. While this threshold was not designed to be a threshold for assessing community risk and hazards, it was designed to protect public health at a regional level by helping an area maintain the NAAQS. Since achieving and

maintaining state and federal AAQS is a reasonable goal at the local scale, the SIL provides a useful reference for comparison. Furthermore, the 0.8 $\mu g/m^3$ threshold is consistent with studies (Kleinman et al 2007) that examined the potential health impacts of roadway particles.

3.2.4. Plan-Level Risk and Hazard Thresholds

Staff proposes plan-level thresholds that will encourage a programmatic approach to addressing the overall adverse conditions resulting from risks and hazards that many Bay Area communities experience. By designating overlay zones in land use plans, local land use jurisdictions can take preemptive action before project-level review to reduce the potential for significant exposures to risk and hazard emissions. While this will require more up-front work at the general plan level, in the long-run this approach is a more feasible approach consistent with Air District and CARB guidance about siting sources and sensitive receptors that is more effective than project by project consideration of effects that often has more limited mitigation opportunities. This approach would also promote more robust cumulative consideration of effects of both existing and future development for the plan-level CEQA analysis as well as subsequent project-level analysis.

For local plans to have a less-than-significant impact with respect to potential risks and hazards, overlay zones would have to be established around existing and proposed land uses that would emit these air pollutants. Overlay zones to avoid risk impacts should be reflected in local plan policies, land use map(s), and implementing ordinances (e.g., zoning ordinance). The overlay zones around existing and future risk sources would be delineated using the quantitative approaches described above for project-level review and the resultant risk buffers would be included in the General Plan (or the EIR for the General Plan) to assist in site planning. BAAQMD will provide guidance as to the methods used to establish the TAC buffers and what standards to be applied for acceptable exposure level in the updated CEQA Guidelines document. Special overlay zones of at least 500 feet (or an appropriate distance determined by modeling and approved by the Air District) on each side of all freeways and high volume roadways would be included in this threshold.

The threshold of significance for plan impacts could affect all plan adoptions and amendments and require mitigation for a plan's air quality impacts. Where sensitive receptors would be exposed above the acceptable exposure level, the plan impacts would be considered significant and mitigation would be required to be imposed either at the plan level (through policy) or at the project level (through project level requirements).

3.2.5. Community Risk Reduction Plans

The goal of a Community Risk Reduction Plan would be to bring TAC and $PM_{2.5}$ concentrations for the entire community covered by the Plan down to acceptable levels as identified by the local jurisdiction and approved by the Air District. This approach provides local agencies a proactive alternative to addressing communities with high levels of risk on a project-by-project approach. This approach is supported by CEQA Guidelines Section 15030(a)(3), which provides that a project's contribution to a cumulative problem can be less than cumulatively considerable "if the project is required to implement or fund its fair share of a mitigation measure or measures designed to alleviate the cumulative impact." This approach is also further supported by CEQA Guidelines Section 15064(h)(3), which provides that a project's contribution to a cumulative effect is not considerable "if the project will comply with the requirements in a previously approved plan or mitigation program which provides specific requirements that will avoid or substantially lessen the cumulative problem."

Qualified Community Risk Reduction Plans

(A) A qualified Community Risk Reduction Plan adopted by a local jurisdiction should include, at a minimum, the following elements. BAAQMD's revised CEQA Guidelines provides the methodology to determine if a Community Risk Reduction Plan meets these requirements. Define a planning area;

(B) Include base year and future year emissions inventories of TACs and PM2.5;

(C) Include Air District–approved risk modeling of current and future risks;

(D) Establish risk and exposure reduction goals and targets for the community in consultation with Air District staff;

(E) Identify feasible, quantifiable, and verifiable measures to reduce emissions and exposures;

(F) Include procedures for monitoring and updating the inventory, modeling and reduction measures in coordination with Air District staff;

(G) Be adopted in a public process following environmental review.

4. CRITERIA POLLUTANT THRESHOLDS

4.1. THRESHOLDS OF SIGNIFICANCE

Project Construction	
Pollutant	**Average Daily (pounds/day)**
ROG (reactive organic gases)	54
NO_X (nitrogen oxides)	54
PM_{10} (exhaust) (particulate matter-10 microns)	82
$PM_{2.5}$ (exhaust) (particulate matter-2.5 microns)	54
$PM_{10}/PM_{2.5}$ (fugitive dust)	Best Management Practices
Local CO (carbon monoxide)	None

Project Operations		
Pollutant	**Average Daily (pounds/day)**	**Maximum Annual (tons/year)**
ROG	54	10
NO_X	54	10
PM_{10}	82	15
$PM_{2.5}$	54	10
Local CO	9.0 ppm (8-hour average), 20.0 ppm (1-hour average)	

Plans
1. Consistency with Current Air Quality Plan control measures 2. Projected VMT or vehicle trip increase is less than or equal to projected population increase

Regional Plans (Transportation and Air Quality Plans)
No net increase in emissions of criteria air pollutants and precursors

4.2. JUSTIFICATION AND SUBSTANTIAL EVIDENCE SUPPORTING THRESHOLDS

4.2.1. Project Construction Criteria Pollutant Thresholds

Staff proposes criteria pollutant construction thresholds that add significance criteria for exhaust emissions to the existing fugitive dust criteria employed by the Air District. While our current Guidelines considered construction exhaust emissions controlled by the overall air quality plan, the implementation of new and more stringent state and federal standards over the past ten years now warrants additional control of this source of emissions.

The average daily criteria air pollutant and precursor emission levels shown above are recommended as the thresholds of significance for construction activity for exhaust emissions. These thresholds represent the levels above which a project's individual emissions would result in a considerable contribution (i.e., significant) to the SFBAAB's existing non-attainment air quality

conditions and thus establish a nexus to regional air quality impacts that satisfies CEQA requirements for evidence-based determinations of significant impacts.

For fugitive dust emissions, staff recommends following the current best management practices approach which has been a pragmatic and effective approach to the control of fugitive dust emissions. Studies have demonstrated (Western Regional Air Partnership, U.S.EPA) that the application of best management practices at construction sites have significantly controlled fugitive dust emissions. Individual measures have been shown to reduce fugitive dust by anywhere from 30 percent to more than 90 percent. In the aggregate best management practices will substantially reduce fugitive dust emissions from construction sites. These studies support staff's recommendation that projects implementing construction best management practices will reduce fugitive dust emissions to a less than significant level.

4.2.2. Project Operation Criteria Pollutant Thresholds

The thresholds for project operations are the average daily and maximum annual criteria air pollutant and precursor levels shown above. These thresholds are based on the federal BAAQMD Offset Requirements to ozone precursors for which the SFBAAB is designated as a non-attainment area which is an appropriate approach to prevent further deterioration of ambient air quality and thus has nexus and proportionality to prevention of a regionally cumulative significant impact (e.g. worsened status of non-attainment). Despite non-attainment area for state PM_{10} and pending nonattainment for federal $PM_{2.5}$, the federal NSR Significant Emission Rate annual limits of 15 and 10 tons per year, respectively, are the thresholds as BAAQMD has not established an Offset Requirement limit for $PM_{2.5}$ and the existing limit of 100 tons per year is much less stringent and would not be appropriate in light of our pending nonattainment designation for the federal 24-hour $PM_{2.5}$ standard. These thresholds represent the emission levels above which a project's individual emissions would result in a cumulatively considerable contribution to the SFBAAB's existing air quality conditions. The thresholds would be an evaluation of the incremental contribution of a project to a significant cumulative impact. These threshold levels are well-established in terms of existing regulations as promoting review of emissions sources to prevent cumulative deterioration of air quality. Using existing environmental standards in this way to establish CEQA thresholds of significance under Guidelines section 15067.4 is an appropriate and effective means of promoting consistency in significance determinations and integrating CEQA environmental review activities with other areas of environmental regulation. (*See Communities for a Better Environment v. California Resources Agency* (2002) 103 Cal. App. 4th 98, 111.[6])

4.2.3. Local Carbon Monoxide Thresholds

The carbon monoxide thresholds are based solely on ambient concentration limits set by the California Clean Air Act for Carbon Monoxide and Appendix G of the State of California CEQA Guidelines.

Since the ambient air quality standards are health-based (i.e., protective of public health), there is substantial evidence (i.e., health studies that the standards are based on) in support of their use

[6] The Court of Appeal in the *Communities for a Better Environment* case held that existing regulatory standards could not be used as a definitive determination of whether a project would be significant under CEQA where there is substantial evidence to the contrary. Staff's thresholds would not do that. The thresholds are levels at which a project's emissions would normally be significant, but would not be binding on a lead agency if there is contrary evidence in the record.

as CEQA significance thresholds. The use of the ambient standard would relate directly to the CEQA checklist question. By not using a proxy standard, there would be a definitive bright line about what is or is not a significant impact and that line would be set using a health-based level.

The CAAQS of 20.0 ppm and 9 ppm for 1-hour and 8-hour CO, respectively, would be used as the thresholds of significance for localized concentrations of CO. Carbon monoxide is a directly emitted pollutant with primarily localized adverse effects when concentrations exceed the health based standards established by the California Air Resources Board (ARB).

In addition, Appendix G of the State of California CEQA Guidelines includes the checklist question: Would the project violate any air quality standard or contribute substantially to an existing or projected air quality violation? Answering yes to this question would indicate that the project would result in a significant impact under CEQA. The use of the ambient standard would relate directly to this checklist question.

4.2.4. Plan-Level Criteria Pollutant Thresholds

This threshold achieves the same goals as the Air District's current approach while alleviating the existing analytical difficulties and the inconsistency of comparing a plan update with AQP growth projections that may be up to several years old. Eliminating the analytical inconsistency provides better nexus and proportionality for evaluating air quality impacts for plans.

Over the years staff has received comments on the difficulties inherent in the current approach regarding the consistency tests for population and VMT growth. First, the population growth estimates used in the most recent AQP can be up to several years older than growth estimates used in a recent plan update, creating an inconsistency in this analysis. Staff recommends that this test of consistency be eliminated because the Air District and local jurisdictions all use regional population growth estimates that are disaggregated to local cities and counties. In addition, the impact to air quality is not necessarily growth but where that growth is located. The second test, rate of increase in vehicle use compared to growth rate, will determine if planned growth will impact air quality. Compact infill development inherently has less vehicle travel and more transit opportunities than suburban sprawl.

Second, the consistency test of comparing the rate of increase in VMT to the rate of increase in population has been problematic at times for practitioners because VMT is not always available with the project analysis. Staff recommends that either the rate of increase in VMT or vehicle trips be compared to the rate of increase in population. Staff also recommends that the growth estimates used in this analysis be for the years covered by the plan. Staff also recommends that the growth estimates be obtained from the Association of Bay Area Governments since the Air District uses ABAG growth estimates for air quality planning purposes.

4.2.5. Criteria Pollutant Thresholds for Regional Plans

Regional plans include the Regional Transportation Plan prepared by the Metropolitan Transportation Commission (MTC) and air quality plans prepared by the Air District.

The Regional Transportation Plan (RTP), also called a Metropolitan Transportation Plan (MTP) or Long-Range Transportation Plan is the mechanism used in California by both Metropolitan Planning Organizations (MPOs) and Regional Transportation Planning Agencies (RTPAs) to conduct long-range (minimum of 20 years) planning in their regions. MTC functions as both the regional transportation planning agency, a state designation, and, for federal purposes, as the region's metropolitan planning organization (MPO). As such, it is responsible for regularly updating the Regional Transportation Plan, a comprehensive blueprint for the development of

comprehensive transportation system that includes mass transit, highway, airport, seaport, railroad, bicycle and pedestrian facilities. The performance of this system affects such public policy concerns as air quality, environmental resource consumption, social equity, "smart growth," economic development, safety, and security. Transportation planning recognizes the critical links between transportation and other societal goals. The planning process requires developing strategies for operating, managing, maintaining, and financing the area's transportation system in such a way as to advance the area's long-term goals.

The Air District periodically prepares and updates plans to achieve the goal of healthy air. Typically, a plan will analyze emissions inventories (estimates of current and future emissions from industry, motor vehicles, and other sources) and combine that information with air monitoring data (used to assess progress in improving air quality) and computer modeling simulations to test future strategies to reduce emissions in order to achieve air quality standards. Air quality plans usually include measures to reduce air pollutant emissions from industrial facilities, commercial processes, motor vehicles, and other sources. Bay Area air quality plans are prepared with the cooperation of MTC and the Association of Bay Area Governments (ABAG).

The threshold of significance for regional plans is no net increase in emissions including criteria pollutant emissions. This threshold serves to answer the State CEQA Guidelines Appendix G sample question: "Would the project Result in a cumulatively considerable net increase of any criteria pollutant for which the project region is non-attainment under an applicable federal or state ambient air quality standard (including releasing emissions which exceed quantitative thresholds for ozone precursors)?"

5. ODOR THRESHOLDS

5.1. THRESHOLDS OF SIGNIFICANCE

Project Operations – Source or Receptor	Plans
Five confirmed complaints per year averaged over three years	Identify the location, and include policies to reduce the impacts, of existing or planned sources of odors

5.2. JUSTIFICATION AND SUBSTANTIAL EVIDENCE SUPPORTING THRESHOLDS

Staff proposes revising the current CEQA significance threshold for odors to be consistent with the Air District's regulation governing odor nuisances (Regulation 7—Odorous Substances). The current approach includes assessing the number of unconfirmed complaints which are not considered indicative of actual odor impacts. Basing the threshold on an average of five confirmed complaints per year over a three year period reflects the most stringent standards derived from the Air District rule and is considered an appropriate approach to a CEQA evaluation of odor impacts.

Odors are generally considered a nuisance, but can result in a public health concern. Some land uses that are needed to provide services to the population of an area can result in offensive odors, such as filling portable propane tanks or recycling center operations. When a proposed project includes the siting of sensitive receptors in proximity to an existing odor source, or when siting a new source of potential odors, the following qualitative evaluation should be performed.

When determining whether potential for odor impacts exists, it is recommended that Lead Agencies consider the following factors and make a determination based on evidence in each qualitative analysis category:

Distance: Use the screening-level distances in Table 9.

Wind Direction: Consider whether sensitive receptors are located upwind or downwind from the source for the most of the year. If odor occurrences associated with the source are seasonal in nature, consider whether sensitive receptors are located downwind during the season in which odor emissions occur.

Complaint History: Consider whether there is a history of complaints associated with the source. If there is no complaint history associated with a particular source (perhaps because sensitive receptors do not already exist in proximity to the source), consider complaint-history associated with other similar sources in BAAQMD's jurisdiction with potential to emit the same or similar types of odorous chemicals or compounds, or that accommodate similar types of processes.

Character of Source: Consider the character of the odor source, for example, the type of odor events according to duration of exposure or averaging time (e.g., continuous release, frequent release events, or infrequent events).

Exposure: Consider whether the project would result in the exposure of a substantial number of people to odorous emissions.

Table 9 – Screening Distances for Potential Odor Sources

Type of Operation Project Screening	Distance
Wastewater Treatment Plant	2 miles
Wastewater Pumping Facilities	1 mile
Sanitary Landfill	2 miles
Transfer Station	1 mile
Composting Facility	1 mile
Petroleum Refinery	2 miles
Asphalt Batch Plant	2 miles
Chemical Manufacturing	2 miles
Fiberglass Manufacturing	1 mile
Painting/Coating Operations	1 mile
Rendering Plant	2 miles
Food Processing Facility	1 mile
Confined Animal Facility/Feed Lot/Dairy	1 mile
Green Waste and Recycling Operations	1 mile
Coffee Roaster	1 mile

California Integrated Waste Management Board (CIWMB). Facilities that are regulated by the CIWMB (e.g. landfill, composting, etc.) are required to have Odor Impact Minimization Plans (OIMP) in place and have procedures that establish fence line odor detection thresholds. The Air District recognizes a lead agency's discretion under CEQA to use established odor detection thresholds as thresholds of significance for CEQA review for CIWMB regulated facilities with an adopted OIMP.

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BAY AREA AIR QUALITY MANAGEMENT DISTRICT

RESOLUTION No. 2010-06

A Resolution of the Board of Directors of the Bay Area Air Quality Management District Adopting Thresholds For Use In Determining the Significance of Projects' Environmental Effects Under the California Environmental Quality Act

WHEREAS, pursuant to Title 14, Chapter 3, Article 5, Section 15064.7 of the California Code of Regulations ("Section 15064.7"), the California Resources Agency encourages public agencies to adopt "Thresholds of Significance" under the California Environmental Quality Act ("CEQA");

WHEREAS, pursuant to Section 15064.7, CEQA Thresholds of Significance are identifiable quantitative, qualitative or performance levels of a particular environmental effect, non-compliance with which means the effect will normally be determined to be "significant" under CEQA, and compliance with which means the effect normally will be determined to be less than significant under CEQA;

WHEREAS, the Board of Directors ("Board") of the Bay Area Air Quality Management District ("District") finds it necessary and appropriate to adopt CEQA Thresholds of Significance as set forth in Attachment A hereto for use by District staff and by other appropriate agencies in determining whether projects may have significant effects on the environment for purposes of CEQA environmental analyses;

WHEREAS, the CEQA Thresholds of Significance as set forth in Attachment A hereto do not alter the existing procedural and substantive requirements of CEQA under California law, but simply clarify the level at which, in the District's considered opinion, an environmental effect should normally be considered "significant" for purposes of existing CEQA law;

WHEREAS, the CEQA Thresholds of Significance set forth in Attachment A hereto were developed through an extensive public review process, which included public workshops, Board meetings and meetings with local government agency and non-government organization staff, including the cities of Berkeley, Colma, Daly City, Dublin, Fremont, Livermore, Oakland, Pleasanton, Richmond, San Leandro, San Mateo, San Francisco and Santa Rosa; the counties of Alameda, Contra Costa, Napa, Santa Clara, and Sonoma; and the CARE Task Force, the Alameda County Planning for Healthy Communities Network and the Governor's Office of Planning and Research Local Government Roundtable;

WHEREAS, District staff held ten public workshops throughout the Bay Area on February 26, 2009, April 27, 29 and 30, 2009, September 8, 9, and 10, 2009, October 2, 2009, and April 15 and 26, 2010; solicited Thresholds of Significance options for consideration; and published for public review and comment the Threshold Options Report on April 24, 2009, the CEQA Thresholds Options and Justification Report on October 8, 2009, and the Proposed Thresholds of Significance Report on November 2, 2009, December 7, 2009 and May 3, 2010;

meetings were held on November 18, 2009, December 2, 2009, January 6, 2010, May 5, 2010 and June 2, 2010;

WHEREAS, at the November 18, 2009, December 2, 2009, January 6, 2010, May 5, 2010 and June 2, 2010 public meetings, the subject matter of the Thresholds of Significance was discussed with interested persons in accordance with all provisions of law;

WHEREAS, the November 18, 2009, December 2, 2009, January 6, 2010, May 5, 2010 and June 2, 2010 public meetings and the other public review opportunities that the District has provided regarding the Thresholds of Significance, constitute a public review process as required by Section 15064.7;

WHEREAS, District staff has prepared and presented to this Board the May 3, 2010, Proposed Thresholds of Significance report, which has been considered by this Board and is incorporated herein by reference;

WHEREAS, the documents and other materials that constitute the record of the public review process under Section 15064.7 on which this Resolution is based are located at the Bay Area Air Quality Management District, 939 Ellis Street, San Francisco, 94109, and the custodian for these documents is Ms. Lisa Harper, Clerk of the Boards;

WHEREAS, District staff recommends adoption of the CEQA Thresholds of Significance set forth in Attachment A hereto;

WHEREAS, the Board of Directors concurs with District staff's recommendations and desires to adopt the CEQA Thresholds of Significance set forth in Attachment A hereto;

NOW, THEREFORE, BE IT RESOLVED that that the Board of Directors of the Bay Area Air Quality Management District does hereby adopt the CEQA Thresholds of Significance, pursuant to the authority granted by law, as set forth in Attachment A hereto, and discussed in the Proposed Thresholds of Significance report dated May 3, 2010, with instructions to staff to correct any typographical or formatting errors before final publication of the CEQA Thresholds of Significance.

BE IT FURTHER RESOLVED that it is the policy of the Bay Area Air Quality Management District that projects that do not comply with the CEQA Thresholds of Significance will normally be determined to have a significant effect on the environment for purposes of CEQA, and projects that comply with the CEQA Thresholds of Significance normally will be determined to have a less-than-significant effect on the environment for purposes of CEQA.

BE IT FURTHER RESOLVED that it is the policy of the Bay Area Air Quality Management District that Lead Agencies in the Bay Area apply the CEQA Thresholds of Significance, except for the Risk and Hazard thresholds for Receptor Projects, for Notices of Preparation issued, and environmental analyses begun, on or after the date of adoption of this Resolution.

BE IT FURTHER RESOLVED that it is the policy of the Bay Area Air Quality Management District that Lead Agencies in the Bay Area apply the CEQA Thresholds of Significance for the

Risk and Hazard thresholds for Receptor Projects for Notices of Preparation issued, and environmental analyses begun, after January 1, 2011.

The foregoing Resolution was duly and regularly introduced, passed and adopted at a regular meeting of the Board of Directors of the Bay Area Air Quality Management District on the Motion of Director KALRA, seconded by Director UILKEMA, on the 2nd day of JUNE, 2010, by the following vote of the Board:

AYES: BATES, GARNER, GIOIA, GROOM, HOSTERMAN, HUDSON, KALRA, MAR, ROSS, SPERING, TORLIATT, UILKEMA, YEAGER, WAGENKNECHT

NOES: NONE

RECUSED: HAGGERTY

ABSENT: BROWN, DALY, DUNNIGAN, KLATT, KNISS, MILEY, ZANE

Brad Wagenknecht
Chairperson of the Board of Directors

ATTEST:

John Gioia
Secretary of the Board of Directors

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ATTACHMENT A

Proposed Air Quality CEQA Thresholds of Significance (May 3, 2010)

Pollutant	Construction-Related	Operational-Related	
Project-Level			
Criteria Air Pollutants and Precursors (Regional)	**Average Daily Emissions (lb/day)**	**Average Daily Emissions (lb/day)**	**Maximum Annual Emissions (tpy)**
ROG	54	54	10
NO_X	54	54	10
PM_{10} (exhaust)	82	82	15
$PM_{2.5}$ (exhaust)	54	54	10
$PM_{10}/PM_{2.5}$ (fugitive dust)	Best Management Practices	None	
Local CO	None	9.0 ppm (8-hour average), 20.0 ppm (1-hour average)	
GHGs **Projects other than Stationary Sources**	None	Compliance with Qualified Greenhouse Gas Reduction Strategy OR 1,100 MT of CO_2e/yr OR 4.6 MT CO_2e/SP/yr (residents + employees)	
GHGs **Stationary Sources**	None	10,000 MT/yr	
Risks and Hazards – New Source (Individual Project)	Same as Operational Thresholds*	Compliance with Qualified Community Risk Reduction Plan OR Increased cancer risk of >10.0 in a million Increased non-cancer risk of > 1.0 Hazard Index (Chronic or Acute) Ambient $PM_{2.5}$ increase: > 0.3 $\mu g/m^3$ annual average Zone of Influence: 1,000-foot radius from fence line of source or receptor	
Risks and Hazards – New Receptor (Individual Project)	Same as Operational Thresholds*	Compliance with Qualified Community Risk Reduction Plan OR Increased cancer risk of >10.0 in a million Increased non-cancer risk of > 1.0 Hazard Index (Chronic or Acute) Ambient $PM_{2.5}$ increase: > 0.3 $\mu g/m^3$ annual average Zone of Influence: 1,000-foot radius from fence line of source or receptor	
Risks and Hazards – New Source (Cumulative Thresholds)	Same as Operational Thresholds*	Compliance with Qualified Community Risk Reduction Plan OR Cancer: > 100 in a million (from all local sources) Non-cancer: > 10.0 Hazard Index (from all local sources) (Chronic) $PM_{2.5}$: > 0.8 $\mu g/m^3$ annual average (from all local sources) Zone of Influence: 1,000-foot radius from fence line of source or receptor	

Proposed Air Quality CEQA Thresholds of Significance (May 3, 2010)		
Pollutant	**Construction-Related**	**Operational-Related**
Risks and Hazards – New Receptor (Cumulative Thresholds)	Same as Operational Thresholds*	Compliance with Qualified Community Risk Reduction Plan OR Cancer: > 100 in a million (from all local sources) Non-cancer: > 10.0 Hazard Index (from all local sources) (Chronic) $PM_{2.5}$: > 0.8 µg/m^3 annual average (from all local sources) Zone of Influence: 1,000-foot radius from fence line of source or receptor
Accidental Release of Acutely Hazardous Air Pollutants	None	Storage or use of acutely hazardous materials locating near receptors or receptors locating near stored or used acutely hazardous materials considered significant
Odors	None	Complaint History—5 confirmed complaints per year averaged over three years
Plan-Level		
Criteria Air Pollutants and Precursors	None	1. Consistency with Current Air Quality Plan control measures 2. Projected VMT or vehicle trip increase is less than or equal to projected population increase
GHGs	None	Compliance with Qualified Greenhouse Gas Reduction Strategy (or similar criteria included in a General Plan) OR 6.6 MT CO2e/ SP/yr (residents + employees)
Risks and Hazards	None	1. Overlay zones around existing and planned sources of TACs (including adopted Risk Reduction Plan areas) 2. Overlay zones of at least 500 feet (or Air District-approved modeled distance) from all freeways and high volume roadways
Odors	None	Identify locations of odor sources in general plan
Accidental Release of Acutely Hazardous Air Pollutants	None	None
Regional Plans (Transportation and Air Quality Plans)		
GHGs, Criteria Air Pollutants and Precursors, and Toxic Air Contaminants	None	No net increase in emissions

Notes: CO = carbon monoxide; CO_2e = carbon dioxide equivalent; GHGs = greenhouse gases; lb/day = pounds per day; MT = metric tons; NO_X = oxides of nitrogen; $PM_{2.5}$= fine particulate matter with an aerodynamic resistance diameter of 2.5 micrometers or less; PM_{10} = respirable particulate matter with an aerodynamic resistance diameter of 10 micrometers or less; ppm = parts per million; ROG = reactive organic gases; SP = service population; tpy = tons per year; yr= year.

* Note: The Air District recommends that for construction projects that are less than one year duration, Lead Agencies should annualize impacts over the scope of actual days that peak impacts are to occur, rather than the full year.

E. GLOSSARY

Aerosol -- Particle of solid or liquid matter that can remain suspended in the air because of its small size (generally under one micrometer in diameter).

Air Quality Management District (AQMD) -- Local agency charged with controlling air pollution and attaining air quality standards. The Bay Area Air Quality Management District is the regional AQMD that includes Alameda, Contra Costa, Marin, Napa, San Francisco, San Mateo and Santa Clara Counties and the southern halves of Solano and Sonoma Counties.

Air Resources Board (ARB) -- The State of California agency responsible for air pollution control. Responsibilities include: establishing State ambient air quality standards, setting allowable emission levels for motor vehicles in California and oversight of local air quality management districts.

Area Sources -- Sources of air pollutants that individually emit relatively small quantities of air pollutants, but that may emit considerable quantities of emissions when aggregated over a large area. Examples include water heaters, lawn maintenance equipment, and consumer products.

Best Available Control Technology (BACT) -- The most stringent emissions control that has been achieved in practice, identified in a state implementation plan, or found by the District to be technologically feasible and cost-effective for a given class of sources.

California Clean Air Act (CCAA) -- Legislation enacted in 1988 mandating a planning process to attain state ambient air quality standards.

CALINE -- A model developed by the Air Resources Board that calculates carbon monoxide concentrations resulting from motor vehicle use.

Carbon Monoxide (CO) -- A colorless, odorless, toxic gas produced by the incomplete combustion of carbon-containing substances. It is emitted in large quantities by exhaust of gasoline-powered vehicles.

Carbon Dioxide (CO_2) -- A colorless, odorless gas that is an important contributor to Earth's greenhouse effect.

Carbon Dioxide Equivalent (CO_2E) -- A metric measure used to compare the emissions from various greenhouse gases based upon their global warming potential.

Chlorofluorocarbons (CFCs) -- A family of inert, nontoxic, and easily liquefied chemicals used in refrigeration, air conditioning, packaging, insulation, or as solvents and aerosol propellants. CFCs drift into the upper atmosphere where their chlorine components destroy stratospheric ozone.

Clean Air Act (CAA) -- Long-standing federal legislation, last amended in 1990, that is the legal basis for the national clean air programs.

Conformity -- A requirement in federal law and administrative practice that requires that projects will not be approved if they do not conform with the State Implementation Plan by: causing or contributing to an increase in air pollutant emissions, violating an air pollutant standard, or increasing the frequency of violations of an air pollutant standard.

Criteria Air Pollutants -- Air pollutants for which the federal or State government has established ambient air quality standards, or criteria, for outdoor concentration in order to protect public

health. Criteria pollutants include: ozone, carbon monoxide, sulfur dioxide PM10 (previously total suspended particulate), nitrogen oxide, and lead.

EMFAC -- The computer model developed by the California Air Resources Board to estimate composite on-road motor vehicle emission factors by vehicle class.

Emission Factor -- The amount of a specific pollutant emitted from a specified polluting source per unit quantity of material handled, processed, or burned.

Emission Inventory -- A list of air pollutants emitted over a determined area by type of source. Typically expressed in mass per unit time.

Environmental Protection Agency (EPA) -- The federal agency responsible for control of air and water pollution, toxic substances, solid waste, and cleanup of contaminated sites.

Exceedance -- A monitored level of concentration of any air contaminant higher than national or state ambient air quality standards.

Global Warming Potential (GWP) -- The index used to translate the level of emissions of various gases into a common measure in order to compare the relative radiative forcing of different gases without directly calculating the changes in atmospheric concentrations. GWPs are calculated as the ratio of the radiative forcing that would result from the emissions of one kilogram of a greenhouse gas to that from emission of one kilogram of carbon dioxide over a period of time (usually 100 years).

Greenhouse Gas (GHG) -- Any gas that absorbs infrared radiation in the atmosphere. Greenhouse gases include water vapor, carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), halogenated fluorocarbons (HCFCs), ozone (O_3), perfluorocarbons (PFCs), sulfur hexafluoride (SF_6) and hydrofluorocarbons (HFCs).

Hazardous Air Pollutants – Federal terminology for air pollutants which are not covered by ambient air quality standards but may reasonably be expected to cause or contribute to serious illness or death (see NESHAPs).

Health Risk Assessment -- An analysis where human exposure to toxic substances is estimated, and considered together with information regarding the toxic potency of the substances, to provide quantitative estimates of health risk.

Hot Spot -- A location where emissions from specific sources may expose individuals and population groups to elevated risks of adverse health effects and contribute to the cumulative health risks of emissions from other sources in the area.

Hydrogen Sulfide (H_2S) -- A gas characterized by "rotten egg" smell, found in the vicinity of oil refineries, chemical plants and sewage treatment plants.

Impacted Communities – Also known as priority communities, the Air District defines impacted communities within the Bay Area as having higher emitting sources, highest air concentrations, and nearby low income and sensitive populations. The Air District identified the following impacted communities: the urban core areas of Concord, eastern San Francisco, western Alameda County, Redwood City/East Palo Alto, Richmond/San Pablo, and San Jose.

Indirect Sources – Land uses and facilities that attract or generate motor vehicle trips and thus result in air pollutant emissions, e.g., shopping centers, office buildings, and airports.

Inversion -- The phenomenon of a layer of warm air over cooler air below. This atmospheric condition resists the natural dispersion and dilution of air pollutants.

Level of Service (LOS) -- A transportation planning term for a method of measurement of traffic congestion. The LOS compares actual or projected traffic volume to the maximum capacity of the road under study. LOS ranges from A through F. LOS A describes free flow conditions, while LOS F describes the most congested conditions, up to or over the maximum capacity for which the road was designed.

Mobile Source -- Any motor vehicle that produces air pollution, e.g., cars, trucks, motorcycles (on-road mobile sources) or airplanes, trains and construction equipment (off-road mobile sources).

National Ambient Air Quality Standards (NAAQS) -- Health-based pollutant concentration limits established by EPA that apply to outdoor air (see Criteria Air Pollutants).

National Emissions Standards for Hazardous Air Pollutants (NESHAPs) – Emissions standards set by EPA for air pollutants not covered by NAAQS that may cause an increase in deaths or in serious, irreversible, or incapacitating illness.

Nitrogen Oxides (NO_X) -- Gases formed in great part from atmospheric nitrogen and oxygen when combustion takes place under conditions of high temperature and high pressure; NOX is a precursor to the criteria air pollutant ozone.

Nonattainment Area -- Defined geographic area that does not meet one or more of the

Ambient Air Quality Standards for the criteria pollutants designated in the federal Clean Air Act and/or California Clean Air Act.

Ozone (O_3) -- A pungent, colorless, toxic gas. A product of complex photochemical processes, usually in the presence of sunlight. Tropospheric (lower atmosphere) ozone is a criteria air pollutant.

Particulate -- A particle of solid or liquid matter; soot, dust, aerosols, fumes and mists.

Photochemical Process -- The chemical changes brought about by the radiant energy of the sun acting upon various polluting substances. The products are known as photochemical smog.

$PM_{2.5}$ -- Fine particulate matter (solid or liquid) with an aerodynamic diameter equal to or less than 2.5 micrometers. Individual particles of this size are small enough to be inhaled deeply into the lungs..

PM_{10} -- Fine particulate matter (solid or liquid) with an aerodynamic diameter equal to or less than 10 micrometers. Individual particles of this size are small enough to be inhaled into human lungs; they are not visible to the human eye.

Precursor -- Compounds that change chemically or physically after being emitted into the air and eventually produce air pollutants. For example, organic compounds are precursors to ozone.

Prevention of Significant Deterioration (PSD) -- EPA program in which State and/or federal permits are required that are intended to restrict emissions for new or modified sources in places where air quality is already better than required to meet primary and secondary ambient air quality standards.

Reactive Organic Gases (ROG) -- Classes of organic compounds, especially olefins, substituted aromatics and aldehydes, that react rapidly in the atmosphere to form photochemical smog or ozone.

Sensitive Receptors -- Facilities or land uses that include members of the population that are particularly sensitive to the effects of air pollutants, such as children, the elderly, and people with illnesses. Examples include schools, hospitals and residential areas.

State Implementation Plan (SIP) -- EPA-approved state plans for attaining and maintaining federal air quality standards.

Stationary Source -- A fixed, non-mobile source of air pollution, usually found at industrial or commercial facilities.

Sulfur Oxides (SO_X) -- Pungent, colorless gases formed primarily by the combustion of sulfur-containing fossil fuels, especially coal and oil. Considered a criteria air pollutant, sulfur oxides may damage the respiratory tract as well as vegetation.

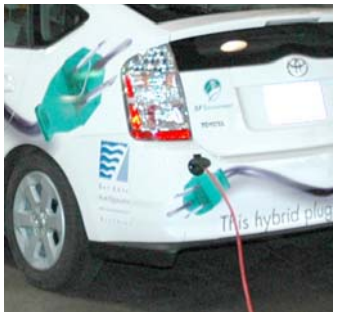
Toxic Air Contaminants -- Air pollutants which cause illness or death in relatively small quantities. Non-criteria air contaminants that, upon exposure, ingestion, inhalation, or assimilation into organisms either directly from the environment or indirectly by ingestion through food chains, may cause death, disease, behavioral abnormalities, cancer, genetic mutations, physiological malfunctions, or physical deformations in such organisms or their offspring.

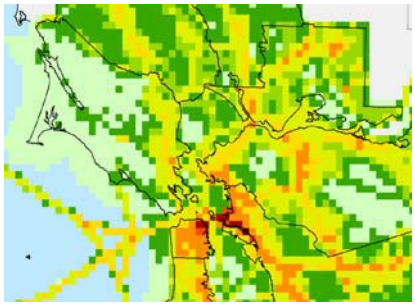
Transportation Control Measures (TCMs) -- Measures to reduce traffic congestion and decrease emissions from motor vehicles by reducing vehicle use.

URBEMIS -- A computer model developed by the California Air Resources Board to estimate air pollutant emissions from motor vehicle trips associated with land use development.

Bay Area Air Quality Management District

Draft Bay Area 2010 Clean Air Plan







Volume I

Association of Bay Area Governments

bcdc

Metropolitan Transportation Commission

March 2010

DRAFT
BAY AREA
2010 CLEAN AIR PLAN

MARCH 2010

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Acronyms and Terms

ABAG	Association of Bay Area Governments
ARB	(California) Air Resources Board
ATCM	Airborne Toxic Control Measure
BAAQMD	Bay Area Air Quality Management District
BACM	Best Available Control Measures
BACT	Best Available Control Technology
BAR	Bureau of Automotive Repair
BARCT	Best Available Retrofit Control Technology
BART	Bay Area Rapid Transit District
BCDC	Bay Conservation & Development Commission
CAA	(Federal) Clean Air Act
CAP	Clean Air Plan (for State ozone standard)
CAPCOA	California Air Pollution Officers Association
CARB	California Air Resources Board
CARE	Community Air Risk Evaluation program
CCAA	California Clean Air Act
CCOS	Central California Ozone Study
CEQA	California Environmental Quality Act
CMA	Congestion Management Agency
CMAQ	Congestion Management and Air Quality (Improvement Program)
CMP	Congestion Management Program
CO	Carbon Monoxide
CO_2	Carbon Dioxide
ECM	Energy & Climate Measure
EIR	Environmental Impact Report
EMFAC	CARB model (including emission factors) to calculate motor vehicle emissions
EPA	(United States) Environmental Protection Agency
EPDC	Expected Peak Day Concentration
FSM	Further Study Measure
GHG	Greenhouse Gas
HOV	High-Occupancy Vehicle

I & M	(Motor Vehicle) Inspection and Maintenance Program ("Smog Check")
ISR	Indirect Source Review
JPC	Joint Policy Committee
LEV	Low Emission Vehicle
LUM	Land Use & Local Impact Measure
MSM	Mobile Source Measure
MTC	Metropolitan Transportation Commission
NAAQS	National Ambient Air Quality Standards
NH3	Ammonia
NO_x	Oxides of Nitrogen
NSR	New Source Review
O_3	Ozone
OBD	On-Board Diagnostic program
$PM_{2.5}$	Particulate Matter less than 2.5 microns in diameter
PM_{10}	Particulate Matter less than 10 microns in diameter
ppb	Parts per billion
pphm	Parts per hundred million
ppm	Parts per million
RACM	Reasonably Available Control Measure
RFP	Reasonable Further Progress
ROG	Reactive Organic Gases
RTP	Regional Transportation Plan
SIP	State Implementation Plan
SSM	Stationary Source Measure
TAC	Toxic Air Contaminant
TCMs	Transportation Control Measures
TDA	Transportation Development Act
TFCA	(BAAQMD) Transportation Fund for Clean Air
TIP	Transportation Improvement Program
TLC	(MTC) Transportation for Livable Communities Program
tpd	Tons per day
VMT	Vehicle Miles Traveled
VOC	Volatile organic compounds
ZEV	Zero Emission Vehicle

Executive Summary – Bay Area 2010 Clean Air Plan

Purpose of the CAP

The Bay Area 2010 Clean Air Plan (CAP) provides a comprehensive plan to improve Bay Area air quality and protect public health. The 2010 CAP has been prepared in close collaboration with the Air District's regional agency partners, and has been informed by extensive outreach to the public and interested stakeholders.

The CAP defines a control strategy that the Air District and its partners will implement to: (1) reduce emissions and decrease ambient concentrations of harmful pollutants; (2) safeguard public health by reducing exposure to air pollutants that pose the greatest health risk, with an emphasis on protecting the communities most heavily impacted by air pollution; and (3) reduce greenhouse gas (GHG) emissions to protect the climate.

The legal impetus for the CAP is to update the most recent ozone plan, the Bay Area 2005 Ozone Strategy, to comply with state air quality planning requirements as codified in the California Health & Safety Code. Although we have made steady progress in reducing ozone levels in the Bay Area, the region is designated as non-attainment for both the one-hour and eight-hour state ozone standards. In addition, emissions of ozone precursors in the Bay Area contribute to air quality problems in neighboring air basins. Under these circumstances, state law requires the CAP to include all feasible measures to reduce emissions of ozone precursors and to reduce transport of ozone precursors to neighboring air basins.

The Bay Area was recently designated as non-attainment for the national 24-hour fine particulate matter (PM2.5) standard, and will be required to prepare a PM2.5 State Implementation Plan (SIP) pursuant to federal air quality guidelines by December 2012. The 2010 CAP is not a SIP document and does not respond to federal requirements for PM2.5 or ozone planning. However, in anticipation of future PM2.5 planning requirements, the CAP control strategy also aims to reduce PM emissions and concentrations. In addition, U.S. EPA is currently reevaluating national ozone standards, and is likely to tighten those standards in the near future. The control measures in the CAP will also help in the Bay Area's continuing effort to attain national ozone standards.

A Multi-Pollutant Plan

In addition to updating the Bay Area's state ozone plan, the 2010 CAP will also serve as a multi-pollutant plan to protect public health and the climate. This effort to develop its first-ever multi-pollutant air quality plan is a voluntary initiative by the Air District. The Air District believes that an integrated and comprehensive approach to planning is

critical to respond to air quality and climate protection challenges in the years ahead. In its dual roles as an update to our state ozone plan and a multi-pollutant plan, the 2010 CAP addresses four categories of pollutants:

- Ground-level ozone and its key precursors, ROG and NOx;
- Particulate matter: primary PM2.5, as well as precursors to secondary PM2.5;
- Air toxics; and
- Greenhouse gases.

The major purpose for developing a multi-pollutant plan is to achieve the greatest possible public health benefit by reducing emissions, ambient concentrations, and public exposure across the four categories of air pollutants addressed in the 2010 CAP. In developing the CAP control strategy, the Air District has attempted to maximize co-benefits, while at the same time minimizing any potential trade-offs among pollutants.

Evaluating control measures on the basis of their potential to reduce multiple pollutants is complex, and little guidance or precedent is currently available. To address this issue, the Air District developed a Multi-Pollutant Evaluation Method (MPEM) which integrates the three core goals of the 2010 CAP: improving air quality, protecting public health, and protecting our climate. The MPEM analyzes how a given reduction (or increase) in emissions of each pollutant will affect ambient concentrations, population exposure, and health effects related to that pollutant. The MPEM then aggregates the impacts of each control measure on a multi-pollutant basis. Finally, the MPEM monetizes the value of the health and climate protection benefits for each control measure and expresses these benefits in dollar terms, in order to facilitate comparison of the relative benefit of the various control measures.

CAP Control Strategy

The proposed 2010 CAP control strategy builds on a solid foundation established by the 2005 Ozone Strategy, and previous ozone plans prepared in the 1991 to 2005 period. But the 2010 CAP also moves in new directions to address emerging challenges and opportunities. The 2010 CAP control strategy includes revised, updated, and new measures in the three traditional control measure categories: Stationary Source Measures, Mobile Source Measures, and Transportation Control Measures. In addition, the CAP identifies two new categories of control measures: Land Use and Local Impact Measures, and Energy and Climate Measures.

The draft control strategy proposes a total of 55 control measures, including:

- 18 Stationary Source Measures;
- 10 Mobile Source Measures;
- 17 Transportation Control Measures;
- 6 Land Use and Local Impact Measures; and
- 4 Energy and Climate Measures.

The 2010 CAP also describes 17 Further Study Measures, which will be further evaluated as potential control measures. In addition, the CAP includes a Leadership Platform. The Leadership Platform is intended to complement the control strategy by identifying policies and actions, such as legislation or adoption of regulations by other agencies, which will support or enhance the control measures identified in the CAP.

In sum, the Bay Area 2010 CAP provides a control strategy designed to:

- reduce emissions of ozone precursors, PM, air toxics, and greenhouse gases;
- continue progress toward attainment of state ozone standards;
- reduce transport of ozone precursors to neighboring air basins;
- protect public health by reducing population exposure to the most harmful air pollutants; and
- protect the climate.

Key Findings

In preparing the 2010 CAP, Air District staff analyzed air pollutant trends and the health risks associated with past levels and current levels of air pollution. Key findings of this analysis for the Bay Area can be summarized as follows:

- Bay Area air quality has improved significantly in recent decades. Ambient concentrations of - and population exposure to - harmful air pollutants, including ozone, PM, and air toxics, have all been greatly reduced.

- The improvement in air quality in recent decades has greatly reduced health effects related to air pollution.

- Premature deaths related to air pollution have declined by several thousand from approximately 6,400 per year in the late 1980's to approximately 2,800 per year in 2008.

- The estimated lifetime cancer risk (over a 70-year lifespan) from all toxic air contaminants combined declined by 70 percent between 1990 and 2008, from approximately 1,330 cases per million people to approximately 405 cases per million.

- The improvement in air quality has extended average life expectancy in the Bay Area by approximately 6 months over the past two decades.

- In economic terms, the public health dividend of the improvement in air quality provides billions of dollars in benefits to the Bay Area each year.

Despite this progress, air pollution still has negative health impacts for many Bay Area residents. These effects include acute and chronic respiratory problems, asthma, cardiovascular effects, and premature mortality.

- Exposure to PM2.5 is by far the leading public health risk from air pollution in the Bay Area, accounting for more than 90% of premature mortality related to air pollution.

- Implementation of the proposed control measures in the 2010 CAP should result in approximately 85 fewer premature deaths per year in the Bay Area.

- Implementation of the proposed control measures in the 2010 CAP will, collectively, provide benefits with a monetary value in the range of $270 million to $1.5 billion per year, with a likely value on the order of $770 million per year, in terms of reduced medical costs, increased life expectancy, and reduced impacts of climate change.

- Roughly 80% of the estimated economic benefits from the CAP control measures can be attributed to reductions in PM2.5 (66% non-diesel PM2.5 and 14% diesel PM2.5). Reductions in greenhouse gases account for approximately 20% of the economic benefits.

- Although emissions and ambient concentrations of criteria pollutants and air toxics in the Bay Area have been declining, emissions and concentrations of greenhouse gases have been increasing in the Bay Area and elsewhere.

- Climate change due to increased emissions and concentrations of greenhouse gases is expected to result in an increase in the number of high heat days and wildfires in the Bay Area and adjacent areas. These impacts are likely to exacerbate air pollution and complicate efforts to attain air quality standards for ozone and PM.

- The control measures in the CAP will reduce emissions of greenhouse gases. Some CAP measures will directly reduce GHG emissions; many other measures will provide GHG reductions as a co-benefit.

- To provide a comprehensive plan that addresses multiple pollutants and protects public health and the climate, new types of control measures, such as the Land Use and Local Impact Measures and the Energy and Climate Measures, have been incorporated in the 2010 CAP control strategy.

Looking Forward

The 2010 CAP moves the Bay Area toward a new approach to air quality planning. The key goals defined in the CAP are to protect air quality, public health, and the climate. Despite impressive progress in improving Bay Area air quality in recent decades, we face significant challenges as we strive to achieve these goals in the future. The challenges include tighter air quality standards, limited resources, the dearth of new "low-hanging fruit" in terms of emissions control programs, future economic and population growth in the region, and the potential impacts of climate change and higher temperatures on air quality.

Under these circumstances, the multi-pollutant framework can provide a means to evaluate and balance competing objectives, maximize co-benefits from control strategies, improve the cost-effectiveness of programs to reduce emissions of criteria pollutants and greenhouse gases, and optimize the use of limited resources by the Air District, its partner agencies, and the regulated community.

Looking forward, the Air District will continue its efforts to achieve the CAP goals and to build its multi-pollutant planning capacity by:

- Developing an integrated emissions inventory that includes all pollutants;
- Developing an integrated air quality modeling platform;
- Enhancing the Multi-Pollutant Evaluation Method developed for the 2010 CAP to include a wider range of pollutants and health effects;
- Enhancing its capacities to measure and analyze ambient concentrations and population exposure in impacted communities;
- Developing better measurements of population exposure to pollutants on a region-wide basis;
- Evaluating the potential benefits and policy and technical issues related to extending the risk-weighted multi-pollutant approach to programs such as stationary source permitting and New Source Review; and
- Better integrating strategies to reduce criteria pollutants and greenhouse gases.

The Air District elected to develop the 2010 CAP as a multi-pollutant plan as a matter of choice. However, future challenges are likely to make multi-pollutant planning a necessity in years to come. In addition to serving as a blueprint for the Bay Area, the Air District offers the 2010 CAP as an example of a multi-pollutant plan that other agencies can build upon to advance this concept.

Bay Area 2010 Clean Air Plan – Framing the Challenge

Protecting air quality in the San Francisco Bay Area air basin[1] is the core mission of the Bay Area Air Quality Management District (Air District). Clean air is fundamental to public health and to the high quality of life that makes the Bay Area a desirable place to live, work, and visit. In addition, good air quality:

- Supports healthy ecosystems, diverse flora and fauna, and productive agriculture;
- Provides economic benefits by stimulating human productivity, reducing health care costs, enhancing property values, and helping to attract investment and tourism; and
- Enhances the natural beauty of the Bay Area.

Despite the importance of good air quality, the fact is that we all breathe air pollution every day. There are millions of emissions sources in the Bay Area – oil refineries, manufacturers, dry cleaners, cars and trucks, construction equipment, lawn mowers, fireplaces, wood stoves, consumer products, and many other sources – that collectively emit many different types of air pollutants. And there are millions of receptors: all of us – children, teens, adults, and seniors - who inhale these emissions. Air pollution has a wide range of negative impacts on public health. Exposure to air pollutants can damage the pulmonary and cardio-vascular systems, and may cause or contribute to both acute and chronic health effects including bronchitis, asthma, stroke, and heart attack.

In an urban environment it is impossible to completely eliminate air pollution. But through a combination of strong laws, good planning, improved technology, strategic partnerships, and voluntary actions, we can greatly reduce air pollution and its negative impacts on public health and ecosystems.

Although we have made tremendous progress in improving air quality, today we face new challenges related to emissions of carbon dioxide (CO2) and other greenhouse gases (GHGs) that contribute to climate change.[2] Climate change presents many environmental and economic challenges for the Bay Area, not least of which is that it threatens to degrade air quality.

The air we breathe and the climate that supports us have no natural defenses. Just as we all deserve to breathe clean air, we all need to be part of the solution to protect our air quality and climate. We still have a great deal of work to do to improve Bay Area air quality and protect the climate. But to put our challenges in perspective, it is important

[1] The San Francisco Bay Area air basin consists of all of Alameda, Contra Costa, Marin, Napa, San Francisco, San Mateo and Santa Clara counties, and the southern portions of Solano and Sonoma counties.

[2] In the CAP, the term "climate change" is used in lieu of "global warming."

to first recognize that we have made great strides in reducing air pollution in the Bay Area.

Achievements

Air quality control is an incremental proposition - a marathon, not a sprint. The regulations and plans that the Air District and its partners have developed and implemented over the past several decades have served the region well, enabling us to make steady progress in improving air quality. Over the past 40 years, the Bay Area has made great strides in reducing emissions of air pollutants, as well as the health impacts related to public exposure to air pollutants. We have been able to accomplish this even as the region's population, vehicle fleet, vehicle miles of travel (VMT), and economic output have all increased sharply.

Nearly 40 years have passed since Congress adopted the federal Clean Air Act (CAA) of 1970. The CAA led to the establishment of standards for ambient concentrations of six "criteria" air pollutants: ozone (O3), carbon monoxide (CO), sulfur dioxide (SO2), nitrogen dioxide (NO2), lead, and particulate matter (PM).[3] Today, outdoor air in the Bay Area is much cleaner than it was 40 years ago. Air quality monitoring data shows that concentrations of each of the six criteria pollutants in the air we breathe have all been reduced by more than half in the Bay Area since the CAA was enacted.[4]

In 1970, the Bay Area frequently violated standards for ozone, particulate matter, carbon monoxide and lead, and violations often exceeded the standards by a wide margin. Thanks to aggressive state and regional regulatory programs for both stationary and mobile sources of emissions,[5] the Bay Area meets, or is close to meeting, current national air quality standards. In fact, for four of the six criteria pollutants - lead, carbon monoxide, sulfur dioxide, and nitrogen dioxide - the Bay Area is well below all existing standards. However, the Bay Area does not yet attain national ozone and PM2.5 standards, or the more stringent California standards for particulate matter and ozone. In addition to reducing ambient levels of criteria air pollutants, great progress has been made in reducing emissions of, and exposure to, toxic air contaminants. Although the effort is by no means complete, progress in improving Bay Area air quality has been impressive.

So what does this improvement in air quality mean in terms of reducing health impacts related to air pollution? To answer this question, Air District staff performed an analysis

[3] The 1970 Clean Air Act identified six pollutants – ozone, PM, carbon monoxide, nitrogen dioxide, sulfur dioxide, and lead – as being particularly dangerous. It mandated that each be regulated based on concentration standards. These standards were based upon "criteria documents" – compendia of scientific information on the formation, concentrations, distribution, and health effects of the pollutants. Hence, these are referred to as "criteria pollutants."

[4] See Chapter 2 for more detailed data regarding Bay Area attainment status and air quality trends.

[5] In California, vehicle emission standards and fuel standards are established by the Air Resources Board.

to compare air pollution levels and population exposure from earlier decades to the pollution levels that prevail today, using the best available air quality monitoring data. The analysis then estimated how the improvement in air quality translates into reductions in key health impacts and the economic benefit of reducing these health impacts. The results of this analysis, summarized below, are presented in greater detail in Appendix A.

The analysis found significant reductions in each of the seven health impacts analyzed.[6] In economic terms, we estimate that improved Bay Area air quality provides health benefits with a value on the order of $25 billion per year. The benefit of the reduction in our health burden is most dramatic in relation to mortality; i.e., the reduction in the number of deaths caused by or related to air pollution. Premature mortality related to air pollution has decreased from approximately 6,400 per year in the late 1980's to approximately 2,800 per year in 2008. Also, the estimated lifetime cancer risk in the Bay Area from exposure to airborne toxics has been reduced by 70 percent from 1990 to 2008.

The reduction in mortality risk can be expressed in terms of increased life expectancy. Overall, due to a variety of factors including improved health care, reduced smoking, and cleaner air, Bay Area life expectancy has increased significantly in recent years. Data shows that Bay Area life expectancy has increased by almost 5 years, from 75.7 years in 1990 to 80.5 in 2006. Of the 5-year increase in life expectancy during this period, we estimate that improved air quality can be credited with extending average life expectancy in the Bay Area by 6 months.[7] Thus, the Air District analysis suggests that approximately 10% of the improvement in Bay Area average life expectancy over the 1990-2006 period can be attributed to cleaner air.

This is very good news, indeed. The bad news, however, is that current levels of air pollution in the Bay Area still cause or contribute to several thousand deaths and billions of dollars in health costs and social costs each year. We estimate that there are approximately 2,800 premature deaths in the Bay Area per year related to current air pollution levels, and that the vast majority of these deaths - more than 90% - are related to exposure to fine particulate matter (PM2.5).[8]

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[6] The health impacts included asthma emergency room visits, respiratory hospital admissions, cardio-vascular hospital admissions, chronic bronchitis, non-fatal heart attacks, cancer onset, and mortality.

[7] A recent study that looked at the benefits of reducing PM in 51 metro areas across the US found a direct correlation between reductions in PM concentrations and increased life expectancy. See Pope et al. "Fine Particulate Air Pollution and Life Expectancy in the United States." *New England Journal of Medicine*, January 22, 2009.

[8] For purposes of comparison, the total number of deaths from all causes in the Bay Area is about 45,000 per year, and the annual number of transportation-related deaths (primarily auto-related fatalities) in the Bay Area is 600 to 700.

So despite substantial and well-documented progress in reducing air pollution, we must continue to work to further improve air quality and to better protect public health. And even as we make progress in reducing air pollution, we face significant challenges that demand fresh thinking and new approaches.

Challenges

The Bay Area must plan today to meet the challenges that we will face in the years to come. Key factors that will influence future conditions include:

- Population and economic growth in the Bay Area;
- Development patterns: where and how we accommodate future growth;
- Changes in infrastructure, including our roadway and transit systems, goods movement systems, and high-speed rail;
- Technological change;
- Climate change;
- Potential local impacts from pollutants emitted by expanding economies in Asia; and
- Public awareness and action to support air quality and climate protection strategies.

Major challenges that we face in the realm of air quality and climate protection, and the opportunities that flow from these challenges, are summarized below.

Criteria Pollutant & Air Toxics Challenges

More stringent standards: Air quality standards are becoming progressively more stringent in response to epidemiological research that shows adverse health effects at lower pollution concentrations than previously known. To attain these increasingly stringent standards, air districts throughout California will need to pursue innovative strategies to complement our traditional, command-and-control, technology-based approach.

Protecting Impacted Communities: Recent health studies related to particulate matter and air toxics highlight the need to focus on reducing pollution exposures in the most heavily-impacted communities that bear the brunt of pollution from ports, freeways, and industry. Analysis performed for the Air District's CARE program indicates that mobile sources, including cars, trucks, and off-road equipment, account for most of the emissions and health risks in impacted communities. These sources are not under the regulatory jurisdiction of the Air District. Improving air quality in impacted communities will entail reducing emissions from all sources, especially heavy-duty vehicles and equipment. And it will require local governments to consider new approaches in land use decision-making.

Reducing PM: Fine particulate matter (PM2.5) is the pollutant that imposes the greatest public health burden on the Bay Area. Exposure to fine and ultrafine PM from motor vehicles endangers people who live or work in close proximity to freeways, ports, and goods movement corridors and facilities. Reducing PM emissions from diesel engines is essential, but we also need to decrease fine PM of all types, including wood smoke, in order to protect public health.

Diminishing returns: Aggressive efforts to reduce emissions from all sources have greatly reduced pollution levels. But we have picked the "low-hanging fruit" – it is becoming harder and harder to find regulations and other control measures that provide significant reductions in criteria pollutants. To make further progress, we will need to pursue new approaches.

Land Use Challenges

Our land use patterns and transportation infrastructure have a profound impact on air quality and population exposure to pollution. In the long run, where and how the Bay Area chooses to develop is likely to have as great or greater an impact on air quality, public health, and climate change than any rules or regulations that the Air District adopts.

Despite current economic challenges, the Bay Area will experience population growth and economic growth in the coming decades. If existing land use development patterns continue, this will result in a major increase in the number of motor vehicles competing for space on our roads, and additional pressure to build housing and commercial property on the periphery of the region, thus complicating our efforts to attain air quality standards and the State's climate protection goals. We need to find a way to accommodate growth through sustainable land use patterns.

Promoting focused development to create vibrant communities in core areas of the region is essential in order to reduce motor vehicle emissions and achieve our air quality and climate protection goals. However, *we must pursue focused development in a way that does not put people at risk from exposure to existing and/or new sources of pollution.*

Climate Protection / Greenhouse Gas Challenges

Climate change is the greatest environmental challenge of the 21st century. We need to radically reduce greenhouse gas emissions to attain the state's ambitious GHG reduction goals for the year 2050. Can the Bay Area find a way to slash greenhouse gas emissions per capita, while still maintaining a strong economy and high quality of life?

Climate change will exacerbate air pollution, and complicate our efforts to attain and maintain air quality standards. Higher temperatures may increase emissions of ozone precursors and ozone formation, eroding the progress that the region has made over the past 50 years of regulatory action.

Climate change has been implicated in increasing the number and severity of summer wildfires in California. Some of these fires have impacted the Bay Area, producing fine particle concentrations that exceed air pollution standards.

Emissions of carbon dioxide (CO2), the primary greenhouse gas, are a direct product of fossil fuel combustion. To protect our climate and avoid global warming, we must reduce combustion of fossil fuels (coal, petroleum products, natural gas, etc.). Recent research indicates that particulate matter from fires and vehicle exhaust contributes directly to global climate change in the form of black carbon, a soot-like substance that both absorbs radiation and diminishes the ability of snow and icepack to reflect radiation away from the earth's surface.

Opportunities

In responding to the challenges described above, the Bay Area has an opportunity to show the world that a diverse region can marshal its economic, political, and social assets to build a sustainable economy and communities that protect our environment and climate. Some of the key ways to achieve this are summarized below.

Attack root causes: To date, emission control strategies have often focused on the tail end of processes, for example by installing scrubbers on smoke stacks or catalytic converters on motor vehicle tail pipes. But we need to tackle the root causes of our air quality and climate challenges by pursuing greater efficiency in all sectors of our society and economy: industrial processes, power generation, motor vehicles and transportation, and design of our buildings and communities.

Promote focused development: We need to change the way in which we live, work, play, and get around. Linking land use, transportation, and air quality planning is a key long-term strategy to reduce emissions of criteria air pollutants, air toxics, and greenhouse gases. We must build public support for a robust Sustainable Communities Strategy [9] for the Bay Area (in response to SB 375) to promote land use, transportation and lifestyle changes that decrease motor vehicle travel and encourage less energy-intensive modes of transportation.

Reduce emissions from goods movement: Goods movement (trucking, rail, ports, etc.) is a major source of air pollution and greenhouse gases. Reducing emissions from the

[9] See discussion of SB 375 and Sustainable Communities Strategy in Chapter 4.

goods movement sector will provide benefits in reducing population exposure to air toxics in impacted communities.

Protect impacted communities: Improving air quality in impacted communities will require a comprehensive strategy and sustained collaboration between the Air District, local governments, health departments, community groups, industry, and other stakeholders.

Take personal responsibility: Each of us makes decisions every day that have a direct impact on our environment and our climate: how we travel, what we buy (or don't buy), the type of vehicle we drive, whether to light a fire in our fireplace. Taken together, these individual decisions have powerful impacts. In the final analysis, each of us has both a direct stake and a direct responsibility in protecting our environment and our climate.

Organization of the CAP

The CAP includes two volumes, plus appendices. Volume I consists of five chapters which present the overall framework of the plan. Chapter 1 explains the goals of the plan and innovative directions that the CAP pursues to address the challenges described above. Chapter 2 lays out the technical foundation for the plan, including air quality standards, Bay Area attainment status, emissions inventory data, trends in emissions and population exposure, and air quality modeling, and also provides a profile of each pollutant addressed in the CAP. Chapter 3 describes the context for this plan, summarizing existing Air District programs that provide the foundation for the CAP, as well as external plans and programs that complement the CAP. Chapter 4 provides an overview of the CAP control strategy and its rationale, and describes key policy issues that informed the development of the control strategy. Chapter 5 briefly summarizes key findings and outcomes of the CAP.

Volume I also includes the following appendices:

- Appendix A: Bay Area Health Burden from Air Pollution: Past & Present
- Appendix B: Public Outreach for the 2010 CAP
- Appendix C: State Air Quality Planning Requirements
- Appendix D: Ecosystem impacts of Air Pollution
- Appendix E: Photochemical Modeling
- Appendix F: Evaluation of Potential Control Measures
- Appendix G: Progress Toward 2010 CAP Performance Objectives

Volume II provides detailed descriptions of the 55 control measures that comprise the CAP control strategy, as well as Further Study Measures and the CAP Leadership Platform.

Chapter 1 – Scope & Purpose of 2010 CAP

The Bay Area 2010 Clean Air Plan (CAP) provides a comprehensive plan to improve air quality, protect public health, and protect the climate. The plan proposes a control strategy to reduce four types of air pollutants – ozone, particulate matter (PM), air toxics, and greenhouse gases – in a multi-pollutant framework. Chapter 1 describes the key goals and objectives of this plan, and the innovative approaches that the Air District employed in developing the 2010 CAP.

The 2010 CAP has been prepared in collaboration with the Air District's regional agency partners: the Association of Bay Area Governments (ABAG), the Bay Conservation and Development Commission (BCDC) and the Metropolitan Transportation Commission (MTC).

In developing the CAP, the Air District performed extensive outreach to the public and interested stakeholders, as described in Appendix B, including multiple rounds of public workshops in various locations throughout the Bay Area. The input provided by interested parties helped to inform the development of the CAP and the CAP control measures.

Update to State Ozone Plan

The legal impetus for the 2010 CAP is to update our most recent state ozone plan,[10] the Bay Area 2005 Ozone Strategy, in order to fulfill the requirements of the California Clean Air Act (CCAA) as codified in the California Health & Safety Code. The CCAA planning requirements, and how the 2010 CAP fulfills these requirements, are described in Appendix C. The key requirements can be summarized as follows:

- Report on progress in implementing the region's most recent plan to address state ozone standards, the *Bay Area 2005 Ozone Strategy;*
- Propose a control strategy that includes all feasible measures to reduce emissions of ozone precursors: reactive organic gases (ROG) and nitrogen oxides (NOx); and
- Reduce transport of ozone and ozone precursors to neighboring air basins.

Section 40914 of the Health & Safety Code requires that air district plans shall either be designed to achieve a reduction in emissions of 5% or more per year for each non attainment pollutant or its precursors, or the plan shall provide an alternative emission reduction strategy that includes all feasible control measures. To date, no air district in the state has been able to demonstrate a 5% reduction in ozone precursors each year. As in the case of previous Bay Area ozone plans that address state air quality planning requirements, the control strategy for the 2010 CAP is based on the "all feasible measures" alternative.

[10] The 2010 CAP responds to planning requirements pursuant to state law only. The CAP does not address federal air quality planning requirements, and is not part of a SIP (State Implementation Plan) for federal air quality planning purposes.

2010 CAP Goals and Performance Objectives

The 2010 CAP is focused on three related goals of fundamental importance, namely to:

- Protect air quality;
- Protect public health; and
- Protect the climate.

To better define these goals and to measure progress toward their achievement, several performance objectives have been identified for the 2010 CAP.

Air Quality: For air quality performance objectives, the CAP seeks to attain the ambient air quality standards established by the California Air Resources Board (CARB) and the US Environmental Protection Agency (EPA), as summarized in Table 2-1.

Public Health: Two public health objectives have been identified for the CAP:

- Reduce PM2.5 exposure by 10% by 2015;[11] and
- Reduce diesel PM exposure by 85% by 2020

Climate Protection: The CAP performance objectives, consistent with the State of California's climate protection goals, are to:

- Reduce emissions of greenhouse gases (GHGs) to 1990 levels by 2020 and 40% below 1990 levels by 2035.[12]

New Directions in Air Quality Planning

To pursue the goals defined above, the 2010 CAP employs an integrated, multi-pollutant planning framework. This represents a departure from the traditional approach to air quality planning, embodied in state and federal guidelines, whereby plans are prepared to address a single pollutant, such as ozone or particulate matter (PM). Although the single-pollutant approach has been successful in reducing ambient ozone concentrations in the Bay Area and elsewhere, it suffers from several limitations. In particular, it does not directly consider:

- The co-benefits or trade-offs for control strategies that affect multiple pollutants;
- The range and severity of health effects of different pollutants (e.g. air toxics), and the potential health benefits of reducing the various pollutants; or

[11] Since it is difficult to measure population exposure to PM, our analysis of progress in meeting the PM2.5 and diesel PM performance objectives uses emissions reductions as a surrogate for reducing population exposure.

[12] The goal of reducing GHG emissions to 1990 levels by 2020, established in AB 32, will require reducing 2009 emissions by 15%. The 2035 goal is a prorated target based upon the goal in the Governor's 2005 Executive Order S-3-05 to reduce GHGs emissions to 80% below 1990 levels by year 2050. The 2035 goal is the same as the goal expressed in MTC's *Transportation 2035* plan and ABAG's *Projections 2009*.

- The effects that control measures designed to reduce criteria pollutants may have in increasing or decreasing emissions of CO2 and other greenhouse gases that contribute to climate change.

Considering the limitations of the single-pollutant approach, there is growing recognition of the need to move in the direction of integrated, multi-pollutant air quality planning. The conceptual rationale for multi-pollutant planning was initially set forth in recommendations issued by the National Research Council (NRC), an arm of the National Academy of Sciences, in January 2004.[13] The NRC report advocated that air quality planning should employ a risk-based, multi-pollutant approach to address the major goals of the Federal Clean Air Act, including:

- Reduce concentrations of the six "criteria" pollutants: ozone, PM, SO2, PM, lead, NO2;
- Reduce exposure to air toxics; and
- Address ecosystem impacts related to criteria air pollutants, including acid deposition and stratospheric ozone depletion.[14]

In response to the NRC report, the US EPA Office of Air Quality Planning and Standards (OAQPS) has been investigating the multi-pollutant planning concept in recent years.[15] In May 2007, US EPA issued a call for states or regions interested in pursuing multi-pollutant pilot projects. Multi-pollutant pilot projects under the aegis of US EPA are currently under way in four areas: New York State, North Carolina, Detroit, and the St. Louis MO/IL metro area.

Although the NRC has provided the conceptual basis for multi-pollutant planning, there are currently no laws or regulations that require, or even directly encourage, the preparation of multi-pollutant plans. Nor are there any detailed guidelines available as to how to prepare such a plan.

The CAP as a Multi-Pollutant Plan

The Air District has chosen to develop the 2010 CAP as an integrated, multi-pollutant air quality plan in the belief that this is the best way to address the Bay Area's air quality and climate protection challenges. The sections below describe the rationale for multi-pollutant planning, the potential benefits of this concept, and how the Air District approached multi-pollutant planning for the CAP. Key findings from the Air District's multi-pollutant analysis are also discussed.

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[13] *Air Quality Management in the United States*, National Research Council, January 2004.

[14] In terms of ecosystem impacts, the CAP focuses on the link between air quality and climate change. There are, however, a range of ecosystem impacts related to criteria pollutants, such as nitrogen deposition, acid rain, etc. An overview of these other ecosystems impacts is provided in Appendix D. The NRC report also notes that, ideally, multi-pollutant planning should address multiple media, including air quality, water quality, soil, etc.

[15] *The Multi-Pollutant Report: Technical Concepts & Examples,* U.S. EPA, July 2008.

Scientific Rationale for Multi-Pollutant Planning

The scientific rationale for multi-pollutant planning is summarized below.

Shared chemistry and meteorology: Air pollutants share common precursor chemicals and interact with one another in the atmosphere in response to meteorology in complex ways. Similar atmospheric processes create, remove or transform multiple pollutants. A few examples of the complex interactions among air pollutants include the following:

- ROG and NOx act as precursors to formation of both ozone and PM, but the processes are different.[16]

- Benzene, 1-3 butadiene, acetaldehyde, and formaldehyde are air toxics with direct health effects, but they are also components of ROG and thus act as precursors to ozone and PM formation.

- Climate change and ozone are intertwined: higher temperatures related to climate change are expected to increase ozone formation; ozone, in turn, acts as a potent, albeit short-lived, greenhouse gas.

- PM has a complex role in terms of global warming. Black (elemental) carbon, also referred to as soot, is a component of PM that appears to accelerate the effects of climate change, such as melting of the polar ice caps. But other aerosol forms of PM such as organic carbon, sulfates and nitrates scatter light, and thus have a cooling effect. Dust particles (e.g. dust from agriculture and construction activities) that contribute to PM also have a cooling effect.

- Emissions of methane, one of the top GHGs, also contribute to increasing background levels of ozone at the global scale.[17] Thus, reducing methane emissions can help to reduce both climate change and ground-level ozone concentrations.

Pollutants may have common emission sources: Many emission sources produce multiple air pollutants. For example, combustion of fossil fuels in motor vehicle engines emits ROG and NOx, which act as precursors to formation of ozone and PM; direct emissions of PM; air toxics such as diesel PM, benzene, 1-3 butadiene, and ammonia; as well as greenhouse gases, including significant quantities of CO2, and small amounts of methane.

[16] In the Bay Area, where ozone formation is limited by the availability of ROG, air quality modeling suggests that reducing NOx may actually increase ozone levels, at least under certain conditions in the short term.
[17] Seinfeld J.H. and S. N. Pandis, Atmospheric Chemistry and Physics: From Air Pollution to Climate Change, p. 246-249, John Wiley & Sons, Inc, New York, 1998. Also, Fiore et al, Linking ozone pollution and climate change: the case for controlling methane, Geophysical Research Letters, Vol. 29, No. 19, 2002.

Multiple pollutants can interact in terms of health effects: From the standpoint of health effects, the interaction among pollutants can be *additive* (the simple sum of the individual effects of each pollutant, *synergistic* (whereby the combined effect is greater than the sum of the effect of each individual pollutant), or *antagonistic* (where the combined effect is less than the sum of the effect of each individual pollutant). Although more research is needed, there is evidence[18] that interaction among multiple pollutants can produce a combined effect that is greater than the simple additive outcome of each individual pollutant.

Policy Rationale for Multi-Pollutant Planning

Multi-pollutant planning also makes sense from the policy perspective. Since available resources are finite both for air quality regulators and for the regulated community, it is important to maximize the cost-effectiveness of pollution control programs. Developing an integrated control strategy that addresses multiple pollutants can optimize the cost-effectiveness of air quality regulations and plans. Multi-pollutant planning can also help to:

- Provide stakeholders and the public with a comprehensive analysis of key air quality issues, build support for strategies to address these issues, and help target resources where they will yield the greatest benefit;
- Maximize co-benefits and avoid trade-offs between the different pollutants;
- Analyze pollutants on the basis of their health risks, and design a control strategy to maximize reductions in health risks;
- Provide better justification for new control measures by analyzing the full range of pollutants reduced and the potential health benefit for proposed measures; and
- Integrate climate protection into air quality planning.

A key rationale for multi-pollutant planning is to maximize co-benefits in reducing multiple pollutants and minimize any potential trade-offs. Control measures that reduce multiple pollutants provide desirable co-benefits. However, in some cases, a particular control measure or technology may reduce one or more pollutants, but at a cost of increasing emissions of some other pollutant(s). Analyzing control measures on a multi-pollutant basis provides a means to evaluate and minimize any potential trade-offs, and to determine whether a potential trade-off, if unavoidable, may nevertheless still provide a net air quality benefit.

Multi-Pollutant Issues and Challenges

Although multi-pollutant planning makes sense conceptually, it is inherently more complex than single-pollutant planning, especially in the absence of state or federal guidelines. Therefore, it presents a range of challenges from both the policy and technical perspective. These challenges include:

[18] *Is There Evidence for Synergy Among Air Pollutants in Causing Health Effects?* Joe L. Mauderly and Jonathan M. Samet, Environmental Health Perspectives vol. 117, Number 1, January 2009.

- The scope of multi-pollutant planning is open to interpretation. Once beyond the well-defined boundaries of ozone or PM planning, where should one draw the line in terms of the range of pollutants, health effects, and ecosystem impacts to address?
- Do we have adequate technical knowledge and tools to allow us to plan on a multi-pollutant basis? (See Chapter 2)
- What does the science and health data tell us about the relative harmfulness of the different pollutants?
- How to develop an effective multi-pollutant control strategy?

Although multi-pollutant planning has conceptual appeal and practical value, it should not be seen as a panacea. In the final analysis, the effectiveness of any air quality plan depends upon identifying and implementing effective emission control measures. Multi-pollutant planning provides a broader lens through which to evaluate control measures, but the universe of potential control measures is not necessarily greatly expanded. Finding cost-effective control measures that provide significant emission reductions remains a major challenge.

Air Pollutants Addressed in CAP

There are hundreds of air pollutants, with a multitude of known and suspected health effects. It would be neither technically or practically feasible to address every air pollutant in the CAP, so the Air District has chosen to focus on a manageable subset of pollutants, namely:

- Ground-level ozone and ozone precursors: ROG and NOx
- Particulate matter (PM): both directly-emitted PM and secondary PM
- Key air toxics, such as diesel PM and benzene, and
- The "Kyoto 6" greenhouse gases (GHGs)

The choice of pollutants to include was based primarily on which pollutants pose the greatest risk to public health and to the climate.[19] Ozone and PM were chosen because they are the two criteria air pollutants for which the Bay Area continues to exceed state and national air quality standards. PM was also chosen because it has been identified as a major cause of serious health effects.

The California Air Resources Board (CARB) has identified 191 air toxics. In addressing air toxics in the CAP, we focus on a small set of carcinogenic air toxics – benzene, 1,3-butadiene, formaldehyde, acetaldehyde, and diesel PM. Although just a small subset of the full spectrum of toxics, these toxic compounds were chosen because they account for

[19] For additional discussion regarding how the pollutants addressed in this plan were selected, see Section 1.3.1 of the MPEM Technical Document.

approximately 95% of the estimated cancer risk from air toxics in the Bay Area.[20] Diesel PM is both a component of PM2.5 and also the Bay Area's leading airborne carcinogen.[21]

Greenhouse gases are included because they are the agents of climate change. There are many GHGs, but the CAP focuses on the "Kyoto 6" greenhouse gases. Three of these gases - CO_2, methane, and nitrous oxide – represent 99% of the known GHG potential of the Bay Area.[22]

Although they may share characteristics and interact in the atmosphere, the pollutants addressed in the CAP differ in fundamental ways. One of the differences relates to how pollutants are emitted or formed. For example, some pollutants, including many air toxics, are directly emitted. Others, such as ozone, are formed via photochemical processes in the atmosphere. And some, such as PM, are both directly emitted, as well as formed via secondary processes. As summarized in Table 1-1, the pollutants addressed in the 2010 CAP differ in terms of:

- Chemical composition and formation
- Time of year when highest concentrations occur
- Geographic scale (local, regional, global)
- Range and severity of health effects they cause
- Climate and ecosystem impacts

Table 1-1 provides an overview of the key characteristics and impacts of the air pollutants addressed in the 2010 CAP.

[20] In addition to carcinogenic risks, air toxics may have both acute (short-term) and chronic (long-term) non-cancer health effects. However, for purposes of this methodology, we have chosen to focus on toxic cancer risks only.

[21] See CARE *Phase I Findings and Policy Recommendations Related to Toxic Air Contaminants in the San Francisco Bay Area*, BAAQMD, September 2006, at www.baaqmd.gov/Divisions/Planning-and-Research/Planning-Programs-and-Initiatives/CARE-Program.aspx

[22] The other Kyoto 6 GHGs are hydroflourocarbons (HFCs), perflourocarbons (PFCs), and sulfur hexafluoride (SF_6). See additional discussion re: GHGs in Chapter 2.

Table 1-1. Pollutant summary table.

Pollutant	Constituents/ Precursors	Key Anthropogenic Sources	Scale of Impact	Peak Levels	Health Impacts	Other Impacts
Ozone	ROG	Mobile sources (cars) Evaporation of petroleum & solvents Consumer products	Regional & beyond	Summer	Aggravated asthma Acute bronchitis Chronic bronchitis Respiratory symptoms Decreased lung function Heart attacks Premature mortality	Property damage: tires, paints, building surfaces Damage to crops Nitrogen deposition to land & waterways
	NOx	Mobile sources (cars & trucks) Other combustion				
PM2.5	Direct emissions from combustion	Wood-burning Diesel engines Gasoline engines Burning natural gas Commercial cooking	Local & Regional	Winter	Aggravated asthma Respiratory symptoms Increase blood pressure Decreased lung function Heart disease Stroke Premature mortality	Regional haze Acid deposition Water pollution
	ROG	See ROG above				
	NOx	See NOx above				
	Ammonia (NH3)	Landfills, livestock, wastewater treatment, refineries				
	SO2	Petroleum refining Ships				
Air Toxics	Diesel PM Benzene 1,3 Butadiene Formaldehyde Acetaldehyde	Diesel engines Gasoline engines Construction equipment Ships & boats	Local	Year-Round	Acute non-cancer Chronic non-cancer Lung cancer Leukemia Premature mortality	Water pollution
Green House Gases	Carbon dioxide:CO2 Methane (CH4) Nitrous oxide (N2O) Hydroflourocarbons Perflourocarbons Sulfur hexafluoride	Fossil fuel combustion Mobile sources Industrial/commercial Electricity generation	Global	Year-Round	Potentially increase ozone levels Disease vectors Effects from prolonged heat waves	Climate change Rising sea levels Acidification of oceans Species extinction Drought Wildfires

Linking Air Pollution to Health Effects

Protecting public health is one of the key goals of the 2010 CAP. The fundamental linkage between reducing emissions of air pollutants and protecting public health is based on four key steps described below.

Emissions: Many different sources, both stationary (factories, refineries, etc.) and mobile (cars, trucks, locomotives, marine vessels, and farm and construction equipment) emit a wide variety of air pollutants. Identifying the key emission sources and developing strategies to reduce emissions of harmful pollutants (or their chemical precursors) from man-made or "anthropogenic" sources[23] is the first and most fundamental step to improve air quality.

Ambient Concentrations: This term refers to the level of pollutants that are measured in the air. Air quality standards for criteria pollutants are generally defined in terms of ambient concentration, as expressed in terms of either a *parts per million* ratio (e.g., the state 8-hour ozone standard is 0.070 parts per million) or a *mass per volume* basis (e.g., the national 24-hour PM2.5 standard is 35 $\mu g/m^3$). The relationship between emissions and ambient concentrations is complex and depends upon many factors, including meteorological conditions (temperature, wind speed and direction, vertical mixing, etc.) the ratio of precursor pollutants (e.g., the ROG to NOx ratio in the case of ozone), and regional topography. Some pollutants, such as ozone, are regional in scale. In other cases, such as PM and air toxics, ambient concentrations can vary greatly within a small geographic area. The Air District performs sophisticated photochemical modeling to better understand the complex relationship between emissions and ambient concentrations. These emissions-concentrations relationships or "sensitivities" were quantified and used in the multi-pollutant evaluation method (MPEM) described below.

Population Exposure: Population exposure refers to the type and magnitude of exposure to pollution for a given individual or population cohort.[24] From the public health perspective, the key issue is not how much pollution is present in the air, but rather how many people are actually exposed to the pollution, and how much is taken into the body (dosage). Individual exposure to air pollution varies greatly depending upon where people live, work, and play. Activity patterns and lifestyle, such as how much time people are outside, or how much time they spend driving on busy roadways, vary greatly from person to person. The magnitude, frequency, duration, and route of exposure are all key factors in determining total exposure.

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[23] In addition to anthropogenic sources, there are also natural or "biogenic" sources of some pollutants. For example, some species of trees and vegetation emit volatile organic compounds (VOC) that contribute to formation of ozone in the atmosphere.

[24] Inhalation is the primary means of population exposure. Other pathways of indirect exposure to air pollution include absorption through the skin and ingestion.

Just as individual exposure differs, so does the ability of our bodies to tolerate exposure to pollutants. From the standpoint of protecting public health, we are most concerned about reducing population exposure for the most susceptible people, also called "sensitive populations," including children, pregnant women, seniors, and people with existing cardiovascular or respiratory conditions. Activity levels and body weight are also factors; when people, especially children, are exercising, they receive higher dosages relative to exposure.

Health Effects: Air pollution can cause or contribute to a wide range of health effects and illnesses, depending upon individual exposure to and tolerance for air pollution. Key health effects related to the air pollutants addressed in the 2010 CAP are summarized in Table 1-1.

Multi-Pollutant Evaluation Method

Because pollutants differ in terms of their emission sources, formation, health effects, and other factors, evaluating the benefit of potential control measures on a multi-pollutant basis is a challenging task. To address this issue, the Air District developed a multi-pollutant evaluation method (MPEM) for the 2010 CAP.[25]

The MPEM is based on the four links in the emissions to public health chain described above. For each control measure, the MPEM analyzes how the reduction (or increase) in emissions of each pollutant will affect ambient concentrations, population exposure, and changes in health effects related to each pollutant. The MPEM then monetizes the value of the health and climate protection benefits of each control measure in dollar terms in order to compare the relative benefits of the various control measures. The MPEM thus provides a tool that integrates the CAP goals of improving air quality, protecting public health, and protecting the climate.

For purposes of the 2010 CAP, the MPEM has been used to:

- Estimate the health and climate protection benefits, expressed in dollar terms, for individual control measures;
- Analyze trade-offs in the case of control measures that would increase one or more pollutants while reducing others;
- Estimate the aggregate benefit for the proposed CAP control strategy as a whole; and
- Evaluate the health burden associated with pollution levels in years past and compare that to the health burden in more recent years, as described in Appendix A.

[25] A more detailed description is provided in the *MPEM Technical Document* (June 2009) available on the District's website at www.baaqmd.gov/Divisions/Planning-and-Research/Plans/Clean-Air-Plans/Resources.aspx.

MPEM Caveats and Limitations

Although it includes key health effects, the MPEM does not fully consider all pollutants or all the benefits related to improving air quality. The MPEM excludes many air toxics, as well as criteria pollutants for which the Bay Area currently attains applicable standards: i.e., carbon monoxide (CO) and lead.[26] Nor does the MPEM include all potential health effects related to air pollution; only well-documented health effects are included. In addition, the MPEM, as currently designed, does not consider:

- Benefits of improvements in air quality beyond the boundaries of the Air District due to reduction in transport of Bay Area emissions to neighboring air basins;
- Economic benefits in terms of reduced damage to crops and other property (ozone damages tires, building surfaces, etc.), benefits in attracting tourism, the potential increase in property values due to improved air quality, etc.;
- How reducing emissions of air pollutants may provide other environmental benefits such as improving water quality or protecting ecosystems; or
- Co-benefits from control measures that provide enhanced transportation options, improved travel time, improvements in safety for bicyclists and pedestrians, reduced traffic accidents, reduced fuel or energy consumption, etc.

It is important to note that the MPEM provides a means of estimating the benefits of protecting public health and our climate *at this particular point in time*, based on our current understanding of pollutants and their health effects, the current Bay Area emission inventory, and current ambient concentrations. Had the Air District devised a version of the MPEM back in the 1970's or 1980's, when levels of ozone, carbon monoxide and air toxics were much higher than they are today, and the dangers of PM were little understood, the comparative values of different pollutants for purposes of a multi-pollutant comparison would likely have been different than what the MPEM tells us today. Similarly, looking forward, it is likely that the results of a multi-pollutant comparison two or three decades in the future will also tell a different story, in response to evolving science, progress in reducing the different pollutants in the intervening years, and other factors.

The MPEM by necessity incorporates many assumptions and approximations; the estimates of social benefits that it generates are subject to considerable uncertainty. To address this uncertainty, Air District staff performed a probability analysis of MPEM results.[27] The MPEM is intended primarily for purposes of comparing the relative dollar value of benefits across control measures. Although the methodology is a useful tool to help inform our decision-making, it should not be used as the sole arbiter of air quality rule-making or policy. With these caveats, key MPEM findings are presented below.

[26] The Bay Area also attains State and national standards for NO2 and SO2. However, these pollutants are included in the MPEM because they act as precursors in secondary formation of PM.

[27] District staff performed an uncertainty analysis based upon the Monte Carlo method to evaluate the MPEM calculations for each control measure, as described in the MPEM Probability Analysis which is posted on the 2010 CAP page on the District website: www.BAAQMD.gov.

Valuation of Health Effects

Negative health effects related to air pollution impose direct costs to treat illness and disease, as well as indirect costs such as lost work days and diminished productivity. For the MPEM, the following values were used for key health endpoints.[28]

- Mortality: $6,900,000
- New cancer case: $1,750,000
- New chronic bronchitis case: $ 410,000
- Non-fatal heart attack: $ 84,100
- Hospitalization for respiratory/cardiovascular illness: $33,000-$44,000 per admission
- Asthma emergency room visits: $468 per incident

Valuation of Greenhouse Gas Reductions

The MPEM also considers the value of reducing greenhouse gas emissions. Assigning a value to GHG reductions is problematic, given that 1) climate change will have impacts both locally and at the global scale, 2) potential climate change impacts are very broad, including a wide array of health, ecosystem, social, and economic impacts, and 3) the full range and force of climate change impacts from GHGs emitted today will not be experienced until decades, or even centuries, into the future. To develop a credible estimate for the value of reducing GHGs, the Air District performed a literature review and selected the value of $28 per metric ton of GHG reduced (expressed in CO2-equivalent), as described in Section 5.3 of the *MPEM Technical Document*.

Relative Value of Emission Reductions Based on MPEM

The MPEM can be used to compare the benefit of reducing the various air pollutants, as shown in Table 1-2. For this exercise, the MPEM was used to calculate the value of reducing one ton of each pollutant or precursor that is included in the methodology. The relative weight for each pollutant was then determined, using ROG as the unit of comparison. Since studies show that PM is the predominant cause of air pollution-related mortality, as discussed below, and mortality has by far the highest value ($6.9 million) among the health endpoints used in the MPEM, it is not surprising that the MPEM-derived weighting factor for PM reductions is much higher than for the other pollutants analyzed. These weighting factors are instructive for purposes of comparing the value of reducing the various pollutants. They can also be used to calculate the weighted tons of emissions reduced by various control measures for purposes of comparing their overall air quality and climate protection benefit.

[28] Valuations of health effects are explained in Section 5 in the MPEM Technical Document. See: www.baaqmd.gov/Divisions/Planning-and-Research/Plans/Clean-Air-Plans/Resources.aspx.

Table 1-2. Dollar value of reducing one ton per year of each pollutant using MPEM.

Pollutant	$$ Benefit: Reducing One Ton Per Year	Weighting Factor *
ROG	$4,800	1.0
NOx	$7,300	1.5
Diesel PM2.5	$459,300	96.1
Direct PM2.5 (no diesel)	$456,400	95.5
SO2	$37,900	7.9
Ammonia	$53,500	11.2
Acetaldehyde	$5,300 ($500 plus $4,800 as ROG)	1.1
Benzene	$ 12,000 ($7,200 plus $4,800 as ROG)	2.5
1,3-Butadiene	$30,200 ($25,400 plus $4,800 as ROG)	6.3
Formaldehyde	$ 6,000 ($1,100 plus $4,800 as ROG)	1.2
CO2 equivalent	$28	0.03

**Weighting factor: ROG = 1.0. The $ benefit/ton is divided by the ROG value of $4,800/ton to calculate weighting factor for each pollutant. For example, the value of SO2 reductions is $37,900; dividing this by $4,800 yields a weighting factor of 7.9 for SO2. The weighting for benzene, butadiene, formaldehyde, and acetaldehyde includes their effects both as air toxics, as well as components of ROG that contribute to formation of ozone and PM*.

Another way to assess the relative weight of the different pollutants is to compare the monetary benefit of reducing ambient concentrations of the various pollutants covered by the MPEM by 1%, as shown in Figure 1-1.[29]

[29] It should be noted that the relatively low value for (non-diesel) air toxics in Figure 1-1 is due in large part to our success in reducing air toxics over the past 25 years. Also, the greenhouse gas slice of the pie would be larger if a value higher than $28 per ton was ascribed to the value of reducing one reducing GHGs in the MPEM.

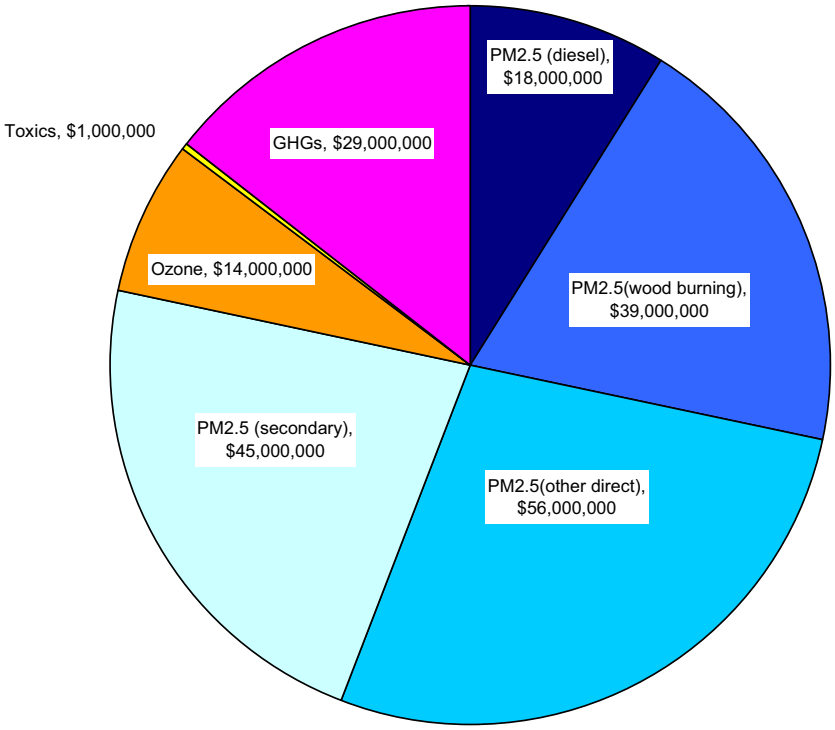


Figure 1-1. Social benefits of a 1% reduction of air pollutants in the Bay Area. The estimated social benefits are based on reductions of 1% of anthropogenic emissions, except for ozone. For ozone, the estimated benefit is based on a 1% reduction in exposures above 0.50 ppm.

Two key points about this pie chart are that (1) reducing PM accounts for roughly 80% of the total benefit and (2) diesel PM accounts for only about 20% of the total PM benefit.[30] The take-away message from Figure 1-1 is that, while reducing diesel PM is very important, we also need to continue, and strengthen, our efforts to reduce PM from wood smoke and other sources such as commercial cooking, and combustion of non-diesel fossil fuels, including gasoline and natural gas.

Protecting Public Health

Protecting public health is one of the core objectives of the 2010 CAP. The CAP is concerned with reducing pollution exposure throughout the region, but we place special emphasis on reducing population exposure and health impacts in the Bay Area communities that are most heavily impacted by air pollution.

[30] Emissions of diesel PM are expected to decline significantly over the next decade in response to stringent CARB rules to control emissions from both on-road and off-road heavy-duty diesel engines.

From the standpoint of public health, air pollutants only become a problem when someone inhales or ingests the pollutant. The greatest risk occurs when a dense population is exposed to elevated concentrations of harmful pollutants, especially among the most sensitive members of that group: children, seniors, or people with pre-existing cardiac or respiratory problems.

Exposure to air pollution can cause a wide range of health effects, as summarized in Table 1-1, including short-term (acute) effects and long-term (chronic) effects, including asthma, bronchitis, cancer, heart attacks, and strokes. To protect public health, it is important to:

- Determine which pollutants are most harmful to public health;
- Identify where the greatest concentrations of people are exposed to the most harmful pollutants; and
- Develop and implement effective strategies to reduce population exposure to the most harmful pollutants.

Defining and documenting the relationship between air pollution and public health is a complex endeavor. It is very difficult to prove a direct causal relationship between pollution and any specific illness or health impact in a given individual. Even if it were possible to accurately measure exposure and dosage to various pollutants at the individual level, the body's response (or lack of response) can vary greatly depending upon the individual. In general, sensitive populations – children, elderly, and people with pre-existing heart or lung conditions – are at greatest risk from air pollution. Because the relationship between air pollution and illness is difficult to prove or measure on an individual level, researchers rely on epidemiological studies of various population groups to tease out the effects of air pollution on public health. Clarifying the link between air quality and public health is also difficult for the following reasons.

- There may be health effects associated with some pollutants (e.g., PM2.5) even at levels below the established air quality standards.
- The Air District's air quality monitoring network is designed primarily to measure ambient concentrations of criteria air pollutants for purposes of determining compliance with state and national ambient standards on a regional basis. However, ambient concentrations for pollutants such as PM2.5 and air toxics can vary significantly at a local scale.[31]
- It is difficult to measure population exposure to pollution, due to variation in personal activity patterns and ambient concentrations of pollution at a local scale, and in micro-environments such as vehicles, homes, schools, offices, and other buildings.

[31] Although the existing Bay Area monitoring network fully complies with all state and federal requirements, it does not provide accurate measurement of PM and air toxics at a fine-grained scale. The Air District conducts special local measurement studies to augment the regional monitoring network. Control measure LUM 6 in Volume II provides a discussion of how the Air District plans to further enhance air monitoring.

- There is still great uncertainty as to how different pollutants may interact (or not) in terms of their health effects. Depending on the specific combination of pollutants, they may interact in ways that are additive, synergistic, or antagonistic in terms of their health effects.
- It is difficult to separate the impact of air pollution from the many other factors that influence health, including lifestyle (diet, exercise habits, smoking, drinking), socio-economic variables, etc.

Nonetheless, a great deal of research has been performed to analyze the public health impacts of air pollution, and the analysis presented in this plan draws upon the best available studies, information, and methodologies.

Which Pollutants Pose the Greatest Risk?

As discussed in Appendix A, the Air District estimates that air pollution is associated with nearly 3,000 premature deaths per year in the Bay Area. Table 1-3 shows the estimated reduction in annual deaths in the Bay Area that would be achieved if all anthropogenic emissions of PM2.5 and air toxics, including diesel PM2.5, were eliminated,[32] and if ozone concentrations were reduced to 0.05 parts per million. The table divides diesel PM in two parts: mortality caused by diesel PM as a component of PM2.5, and mortality from diesel PM in its role as the leading carcinogenic toxic air contaminant in the region. The point estimate for annual deaths that would be avoided is 2,840 per year, with an 80% chance that the number is within the range of 1,140 to 5,060.

Table 1-3. Estimated reduction in annual deaths from elimination of anthropogenic PM2.5, ozone, and selected toxics.

	PM2.5		Ozone	Toxics (lung cancer)		Total
	Diesel (non-cancer)	Non-diesel		Diesel	Non-diesel	
Point estimate	325	2,370	60	75	10	2,840
Lower bound*	130	950	25	30	5	1,140
Upper bound*	600	4,200	105	135	20	5,060

* The probabilities of deaths being fewer than the lower bound or more than the upper bound are each 10%.

The data in Table 1-3 suggest several important points regarding the impact of air pollution, and the role of PM2.5 and diesel PM, on premature mortality.

[32] Reducing all anthropogenic $PM_{2.5}$ would mean reducing average annual Bay Area $PM_{2.5}$ concentrations from about 10.0 $\mu g/m^3$ to 3.5 $\mu g/m^3$.

The vast majority of premature deaths associated with air pollution - more than 90% - are related to exposure to fine particulate matter (PM2.5). Most of the deaths associated with PM2.5 are related to cardiovascular and respiratory problems.

Although PM emitted by diesel engines is the leading air toxic in the Bay Area, only 10-20% of PM-related deaths in the Bay Area are linked to diesel exhaust. Other types of PM, from sources such as wood smoke, cooking, burning other fossil fuels, and secondary formation of PM from precursors such as NOx, SO2, and ammonia, collectively account for most of the PM – and PM-related deaths - in the Bay Area.

To the extent that diesel PM does contribute to premature mortality, it is primarily due to its role as a component of PM2.5, in which it contributes to mortality related to heart attacks, emphysema and chronic bronchitis. Diesel PM appears to be associated with 4-5 times more deaths in its role as PM2.5 than in its role as a carcinogenic air toxin.

Lung cancer caused by exposure to air toxics appears to account for only a modest portion, on the order of 3%, of the total deaths related to air pollution in the Bay Area; and only a tiny fraction, on the order of one in a thousand, of overall cancer cases in the Bay Area. The estimated lifetime cancer risk from air toxics in the Bay Area is on the order of 400 cases per million.[33] This compares to the total lifetime cancer risk of approximately 400,000 cases per million from all causes.

The information presented above highlights the importance of reducing PM emissions and concentrations, because PM has been identified as the leading cause of mortality from air pollution, and a high cost is ascribed to premature mortality. However, it should be emphasized that there are also significant negative health and economic impacts related to ozone and air toxics. Although ozone and air toxics are not leading causes of premature mortality, a wide range of acute and chronic health effects are associated with exposure to elevated levels of these pollutants, causing very real impacts to thousands of Bay Area residents. Therefore, it is essential to continue our efforts to reduce ozone and air toxics in response to both public health imperatives and legal requirements.

How the CAP Addresses Public Health

As described in Chapters 3, 4, and 5, the 2010 CAP addresses public health in many ways, including:

- Identifying public health protection as one of its three primary goals;
- Establishing numerical performance objectives for reducing population exposure to diesel PM and PM2.5;
- Developing the Multi-Pollutant Evaluation Method to estimate the health benefits of proposed control measures and express these benefits in dollar terms;

[33] Estimate is based on concentrations of air toxics measured at Bay Area monitoring stations in 2008, multiplied by OEHHA cancer risk factors.

- Using the MPEM to determine which pollutants pose greatest health risk;
- Developing potential control measures to maximize the reduction in population exposure to air pollutants, both at the regional scale and in local communities;
- Building on the Air District's current programs to reduce population exposure in impacted communities, such as CARE and the Clean Air Communities Initiative, and proposing to strengthen and enhance these efforts in the CAP control strategy; and
- Including a new category entitled Land Use and Local Impacts Measures (LUMs) in the CAP control strategy. The key objective of the six LUMs is to address localized impacts of air pollution, and in particular to help local jurisdictions to pursue transit-oriented infill development in priority areas, while simultaneously protecting people from exposure to air pollution in these areas.

Protecting the Climate

The third key goal of the 2010 CAP is to reduce emissions of greenhouse gases (GHGs) to protect the climate within the multi-pollutant plan framework. Addressing GHGs in an air quality plan is a challenge because GHGs differ in major ways compared to traditional air pollutants.

- Climate change is global in scale, with an enormous range of impacts and a long time frame before the impacts of today's emissions will be fully experienced.
- GHG emissions dwarf the criteria pollutants and air toxics; emissions of GHGs typically outweigh the other pollutants on a mass basis by a factor of 1000 or more.
- The regulatory framework for GHGs is still a work in progress at the national and international level.

Despite these differences, there are compelling reasons from both the policy and the scientific perspective to address climate protection and GHGs in the CAP. The same emission sources are the primary contributors of both traditional air pollutants and GHGs; this provides a good opportunity to achieve co-benefits from control measures. Higher temperatures related to climate change can increase emissions of ozone precursors and intensify ozone formation, as discussed below. Also, reductions in some criteria pollutants, such as black carbon (a component of PM), ROG, and carbon monoxide will help to decrease the "radiative forcing" that drives global warming. Conversely, some technologies to reduce emissions of traditional pollutants increase energy use or decrease fuel economy and thus generate additional CO2 emissions; therefore, it is important to identify, analyze, and attempt to mitigate trade-offs of this nature.

The Air District officially established a climate protection program in June 2005. Since then, the District has made climate protection a key element in its mission and moved aggressively to integrate climate protection into its core programs and plans, as discussed in Chapter 3. In September 2006 the State of California enacted ground-breaking climate protection legislation, the Global Warming Solutions Act (AB 32). In December 2008, CARB adopted a wide-ranging climate scoping plan pursuant to AB 32. The Air District is

committed to using the full scope of its resources and authority to take actions within the Bay Area to help implement and complement the ARB scoping plan.

The range of impacts due to climate change is staggering, and most are beyond the direct scope of this plan. Nonetheless, it is essential that we address global warming in order to prevent, or at least reduce, potential negative impacts on air quality. Although it is difficult to predict how climate change at the global scale will impact air quality in the Bay Area, climate change has the potential to greatly exacerbate our air quality problems and undermine decades of progress in reducing criteria pollutants.

Impacts of Climate Change on Ozone Levels

There is irrefutable scientific evidence that the earth's atmosphere is getting hotter, that man-made emissions of carbon dioxide and other greenhouse gases are the primary cause of global warming, and that the effects of climate change are already being experienced in California and throughout the world.

Climate change is expected to have a direct and significant impact on ozone levels in the Bay Area and throughout the state. Simply stated, high temperatures lead to high ozone levels.
Bay Area emissions of CO2 and other GHGs contribute to climate change on the global scale; conversely, the Bay Area is impacted by emissions of GHGs from all parts of the world. Research suggests that global warming caused by world-wide emissions of GHGs could impact ozone levels through any and all of the following:

- higher temperatures;
- longer and more frequent heat waves;
- more frequent severe temperature spikes;
- increased length of the ozone season;
- increased VOC emissions from trees and other biogenic sources of VOCs, such as isoprene, and monoterpenes, due to higher temperatures;
- increased evaporative emissions of VOCs from storage tanks, solvents, motor vehicles, etc.
- change in ratio of VOC to NOx;
- increased atmospheric water vapor, higher humidity; and
- reduction in wind and vertical mixing that disperse pollutants

Potential Impacts on Bay Area Ozone Levels

Ozone monitoring data and the Air District's air quality modeling both show a strong correlation between extreme heat days and ozone exceedances. Air quality modeling by Air District staff suggests that an anticipated 2 degree Celsius increase in average temperatures

predicted from climate change would set back progress in reducing ozone by a decade.[34] A separate study by UC Berkeley researchers using computer modeling to simulate the impact of higher temperatures on ozone levels in central California found that within the study domain, Bay Area ozone levels may be the most impacted by higher temperatures, and that parts of the Bay Area could experience an increase in ozone concentrations of nearly 10%.[35] An increase of this magnitude could cripple efforts to attain ozone standards in the Bay Area. As shown in Figure 1-2, the years in which the Bay Area has greater numbers of ozone exceedances correlate very closely with the years when the region experiences higher temperatures.

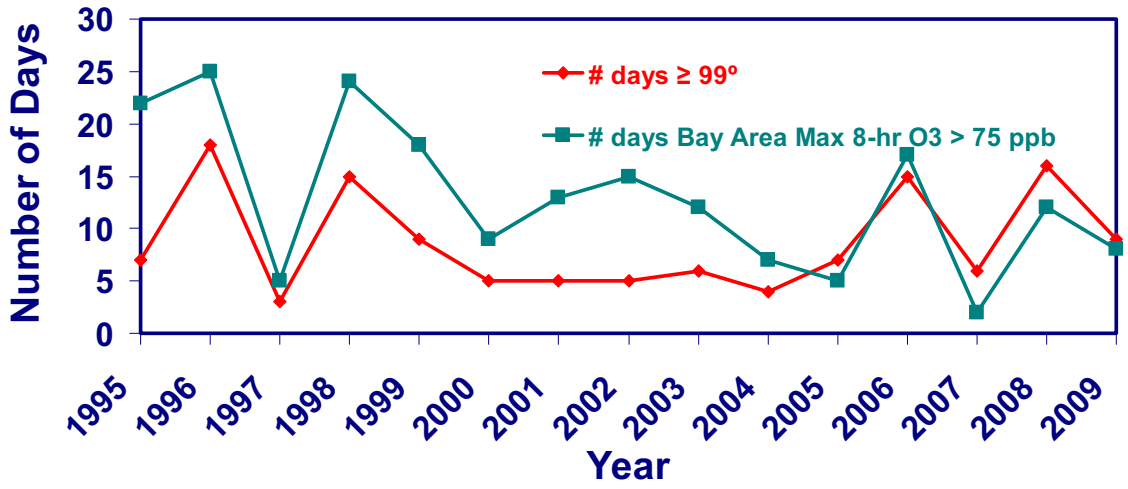


Figure 1-2. Correlation between # of high heat days and # of ozone exceedances in the Bay Area.

The correlation between high heat and increased air pollution is at the heart of the Air District's commitment to climate protection. Figure 1-3 shows several potential scenarios for the number of high heat days per year in coming decades, representing anywhere from a 3-fold to a 10-fold increase over current levels. All these scenarios, even the "low-warming" scenario, would mean a great increase in the number of ozone exceedance days in the Bay Area.

[34] See "The effects of climate change on emissions and ozone in Central California" by Su-Tzai Soong, Cuong Tran, David Fairley, Yiqin Jia, and Saffet Tanrikulu. Paper #590 presented in the 101st Annual Meeting, Air and Waste Management Association, June 24-26, 2008 Portland OR.

[35] Steiner, Allison et al. "Influence of future climate and emissions on regional air quality in California." Journal of Geophysical Research, Vol. 111. D183303, September 21, 2006.

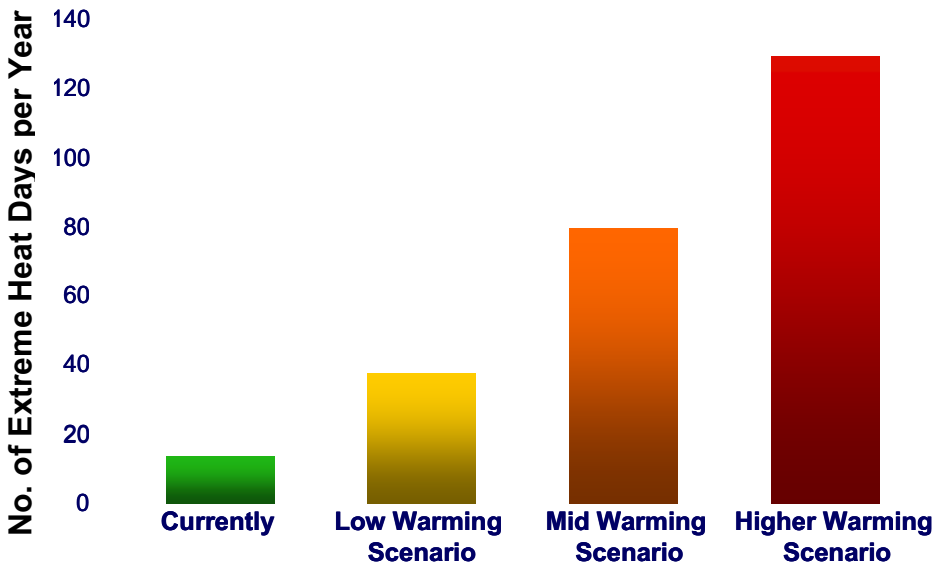


Figure 1-3. Number of extreme heat days per year projected for the San Francisco Bay Area: 2070-2099. (Source: Union of Concerned Scientists, 2006)

Impacts of Climate Change on PM and Air Toxics

Since benzene, 1,3-butadiene and some other air toxics are components of many VOCs, to the extent that those VOCs increase, so will these toxics. The potential impact of GHG emissions and climate change on other pollutants is still under investigation. However, climate change is likely to increase PM and other pollutants as well. For example, increased demand for air conditioning in buildings and vehicles may cause higher emissions of direct PM and PM precursors such as NOx and SO2 from power plants and vehicle engines.

Health Impacts Related to Climate Change

If climate change does, in fact, increase air pollution and impede efforts to attain ozone and PM standards in the Bay Area, this will have negative impacts on public health in years to come. But evidence suggests that climate change may already be degrading air quality and impacting public health in California and other western states due to an increase in the number and severity of wildfires, as a result of changes in the timing and quantity of precipitation, and reduction in mountain snowpack.[36]

[36] Westerling, A. L., H. Hidalgo, D.R. Cayan, and T. Swetnam, 2006: Warming and Earlier Spring Increases Western US Forest Wildfire Activity, *Science*, 313: 940-943. This study found that large wildfire activity increased suddenly and markedly in the mid-1980s, with greater frequency of large wildfires, longer wildfire durations, and longer wildfire seasons. The study concluded that this is strongly associated with increased spring and summer temperatures and an earlier spring snowmelt.

Increased wildfires, although episodic in nature, could prove to be one of the most dramatic impacts of global warming on air quality and public health, since large-scale fires can greatly increase population exposure to PM and other harmful pollutants. The outbreak of wildfires that swept across California in late June 2008 caused ambient concentrations of ozone and PM to soar to unprecedented levels.[37] A recent study found that the PM concentrations not only reached high levels, but that the PM released by these fires was much more toxic than the PM more typically present in the California atmosphere.[38] Acute episodes that combine high levels of PM with much more toxic PM could be especially dangerous to sensitive individuals with pre-existing lung conditions. In addition to these health effects, wildfires also release immense quantities of CO2 stored in trees and vegetation; thus, in an example of a negative feedback loop, fires provoked by global warming create yet more of the gases that exacerbate the problem.

Other impacts of climate change are also likely to have a negative effect on public health, including an increase in vector-borne diseases, and mortality directly caused by longer and more severe heat waves.

Addressing Climate Protection in the CAP

Although reducing greenhouse gas emissions to protect the climate is a key goal for this plan, the CAP is not intended to serve as a comprehensive regional climate protection plan. Instead, the CAP focuses on integrating climate protection into the control strategy to reduce criteria pollutants and air toxics. The CAP control strategy also proposes several new Energy & Climate Measures to reduce emissions of GHGs and mitigate the impacts of climate change.

Greenhouse gas emission inventory data and an analysis of GHG trends are provided in Chapter 2. Existing state, regional, and local efforts to protect the climate are briefly described in Chapter 3. The new Energy & Climate control measures, and other measures that help to reduce GHGs, are presented in Chapter 4. Chapter 5 summarizes how climate protection is addressed in the CAP.

[37] During the final week of June 2008, PM2.5 levels increased five or ten-fold compared to normal readings at several Bay Area monitoring stations.

[38] Wegesser et al. "California Wildfires of 2008: Coarse and Fine Particulate Matter Toxicity." *Environmental Health Perspectives* Volume 117, June 2009

Chapter 2 – Technical Foundation

Overview

Sound air quality planning requires a solid technical foundation. This chapter provides the technical underpinnings for the 2010 CAP. The first part of this chapter describes air quality standards and Bay Area attainment status for the various criteria pollutants, and provides an overview of the Air District's emissions inventories, as well as photo-chemical air quality modeling that has informed this plan. Profiles of each of the four major categories of air pollutants addressed in the CAP are provided in the remainder of this chapter. The profiles describe health impacts, emissions inventories, trends in ambient concentrations, and air quality modeling results, as appropriate, for:

- Ground-level ozone and ozone precursors: ROG [39] and NOx:
- Particulate matter (PM), both directly emitted and secondary PM
- Key air toxics, such as diesel PM and benzene
- The "Kyoto 6" greenhouse gases

Ambient Air Quality Standards and Bay Area Attainment Status

The federal Clean Air Act of 1970 directed US EPA to establish national ambient air quality standards (NAAQS), at a level to provide an adequate margin of safety to protect public health, for six air pollutants: ozone, carbon monoxide, sulfur dioxide, nitrogen dioxide, lead, and particulate matter. These six pollutants are commonly referred to as criteria pollutants because, in setting the NAAQS, US EPA develops a "Criteria Document" that summarizes the scientific evidence on the sources, concentrations, atmospheric dynamics, and health effects of a pollutant. After considering recommendations from an independent committee of experts – the Clean Air Science Advisory Committee (CASAC) - EPA staff presents a range of values for the standard, from which the EPA administrator selects the final standard. EPA is required to review and potentially revise the NAAQS every five years, in light of new scientific evidence.

The State of California also establishes air quality standards, referred to as "state standards" in this plan. State standards are determined by the California Air Resources Board (CARB), based on technical input from the Office of Environmental Health Hazard Assessment (OEHHA). In many cases, state standards are more stringent than national standards.

Air quality standards may be set for different time intervals, ranging from hourly averaged measurements to annual averages. There are multiple standards that apply to

[39] The term ROG (reactive organic gases) is used interchangeably with the term VOC (volatile organic compounds). ROG / VOC include hundreds of reactive hydrocarbon compounds.

some pollutants, such as ozone and PM. Determining whether an air basin attains a given standard requires comparing monitored pollutant values, such as an hourly peak or annual average, with the standard. For purposes of determining whether an air basin attains a given air quality standard, a metric called the *design value* is calculated for each monitoring station. The way the design value is calculated depends upon how the standard is defined; i.e. the "form of the standard." An air basin (e.g., the Bay Area) generally meets the standard for a given pollutant only if the design values for all monitoring sites do not exceed the standard.

Ambient concentrations of all six of the criteria pollutants have been greatly reduced in the Bay Area over the past four decades. The Bay Area attains all national and state standards for four of the six criteria pollutants - lead, carbon monoxide, sulfur dioxide, and nitrogen dioxide. In fact, as shown by the design values in Table 2-1, Bay Area concentrations are well below (i.e., much cleaner than) current standards for these four pollutants. However, the Bay Area does not yet attain standards for ozone and PM.

The national 8-hour ozone standard was lowered to 0.075 ppm in March 2008. US EPA is currently reviewing this standard and considering reducing it to somewhere in the range of 0.060 to 0.070 ppm. It is likely that the Bay Area will be designated as non-attainment when US EPA sets the revised national 8-hour ozone standard and completes the process to designate the attainment status for each air basin under the new standard. The Bay Area does not yet attain the 0.070 ppm State 8-hour ozone standard.

There are national and state standards for both fine PM (PM2.5) and coarse PM (PM10). There are separate standards for annual average PM and for maximum 24-hour concentrations. In 2002, California adopted an annual PM2.5 standard, but the State has yet to adopt a short-term 24-hour PM standard. Recent monitoring data indicates that the Bay Area meets the state annual PM2.5 standard,[40] but the region does not attain the state annual and 24-hour standards for PM10.

The Bay Area attains the national 24-hour PM10 standard and the national annual PM2.5 standard, but violates the national 24-hour PM2.5 standard. The national 24-hour PM2.5 standard was tightened to 35 $\mu g/m^3$ in 2006. The Bay Area was designated as non-attainment for this standard on November 13, 2009. The Air District will be required to prepare a PM2.5 State Implementation Plan (SIP) by December 2012.

Although there are national and state ambient air quality standards (AAQS) for the criteria pollutants, there are no AAQS for air toxics or greenhouse gases. Air toxics are regulated differently, as explained in the Air Toxics section below. Greenhouse gases

[40] Monitoring data shows that the Bay Area now complies with the State annual PM2.5 standard. However, because the region has not yet been re-designated as attainment for the State annual PM2.5 standard by CARB, the Bay Area is shown as non-attainment for this standard in Table 2-1.

are pollutants of a global nature. Although the State of California adopted the Global Warming Solutions Act (commonly referred to as AB 32) in 2006 to reduce emissions of greenhouse gases, the regulatory framework to address GHGs at the national and international level is still under development.

Table 2-1 summarizes current national and state standards, Bay Area attainment status, and Bay Area design values for the national standards for the six criteria pollutants.

Table 2-1. Standards for criteria pollutants, attainment status, and design values[a].

Pollutant	Averaging Time	California Standard[b]	Attainment Status	National Standard	Attainment Status	National Design Value[c] (2008)
Ozone	1-hour	0.09 ppm	N			
Ozone	8-hour	0.070 ppm	N	0.075 ppm – 3-yr average of 4th highest value	N[d]	0.081 ppm[e]
CO	1-hour	20 ppm	A	35 ppm – not to be exceeded > once per year	A	3.8 ppm
CO	8-hour	9 ppm	A	9 ppm – not to be exceeded > once per year	A	2.2 ppm
$PM_{2.5}$	24-hour			35 μg/m^3 – 3-year 98th percentile	N [f]	36 μg/m^3
$PM_{2.5}$	Annual	12 μg/m^3 – 3-year max	N	15 μg/m^3 – 3-year average	A	11.0 μg/m^3
PM_{10}	24-hour	50 μg/m^3	N	150 μg/m^3 [g]	U	78 μg/m^3
PM_{10}	Annual	20 μg/m^3	N			26 μg/m^3
SO2	1-hour	0.25 ppm	A			
SO2	24-hour	0.04 ppm	A	0.14 ppm – not to be exceeded > once per year	A	0.0101 ppm
SO2	Annual			0.030 ppm		0.0017 ppm
NO2	Annual	0.030 ppm	A	0.053 ppm	A	0.017 ppm
NO2	1-hour	0.18 ppm	A			0.073 ppm
Lead	Quarterly			1.5 μg/m^3	A	< 0.01 μg/m^3

* A = Attainment N = Non-Attainment U = Unclassified

[a] Design values are computed on a site-by-site basis. District design value is the highest design value at any individual monitoring site.

[b] California standards are nominally "not to be exceeded," but, other than for annual standards, in practice allow approximately 1 exceedance per year.

[c] The national design value is a statistic based on the monitored concentrations that can be compared with the corresponding standard. The standard is violated if the design value exceeds the standard.

[d] In June 2004, the Bay Area was designated as a marginal nonattainment area of the national 8-hour ozone standard. US EPA lowered the national 8-hour ozone standard from 0.80 to 0.75 PPM (or 75 ppb) in March 2008. US EPA is currently reviewing the 8-hour ozone standard, with a decision expected in July 2011.

[e] Preliminary data show the District's 2009 ozone design value as 0.78 ppm.

[f] US EPA tightened the national 24-hour PM2.5 standard from 65 to 35 μg/m^3 in 2006. The designation of the Bay Area as non-attainment for the 24-hr national PM2.5 standard became effective on December 14, 2009.

[g] The national 24-hour PM10 standard allows one exceedance per year over 3 years with every-day sampling. Because PM10 is sampled on a 1-in-6 day schedule, this means that, in practice, any exceedance would violate the standard.

BAAQMD Monitoring Network

The Air District's air monitoring program operates a network of 28 air monitoring stations to measure air quality levels in the Bay Area, as shown in Table 2-2. The monitoring network is designed to (1) provide the data required to determine the Bay Area's attainment status for both national and state ambient air quality standards; (2) provide air quality data to the public in a timely manner; and (3) support air pollution research and modeling studies. The monitoring network is evaluated and updated on a regular basis in response to changes in monitoring requirements, shifts in population, and other factors. The Air District revises its *Air Monitoring Network Plan* annually to describe changes and improvements to the monitoring network; this plan is available on the District web site. Table 2-2 shows the list of monitoring stations operated by the Air District in 2009.

Table 2-2. Bay Area monitoring stations and pollutants monitored in 2009.

Site	Location	Monitoring Objective *	Pollutants Monitored
1	Berkeley	Population Oriented, Source Impact	O_3, NO_2, SO_2, CO, HC, PM_{10}, $PM_{2.5cont}$, Toxics
2	Bethel Island	Regional Transport	O_3, NO_2, SO_2, CO, PM_{10}, Toxics
3	Concord	Population Oriented & Highest Concentration	O_3, NO_2, SO_2, CO, HC, PM_{10}, $PM_{2.5}$, Toxics
4	Crockett	Source Impact	SO_2, Toxics
5	Cupertino	Population Oriented & Source Impact	PM_{10cont}
6	Fairfield	Regional Transport	O_3
7	Fort Cronkhite	Background	Toxics
8	Fremont	Population Oriented	O_3, NO_2, CO, HC, PM_{10}, $PM_{2.5cont}$, Toxics
9	Gilroy	Population Oriented, Highest Concentration, & Regional Transport	O_3, $PM_{2.5cont}$
10	Hayward	Population Oriented & Regional Transport	O_3
11	Livermore	Highest Concentration	O_3, NO_2, CO, HC, PM_{10}, $PM_{2.5}$, $PM_{2.5cont}$, Speciated $PM_{2.5}$, Toxics
12	Los Gatos	Highest Concentration	O_3
13	Martinez	Source Impact	SO_2, Toxics
14	Napa	Population Oriented	O_3, NO_2, CO, PM_{10}, $PM_{2.5cont}$, Toxics
15	Oakland	Population Oriented	O_3, NO_2, CO, $PM_{2.5cont}$, Toxics
16	Oakland West	Population Oriented	NO_2, SO_2, CO, $PM_{2.5cont}$, Toxics, Black Carbon
17	Pt Reyes	General Background	$PM_{2.5cont}$
18	Pt Richmond	Source Impact	H_2S
19	Redwood City	Population Oriented	O_3, NO_2, CO, PM_{10}, $PM_{2.5}$, $PM_{2.5cont}$, Toxics
20	Richmond 7th	Source Impact	SO_2, H_2S, Toxics

Table 2-2 (continued). Bay Area monitoring stations and pollutants monitored in 2009.

Site	Location	Monitoring Objective *	Pollutants Monitored
21	Rodeo	Source Impact	H_2S
22	San Francisco	Population Oriented	O_3, NO_2, SO_2, CO, HC, PM_{10}, $PM_{2.5cont}$, $PM_{2.5}$, Toxics
23	San Jose	Population Oriented & Highest Concentration	O_3, NO_2, CO, HC, PM_{10}, $PM_{2.5}$, $PM_{2.5cont}$, Speciated $PM_{2.5}$, Toxics, Black Carbon
24	San Martin	Highest Concentration	O_3
25	San Pablo	Population Oriented	O_3, NO_2, SO_2, CO, PM_{10}, Toxics
26	San Rafael	Population Oriented	O_3, NO_2, CO, PM_{10}, $PM_{2.5cont}$, Toxics
27	Santa Rosa	Population Oriented	O_3, NO_2, CO, PM_{10}, $PM_{2.5}$, Toxics
28	Vallejo	Population Oriented	O_3, NO_2, SO_2, CO, PM_{10}, $PM_{2.5}$, $PM_{2.5cont}$, Speciated $PM_{2.5}$, Toxics

* Explanation of Monitoring Objectives in Table 2-2:

Population Oriented: Monitor in areas with high population density.

Highest Concentration: Monitor in areas expected to have the highest concentrations.

Source Impact: Monitor downwind of major stationary sources, such as the five Bay Area oil refineries: Chevron, Shell, Tesoro, Conoco-Phillips, and Valero.

General Background: Monitor in area with no significant emissions from mobile, area, or industrial sources, in order to establish background concentrations.

Regional Transport: Monitor along boundaries with other air districts to measure concentrations of pollutants transported into and out of the Bay Area.

A map showing the 2009 Bay Area monitoring network is shown in Figure 2-1.

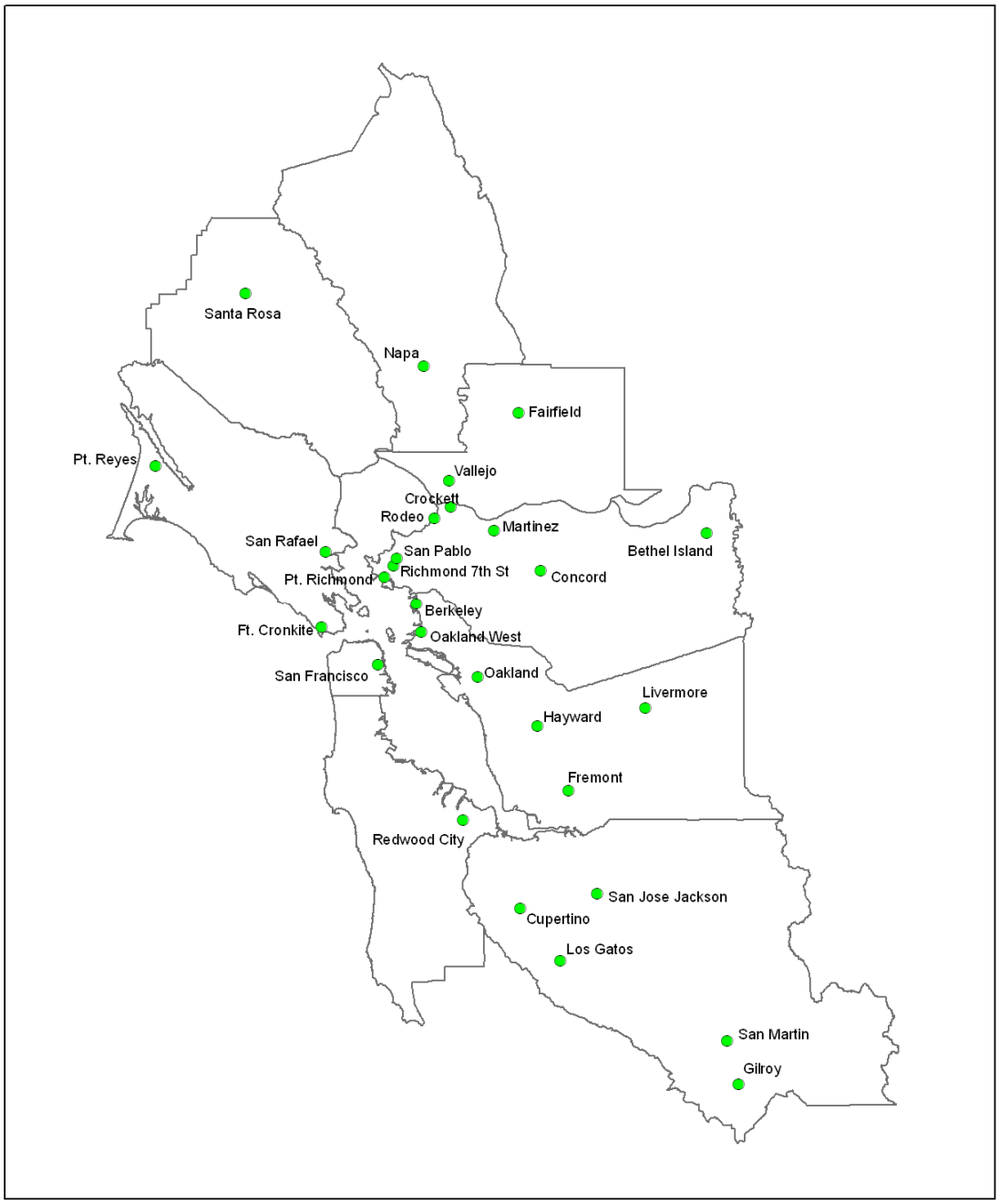


Figure 2-1. 2009 BAAQMD Air Monitoring Network.

Emission Sources

The major categories of emission sources are described in this section. For some pollutants, such as ROG, there are biogenic (natural) sources of emissions, as well as anthropogenic (man-made) sources. However, emissions inventories and control

strategies focus on anthropogenic emissions, since these are most readily subject to control.

The two most basic emission source categories of anthropogenic emissions are stationary sources and mobile sources. Stationary sources include both point sources and area sources. Point sources are those that are identified on an individual facility or source basis, such as refineries and manufacturing plants. For point sources, the District's inventories are based on a computer data base with detailed information on operations and emissions characteristics for nearly 4,000 facilities, with roughly 20,000 different sources, throughout the Bay Area. Data on the activity, seasonal variations, and hours of operation are collected at the process level from each facility. Parameters that affect the quantities of emissions are updated regularly. The emissions from general processes, such as combustion, are computed using generalized or specific emission factors.

Area sources are stationary sources that are individually small, but collectively make a significant contribution to the inventory. Many area sources do not require permits from the Air District, such as residential furnaces and water heaters, and consumer products including paints, solvents, and cleaners. However, some facilities considered to be area sources, such as gas stations, do require permits from the Air District. Emissions estimates for area sources may come from the Air District's data base, from CARB calculations based on statewide data, or from calculations based on surrogate variables such as population.

Mobile sources include on-road motor vehicles such as automobiles, trucks and buses, as well as off-road sources such as construction equipment; boats, ships, trains and aircraft; and small non-road engines including lawn and garden equipment. Estimates of on-road motor vehicle emissions include consideration of the number of vehicles and the fleet mix (vehicle type, model year, and accumulated mileage); miles traveled; ambient temperatures; vehicle speeds; and vehicle emission factors, as developed from Smog Check data, Caltrans vehicle counts, and CARB testing programs.

On-road motor vehicle emissions estimates are based on CARB's latest available emission factor model (EMFAC 2007, Version 2.3, November 2006). Bay Area emission factors incorporate projected growth in vehicle miles of travel (VMT) for the Bay Area developed by the Metropolitan Transportation Commission (MTC) from its travel demand model for the Transportation Air Quality Conformity Analysis of the Regional Transportation Plan 2030 (RTP 2030). MTC's travel demand model utilizes regional demographic forecasts from ABAG's socio-economic and population projections, in this case, Projections 2007.

Off-road mobile sources include boats, ships, trains, and aircraft, as well as garden, farm and construction equipment. Various methodologies are used for compilation of emissions for these mobile sources. Emission factors and methodologies for off-road

mobile sources are calculated from information provided by CARB and EPA. Aircraft mix and activity data specific to each Bay Area airport are used in estimating airport emissions.

Emissions Subject to Air District Control

The Air District has direct regulatory authority over stationary and certain area sources, which account for only a relatively small portion of the sources that comprise the Bay Area emissions inventory. This is especially true in the case of ROG and NOx, which are precursors to the formation of both ozone and secondary PM. In California, CARB establishes emissions standards for on-road and off-road vehicles, as well as vehicles fuels and consumer products. US EPA is responsible for establishing emission standards for ships, aircraft, and locomotives. Therefore, progress in reducing both emissions and concentrations in the Bay Area will depend to a great extent upon actions at the State and federal levels to reduce emissions from sources under their control.

In Figures 2-2 through 2-4 "District jurisdiction" includes stationary and area sources, such as factories, refineries, gas stations, commercial cooking, and wood-burning; "CARB jurisdiction" refers to on-road and off-road vehicles and equipment; and "Federal jurisdiction" includes ships, locomotives, and aircraft. In Figure 2-4, "Non-Regulated" emissions of PM2.5 include dust from construction and farming operations, dust from paved and unpaved roads, other geologic dust, and PM from wildfires.

Although it has no direct authority over motor vehicle emissions, the Air District does work, in partnership with MTC, ABAG, and other agencies, to implement programs to reduce motor vehicle travel and promote the use of clean vehicle technologies, as described in the Mobile Source Measures and the Transportation Control Measures components of the CAP control strategy.

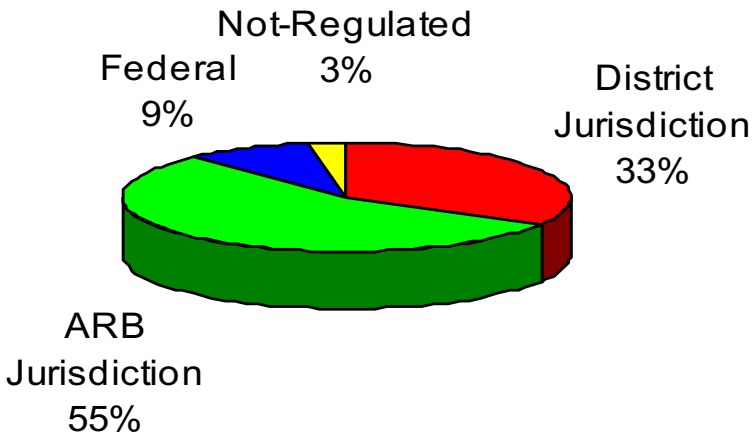


Figure 2-2. Reactive organic gases (ROG), 2009 annual average emissions (344 tons/day).

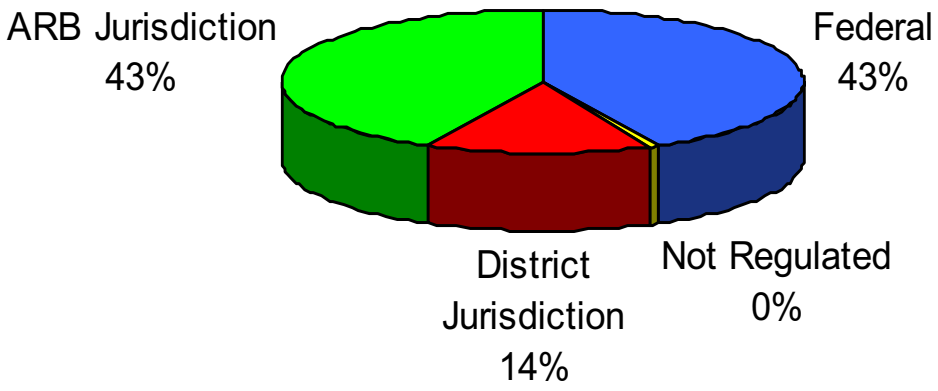


Figure 2-3. Oxides of nitrogen (NOx), 2009 annual average emissions (460 tons/day).

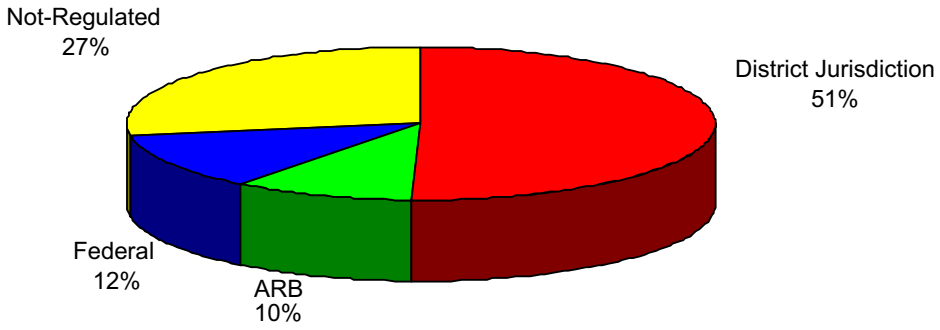


Figure 2-4. Directly emitted $PM_{2.5}$, 2009 annual average emissions (87 tons/day).

Emissions Inventories

Emissions inventories are essential tools for air quality planning. Inventories identify source categories and provide estimates of emissions from each source. Emissions inventories undergo constant refinement in order to reflect changes in emission factors (such as turnover in the vehicle fleet), economic and demographic trends, and rule-making activity. Emissions inventories are used to perform air quality modeling, to identify source categories where there may be opportunities for additional emission reductions, and to estimate potential emission reductions for control measures under consideration. Developing inventories and emission factors for all the pollutants addressed is one of the key technical prerequisites needed to prepare a multi-pollutant air quality plan.

The Air District develops and maintains detailed emissions inventories for a variety of pollutants, including ROG, NOx, PM2.5, and PM10. In recent years, the Air District has also developed an air toxics inventory, as well as an ammonia inventory (ammonia is a key precursor to secondary formation of PM). In November 2006, the Air District became the first air quality agency in the nation to develop a detailed regional greenhouse gas inventory; the GHG inventory was updated in December 2008.

Emissions inventories can be prepared for different seasons (summer or winter) or based on annual average emissions. For purposes of ozone planning, it is customary to use the summer emissions inventory, since this is when ozone exceedances normally occur. For PM planning, the winter emissions inventory is normally used, because PM exceedances typically occur during winter months. Since the 2010 CAP addresses both ozone and PM, Air District staff decided, after consulting with CARB air quality planning staff, to use the annual average inventory in order to avoid potential confusion related to differences between the summer and winter inventories.

Emissions inventories for the various pollutants are described in detail in the profiles of ozone, PM, air toxics, and greenhouse gases provided below. Overall, the emission inventories for criteria pollutants and air toxics have shown a steady downward trend in recent decades. This reflects the combined effect of state and regional programs to reduce emissions, including the Air District's regulations to reduce emissions from stationary sources, CARB programs to reduce emissions from mobile sources, and turnover in the motor vehicle fleet whereby older, high-emitting vehicles are replaced by new vehicles that meet stringent CARB emissions standards. Looking forward, emissions from motor vehicles will continue to decline on a per-mile basis, primarily due to turnover in the vehicle fleet, in combination with CARB regulations to reduce emissions from heavy-duty vehicles, as described in Chapter 3. However, this progress will be offset, at least in part, by continued growth in total vehicle travel in the region.

Whereas emissions of criteria pollutants and air toxics have been decreasing, emissions of CO2 and other greenhouse gases have been increasing, and would be projected to continue to increase under a "business as usual" scenario.

Photochemical Modeling

The Air District has extensive in-house photochemical modeling capabilities. The Air District applies photochemical models to simulate ozone, air toxics, and PM. Ozone modeling started in 1989, air toxics modeling in 2005, and PM modeling in 2008. Model applications and types of models used depend on a number of factors, including Air District needs, U.S. EPA and CARB requirements, staff expertise, availability of appropriate models, and the nature of the problems being investigated.

Although no air quality modeling was required to be performed for the 2010 CAP, results of the Air District's recent modeling work were used in developing the 2010 CAP. In particular, results of photochemical modeling were used for the first time to help evaluate the air quality and health impacts of emission control measures on a multi-pollutant basis. Modeling to show how changes in emissions of ozone precursors, PM, and toxics affect ambient concentrations of these pollutants was essential to the development of the Multi-Pollutant Evaluation Method (MPEM) described in Chapter 1.

In coming years, the Air District intends to develop the capacity to perform integrated "one atmosphere" air quality modeling for ozone, PM, toxics, and greenhouse gases. This will improve our multi-pollutant planning capabilities. Integrated modeling will require a modeling platform based upon unified, full-year, multi-pollutant emission inventories; a single modeling system; and full-year meteorological fields.[41]

Results of modeling performed for ozone, PM, wood smoke, and air toxics are briefly summarized in the respective pollutant profile sections below. A more detailed description of the Air District's modeling work is provided in Appendix E.

Profiles of Pollutants Addressed in the CAP

A profile of each of the four pollutant categories addressed in the CAP is provided below.

Ozone

Ozone (O3), a powerful oxidant, is harmful to public health at high concentrations near ground level.[42] Ozone can damage the tissues of the lungs and respiratory tract. High concentrations of ozone irritate the nose, throat, and respiratory system and constrict the airways. Ozone also can aggravate other respiratory conditions such as asthma, bronchitis, and emphysema, causing increased hospital admissions. Repeated exposure to high ozone levels can make people more susceptible to respiratory infection and lung inflammation and permanently damage lung tissue. Ozone can also have negative cardiovascular impacts, including chronic hardening of the arteries and acute triggering of heart attacks. Children are most at risk, as they tend to be active and outdoors in the summer, when ozone levels are highest. Seniors and people with respiratory illnesses are also especially sensitive to ozone's effects. Even healthy adults, working or exercising outdoors during high ozone levels, can be affected.

Ozone also damages leaf tissue in trees and other plants, and reduces yields of agricultural crops. [43] This reduces the ability of trees and plants to photosynthesize and produce their own food. Ozone can also cause substantial damage to a variety of materials such as rubber, plastics, fabrics, paint, and metals. Exposure to ozone progressively damages both the functional and aesthetic qualities of materials and products, and shortens their life spans. Damage from ozone exposure can result in

[41] The availability of modeling results that cover an entire year would eliminate the need to extrapolate episodic modeling results to the full year (as was done for the MPEM used in the 2010 CAP).

[42] While ground-level ozone is a harmful air pollutant, ozone in the upper atmosphere is beneficial because it blocks the sun's harmful ultraviolet rays. The 2010 Clean Air Plan addresses ground-level ozone only.

[43] In fact, the need to reduce damage to orchards in the Santa Clara Valley was a major factor in the creation of the Bay Area AQMD in 1955, when agriculture was still the backbone of the economy in the South Bay.

significant economic losses as a result of the increased costs of maintenance, upkeep, and replacement of these materials.

Ozone Dynamics

Ozone is not emitted directly from pollution sources. Instead, ozone is formed in the atmosphere through complex chemical reactions in the presence of sunlight between two types of precursor chemicals: hydrocarbons, often referred to as "reactive organic gases" (ROG), and nitrogen oxides (NOx). As air temperatures rise, the formation of ground-level ozone increases at an accelerated pace. Ozone levels are usually highest on hot, windless summer afternoons, especially in inland valleys.

Ozone is a regional pollutant. Emissions of ROG and NOx throughout the Bay Area contribute to ozone formation. Because emissions in one part of the region can impact air quality miles away, efforts to reduce ozone levels focus on reducing emissions of ROG and NOx throughout the region.

The relationship between ROG and NOx in ozone formation is complex; the ratio between the precursor pollutants influences how ozone forms. The Air District's ozone modeling indicates that the Bay Area is "ROG-limited" for ozone formation. This means that reducing ROG emissions will be more productive in reducing ozone, at least in the near term. However, modeling also suggests that large reductions in NOx emissions will be needed to achieve the steep ozone reductions required to attain the very stringent ozone standards.

A certain amount of ozone formation occurs naturally, even in the absence of anthropogenic emissions of ROG and NOx. This natural ozone is referred to as the "background level." Locally, background ozone appears to have increased, perhaps due to reductions in other pollutants: some air pollutants react with and eliminate ozone, sometimes reducing ambient concentrations.[44] Also, as discussed in Chapter 1, increasing emissions of methane at the global scale may be increasing background levels of ozone. In the recent past, ozone standards were roughly three times higher than background levels. Because ozone standards have been tightened, the standards are now less than twice the estimated background level, and may be reduced to even more stringent levels in the future.

Ozone formation in the Bay Area is strongly influenced by the location and strength of the Eastern Pacific High Pressure System. During the summer months, this system normally develops over the Pacific Ocean and travels towards the east. From time to time, depending upon its strength and route of travel, it blocks westerly airflow exiting the Bay Area into the Central Valley and develops meteorological conditions conducive to ozone production: light winds, high temperatures, sunny and clear sky conditions, and a shallow mixing layer. When these conditions occur in mid-summer, typically airflow from the core Bay Area penetrates into the Livermore Valley through the I-680

[44] For example, NO combines with O3 (ozone) to produce NO2 and O2.

corridor from the north and various gaps along the East Bay ridge from the west, carrying polluted air and causing ozone exceedances. At other times, especially in early or late summer, airflow with a weaker westerly push that is unable to cross the East Bay ridge flows southward, causing ozone exceedances in the Santa Clara Valley. San Martin is frequently the exceedance site in the Santa Clara Valley under these conditions.

Sources of Ozone Precursors – Emissions Inventory

There are literally millions of sources of ozone precursors in the Bay Area, including industrial and commercial facilities, motor vehicles, and consumer products such as household cleaners and paints. Even trees and plants produce ozone precursors. Sources of ozone precursors produced by human activity are called "anthropogenic" while natural sources, produced by plants and animals, are called "biogenic". In the Bay Area, emissions from anthropogenic sources are higher than from biogenic sources.

The main sources of ROG emissions in the Bay Area are motor vehicles and evaporation of solvents, fuels and other petroleum products, as shown in Figure 2-5. The main sources of NOx are motor vehicles and combustion at industrial and other facilities, as shown in Figure 2-6.

The Bay Area annual average emission inventory for ozone precursors, ROG and NO_X is presented in Table 2-3.[45] The inventory is based upon CARB EMFAC 2007, Version 2.3 and reflects the effect of regulations adopted as of December 31, 2006. The inventories do not include additional emissions reductions from State or federal measures adopted since 2007 or CARB's "Pavley regulations" to reduce greenhouse gases from motor vehicles. Estimated emission reductions of ROG, NOx, and PM from CARB regulations not reflected in the current inventory are shown in Table 3-10.

[45] Summer and winter emissions inventories are provided in the "Base Year 2005 Emissions Inventory Summary Report" issued by BAAQMD in December 2008. See www.BAAQMD.gov

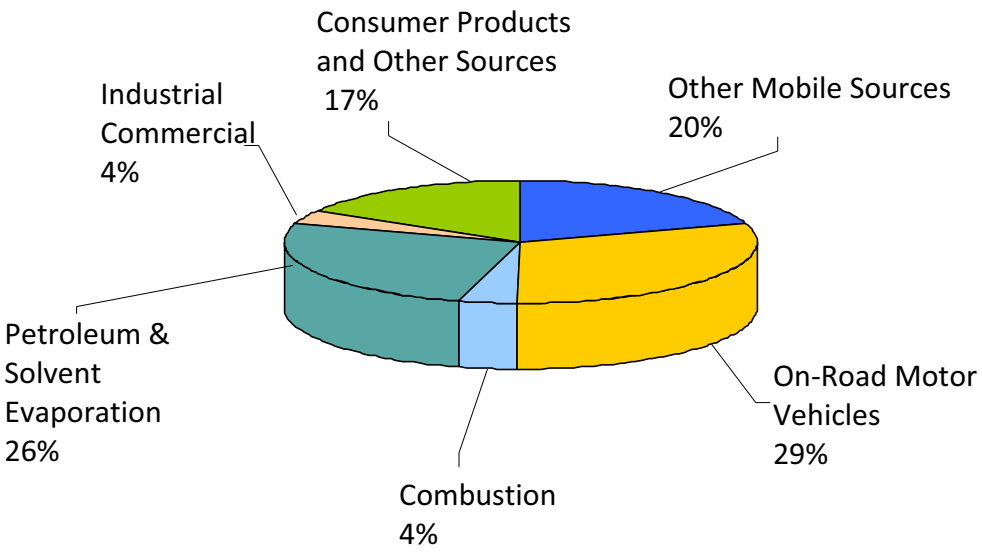


Figure 2-5. ROG anthropogenic emissions by source, 2009.

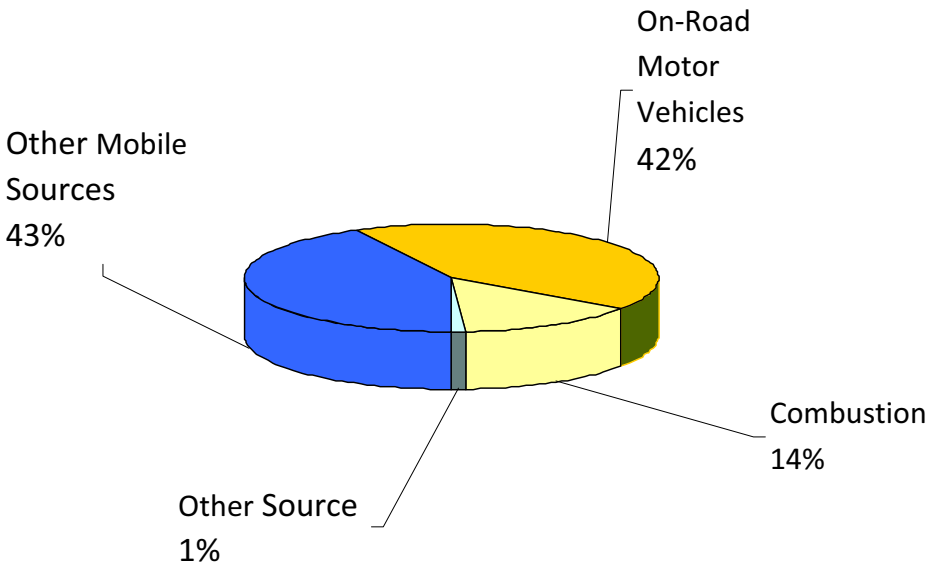


Figure 2-6. NOx emissions by source, 2009.

Table 2-3. Bay Area inventory 2005-2020, ROG & NO_x.

Bay Area Baseline [1] Emission Inventory Projections: 2005 - 2020										
Annual Average Inventory [2] (Tons/Day) [3]										
	Reactive Organic Gases [4]					Oxides of Nitrogen [5]				
SOURCE CATEGORY	**2005**	**2009**	**2012**	**2015**	**2020**	**2005**	**2009**	**2012**	**2015**	**2020**
PETROLEUM PRODUCT/SOLVENT EVAPORATION										
Storage Tanks	3.4	3.6	3.7	3.8	4	--	--	--	--	--
Loading Operations	0.1	0.1	0.1	0.1	0.1	--	--	--	--	--
Subtotal	**3.5**	**3.6**	**3.8**	**3.9**	**4.1**	**--**	**--**	**--**	**--**	**--**
FUELS DISTRIBUTION										
Natural Gas Distribution	0.6	0.6	0.7	0.7	0.8	--	--	--	--	--
Bulk Plants & Terminals	3.1	1.8	1.8	1.9	1.8	--	--	--	--	--
Trucking	3.2	3	2.9	2.9	2.8	--	--	--	--	--
Gasoline Filling Stations	7.5	5.8	5.5	5.3	5	--	--	--	--	--
Aircraft Fueling	2.8	2.6	2.6	2.5	2.5	--	--	--	--	--
Recreational Boat Fueling	0.9	0.9	0.9	1	1	--	--	--	--	--
Portable Fuel Container Spillage	6.7	4.1	3.3	2.8	2.3	--	--	--	--	--
Other Fueling	0.3	0.3	0.3	0.3	0.4	--	--	--	--	--
Subtotal	**25.1**	**19.2**	**18**	**17.3**	**16.6**	**--**	**--**	**--**	**--**	**--**
OTHER ORGANIC COMPOUNDS EVAPORATION										
Cold Cleaning	3.1	3.2	3.3	3.4	3.6	--	--	--	--	--
Vapor Degreasing	--	--	--	--	--	--	--	--	--	--
Hand wiping	3.3	2	1.8	1.9	2	--	--	--	--	--
Dry Cleaners	--	--	--	--	--	--	--	--	--	--
Printing	3	3.1	3.1	3.2	3.3	--	--	--	--	--
Adhesives & Sealants	9.2	9.5	9.6	9.6	9.7	--	--	--	--	--
Structures Coating	23	23.8	24.2	24.7	25.4	--	--	--	--	--
Industrial/Commercial Coating	13.6	13.8	14.1	14.5	15.2	--	--	--	--	--
Storage Tanks	0.8	0.8	0.9	0.9	1	--	--	--	--	--
Lightering & Ballsting	1.9	2.2	2.4	2.6	2.9	--	--	--	--	--
Other Organics Evaporation	1.8	2	2.1	2.2	2.3	--	--	--	--	--

Table 2-3 (continued). Bay Area inventory 2005-2020, ROG & NO_x.

	Reactive Organic Gases [4]					Oxides of Nitrogen [5]				
SOURCE CATEGORY	**2005**	**2009**	**2012**	**2015**	**2020**	**2005**	**2009**	**2012**	**2015**	**2020**
COMBUSTION - STATIONARY SOURCES										
FUELS COMBUSTION										
Domestic	9	9.3	9.6	9.8	10.3	14.4	14.9	15.2	15.6	16.2
Cogeneration	1.4	1.4	1.5	1.5	1.6	4.1	4.2	4.2	4.3	4.6
Power Plants	--	0.1	0.1	0.1	0.1	1.7	2.2	2.2	2.3	2.5
Oil Refineries External Combustion	0.5	0.5	0.5	0.5	0.6	13.7	14.2	14.7	15.1	15.9
Glass Melting Furnaces - Natural Gas	--	--	--	--	--	1.4	1.4	1.5	1.6	1.7
Reciprocating Engines	0.8	0.7	0.6	0.5	0.4	7.7	7.1	6.8	6.5	5.9
Turbines	0.1	0.1	0.1	0.1	0.1	1.6	1.6	1.6	1.7	1.8
Landfill/Cement Plant Combustion	1.2	1.3	1.3	1.4	1.4	16.7	15.3	15.8	16.3	17.1
Subtotal	**13**	**13.3**	**13.6**	**13.9**	**14.5**	**61.2**	**60.9**	**61.9**	**63.2**	**65.6**
BURNING OF WASTE MATERIALS										
Incineration	0.1	0.1	0.1	0.1	0.1	0.3	0.3	0.3	0.3	0.3
Planned Fires	0.3	0.3	0.3	0.3	0.4	0.2	0.2	0.2	0.2	0.2
Subtotal	**0.4**	**0.4**	**0.4**	**0.4**	**0.4**	**0.4**	**0.4**	**0.4**	**0.5**	**0.5**
Banked Emissions 6	**0**	**9.5**	**9.5**	**9.5**	**9.5**	**0**	**7.2**	**7.2**	**7.2**	**7.2**
Alternative Compliance Allowance 7	**0**	**0**	**0**	**0**	**0**	**0**	**4.9**	**4.9**	**4.9**	**4.9**
Subtotal (District Jurisdiction)	**120.2**	**124.4**	**125.3**	**127.1**	**130.5**	**63.8**	**75.8**	**77**	**78.4**	**80.9**
COMBUSTION-MOBILE SOURCES										
ON-ROAD MOTOR VEHICLES										
Passenger Cars	66.3	45.1	33.2	25.6	18.6	52.4	35.4	26	19.3	12.5
Light Duty Trucks<6000lbs	41.3	33.6	29.2	25.4	20.5	50.4	36.9	29.8	23.9	16.5
Medium Duty Trucks 6001-8500 lbs	6	5	4.7	4.5	4.1	11.7	8.7	7.3	6.1	4.4
Light Heavy Duty Trucks 8501-14000lbs	5.2	4	3.4	3	2.5	12	10.2	8.8	7.9	6.6
Medium Heavy Duty Trucks 14001-33000lbs	4.4	3.2	2.4	1.9	1.3	31.7	26.3	20.8	15.9	10.1
Heavy Heavy Duty Trucks>33000 lbs	5.3	4.2	3.3	2.6	1.8	56.1	45.7	34.8	26	16.9
School/Urban Buses	1.2	1.1	1.1	1.1	1.1	16.4	16	15.8	15	14.1
Motor-Homes	0.4	0.3	0.2	0.2	0.1	1.3	1.1	1	0.8	0.5
Motorcycles	8.4	7.5	7	6.9	6.9	1.9	2	2	2.1	2.1
Subtotal	**138.5**	**103.9**	**84.6**	**71.0**	**56.6**	**233.7**	**182.3**	**146.3**	**116.9**	**83.7**

Table 2-3 (continued). Bay Area inventory 2005-2020, ROG & NO_x.

	Reactive Organic Gases [4]					Oxides of Nitrogen [5]				
SOURCE CATEGORY	**2005**	**2009**	**2012**	**2015**	**2020**	**2005**	**2009**	**2012**	**2015**	**2020**
OFF-HIGHWAY MOBILE SOURCES										
Lawn and Garden Equipment	19.5	16.5	15.1	14	12.9	2.9	2.4	2.3	2.2	2.2
Transportation Refrigeration Units	2.4	1.7	1.1	0.8	0.8	4.6	5.1	5.7	5.6	5.6
Agricultural Equipment	1.6	1.3	1	0.8	0.5	7.4	6.2	5.2	4.2	2.7
Construction and Mining Equipment	12.2	9.8	8.4	7.3	5.7	72.9	62.9	54.5	45.1	30.7
Industrial Equipment	3.7	2.6	2.1	1.8	1.6	20.7	15.6	12.8	10.6	8.3
Light Duty Commercial Equipment	7	5.7	4.8	4	3.3	7.9	7.1	6.5	5.6	4.4
Trains	1.1	1	1	1	1.1	13.8	11.9	12.8	13.1	13.8
Off Road Recreational Vehicles	1	0.8	0.8	0.9	1	0.1	--	--	--	0.1
Ships [8]	1.8	2.1	2.3	2.5	2.9	41.3	47	51.8	57.1	67.2
Commercial Boats	3	2.8	2.5	2.2	2.1	24.7	22.1	20	17.2	16.2
Recreational Boats	18.3	16.7	15.8	15.3	15.1	3.6	4.1	4.1	4.1	4.3
Subtotal	**71.6**	**60.8**	**54.9**	**50.5**	**47.1**	**199.8**	**184.4**	**175.7**	**164.9**	**155.4**
AIRCRAFT										
Commercial Aircraft	1.9	2.9	3.6	4.2	5.1	12.1	18.9	21.3	22.3	24.3
General Aviation	0.7	0.7	0.7	0.8	0.8	0.2	0.4	0.4	0.5	0.5
Military Aircraft	3.3	3.3	3.4	3.4	3.4	4.9	4.9	5	5	5.1
Airport Ground Support Equipment	0.9	1	1	1.1	1.2	3.8	4.1	4.3	4.5	4.9
MISCELLANEOUS OTHER SOURCES										
Construction Operations	--	--	--	--	--	--	--	--	--	--
Farming Operations	--	--	--	--	--	--	--	--	--	--
Entrained Road Dust-Paved Roads	--	--	--	--	--	--	--	--	--	--
Entrained Road Dust-Unpaved Roads	--	--	--	--	--	--	--	--	--	--
Wind Blown Dust	--	--	--	--	--	--	--	--	--	--
Animal Waste	5.5	5.5	5.5	5.5	5.5	--	--	--	--	--
Agricultural Pesticides	0.8	0.8	0.8	0.8	0.8	--	--	--	--	--
Non-Agricultural Pesticides	0.2	0.2	0.2	0.2	0.2	--	--	--	--	--
Consumer Products(Excluding Pesticides)	45.2	46.7	47.9	49.1	51.2	--	--	--	--	--
Other Sources	4	3.6	3.6	3.7	3.7	2.2	2	2	2	2
Subtotal	**55.6**	**56.8**	**58**	**59.2**	**61.3**	**2.2**	**2**	**2**	**2**	**2**
GRAND TOTAL EMISSIONS	**393**	**354**	**331**	**317**	**306**	**521**	**473**	**432**	**394**	**357**

Notes for Table 2-3

1. Inventory and projections are based upon CARB EMFAC 2007, Version 2.3 and assume implementation of all control measures adopted as of December 31, 2006, including Smog Check II for the Bay Area.
2. The annual average inventory represents average day emissions. ABAG Projections 2007 were used to project future emissions from on-road motor vehicles and for the regional population projections used for the planning inventory.
3. Entries are rounded to nearest whole number, totals may not equal to sums of column entries.
4. A photochemically reactive organic compound excludes methane and other non-reactives and roughly 160 tpd of ROG emissions from natural sources.
5. Oxides of nitrogen (nitric oxide and/or nitrogen dioxide), NOx as NO2.
6. Banked Emissions show the total current deposits in the District's emissions banking program as allowed by BAAQMD Regulation 2, Rules 2 and 4. These emissions were reduced (beyond regulations) and banked, but may be withdrawn from the bank and emitted in future years.
7. Surplus emissions, voluntarily reduced, available for alternative compliance with BARCT requirements of selected rules, as prescribed by State law and BAAQMD Regulation 2, Rule 9.
8. California Air Resources Board (CARB) has recently developed statewide emissions estimates for ocean-going vessels (OGVs) occurring within 100 nautical miles of the California coastline. As a result, these emissions are substantially higher than those reported in the previous version of the inventory published in the 2005 Ozone Strategy, which accounted for ship activities within three miles of the Golden Gate Bridge.

Trends in ROG and NOx Emissions

Emissions of ROG and NOx have both been greatly reduced in recent decades. However, ROG emissions have been reduced much faster than NOx. Since the early 1980's, ROG emissions have been reduced by about 75%, compared to about 50% for NOx. This reflects the fact that in the 1970-2000 period CARB focused on reducing emissions from light-duty vehicles; light-duty vehicles are a major source of ROG emissions, whereas heavy-duty vehicles are the primary source of NOx emissions. Since diesel engines currently account for more than half (57%) of total NOx emissions in the Bay Area, CARB regulations to reduce emissions of NOx (and PM) from heavy-duty diesel engines, as described in Chapter 3, will be very beneficial in reducing ozone levels.

As shown in Figures 2-7 and 2-8, emissions of ROG and NOx in the Bay Area are projected to continue to decline in future years. These projections reflect the impact of regulations in place as of December 31, 2006. More recent regulations, as well as control measures identified in this CAP, will further reduce emissions in the future.

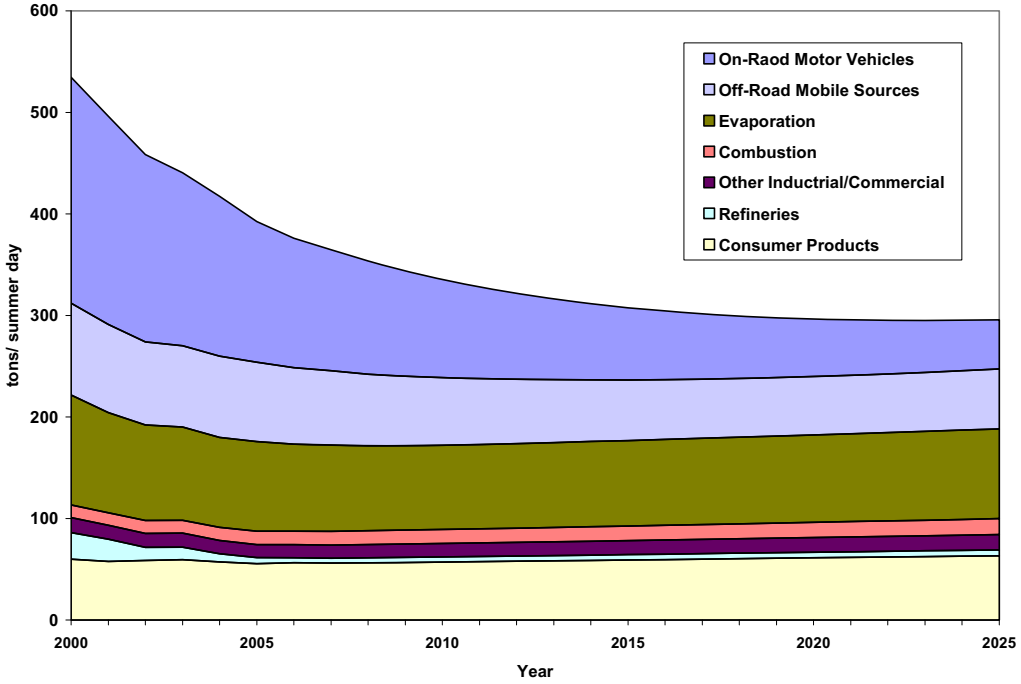


Figure 2-7. Annual average ROG emissions trend: 2000-2025.

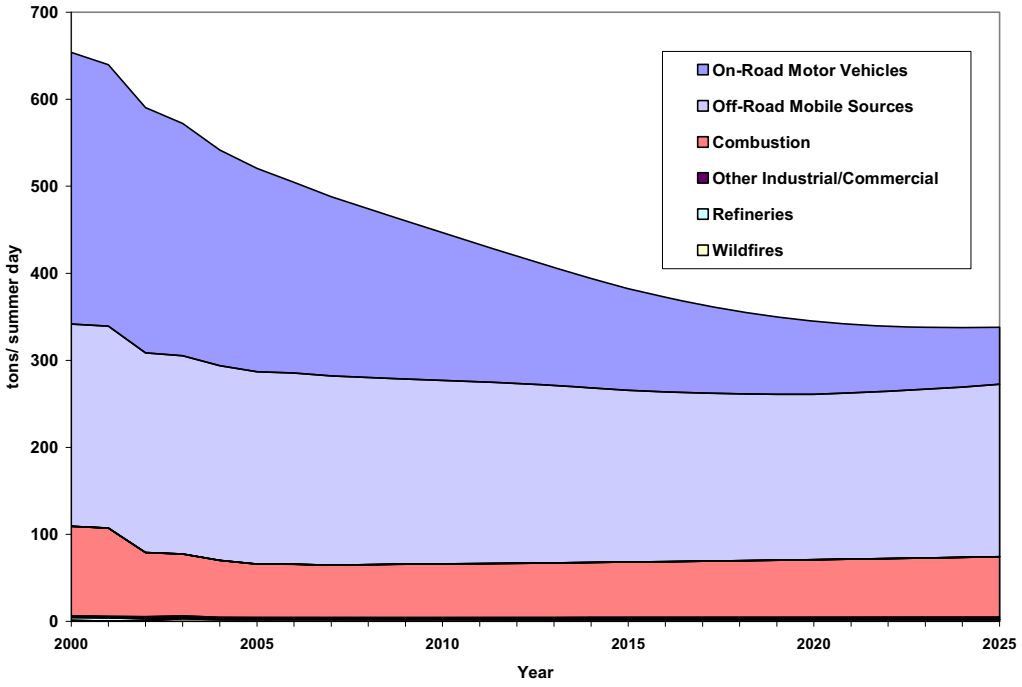


Figure 2-8. Annual average NOx emissions trend: 2000-2025.

In addition to anthropogenic sources of ozone precursors, there are significant quantities of biogenic emissions of ROG from natural sources like plants and animals. Vegetation emits large amounts of isoprene, terpenes, and other organic compounds that act as ozone precursors. Emission rates depend upon species, season, biomass density, time of day, local temperature, moisture and other factors. Total ROG emissions from natural sources in the Bay Area amounts to roughly 105 tons per day on an annual average basis (160 tpd in the summer inventory). Biogenic emissions are not included in the planning emissions inventory because they are generally not subject to control, but these emissions do contribute to ozone formation, and are therefore included in ozone modeling. As discussed in the section on climate change in Chapter 1, higher temperatures due to global warming are likely in increase biogenic emissions of ROG, which will contribute to increased ozone formation.

Trends in Ozone Concentrations

Health and Safety Code Section 40924(b)(1) requires the Air District to assess its progress toward attainment of the California ambient air quality standard for ozone during the most recent triennial period. The analysis in this section examines progress made in the period 2006-08 from the base years 1986-88 and from 1997-99.

Monitoring Data

A basic indicator of air quality trends is the number of days that the region exceeded air quality standards. Table 2-4 shows the annual number of exceedances of the current 0.09 ppm California 1-hour ozone standard at each ozone monitoring station for the 1987-2009 period.

Figure 2-9 shows the annual number of days over the standard at any station during the same period. The figure shows large fluctuations in the numbers of exceedances from year to year. Note, for example, that between 1996 and 1998 the number of exceedances drops from 45 to 10 and then rises to 29. Most of this short-term variation is weather-related. Ozone exceedances only occur on hot, relatively stagnant days, the number of which can vary dramatically from one summer to the next. Variations in the weather can obscure trends in exceedances resulting from changes in emissions of ozone precursors.

Averaging across several years reduces the weather-related "noise." The 3-year moving average in Figure 2-9 shows a relatively steady downtrend in exceedances, from an average of 20 or more exceedance days per year prior to 1990 to about 10 days in the past few years.

Table 2-4. Number of days exceeding the California 1-hour ozone standard by monitoring site 1987-2008.

Stations by Sub-Region	87	88	89	90	91	92	93	94	95	96	97	98	99	00	01	02	03	04	05	06	07	08	09
Northern																							
Benicia																					0	2	
Napa	6	1	2	0	3	0	2	0	4	0	0	3	4	0	1	1	2	0	0	1	0	1	1
San Rafael	1	1	0	0	0	0	0	0	0	2	1	0	2	0	0	0	0	0	0	0	0	0	0
Santa Rosa	1	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	1	0	0	0	0	0	0
Vallejo	6	5	2	2	2	1	3	2	4	5	1	3	4	0	0	1	2	1	0	0	0	1	2
Central																							
Hayward	12	9	1	0	2	1	0	1	7	2	2	4	4	1	2	0	3	0	0	2	0	1	4
Oakland	0	1	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0			0	0
Redwood City	2	2	1	0	0	0	1	0	5	1	0	0	0	0	1	0	1	1	0	0	0	0	0
San Francisco	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
San Leandro	0	0	0	0	2	2	3	0	6	2	3	2	3	1	0	1	2	1	1	0	0	0	
Richmond/San Pablo	0	2	1	0	0	0	2	0	0	0	1	0	1	0	0	0	0	1	0	0	0	0	0
Eastern																							
Bethel Island	14	7	11	5	3	7	3	5	6	6	1	10	5	1	3	5	0	1	0	9	0	4	2
Concord	20	10	6	3	4	3	7	4	9	11	2	13	8	2	6	5	5	1	1	7	1	3	2
Fairfield	9	3	4	1	3	3	3	2	10	5	0	9	9	1	3	3	0	1	0	3	0	2	2
Livermore	26	21	9	8	17	14	7	5	20	22	3	21	14	5	9	10	10	5	6	13	2	5	8
Pittsburg	14	8	5	4	0	3	4	3	8	5	0	4	2	1	2	4	0	0	0	2	1	1	

Table 2-4 (continued). Number of days exceeding the California 1-hour ozone standard by monitoring site 1987-2008.

Stations by Sub-Region	87	88	89	90	91	92	93	94	95	96	97	98	99	00	01	02	03	04	05	06	07	08	09
Southern																							
Fremont	17	7	11	3	6	5	5	4	10	2	2	7	3	2	3	3	4	0	1	4	0	1	4
Los Gatos	25	12	1	5	7	3	8	2	13	10	1	5	4	0	2	4	7	0	3	7	0	2	3
Mt View/ Sunnyvale	16	13	6	1	2	1	2	0	2	3	1	2	7		0	0	4	1	1	3	0	0	
San Jose	23	12	10	4	6	3	3	2	14	5	0	4	3	0	2	0	4	0	1	5	0	1	0
San Jose - East	22	13	9	1		5	5	3	15	5	1	5	2	1	0	0	2	0	1				
Gilroy	19	23	10	5	5	11	6	3	10	15	1	10	3		3	6	6	0	0	4	0	1	1
San Martin					7	17	9	5	14	18	0	15	7	4	7	8	9	0	2	7	1	2	4
Total Days	**47**	**41**	**22**	**14**	**23**	**29**	**24**	**13**	**30**	**45**	**10**	**29**	**20**	**12**	**15**	**16**	**19**	**7**	**9**	**18**	**4**	**9**	**11**

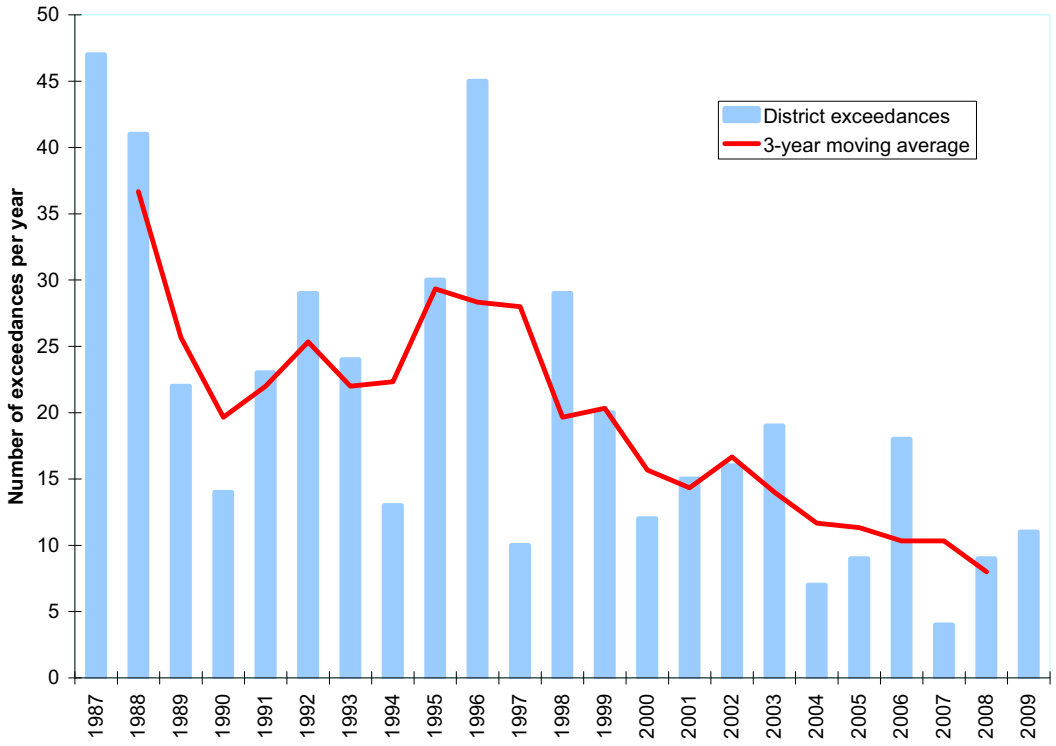


Figure 2-9. Annual Bay Area days exceeding the 0.09 ppm state 1-hour ozone standard at any monitoring station: 1987-2009.

Figure 2-10 shows Bay Area trends relative to the current State 8-hour standard (0.70 ppm), with reductions in exceedances similar to those seen in Figure 2-9 above.

Peak Ozone Concentrations and Exposure

CARB guidance requires the calculation of three air quality indicators to assess the extent of air quality improvements within an air basin: (1) Expected Peak Day Concentration (EPDC), which is an estimate of the ozone concentration that would be exceeded once per year on average, (2) population-weighted exposure to ozone levels that exceed the state standard, and (3) area-weighted exposure to levels that exceed the state standard.

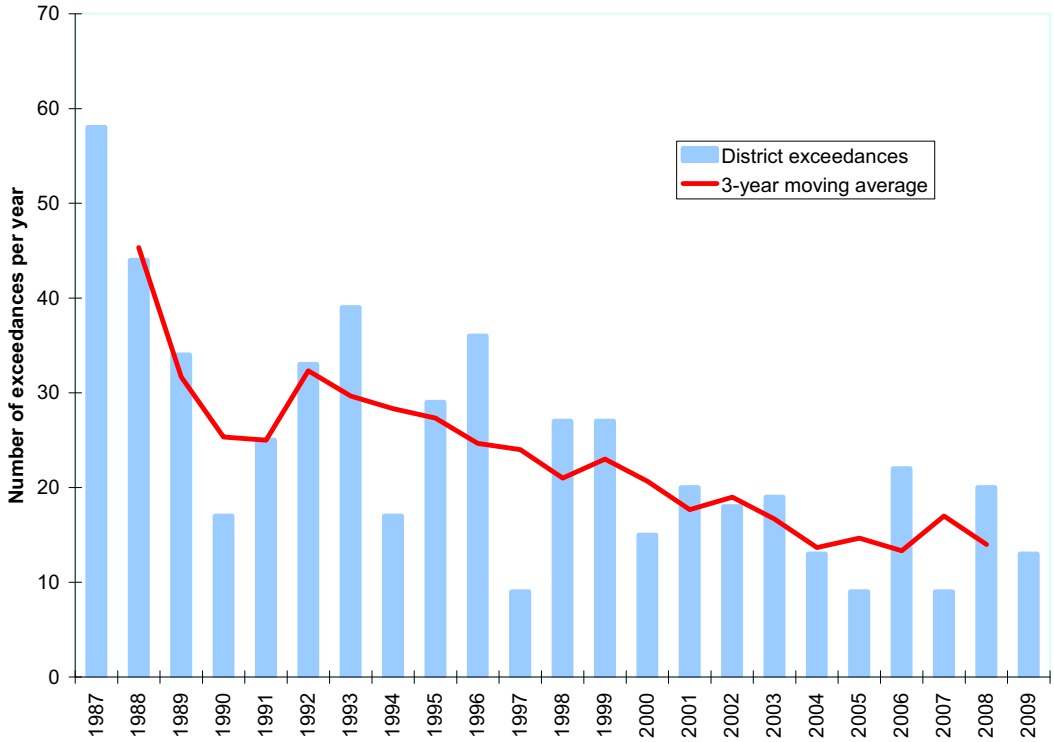


Figure 2-10. Annual Bay Area days exceeding the 0.070 ppm state 8-hour ozone standard at any monitoring station: 1987-2008.

Expected Peak Day Ozone Concentrations

The EPDC for the State 1-hour ozone standard at Bay Area monitoring sites are listed in Table 2-5 for 1986-88, 1997-99, and 2006-08. Also shown are annual percentage reductions. Table 2-6 presents this data for the 8-hour ozone standard. There was an average annual reduction in 1-hour ozone of 1.1% per year across all Bay Area sites between 1986-88 and 2006-08, and a reduction of 1.0% per year in 8-hour ozone, with total reductions of 19% and 18% respectively. No site shows an increase in ozone over this period, indicating that progress is region-wide. During the period from 1997 through 2008, the reduction was 1.0% per year for 1-hour ozone and 0.8% per year for 8-hour ozone, indicating that progress has continued in recent years.

The progress has not been uniform, however. As the tables show, there were substantial reductions in the southern areas, including Los Gatos and Gilroy, sites that once registered some of the District's highest values. There was progress in the north also. In the central area, the progress is mixed, but at locations where there has been little reduction since the late 1990s, ozone values actually meet the standard. In the eastern areas there have also been reductions, but long-term progress has been slower. At the Air District’s design value site in Livermore reductions have averaged 0.8% per year, which is on the order of 1 ppb per year, since the late 1990s.

State ozone standards in essence require that there be no more than one exceedance per year at any monitoring site. Since the EPDC is an estimate of the ozone concentration that would be exceeded once per year, a site whose EPDC is less than 95 ppb could be considered to meet the 1-hour standard, and a site whose EPDC is less than 71 ppb could be considered to meet the State 8-hour standard. Between 1986-88 and 2006-08, the number of sites meeting the 1-hour standard increased from 4 to 9, and the number meeting the 8-hour standard increased from 4 to 8.

Table 2-5. Expected peak day concentrations for 1-hour max ozone at Bay Area sites: 1986-2008.

	Expected Peak Day Concentration (ppb)			Annual Percentage Change in EPDC*	
Monitoring Site:	**1986-88**	**1997-99**	**2006-08**	**97-99 to 06-08**	**86-88 to 06-08**
Northern					
Napa	107	106	88	-2.1	-1.0
San Rafael	93	85	74	-1.5	-1.2
Santa Rosa	87	86	72	-1.9	-0.9
Vallejo	109	98	83	-1.8	-1.4
Central					
Hayward	129	112	96	-1.7	-1.4
Redwood City	97	71	74	0.4	-1.3
Richmond/ San Pablo**	83	80	68	-1.8	-1.0
San Francisco	74	59	59	0.0	-1.1
Eastern					
Bethel Island	111	117	108	-0.9	-0.2
Concord	128	127	109	-1.7	-0.8
Fairfield	111	122	103	-1.8	-0.4
Livermore	145	143	123	-1.7	-0.8
Pittsburg	117	95	96	0.1	-1.0
Southern					
Fremont	132	107	93	-1.5	-1.7
Los Gatos	139	113	106	-0.7	-1.4
Mt View/ Sunnyvale***	140	106	94	-1.4	-2.0
San Jose	131	107	100	-0.7	-1.3
Gilroy	142	113	101	-1.2	-1.7
San Martin Airport		125	110	-1.4	
Average	**117**	**104**	**95**	**-1.0**	**-1.1**

* Percentage change results shown may differ slightly from those calculated using displayed data points because of rounding for display purposes.

** Monitoring site moved from Richmond to San Pablo in 1997.

*** Site moved from Mountain View to Sunnyvale in 2000.

Table 2-6. Expected peak day concentrations for 8-hr max ozone at Bay Area sites 1986-2008.

	Expected Peak Day Concentration (ppb)			Annual Percentage Change in EPDC*	
Monitoring Site:	**1986-88**	**1997-99**	**2006-08**	**97-99 to 06-08**	**86-88 to 06-08**
Northern					
Napa	85	80	70	-1.4%	-1.0%
San Rafael	69	60	58	-0.3%	-0.9%
Santa Rosa	68	63	58	-0.9%	-0.7%
Vallejo	85	72	67	-0.8%	-1.2%
Central					
Hayward	102	88	78	-1.3%	-1.3%
Redwood City	71	56	61	1.0%	-0.8%
Richmond/ San Pablo**	65	63	56	-1.4%	-0.8%
San Francisco	59	50	51	0.3%	-0.7%
Eastern					
Bethel Island	103	101	92	-1.1%	-0.6%
Concord	101	102	91	-1.2%	-0.6%
Fairfield	99	101	84	-2.1%	-0.9%
Livermore	112	111	95	-1.8%	-0.8%
Pittsburg	99	81	82	0.1%	-0.9%
Southern					
Fremont	98	73	69	-0.7%	-1.7%
Los Gatos	111	91	86	-0.6%	-1.2%
Mt View/ Sunnyvale***	104	74	71	-0.5%	-1.9%
San Jose	107	77	76	-0.1%	-1.7%
Gilroy	113	91	87	-0.6%	-1.3%
San Martin Airport		100	90	-1.1%	
Average	92	81	75	-0.8%	-1.0%

* Percentage change results shown may differ slightly from those calculated using displayed data points because of rounding for display purposes.
** Monitoring site moved from Richmond to San Pablo in 1997.
*** Site moved from Mountain View to Sunnyvale in 2000.

Population-Weighted Exposure to Ozone

Peak ozone concentrations reflect potential population exposure in areas with the highest ozone levels, but not the exposure of the Bay Area's population as a whole. Therefore, population-weighted exposure to high ozone concentrations is another indicator used to assess progress in reducing public exposure to ozone on a per-capita region-wide basis.

Population-weighted exposure is computed by estimating hourly ozone concentrations for each census tract in the Bay Area based on the hourly values actually measured at

Air District monitoring sites. Concentrations are estimated by averaging ozone from nearby monitors inversely weighted by distance to the tract. For each census tract, for each hour where its estimated ozone exceeds the standard, the estimated amount by which the ozone level exceeds the standard is multiplied by the population of the tract. These values are summed across all hours for a year for each tract, and then for all tracts in each county. The result is divided by the population of the county. The result is per capita exposure, specifically person-ppm-hours above the standard.[46]

Table 2-7 shows population-weighted exposures for 1986-88, 1997-99 and 2004-06 for Bay Area counties in relation to the state 1-hour ozone standard. Also shown are the total decreases in exposure between these periods. Population exposure decreased from an average of 19 to 2 person-ppm-hours above the standard per year from 1986-88 to 2006-2008, for an overall reduction of 88%. Today, no county experiences an average of more than 4 person-ppm-hours above the standard per year.

Table 2-7. Population-weighted exposure to ozone exceeding the state one-hour standard in the Bay Area.

	Per Capita Exposure (person-ppm-hours above 95 ppb/total population)			Percent Decrease*	
County	86-88	97-99	06-08	86-88 to 06-08	97-99 to 06-08
Alameda	18	7	2	87	64
Contra Costa	22	17	4	80	75
Marin	0	1	0	NA	100
Napa	3	6	1	73	88
San Francisco	0	0	0	NA	NA
San Mateo	3	0	0	98	79
Santa Clara	46	7	4	91	42
Solano	8	9	2	78	80
Sonoma	1	1	0	88	88
Bay Area	**19**	**6**	**2**	**88**	**64**

* Values for per capita exposure are rounded to the nearest whole number. Percentage decrease is based on unrounded data.

Figure 2-11 shows the Bay Area per-capita population exposure to ozone by year, and also a 3-year moving average. Exposures vary dramatically from year to year, but the 3-year average shows progress toward reduced exposure.

[46] This is sometimes termed "backyard" exposure because it assumes that everyone is at home and outside every hour that ozone exceeds the standard. While there are obvious limitations to this measure, it may be reasonable for children, who are often at or near home, and frequently outside, at times when ozone exceeds the standard.

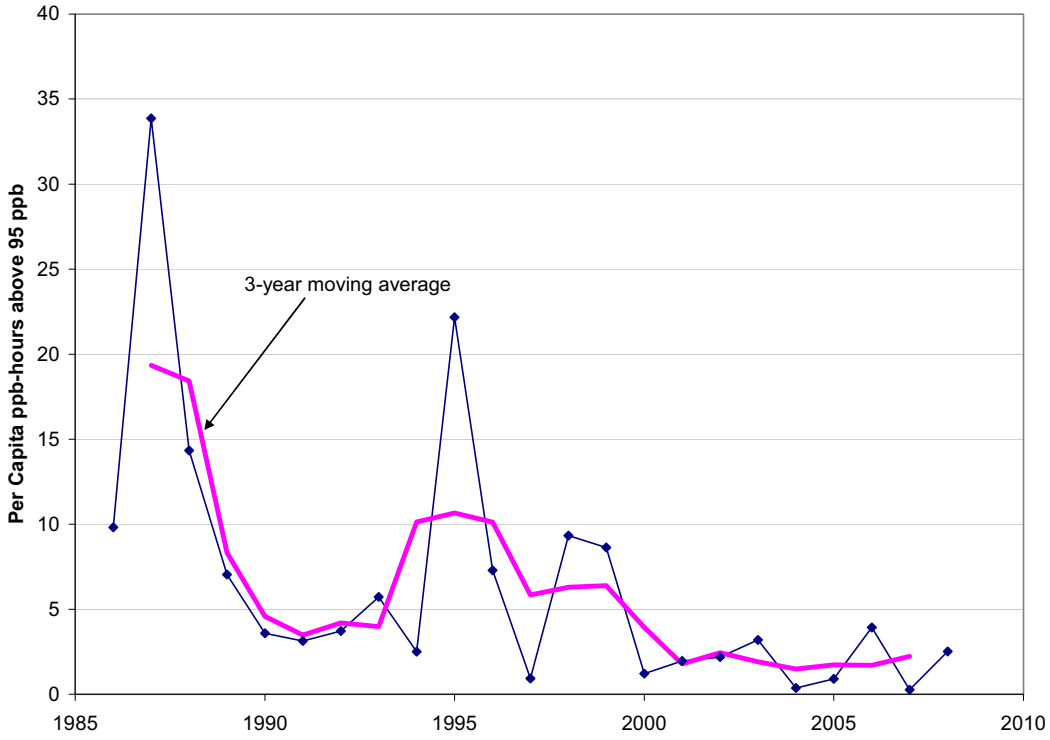


Figure 2-11. Average per-capita population exposure to ozone levels exceeding the 0.09 ppm state 1-hour standard in the Bay Area, 1986-2008.

Area-Weighted Exposure to Ozone

The third indicator used in assessing progress in reducing exposure to ozone is area-weighted exposure. This is calculated similarly to population-weighted exposure, except with census tract area replacing census tract population.

Reductions in area-weighted exposure are important because high ozone levels harm not only humans but also vegetation, other animals, and most surfaces with which it comes in contact, such as architectural finishes, tires, and plastics. Table 2-8 shows the average km^2-ppm-hours above the state standard for each county and the District as a whole. The trends and exposure patterns among counties are quite similar to population-weighted exposures. The table shows reductions similar to those in Table 2-7, with area-weighted exposure dropping 84% since 1986-88 and 64% since 1997-99.

Table 2-8. Area-weighted exposure to ozone in the Bay Area, 1986-2008.

	Area-Weighted Exposure (km^2-ppm-hours above 95 ppb/total km^2)			Percent Decrease*	
County	86-88	97-99	04-06	86-88 to 06-08	97-99 to 06-08
Alameda	40	19	8	80	58
Contra Costa	27	20	6	77	69
Marin	1	1	0	100	100
Napa	3	6	1	72	85
San Francisco	0	0	0	NA	NA
San Mateo	12	1	1	93	45
Santa Clara	52	13	6	88	51
Solano	12	11	2	79	77
Sonoma	1	2	0	85	88
Bay Area	**20**	**9**	**3**	**84**	**64**

* Values for area-weighted exposure are rounded to the nearest whole number. Percentage decrease is based on unrounded data.

Summary of Key Ozone Modeling Findings

Photochemical modeling, as described in Appendix E, was used to estimate the impacts of NOx and VOC emissions reductions on ozone concentration for the Bay Area and its neighboring ozone non-attainment regions. Reducing Bay Area emissions of NOx and VOC by 40% resulted in significant reductions of up to 15 ppb for Bay Area 8-hour ozone levels. The impacts of reductions in precursor emissions transported from the Bay Area were much smaller than the local impacts of the Bay Area emissions. Reducing the Bay Area emissions by 40% benefited the downwind Sacramento and San Joaquin Valley non-attainment areas by only 1-3 ppb reduced relative to the 8-hour ozone level.

Summary of Key Modeling Findings: Impacts of Climate Change on Ozone

Photochemical modeling was used to estimate the impacts of a 2 degree Celsius increase in Bay Area temperatures on regional ozone levels. This increase in global average temperature is estimated by the Intergovernmental Panel on Climate Change (IPCC) to occur by 2050. Higher temperatures related to global warming are expected to promote ozone formation through several mechanisms, including an increase in biogenic emissions of ozone precursors (ROG). The model indicated Bay Area maximum 8-hour ozone levels would increase by about 8 ppb during ozone exceedance days. Assuming the simulated scenario is reasonable, increased ozone levels due to climate change may offset at least 10 years of ozone emissions control efforts in the Bay Area between now and 2050.

Particulate Matter

Particulate matter (PM) is a mixture of suspended particles and liquid droplets (aerosols). PM includes elements such as carbon and metals; compounds such as nitrates, organics, and sulfates; and complex mixtures such as diesel exhaust, wood smoke, and soil. Unlike the other criteria pollutants, which are individual chemical compounds, particulate matter is the total of all particles in the air in a certain size range. PM is both directly emitted (referred to as direct PM or primary PM) and also formed in the atmosphere through reactions among different pollutants (this is referred to as indirect or secondary PM).

As discussed both in Chapter 1 and below, compelling evidence suggests that fine PM is the most harmful of all air pollutants in the Bay Area in terms of its impact on public health. Significant progress has been made to enhance our technical understanding of PM, including improved monitoring and enhanced modeling capabilities. However, because the shift in focus toward PM is relatively recent, efforts to analyze and control PM still lag behind pollutants such as ozone and carbon monoxide.

One of the challenges in devising strategies to reduce PM is that scientists are still working to determine the relative risk associated with the many types and sources of particles that comprise PM. Better information in this regard will help us understand where to focus our efforts in order to get the greatest benefit in reducing health risks associated with PM. Nevertheless, our best knowledge to date suggests that fine particles themselves are harmful, irrespective of composition.

In addition to its negative health effects, PM is also a prime cause of regional haze. Research is still on-going, but PM emissions also have implications for global warming. PM aerosols can help to reduce (or mask) the full effect of global warming by scattering sunlight. But black carbon or soot, a component of PM, appears to contribute significantly to global warming.

PM Health Effects

A large and growing body of scientific evidence indicates that both short-term and long-term exposure to fine particles can cause a wide range of health effects, including: aggravating asthma and bronchitis; causing visits to the hospital for respiratory and cardio-vascular symptoms, and contributing to heart attacks and deaths.

Breathing PM has long been understood as a health hazard.[47] Although PM was designated as one of the criteria pollutants in the original 1970 federal Clean Air Act, in recent years many epidemiological studies have drawn increased attention to the health

[47] The London fogs of the early 1950s that killed thousands of people were primarily caused by PM from coal, which led to the banning of coal burning within the city.

risks associated with PM. In fact, as discussed in Appendix A, the number of deaths in the Bay Area associated with current PM levels likely exceeds the number of deaths from motor vehicle accidents. Reducing PM emissions can reduce mortality and increase average life span.[48]

Although the epidemiological evidence that shows a strong correlation between elevated PM levels and public health effects is very well-documented, scientists are still working to understand the precise biological mechanisms through which PM damages our health. A recent study by researchers at the University of Michigan suggests that PM may harm our bodies by a combination of 1) increasing blood pressure and 2) triggering a response which causes inflammation that can stiffen and damage blood vessels.[49]

PM Standards and Attainment Status

PM is often characterized on the basis of particle size. Ultra-fine PM includes particles less than one micron in diameter. Fine PM consists of particles 2.5 microns or less in diameter. PM10 consists of particles 10 microns or less in diameter. TSP (total suspended particulates) includes suspended particles of any size.

The 1970 Clean Air Act initially established PM standards for TSP only. Subsequently, scientific evidence pointed to small particles as posing the most serious health threat. Therefore, in 1987, the TSP standard was replaced with a PM10 standard – one that regulated particles less than 10 microns in diameter. In 1997, the PM10 standard was augmented and largely superseded by a PM2.5 standard: i.e., particles less than 2.5 microns in diameter.

PM standards and Bay Area attainment status are shown in Table 2-1. Both national and state PM standards have been tightened since 2000. However, to date, researchers have not been able to identify a clear threshold below which there are no health effects from exposure to fine PM. This suggests that PM2.5 standards may be further tightened in the future.

PM Dynamics

PM chemistry and formation is complex and variable. PM concentrations vary considerably both in composition and spatial distribution on a day-to-day basis and on a

[48] For example, a recent study of nationwide scope found that reducing fine PM results in significant and measurable improvements in human health and life expectancy**.** Pope, C. Arden III et al. "Fine Particulate Air Pollution and Life Expectancy in the United States." New England Journal of Medicine, January 22, 2009. Volume 360:376-386. No. 4.

[49] See Robert Brook et al. "Insights into the Mechanism and Mediators of the Effects of Air Pollution Exposure on Blood Pressure and Vascular Function in Healthy Humans" Hypertension: Journal of the American Heart Association, July 29, 2009.

seasonal basis, due to changes in weather and emissions. The Bay Area experiences its highest PM concentrations in the winter; exceedances of the 24-hour national PM2.5 almost always occur in the November through February period. High PM2.5 episodes are typically regional in scale, impacting multiple Bay Area locations. During other seasons, by contrast, Bay Area PM2.5 tends to be low thanks to the area's natural ventilation system. Thus, on an annual average basis, the Bay Area's PM2.5 levels are among the lowest measured in major U.S. metropolitan areas.

Consecutive stagnant and clear winter days are typically prerequisites for development of PM2.5 episodes. The lower levels of solar radiation (sunlight) in the winter lead to stronger temperature inversions; these inversions are conducive to the buildup of PM in ambient air near ground level, especially ultrafine particles, which can remain airborne for a number of days. Winter is also when the most residential wood burning occurs; in some parts of the Bay Area, wood smoke accounts for the majority of airborne PM2.5 during high PM episodes.

Secondary PM2.5 levels are likewise only elevated during the winter months. Cool weather is conducive to the formation of ammonium nitrate. Ammonium nitrate is the main type of secondary PM2.5 in winter months, contributing an average of about 35% of total PM2.5 under peak PM conditions. This semi-volatile PM2.5 component is stable in its solid form only during the cooler winter months. Although the contribution of ammonium sulfate is relatively low (averaging 1-2 $\mu g/m^3$) it accounts for approximately 10% of total PM2.5 on an annual average basis. In the Bay Area, geological dust contribute only modestly to PM2.5 concentrations, but it accounts for a significant portion of PM10, as shown in Figures 2-12 and 2-13.

Chemical mass balance[50] analysis shows that both fossil fuels and biomass (primarily wood) combustion sources are prevalent PM2.5 contributors for all seasons. The biomass combustion contribution to peak PM2.5 levels is about 3-4 times higher in winter than the other seasons, as confirmed by isotopic carbon (^{14}C) analysis. The increased winter biomass combustion sources reflect increased levels of wood burning during the winter season.

[50] Chemical mass balance (CMB) analysis is a methodology in which a computer model is used to apportion ambient PM2.5 collected on filters over 24-hour periods at monitoring sites around the Bay Area to a set of source categories. Each filter was analyzed for a range of chemical species. The same species were measured in special studies of emissions from various sources, such as motor vehicles and wood burning. The CMB model finds the mix of these source measurements that best matches the ambient sample, chemical species by chemical species.

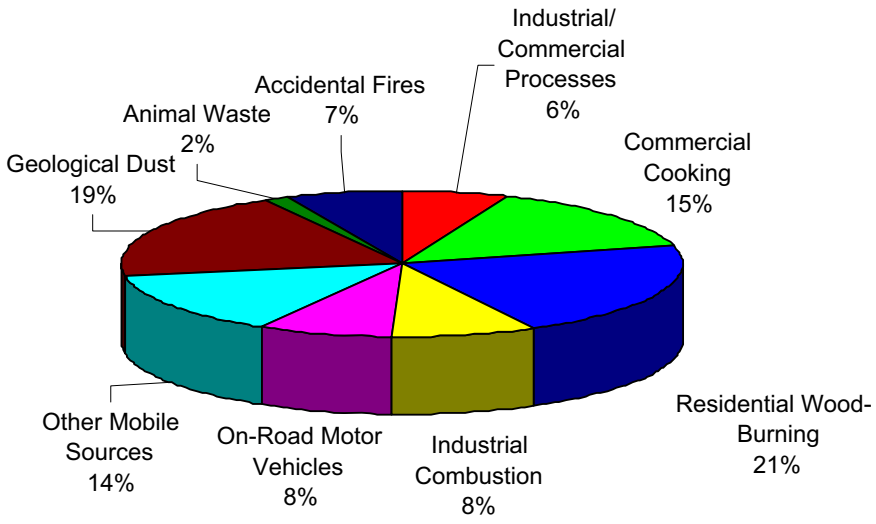


Figure 2-12. Direct PM2.5 emissions by source, annual average, 2009 (87 tons/day).

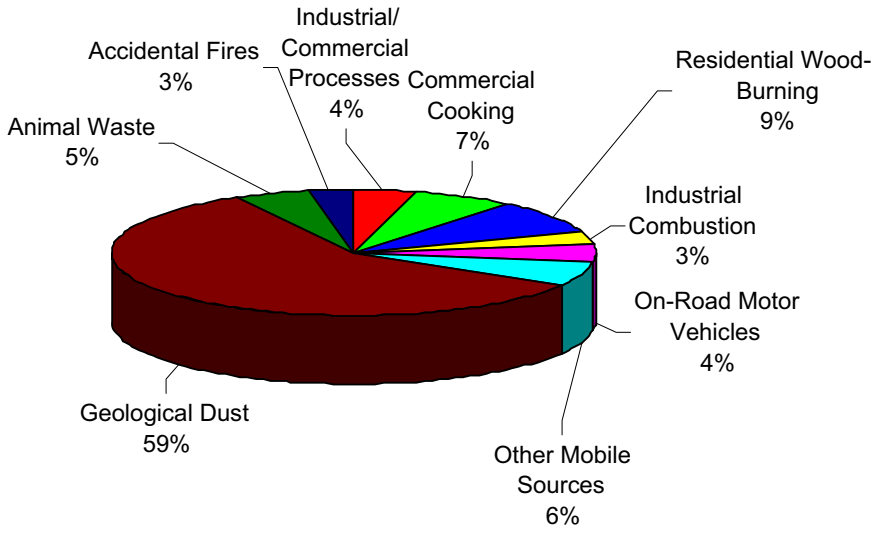


Figure 2-13. Direct PM_{10} emissions by source, annual average, 2009 (214 tons/day).

As in the case of ozone, the PM2.5 levels that occur on a given day are strongly influenced by the prevailing weather. The relationship between the weather and PM2.5 levels was analyzed using a statistical technique known as cluster analysis to find groups of days exhibiting similar conditions. Cluster analysis was applied to 10 years of measurements to determine winter weather patterns associated with elevated Bay Area PM2.5 levels.

Cluster analysis found that a single weather pattern accounted for most 24-hour PM2.5 episodes in the Bay Area. PM2.5 exceedances in the Bay Area usually occurred after 2-4 consecutive days of PM2.5 buildup under a high pressure system. These conditions occur when a high pressure system moves over Central California in winter months, resulting in sunny days and clear, cold nights with little wind. Such conditions are highly conducive to formation of ammonium nitrate, a key component of secondary PM2.5, in the Central Valley. As dense cold air converges on the Central Valley floor, this increases air pressure in the Central Valley, causing air to flow westward through the Carquinez Strait and into the Bay Area, thereby transporting ammonium nitrate PM2.5 from the Central Valley to the Bay Area. When ammonium nitrate transported from the Central Valley to the Bay Area combines with PM2.5 emitted or formed within the Bay Area, this can result in elevated PM levels in the Bay Area, especially in the eastern parts of the region closest to the Central Valley.

Ultra-Fine Particles

The smaller the particle, the more easily it can evade the body's filtration system, penetrate deep into the lungs and enter the bloodstream. Research in recent years suggests that "ultra-fine" particles, those less than 1.0 micron in diameter, may actually pose the most serious threat to public health.[51] Internal combustion engines are a major source of ultrafine PM. Engines powered by gasoline, diesel, and natural gas all emit a large fraction of particles in the ultrafine size range. Studies in southern California have found elevated counts of ultrafine particles near freeways. Numerous studies have shown increased incidence of respiratory and cardiovascular disease near heavily traveled roadways.

Because of their small size, ultrafine particles account for just a small fraction of total PM mass (less than 10%); however, they make up the vast majority of particles by number. In addition, ultrafine particles have a much higher surface area per mass than larger particles; therefore, they act as carriers for other agents such as trace metals and organic compounds that collect on their surface. Despite these concerns, research on the health impacts of ultra-fine particles is still evolving, and no ambient air quality standards for ultra-fine PM have been established as yet. Existing state and national PM standards are based on mass (weight) concentrations in the air, rather than the number of airborne particles.

[51] See Chapter 11 (Ultrafine Particles) in the 2007 South Coast Air Quality Management Plan.

Diesel Particulate Matter

Diesel engines emit a complex mixture of air pollutants, with a major fraction consisting of fine PM. These emissions include many carbon particles, as well as gases that become PM as they cool and undergo chemical reactions. Diesel emissions account for roughly one-sixth of total emissions of carbonaceous PM2.5 in the Bay Area.

Emissions of diesel PM pose a risk to public health in the Bay Area in two ways: 1) as a component of PM2.5, which has been implicated in increased premature mortality, and 2) as the leading carcinogenic toxic air contaminant. As discussed in the Air Toxics Trends section below, diesel PM emissions are responsible for the majority of cancer risk from air pollution in the Bay Area. However, analysis performed in the course of developing the Air District's multi-pollutant evaluation method shows that the risk of death from diesel particles in their role as a component of PM2.5 is roughly an order of magnitude greater than the risk they pose as carcinogens. In other words, even if diesel particles were not carcinogenic, the risk they pose as PM2.5 would be still be very large.

Sources of PM Emissions

Particulate matter is both directly emitted, as well as formed indirectly from precursor chemicals, such as ROG, NOx, and ammonia (NH3). Direct PM2.5 emissions in the Bay Area are produced by a wide variety of sources, both man-made and natural, but dominated by a few. About half of Bay Area PM2.5 is directly emitted from combustion, i.e., burning fossil fuels, wood, other vegetative matter; or cooking. This PM2.5 is mostly composed of organic carbon compounds, and also soot containing pure carbon. Sea salt from the ocean contributes another 10% on an annual basis.

Combustion of fossil fuels in all types of engines produces direct emissions of PM. In addition to direct PM from engine combustion, motor vehicles also 1) contribute to secondary formation of PM by emitting NOx, and 2) create PM by means of tire and brake wear. Reducing emissions of diesel PM from heavy-duty engines is a priority of CARB and the Air District because diesel PM is a carcinogenic toxic air contaminant.

Light-duty and medium-duty vehicles (8,500 pounds gross vehicle weight or less) emit very little PM on a per-mile basis. However, light and medium-duty vehicles currently account for more than half of the total emissions of both PM2.5 and PM10 from on-road vehicles in the region. PM emissions from heavy-duty vehicles are expected to decrease significantly over the next decade in response to recent CARB regulations pursuant to its Diesel Risk Reduction Program. With emissions from heavy-duty vehicles projected to decline and total vehicle miles of travel (VMT) from light and medium-duty vehicles projected to increase, PM emissions from light and medium-duty vehicles are expected to account for roughly 80% of direct emissions of PM2.5 and PM10 from on-road vehicles in the Bay Area by 2020.

Table 2-9 shows the detailed Bay Area inventory of annual average direct PM2.5 and PM10 emissions, with base year 2005 projected trough 2020.[52] The inventory is based upon CARB EMFAC 2007, Version 2.3 and reflects the effect of regulations adopted as of December 31, 2006. The inventories do not include additional emission reductions from State or federal measures adopted since 2007 or CARB's "Pavley regulations" to reduce greenhouse gases from motor vehicles. Estimated emission reductions of ROG, NOx, and PM from CARB regulations not reflected in the current inventory are shown in Table 3-10.

Major sources of direct PM2.5 and PM10 emissions are shown in Figures 2-12 and 2-13, respectively. Geological dust, which includes road dust, construction dust, and windblown dust, accounts for a relatively modest fraction of PM2.5 (19%), but a very large portion of PM10 (59%). There is still considerable uncertainty regarding the inventory of geological dust. The Air District is working with CARB in a collaborative effort to improve PM emissions inventory estimates statewide and in the Bay Area. Inventory estimates are under review for a variety of sources, including road dust and commercial cooking.

[52] Summer and winter emissions inventories are provided in the "Base Year 2005 Emissions Inventory Summary Report" issued by BAAQMD in December 2008. See www.BAAQMD.gov

Table 2-9. Bay Area inventory 2005-2020, PM10 & $PM_{2.5}$.

Bay Area Baseline Emission Inventory Projections : 2005 – 2020 (1)										
Annual Average Inventory (2) in Tons/Day (3)										
	Particulate Matter< 10 microns (4)					Particulate Matter< 2.5 microns (4)				
SOURCE CATEGORY	2005	2009	2012	2015	2020	2005	2009	2012	2015	2020
INDUSTRIAL/COMMERCIAL PROCESSES										
PETROLEUM REFINING FACILITIES										
Basic Refining Processes	0.82	0.85	0.88	0.9	0.95	0.49	0.51	0.53	0.54	0.57
Wastewater (Oil-Water) Separators	--	--	--	--	--	--	--	--	--	--
Wastewater Treatment Facilities	--	--	--	--	--	--	--	--	--	--
Cooling Towers	0.16	0.17	0.17	0.18	0.19	0.15	0.16	0.16	0.17	0.18
Flares & Blowdown Systems	--	--	--	--	--	--	--	--	--	--
Other Refining Processes	0.06	0.06	0.06	0.06	0.07	--	--	--	--	--
Fugitives	--	--	--	--	--	--	--	--	--	--
Subtotal	1.05	1.09	1.12	1.15	1.21	0.69	0.71	0.73	0.76	0.8
CHEMICAL MANUFACTURING FACILITIES										
Coating, Inks, Resins & Other Facilities	0.11	0.12	0.12	0.13	0.14	0.07	0.07	0.08	0.08	0.09
Pharmaceuticals & Cosmetics	0.39	0.41	0.44	0.46	0.49	0.39	0.41	0.43	0.45	0.49
Fugitives - Valves & Flanges	--	--	--	--	--	--	--	--	--	--
Subtotal	0.5	0.53	0.56	0.58	0.63	0.45	0.48	0.51	0.53	0.57
OTHER INDUSTRIAL/COMMERCIAL PROCESSES										
Bakeries	--	--	--	--	--	--	--	--	--	--
Cooking	13.7	13.92	14.24	14.43	15.06	12.8	13	13.3	13.48	14.06
Wineries & Other Food & Agr. Processes	0.5	0.5	0.5	0.51	0.51	0.32	0.32	0.32	0.33	0.33
Metallurgical & Minerals Manufacturing	4.23	4.49	4.69	4.91	5.27	2.86	3.02	3.15	3.29	3.53
Waste Management	1.13	1.19	1.22	1.24	1.28	0.32	0.34	0.35	0.35	0.37
Semiconductor Manufacturing	--	--	--	--	--	--	--	--	--	--
Fiberglass Products Manufacturing	--	--	--	--	--	--	--	--	--	--
Rubber & Plastic Products Manufacturing	--	--	--	--	--	--	--	--	--	--
Contaminated Soil Aeration	--	--	--	--	--	--	--	--	--	--
Other Industrial Commercial	1.12	1.15	1.19	1.23	1.3	0.5	0.51	0.53	0.55	0.58
Subtotal	20.71	21.3	21.89	22.36	23.47	16.83	17.23	17.7	18.04	18.92

Table 2-9 (continued). Bay Area inventory 2005-2020, PM10 & $PM_{2.5}$.

SOURCE CATEGORY	Particulate Matter< 10 microns (4)					Particulate Matter< 2.5 microns (4)				
	2005	2009	2012	2015	2020	2005	2009	2012	2015	2020
COMBUSTION - STATIONARY SOURCES										
FUELS COMBUSTION										
Domestic	19.73	20.43	21	21.59	22.61	19.04	19.72	20.27	20.84	21.82
Cogeneration	0.82	0.86	0.89	0.92	0.98	0.81	0.85	0.88	0.91	0.97
Power Plants	0.26	0.41	0.42	0.44	0.48	0.26	0.41	0.42	0.43	0.48
Oil Refineries External Combustion	1.7	1.77	1.82	1.88	1.97	1.7	1.77	1.82	1.88	1.97
Glass Melting Furnaces - Natural Gas	--	--	--	--	--	--	--	--	--	--
Reciprocating Engines	0.34	0.3	0.28	0.26	0.22	0.33	0.29	0.27	0.25	0.22
Turbines	0.14	0.15	0.16	0.16	0.17	0.14	0.15	0.15	0.16	0.17
Landfill/Cement Plant Combustion	2.03	2.1	2.17	2.24	2.35	2.03	2.1	2.17	2.23	2.34
Subtotal	25.02	26.02	26.73	27.48	28.78	24.31	25.28	25.98	26.71	27.97
BURNING OF WASTE MATERIAL										
Incineration	0.07	0.07	0.07	0.08	0.08	0.09	0.09	0.1	0.1	0.1
Planned Fires	0.41	0.42	0.43	0.45	0.46	0.38	0.4	0.41	0.42	0.44
Subtotal	0.5	0.52	0.54	0.55	0.57	0.48	0.49	0.51	0.52	0.54
Banked Emissions (5)	0	0.3	0.3	0.3	0.3	0	0.2	0.2	0.2	0.2
Alternative Compliance Allowance (6)	0	0	0	0	0	0	0	0	0	0
Subtotal (District Jurisdiction)	47.78	49.76	51.14	52.42	54.96	42.76	44.39	45.63	46.76	49
COMBUSTION - MOBILE SOURCES										
ON-ROAD MOTOR VEHICLES										
Passenger Cars	3.05	3.22	3.38	3.55	3.82	1.72	1.84	1.93	2.03	2.2
Light Duty Trucks<6000lbs	2.42	2.64	2.83	3.01	3.3	1.53	1.73	1.88	2.02	2.23
Medium Duty Trucks 6001-8500 lbs	0.56	0.62	0.68	0.74	0.82	0.36	0.42	0.47	0.52	0.59
Light Heavy Duty Trucks 8501-14000lbs	0.2	0.18	0.18	0.17	0.18	0.14	0.12	0.11	0.11	0.11
Medium Heavy Duty Trucks 14001-33000lbs	0.82	0.75	0.67	0.6	0.52	0.72	0.65	0.58	0.51	0.43
Heavy Duty Trucks>33000 lbs	2.33	1.73	1.33	1.01	0.68	2.05	1.5	1.12	0.83	0.52
School/Urban Buses	0.33	0.33	0.33	0.33	0.33	0.29	0.29	0.29	0.29	0.29
Motor-Homes	--	--	--	--	--	--	--	--	--	--
Motorcycles	0.08	0.08	0.07	0.06	0.06	--	--	--	--	--
Subtotal	9.81	9.58	9.49	9.5	9.72	6.87	6.6	6.44	6.36	6.42

Table 2-9 (continued). Bay Area inventory 2005-2020, PM10 & $PM_{2.5}$.

SOURCE CATEGORY	Particulate Matter< 10 microns (4)					Particulate Matter< 2.5 microns (4)				
	2005	2009	2012	2015	2020	2005	2009	2012	2015	2020
OFF-HIGHWAY MOBILE SOURCES										
Lawn and Garden Equipment	0.35	0.32	0.31	0.3	0.31	0.34	0.32	0.3	0.3	0.31
Transportation Refrigeration Units	0.51	0.43	0.34	0.21	0.08	0.49	0.42	0.33	0.21	0.08
Agricultural Equipment	0.44	0.36	0.3	0.23	0.13	0.43	0.35	0.29	0.22	0.13
Construction and Mining Equipment	4.4	3.7	3.18	2.52	1.6	4.29	3.62	3.1	2.46	1.57
Industrial Equipment	0.67	0.57	0.48	0.37	0.25	0.66	0.56	0.47	0.37	0.24
Light Duty Commercial Equipment	0.71	0.69	0.67	0.61	0.53	0.7	0.68	0.66	0.61	0.53
Trains	0.32	0.28	0.29	0.3	0.32	0.31	0.27	0.29	0.29	0.31
Off Road Recreational Vehicles	--	--	--	--	--	--	--	--	--	--
Ships (7)	3.12	3.55	3.92	4.32	5.08	3.05	3.47	3.82	4.21	4.96
Commercial Boats	1.11	1.01	0.92	0.8	0.75	1.09	0.99	0.89	0.78	0.74
Recreational Boats	1.04	1.28	1.51	1.77	2.26	1.04	1.28	1.5	1.76	2.26
Subtotal	12.68	12.19	11.91	11.44	11.32	12.42	11.94	11.68	11.22	11.12
AIRCRAFT										
Commercial Aircraft	0.1	0.11	0.11	0.12	0.14	0.09	0.1	0.11	0.12	0.14
General Aviation	--	--	--	--	--	--	--	--	--	--
Military Aircraft	0.27	0.27	0.27	0.28	0.28	0.27	0.27	0.27	0.27	0.28
Airport Ground Support Equipment	0.12	0.13	0.14	0.15	0.16	0.1	0.1	0.11	0.11	0.12
Subtotal	0.5	0.52	0.54	0.56	0.59	0.47	0.49	0.5	0.52	0.55
MISCELLANEOUS OTHER SOURCES										
Construction Operations	26.96	27.32	28.71	30.15	32.62	2.69	2.73	2.87	3.01	3.26
Farming Operations	1.21	1.21	1.21	1.21	1.21	0.18	0.18	0.18	0.18	0.18
Entrained Road Dust-Paved Roads	72.14	76.51	79.82	83.39	89.48	10.82	11.48	11.98	12.51	13.43
Entrained Road Dust-Unpaved Roads	12.57	13.07	13.44	13.82	14.48	1.26	1.31	1.34	1.38	1.45
Wind Blown Dust	6.54	6.54	6.54	6.54	6.54	1.15	1.15	1.15	1.15	1.15
Animal Waste	11.15	11.15	11.15	11.15	11.15	1.39	1.39	1.39	1.39	1.39
Agricultural Pesticides	--	--	--	--	--	--	--	--	--	--
Non-Agricultural Pesticides	--	--	--	--	--	--	--	--	--	--
Consumer Products(Excluding Pesticides)	--	--	--	--	--	--	--	--	--	--
Other Sources	6.95	6.38	6.38	6.38	6.39	6.25	5.74	5.74	5.74	5.75
Subtotal	137.54	142.17	147.26	152.64	161.87	23.75	23.98	24.65	25.37	26.6

Table 2-9 (continued). Bay Area inventory 2005-2020, PM10 & $PM_{2.5}$.

SOURCE CATEGORY	Particulate Matter< 10 microns (4)					Particulate Matter< 2.5 microns (4)				
	2005	2009	2012	2015	2020	2005	2009	2012	2015	2020
Biogenics	--	--	--	--	--	--	--	--	--	--
Subtotal	--	--	--	--	--	--	--	--	--	--
Total Emissions	208.32	213.92	220.04	226.27	238.16	86.27	87.22	88.7	90.02	93.49
GRAND TOTAL EMISSIONS	208.32	214.22	220.34	226.57	238.46	86.27	87.42	88.9	90.22	93.69

1. Inventory and projections are based upon CARB EMFAC 2007, Version 2.3 and assume implementation of all control measures adopted as of December 31, 2006, including Smog Check II for the Bay Area.
2. The Annual Average inventory represents emissions on an average day. ABAG Projections 2007 were used to project future emissions from on-road motor vehicles and for the regional population projections used for the planning inventory.
3. Entries are rounded to nearest whole number, totals may not equal to sums of column entries.
4. Table shows directly emitted PM only. Figures do not include secondary PM10 such as ammonium nitrate and ammonium sulfate
5. Banked Emissions show the total current deposits in the District's emissions banking program as allowed by BAAQMD Regulation 2, Rules 2 & 4. These emissions were reduced (beyond regulations) and banked, but may be withdrawn from the bank and emitted in future years.
6. Surplus emissions, voluntarily reduced, available for alternative compliance with BARCT requirements of selected rules, as prescribed by State law and BAAQMD Regulation 2, Rule 9.
7. CARB has recently developed statewide emissions estimates for ocean-going vessels occurring within 100 nautical miles of the California coastline. As a result, these emissions are substantially higher than those reported in the previous version of the inventory published in the 2005 Ozone Strategy, which accounted for ship activities within three miles of the Golden Gate Bridge.

Figure 2-14 provides a breakdown of Bay Area ammonia emissions by source. Ammonia is a key precursor to secondary PM, as it combines with NOx to form ammonium nitrate and combines with SOx to form ammonium sulfate.

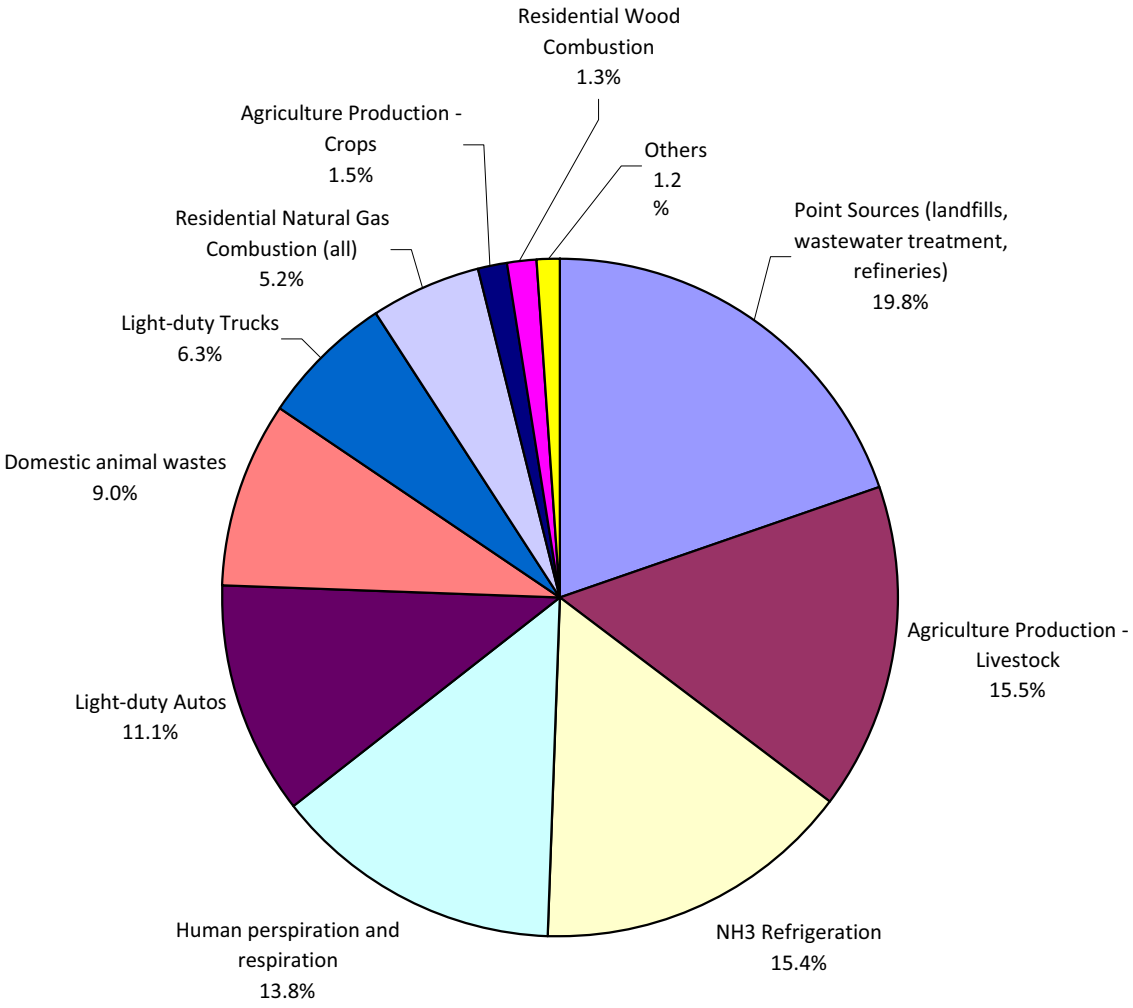


Figure 2-14. Annual average ammonia emissions by source, 2008 (52 tons/day).

Source Contributions to Ambient PM Concentrations

Ambient PM2.5 derives both from direct emissions and secondary compounds created in the atmosphere. Determining the relative contributions of various sources of direct PM2.5 emissions and PM2.5 precursors to total PM concentrations is complex. To estimate the overall contribution of various sources, we combine emissions inventory data with the results of chemical mass balance (CMB) analysis, the latter providing information on the relative contributions from source categories contributing to primary and secondary PM.

In analyzing PM sources there may be discrepancies between the estimated PM emissions inventory and ambient PM concentrations estimated from CMB analysis. For example, the emissions inventory lists road and windblown dust as significant sources, whereas chemical mass balance analysis shows such dust to be a very small contributor on ambient filters. There are several likely reasons, a primary one being that what gets emitted does not necessarily stay airborne to be sampled. Thus, larger PM2.5 particles – those nearly 2.5 microns in diameter such as the bulk of geological dust – tend to settle out relatively quickly, whereas smaller particles – those less than 1 micron in diameter including combustion-related PM2.5 – can stay airborne for days.

Figure 2-15 shows estimated contributions to both primary and secondary annual average PM2.5 by source.[53] The contributions in Figure 2-15 differ from those in Figure 2-12 in a number of respects: Sea salt constitutes about 11% of Bay Area PM2.5, but is not included in the Emissions Inventory. Emissions of NOx from motor vehicles contribute significantly to secondary PM2.5, namely ammonium nitrate; because of this, the overall contribution of motor vehicles to PM2.5 concentrations is considerably larger than their direct emissions alone. Similarly, refineries emit significant amounts of SO2, so that their contribution to ammonium sulfate is significant. A key point is that most Bay Area anthropogenic PM2.5 derives from combustion – either wood (biomass) burning, or combustion of fossil fuels.

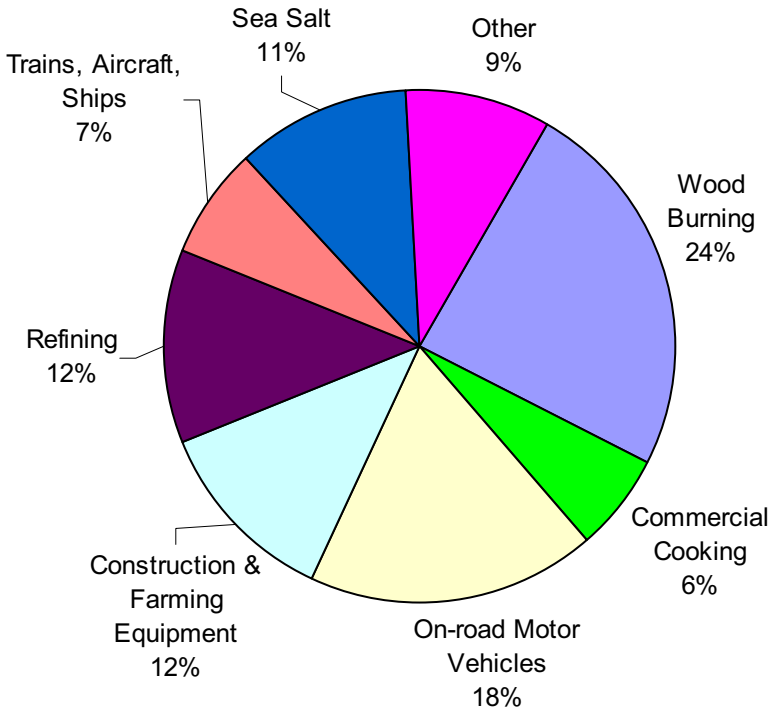


Figure 2-15. Estimated contributions to annual PM2.5 concentrations in the Bay Area.

[53] See report entitled *Sources of Bay Area Fine Particles*.
www.baaqmd.gov/~/media/Files/Planning%20and%20Research/Particulate%20Matter/PM_Report.ashx

Figure 2-16 is similar to Figure 2-15, except that it shows the relative contributions to peak PM2.5 concentrations; those relevant for the national 24-hour PM2.5 standard. In the Bay Area, the highest PM2.5 occurs in the wintertime. Wood burning represents a large portion of the total. Wood burning is primarily residential wood fires, but also includes wildfires and prescribed burns. Figure 2-16 shows wood-burning as contributing roughly one-third of peak PM2.5 concentrations. However, on certain days and in certain locations, wood-burning can account for more than half of total ambient PM2.5. Another large portion of winter PM2.5 is ammonium nitrate deriving from NOx and ammonia. Thus, on-road motor vehicles are also a large contributor because they are the principal source of NOx emissions.

In addition to directly emitted PM, emissions of PM precursors such as NOx, ammonia, and sulfur dioxide contribute to the formation of secondary PM. Combustion of fossil fuels produces NOx, which combines with ammonia[54] in the atmosphere to form ammonium nitrate, and sulfur dioxide (SO2), which combines with ammonia to form ammonium sulfate. These secondary compounds constitute another one-third of Bay Area PM2.5 on an annual basis and approximately 40-45% during winter peak periods.

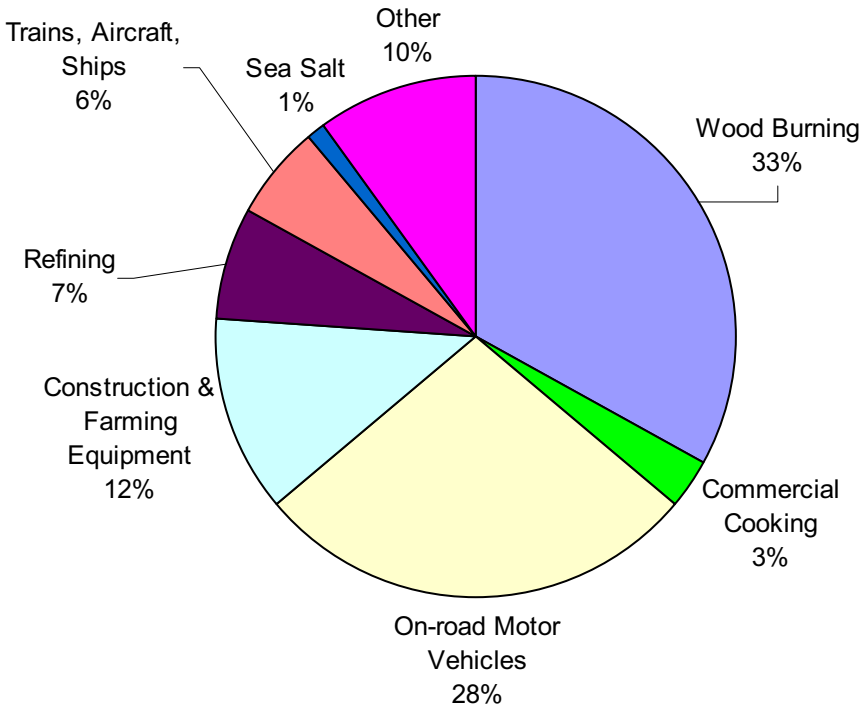


Figure 2-16. Estimated contributions to peak PM2.5 concentrations in the Bay Area

[54] As shown in Figure 2-14, the leading sources of ammonia emissions in the Bay Area include livestock, commercial refrigeration (wineries, breweries, and cold storage warehouses), human respiration and perspiration, domestic animal waste, and motor vehicles.

In recent years, as industrial production and air pollution have increased in China and other Asian countries, researchers have been investigating the possible impact of Asian emissions in terms of ambient air quality and deposition in North America. More research is needed in this area. However, preliminary analysis suggests that while there may be substantial transport of PM from Asia, most of it apparently passes far above the Bay Area, continuing eastward where some may be deposited on the slopes of the Sierras.[55]

Trends in Monitored PM Concentrations

The Bay Area has achieved significant reductions in PM concentrations since 1990 but continues to exceed several PM standards. Figure 2-17 shows trends relative to the standards.

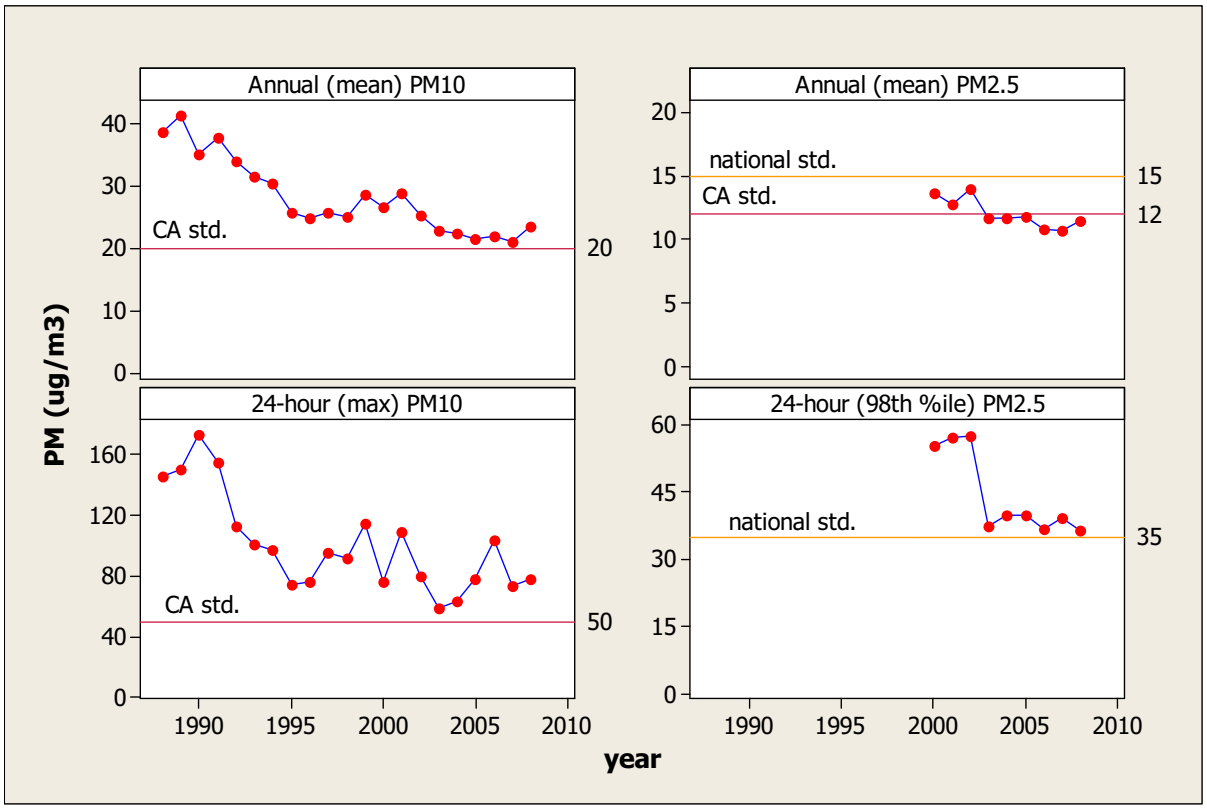


Figure 2-17. Bay Area PM trends relative to national and California standards.

The Bay Area's peak 98th percentile values, which serve as the basis for determining attainment of the national 24-hour $PM_{2.5}$ standard, were just over the national 35 µg/m^3 standard in 2008. Given the continued reductions in emissions of both primary PM2.5 and

[55] Chin, M., Diehl, T., Ginoux, P., Malm, W., 2007. Intercontinental transport of pollution and dust aerosols: implications for regional air quality. Atmos. Chem. Phys. 7, 5501–5517

also its secondary precursors, the standard may be met in a few years. The Bay Area continues to violate state PM10 standards by a considerable margin, however.

The Bay Area has seen significant reductions in PM10 levels since 1990; peak concentrations have declined by approximately half and annual average values have declined by about one-third. PM2.5 has only been measured since 1999, so quantitative trend analysis is currently limited. However, it is likely that PM2.5 has been reduced at least as much as PM10.[56] Analysis of ambient PM10 measurements shows that ammonium nitrate values have dropped faster than PM10 as a whole. This reduction is likely due to reductions in NO_x emissions, which have decreased significantly since 1990; reducing secondary PM represents an additional benefit of reducing NOx as an ozone precursor.

Summary of Key PM Modeling Findings

Photochemical modeling was used to estimate the impacts of reducing PM and its precursor emissions for the Bay Area and its neighboring PM nonattainment regions. Reducing primary (directly-emitted) PM2.5 emissions in the Bay Area provided far greater reductions in ambient Bay Area PM2.5 levels than reducing Bay Area secondary PM2.5 precursor emissions. Of the precursor emissions reductions simulated (ammonia, NOx, VOC, and sulfur-containing compounds), Bay Area ammonia reductions were most effective in reducing PM concentrations. The ammonia emissions reductions lowered Bay Area ammonium nitrate PM2.5 levels only for relatively cold winter days favoring ammonium nitrate buildup. (Ammonium nitrate PM2.5 tends to evaporate faster than it forms at temperatures above around 60 degrees Fahrenheit.) Combined NOx and VOC emissions reductions for the Bay Area were relatively ineffective. NOx emissions reductions were relatively ineffective because ammonium nitrate PM2.5 formation involves the relatively slow and incomplete conversion of NOx to nitric acid. Reducing Bay Area sulfur-containing PM precursor emissions typically had a small impact on Bay Area ambient PM2.5 levels. Under certain conditions, however, reducing Bay Area sulfur-containing emissions did provide around 1 $\mu g/m^3$ reduced Bay Area PM2.5 level.

Photochemical simulations were also performed with zero Bay Area anthropogenic emissions to gauge the impacts of transported PM2.5 and precursors. Significant amounts of both primary and secondary PM2.5 were transported into the Bay Area. On days when the Bay Area exceeded the 24-hour PM2.5 standard, transported primary PM2.5 levels averaged as high as 8 $\mu g/m^3$ and transported secondary PM2.5 levels averaged as high as 13 $\mu g/m^3$. The largest transport impacts for both primary and secondary PM2.5 occurred along the eastern boundary of the Bay Area.

[56] Fine PM is almost completely combustion-related, whereas geological dust, for which emissions appear to be increasing, and marine air, which is trendless, are both more prevalent among the coarse (larger) PM10 particles.

Summary of Modeling Findings: Impact of Wood Smoke Reductions on PM

Locally-emitted wood smoke accounts for approximately one-third of PM2.5 levels on days when Bay Area PM levels exceed the national 24-hr PM2.5 standard. Preliminary wood smoke simulations have suggested that the wood smoke rule may have been effective at reducing ambient wood smoke levels by 50-75 percent at key PM2.5 monitoring locations. This conclusion, however, assumes 100% compliance with the wood smoke rule, which may not have occurred. The largest reductions in wood smoke PM2.5 levels were simulated for the locations having peak wood smoke levels; these locations often were not near any monitor. Therefore, reductions of population exposure to wood smoke resulting from the rule may be significantly greater than indicated by the monitoring data. Multiple, consecutive no-burn days may provide the added benefit of reducing both fresh wood smoke emissions, as well as smoke carried over from prior days.

Air Toxics

Air toxics (often referred to as "toxic air contaminants") are a class of pollutants that include hundreds of individual airborne chemical species hazardous to human health. A number of these are common in urban environments. Reducing emissions of air toxics and population exposure to these chemicals is a key priority for the Air District.

Air Toxics Health Effects

Air toxics can cause or contribute to a wide range of health effects, including acute (short-term) health effects, such as eye and throat irritation; chronic (long-term) non-cancer effects, such as neurological damage, hormone disruption, and developmental defects; and cancer. CARB has identified 191 air toxics, including diesel particulate matter (diesel PM) and environmental tobacco smoke.

Unlike criteria pollutants which are subject to ambient air quality standards, air toxics are primarily regulated at the individual emissions source level based on risk assessment. Human outdoor exposure risk associated with an individual air toxic species is calculated as its ground-level concentration multiplied by an established unit risk factor for that species. Total risk due to air toxics is the sum of the individual risks associated with each species.

The Air District's cancer-risk-weighted emissions inventory, developed based upon OEHHA health risk estimates, shows that a small subset of air toxics account for approximately 95% of the total cancer risk from air pollutants in the Bay Area, as illustrated in Figure 2-18. This cancer risk is estimated at several hundred cases per million in many parts of the Bay Area,

and higher in certain communities most impacted by diesel emissions, as discussed in the Air Toxics Trends section below. Diesel PM alone accounts for roughly 85% of this risk.[57]

Diesel particulate matter has been shown to be a lung carcinogen in occupational health studies[58] and is also a respiratory irritant. Mobile sources, especially heavy-duty diesel engines in trucks, construction equipment, locomotives, and ships, account for most of the cancer risk associated with air toxics in the Bay Area, as shown in Figure 2-19.

Benzene, present in gasoline vapors and also a byproduct of combustion, has been classified as a human carcinogen and is associated with leukemia. 1,3-butadiene, produced from motor vehicle exhaust and other combustion sources, has also been associated with leukemia. Reducing 1,3-butadiene also has a co-benefit in reducing the air toxic acrolein.[59]

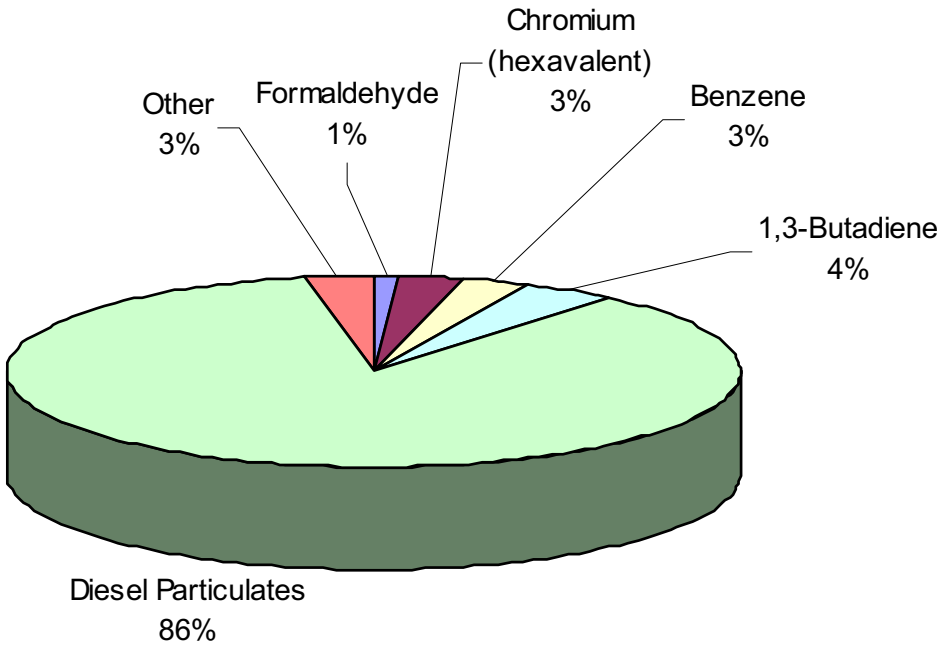


Figure 2-18. Cancer-risk weighted emission estimates for the San Francisco Bay Area.

[57] Unlike most other air toxics, diesel PM cannot be measured directly because no accepted measurement method currently exists. Therefore, the concentration estimates for diesel PM have been made using elemental carbon measurements collected via the IMPROVE method or using a PM-based exposure method.
[58] See "Health Risk Assessment for Diesel Exhaust," Chapter 6.2. Office of Environmental Health Hazard Assessment, California Environmental Protection Agency, May 1998.
[59] Acrolein, which is emitted directly in combustion processes and chemically produced from 1,3-butadiene in the atmosphere, has been associated with both chronic and acute health effects [OEHAA, EPA REF], including respiratory aliments, decreased respiratory function, and eye irritation.

Acetaldehyde and formaldehyde are emitted from fuel combustion and other sources and formed photo-chemically in the atmosphere from other compounds. Both compounds have been found to cause nasal cancers in animal studies; both are also associated with skin and respiratory irritation. Human studies for carcinogenic effects of acetaldehyde are sparse but, in consideration of animals studies, sufficient to support classification as a probable human carcinogen. Formaldehyde has been associated with nasal sinus cancer and nasopharyngeal cancer, and possibly with leukemia.

Air Toxics Emissions Inventory

Through the Air District's Community Air Risk Evaluation (CARE) program (described in Chapter 3), estimates of air toxics emissions in 2005 were compiled within the Bay Area for all major source categories: stationary permitted (point); other stationary, non-point; on-road mobile; and off-road mobile sources. The point source category includes industrial emissions from sources such as refineries, power plants and landfills, which are required to provide annual updates to the BAAQMD on their toxic emissions. The non-point area source category includes emissions from sources such as dry-cleaners, gasoline dispensing facilities, and lawn and garden equipment. The on-road mobile source category includes emissions from cars and trucks on freeways and roadways. The off-road mobile source category includes emissions from sources such as ships, trains, and construction equipment.

The air toxics emission inventories for on-road and areas sources were compiled following a "top-down" approach, beginning with total organic gases (TOG) and PM10 emissions estimated at the county level. Air toxics emissions for both on-road and area sources are estimated from chemical speciation of TOG and PM10, using source-specific speciation profiles to transform TOG and PM emissions into emissions of individual air toxics. These estimates were combined with the existing point source inventory of air toxics emissions. The mass-based emissions were converted to toxicity-weighted emissions for cancer, chronic, and acute risks using available cancer unit risk (UR) factors and non-cancer reference concentrations (RfC) for the inhalation exposure pathway.

An inventory showing the major sources of key air toxics is provided in Table 2-10. [60] The emissions shown in this table are raw numbers; that is, the data has not been weighted based upon health risk.

Figure 2-19 shows cancer-risk-weighted air toxics emissions by source category.

[60] The District is in the process of preparing a toxic inventory that will estimate toxics emissions in future years, but the future year inventory was not available in time for inclusion in the Draft CAP.

Table 2-10. Bay Area air toxics inventory for the year 2005.

Annual Average Emissions in pounds/day (not risk-weighted)						
SOURCE CATEGORY	BENZENE	DPM	1,3-BUTADIENE	FORMALDEHYDE	ACETALDEHYDE	HEXAVALENT CHROMIUM
PETROLEUM REFINING	133.2		3.8	37.4	3.3	0.02
OTHER INDUSTRIAL PROCESSES	50.3		0.04	64.6	8.3	0.06
ORGANIC COMPOUNDS EVAPORATION	316.9		0.00	5.4	14.9	
COMBUSTION – STATIONARY SOURCES	385.6	522.2	3.5	3003.4	1751.2	0.01
OFF-ROAD MOBILE SOURCES	3,072.1	15,441.7	830.8	6,490.3	5,875	0.32
ON-ROAD MOBILE SOURCES	6,310.7	7,465.4	1,321.3	4,741.9	3,505.6	0.29
MISCELLANEOUS			126.3			1.05
TOTAL EMISSIONS	10,269	23,429	2,286	14,343	11,158	1.74

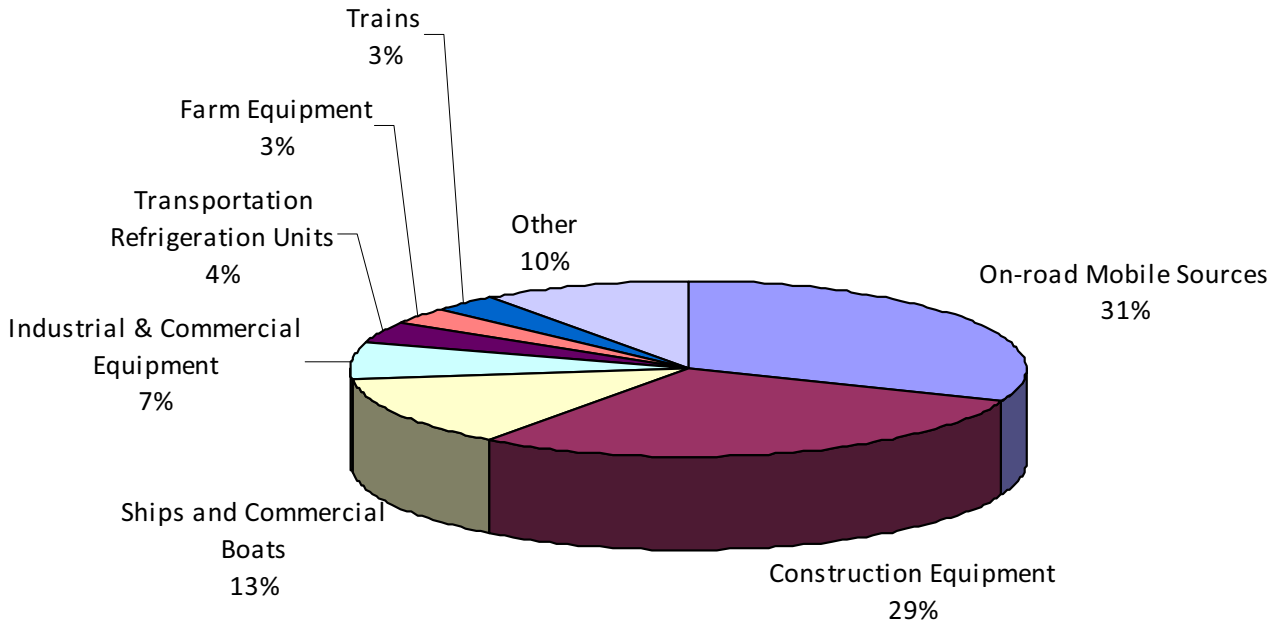


Figure 2-19. Cancer-risk-weighted air toxics emissions by source category.

Air Toxics Trends

The Air District and CARB have monitored selected air toxics in the San Francisco Bay area since the late 1980s. By analyzing trends in the air toxics monitoring data, the Air District estimates that between 1990 and 2005 there was about a 7 percent reduction per year in the cancer risk from air toxics.[61] The health risks of 1,3-butadiene and benzene have been reduced by about 78 percent and 83 percent, respectively, between 1990 and 2005.

As shown in Figure 2-20, using OEHHA cancer risk factors,[62] the estimated lifetime cancer risk (over a 70-year lifespan) from all air toxics combined declined from 1,330 cases per million in 1990 to 405 cases per million people in 2008. This represents a 70 percent drop between 1990 and 2008.

[61] Similar trends estimates are available from CARB (CARB Almanac, 2009).
[62] See Appendix A of May 2009 OEHHA document: Technical Support Document for Cancer Potency Factors. www.oehha.ca.gov/air/hot_spots/2009/AppendixA.pdf

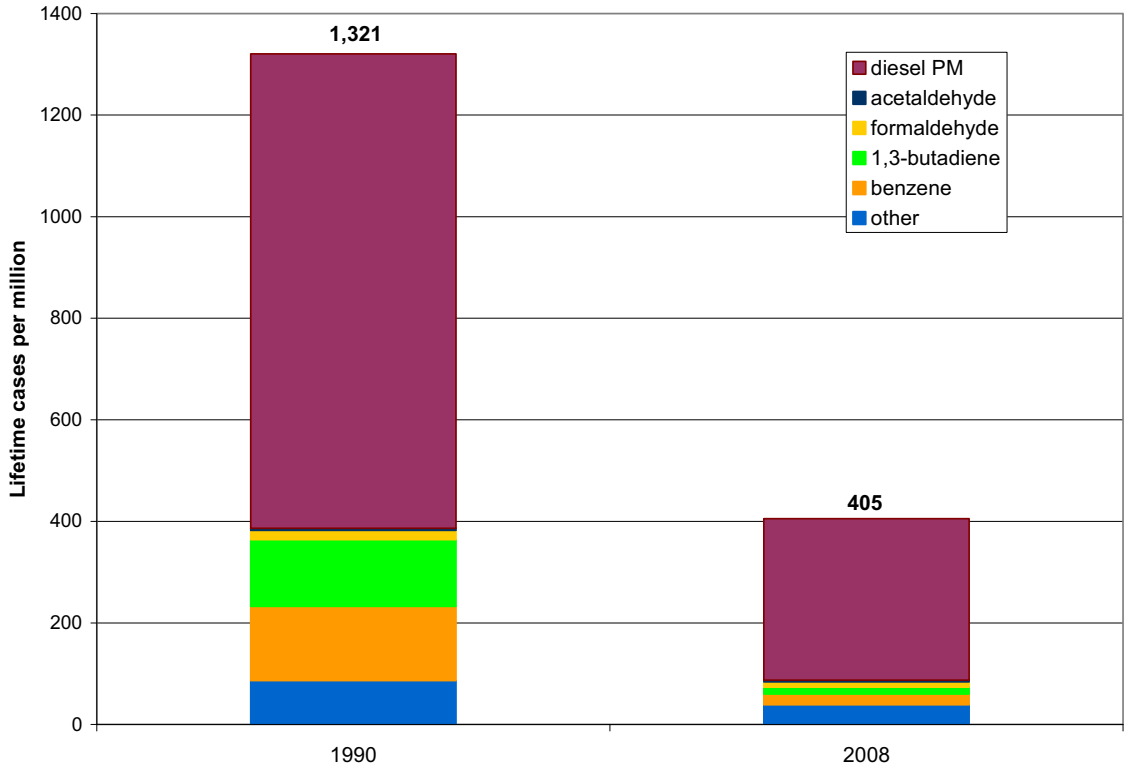


Figure 2-20. Cancer risk-weighted toxics emissions trends.

Summary of Key Air Toxics Modeling Findings

Six air toxics species were simulated over the Bay Area. Five of the species were estimated to account for the bulk of total air toxics cancer risk in the Bay Area: acetaldehyde; benzene; 1,3-butadiene; diesel PM; and formaldehyde. The sixth species, acrolein, was believed to be the ambient toxic with the most serious non-cancer health effects. Over 80% of the Bay Area population-weighted cancer risk derived from diesel PM. The highest simulated annual average diesel PM concentration (10-12 µg/m^3) was located over West Oakland, extending toward Emeryville and along both sides of the eastern span of the Bay Bridge. The second highest (8-10 µg/m^3) locations were over an area southeast of downtown Oakland, Alameda, and the Transbay District/Rincon Hill areas in San Francisco. Cancer risk was used to define six impacted communities [63] within the Bay Area: Concord; eastern San Francisco; western Alameda County; Redwood City and East Palo Alto; Richmond and San

[63] See *Applied Method for Developing Polygon Boundaries for CARE Impacted Communities* (December 2009) available at www.baaqmd.gov/Divisions/Planning-and-Research/CARE-Program/CARE-Documents.aspx.

Pablo; and San Jose. (See impacted communities map in Figure 3-2.) These six impacted communities accounted for nearly half of the total Bay Area population-weighted lifetime cancer risk for sensitive groups (those under 18 or over 64 years of age).

Air Toxics Programs at the National and State Level

There are both national and state programs to regulate air toxics. US EPA regulates air toxics (using the term "hazardous air pollutants" or HAPs) pursuant to Title III, Section 112(b) of the 1990 Clean Air Act Amendments.[64] California's program to reduce exposure to air toxics was established by the Toxic Air Contaminant Identification and Control Act via AB 1807 in 1983, and the Air Toxics "Hot Spots" Information and Assessment Act via AB 2588 in 1987. Under AB 1807, CARB and OEHHA determine if a substance should be formally identified as a toxic air contaminant in California. CARB assesses the potential for human exposure to a substance and OEHHA evaluates the health effects.

The AB 1807 program was amended in 1993 by AB 2728, which required the CARB to identify the 189 federal hazardous air pollutants as air toxics. AB 2588 supplements the AB 1807 program, by requiring a statewide air toxics inventory, notification of people exposed to a significant health risk, and facility plans to reduce these risks. In 1992, the "Hot Spots" Act was amended by Senate Bill 1731 which required facilities that pose a significant health risk to the community to reduce their risk through a risk management plan.

District Programs to Reduce Air Toxics

Two programs comprise the backbone of the Air District's air toxics reduction program for stationary sources: New Source Review for Air Toxics and the Air Toxics Hot Spots Program.

New Source Review: Pursuant to Regulation 2, Rule 5, new or modified emissions sources are required to perform health risk screening analysis for air toxics and utilize Best Available Control Technology to reduce emissions of air toxics.

Air Toxics Hot Spots Program: This is a state program implemented by regional air districts in California. Pursuant to Assembly Bill 2588 (1987) and Senate Bill 1731 (1992), facilities are required to provide information about their air toxics emissions, and facilities that pose a significant risk are required to develop and implement site-specific risk reduction plans and audits.

In addition to these core air toxics programs, the Air District seeks to reduce population exposure to air toxics through a variety of rules and programs which are described in Chapter 3, including the CARE program, the Clean Air Communities Initiative, and grant and incentives programs.

[64] For more details on the 1990 CAAA, see http://www.epa.gov/air/caa/.

Greenhouse Gases

Greenhouse gases that cause climate change are an entirely different type of pollutant than criteria pollutants or air toxics. Climate change and atmospheric warming are global in scale, both in terms of causes and effects. The scientific consensus is clear that climate change poses enormous risks on a worldwide basis. Climate change is expected to have profound impacts on both the natural and man-made systems that sustain us. The range of potential impacts includes reduction in agricultural and forestry productivity, changes in human demographics and migration, reduced water supply, acidification of oceans, changes in natural habitat, extinction of species and loss of biodiversity, more powerful or more frequent hurricanes and cyclones, etc.

As discussed in Chapter 1, climate change poses a direct threat to air quality and public health in the Bay Area. Anticipated impacts include sea level rise (threatening coastal areas, the bay and the delta, as well as key infrastructure), reduced Sierra snowpack (vital to our water supply), increased wildfires, and higher levels of air pollution.

There are dozens of greenhouse gases (GHGs), but a handful of these gases are the primary agents of climate change. For purposes of the CAP, we consider the six GHGs described below, often referred to as the "Kyoto Six."[65] These are the GHGs included in the District's *Source Inventory of Bay Area Greenhouse Gas Emissions* described below, and also included in the CAP *Multi-Pollutant Evaluation Methodology*.

Carbon Dioxide (CO2) is released to the atmosphere when fossil fuels (oil, gasoline, diesel, natural gas, and coal), solid waste, and wood or wood products are burned.

Methane (CH4) is emitted during the production and transport of coal, natural gas, and oil. Methane emissions also result from the decomposition of organic waste in municipal solid waste landfills and the raising of livestock.

Nitrous oxide (N2O) is emitted during agricultural and industrial activities, as well as during combustion of solid waste and fossil fuels.

Hydrofluorocarbons (HFCs), ***perfluorocarbons*** (PFCs), and ***sulfur hexafluoride*** (SF6), are generated in a variety of industrial processes. Although these gases are small in terms of their absolute mass, they are potent agents of climate change as expressed by their global warming potential.

[65] These six gases were recognized as the leading GHGs in the Kyoto protocol of 1997. They are considered the primary GHGs by many national and international institutions, including U.S. EPA and the Intergovernmental Panel on Climate Change (IPCC).

Global Warming Potential

Each greenhouse gas differs in its ability to absorb heat in the atmosphere; this is often referred to by the term "radiative forcing" or *global warming potential* (GWP). The GWP of the Kyoto 6 GHGs is shown in Table 2-11. Greenhouse gas emissions are often expressed in terms of carbon dioxide equivalents (CO2e), in which each gas is weighted by its GWP.

Table 2-11. Global warming potentials (GWPs) for greenhouse gases.

Greenhouse Gas	Global Warming Potential
CO2	1
Methane (CH4)	21
N2O	310
HFCs/PFCs	90- 11,700
SF6	23,900

There is great variation in terms of the emissions of each GHG on a mass basis, as well as in their GWP. Even though other GHGs absorb much more heat on a molecule per molecule basis, CO2 emissions dominate the Bay Area GHG inventory, accounting for 91.4% of total GHGs on a GWP-weighted basis, because the amount of CO2 emitted is so enormous.

GHGs Not Addressed in CAP

There are a number of other greenhouse gases or agents that are not addressed in the CAP. The reasons that these GHGs were not included are explained below.

Chloroflourocarbons (CFCs) and **hydrochloroflourocarbons** (HCFCs) are pollutants that deplete stratospheric ozone. Because these emissions are covered under the *Montreal Protocol on Substances that Deplete the Ozone Layer* (1989), they are not included in the Kyoto Protocol.

Water vapor is a naturally occurring greenhouse gas which accounts for a large percentage of the total greenhouse effect. However anthropogenic emissions of water vapor do not contribute significantly to the change of atmospheric water vapor concentration. Therefore, *IPCC Guidelines* do not deal with water vapor as an anthropogenic GHG.

Ozone acts as a greenhouse gas that contributes to climate change, in addition to its role as a criteria air pollutant. Thus, reductions in emissions of ozone precursors (ROG and NOx) will provide an important co-benefit in reducing total GHG emissions.

Carbon Monoxide (CO) has been identified as an important indirect greenhouse gas. An increase in CO emissions alters atmospheric chemistry so as to increase concentrations of methane, which is a potent GHG.

Black Carbon, a key component of fine PM, may also contribute significantly to climate change. The IPCC notes a small effect from fossil fuel–based black carbon, but some researchers have suggested that the impact has been underestimated (Hansen and Nazarenko 2004; Jacobson 2001).[66] In the United States, diesel emissions account for more than half of the black carbon (CARB, 2007). In the Bay Area, combustion of wood and gasoline also contribute significantly to black carbon concentrations. As in the case of ozone, reducing emissions of black carbon may provide an important co-benefit in terms of climate protection.

Bay Area GHG Inventory and GHG Emissions Trends

In November 2006 the BAAQMD became the first air district in the nation to develop a detailed GHG emissions inventory. The Bay Area GHG inventory was updated in December 2008; minor revisions were also made in January 2010. The Air District's greenhouse gas inventory only includes GHGs that are emitted within the Bay Area, as well as GHGs emitted in the production of electricity that is imported to the region. The inventory does not include GHGs associated with other goods or products that are imported into the region. If GHGs from imported goods were included, the region's actual GHG footprint would be considerably larger.

Greenhouse gas emissions have been increasing on a regional, statewide, national, and global scale for many decades. Under "business as usual" conditions – that is, absent some combination of regulatory, policy, land-use, and/or market-based changes - Bay Area GHG emissions would be expected to continue to increase at an average rate of approximately 1.4 percent per year in the future due to population growth, economic expansion, and other factors.

Figure 2-21 shows the current Bay Area inventory by source category. The industrial/ commercial and the transportation sectors combined account for over 70% of GHG emissions in the Bay Area inventory.

[66] Hansen, J., and L. Nazarenko, 2004: Soot climate forcing via snow and ice albedos. *Proceedings of the National. Academy of Sciences*, 101, 423-428. Also see Jacobson, M. Z., Strong radiative heating due to mixing state of black carbon in atmospheric aerosols, *Nature, 409*, 695-697, 2001.

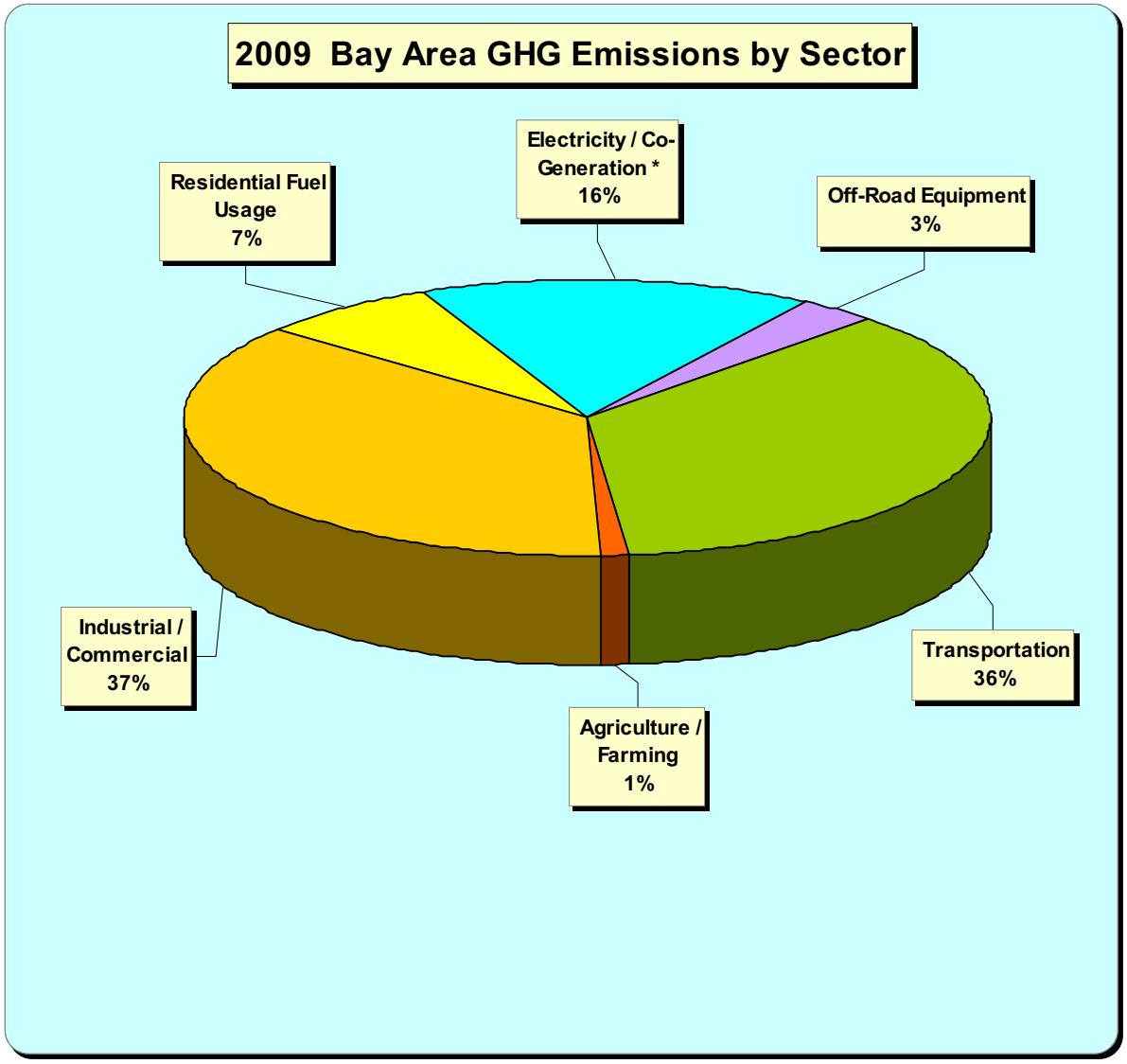


Figure 2-21. Bay Area GHG emissions by source category.

The latest Bay Area GHG inventory shown in Table 2-12 reflects regulatory programs that were in place as of 2007.[67]

[67] The benefits of CARB's GHG regulation for motor vehicles adopted in 2004, the "Pavley regulations" (AB 1493) to reduce emissions of GHGs from motor vehicles, are not included in Table 2-12. This regulation had been on hold, pending U.S. EPA approval of a waiver required under the terms of the federal Clean Air Act. The waiver was finally approved in June 2009. However, CARB has not yet updated its emission factors to incorporate the projected benefits of AB 1493.

Table 2-12. Bay Area greenhouse gas emission inventory projections for 2005-2020 (million metric tons CO2 equivalent).

SOURCE CATEGORY	Year 2005	Year 2009	Year 2012	Year 2015	Year 2020
INDUSTRIAL/ COMMERCIAL					
Oil Refineries					
Refining Processes	3.4	3.5	3.6	3.7	3.9
Refinery Make Gas Combustion	4.7	4.9	5.0	5.2	5.4
Natural Gas and Other Gases Combustion	4.8	5.0	5.1	5.3	5.5
Liquid Fuel Combustion	0.1	0.1	0.1	0.1	0.1
Solid Fuel Combustion	1.0	1.0	1.1	1.1	1.1
Waste Management					
Landfill Combustion Sources	0.0	0.0	0.0	0.0	0.0
Landfill Fugitive Sources	1.2	1.2	1.2	1.2	1.2
Composting/POTWs	0.4	0.4	0.4	0.4	0.4
Other Industrial/ Commercial					
Cement Plants	0.9	0.9	0.9	0.9	1.0
Commercial Cooking	0.1	0.1	0.1	0.1	0.2
ODS Substitutes/Nat. Gas Distrib./Other	3.6	5.2	6.3	7.5	9.4
Reciprocating Engines	0.6	0.6	0.6	0.7	0.7
Turbines	0.4	0.4	0.4	0.4	0.4
Natural Gas- Major Combustion Sources	1.6	2.5	2.6	2.7	2.8
Natural Gas- Minor Combustion Sources	8.8	9.2	9.5	9.9	10.4
Coke Coal	1.0	1.0	1.1	1.1	1.2
Other Fuels Combustion	0.3	0.4	0.4	0.4	0.4
Subtotal	32.8	36.3	38.4	40.6	44.2
RESIDENTIAL FUEL USAGE					
Natural Gas	6.4	6.6	6.8	6.9	7.2
LPgas/Liquid Fuel	0.2	0.2	0.2	0.2	0.2
Solid Fuel	0.1	0.2	0.2	0.2	0.2
Subtotal	6.7	6.9	7.1	7.2	7.5
ELECTRICITY/ CO-GENERATION					
Co-Generation	5.5	5.5	5.7	6.0	6.4
Electricity Generation	2.8	3.1	3.2	3.3	3.5
Electricity Imports	6.8	7.3	7.6	7.9	8.3
Subtotal	15.1	15.8	16.5	17.2	18.3
OFF-ROAD EQUIPMENT					
Lawn and Garden Equipment	0.1	0.1	0.1	0.1	0.1
Construction Equipment	1.7	1.9	1.9	2.0	2.2
Industrial Equipment	0.7	0.8	0.8	0.9	1.0
Light Commercial Equipment	0.2	0.2	0.3	0.3	0.3
Subtotal	2.8	3.0	3.2	3.3	3.6

Table 2-12 (continued). Bay Area greenhouse gas emission inventory projections for 2005-2020 (million metric tons CO2 equivalent).

SOURCE CATEGORY	Year 2005	Year 2009	Year 2012	Year 2015	Year 2020
TRANSPORTATION					
Off-Road					
Locomotives	0.1	0.1	0.1	0.1	0.1
Ships	0.7	0.8	0.8	0.9	1.0
Boats	0.6	0.6	0.5	0.5	0.6
Commercial Aircraft	1.8	2.0	2.1	2.3	2.6
General Aviation	0.2	0.2	0.2	0.3	0.3
Military Aircraft	0.5	0.5	0.5	0.5	0.5
On-Road					
Passenger Cars/Trucks up to 10,000 lbs	26.6	27.1	27.9	29.0	30.9
Medium/Heavy Duty Trucks > 10,000 lbs	3.3	3.3	3.4	3.5	3.7
Urban, School and Other Buses	0.8	0.8	0.8	0.8	0.9
Motor-Homes and Motorcycles	0.2	0.2	0.2	0.2	0.2
Subtotal	34.8	35.6	36.7	38.1	40.7
AGRICULTURE/ FARMING					
Agricultural Equipment	0.2	0.2	0.2	0.2	0.2
Animal Waste	0.6	0.6	0.6	0.6	0.6
Soil Management	0.3	0.3	0.3	0.3	0.3
Biomass Burning	0.0	0.0	0.0	0.0	0.0
Subtotal	1.1	1.1	1.1	1.1	1.1
GRAND TOTAL EMISSIONS	**93.4**	**98.7**	**103.0**	**107.5**	**115.4**

Chapter 3 – Planning Context

This chapter provides the policy and planning context for the CAP. The 2010 Clean Air Plan builds on many other plans and programs, including existing and new Air District initiatives, as well as plans developed and implemented by other agencies. This chapter describes:

- Progress in implementing the Bay Area 2005 Ozone Strategy;
- Key Air District programs and initiatives that are linked to the CAP;
- External plans and programs that complement the CAP; and
- State and federal emission reduction programs.

Implementation of the Bay Area 2005 Ozone Strategy

The 2010 CAP updates the Air District's most recent state ozone plan, the 2005 Ozone Strategy. The 2005 Ozone Strategy laid out a comprehensive plan to reduce emissions of ozone precursors, including 15 Stationary Source Measures (SSMs), four Mobile Source Measures (MSMs), and 20 Transportation Control Measures (TCMs). The Air District and its partner agencies have taken action to implement the control measures in the 2005 Ozone Strategy, as summarized below. SSMs have been implemented through the Air District's rule development process. MSMs and TCMs have been implemented through a wide range of mechanisms, including partnerships, grants, and public outreach and education.

In addition, the 2005 Ozone Strategy identified 20 Further Study Measures (FSMs). These FSMs were not a formal part of the control strategy, but the Air District did make a commitment to evaluate these measures further to determine whether they could be developed into formal control measures. Several FSMs were in fact developed into formal measures and adopted as rules, as discussed below.

Stationary Source Measures in the 2005 Ozone Strategy

Table 3-1 shows the outcome of Stationary Source Measures identified in the 2005 Ozone Strategy. Of the 15 stationary measures, 13 have been adopted.

Table 3-1. Implementation of stationary source measures in 2005 ozone strategy.

Control Measure (Reg. – Rule) 2005 Ozone Strategy Control Measure #	Date Adopted	Emissions Reduced (tons per day)	
		ROG	NOx
SSM 1: Auto Refinishing (8-45)	12/3/08	3.7	
SSM 2: Graphic Arts Operations (8-20)	11/19/08	1.65	
SSM 3: High-Emitting Spray Booths [1]			
SSM 4: Polyester Resin Operations (8-50)	12/02/09	0.15	
SSM 5: Wood Coating Operations (8-32)	8/5/09	0.45	
SSM 6: Petroleum Refinery Flares (12-12) [2]	7/20/05	Unknown	
SSM 7: Gasoline Bulk Terminals/Plants (8-33 & 39)	4/15/09	0.07	
SSM 8: Marine Loading Operations (8-44)	12/7/05	0.44	
SSM 9: Organic Liquid Storage (8-5)	10/18/06	0.03	
SSM 10: Pressure Relief Devices (8-28) [3]	12/21/05	0.001	
SSM 11: Wastewater Systems (8-8)	9/15/04	2.1	
SSM 12: Boilers (9-7)	7/30/08		3.8
SSM 13: Residential Water Heaters (9-6)	11/7/07		2.5
SSM 14: Stationary Gas Turbines (9-9)	12/6/06		0.43
SSM 15: Promote Energy Conservation [4]	NA		
Total Emission Reductions		8.59	6.73

[1] SSM 3 is proposed for deletion, as discussed below.

[2] Regulation 12, Rule 12 reduces emissions or ROG, NOx, PM and SOx.

[3] The amendments to SSM 10 increase monitoring, inspection and reporting requirements to ensure that any significant release is detected, measured and controlled, thereby reducing potential exposure in nearby communities.

[4] SSM 15 has been reconfigured as ECM 1 in the 2010 CAP.

SSM 3 (High Emitting Spray Booths) is proposed for deletion. Analysis by Air District staff indicates that due to the adoption of other control measures (SSM-1 and SSM-5), plant closures and voluntary reductions, the potential emissions reductions from this measure are de minimis; therefore further rule development is not warranted at this time.

SSM 15 (Promote Energy Conservation), which was not proposed to be adopted as an Air District rule, has been implemented primarily through the District's Climate Protection Program. SSM 15 has been reconfigured and incorporated into measure ECM 1 in the 2010 CAP control strategy.

Additional Rules Adopted Since 2005

In addition to rules adopted pursuant to the Stationary Source Measures in the 2005 Ozone Strategy, the Air District has adopted or amended a number of other rules since

2005, as shown in Table 3-2. Several of these rules had been included as Further Study Measures (FSMs) in the 2005 Ozone Strategy. The additional actions include:

- Rules to reduce emissions of air toxics, including Regulation 2, Rule 5, New Source Review for Toxic Air Contaminants; as well as Regulations 11-16 and 8-17, both of which apply to dry cleaning operations
- Rules to require that agricultural feed lots (large confined animal sources) of a certain size obtain permits and mitigate their emissions;
- Rules to reduce emissions of PM pursuant to SB 656, including stationary internal combustion engines (Reg. 9-8), commercial broiling operations (Reg. 6-2), and residential wood-burning devices (Reg. 6-3).

Table 3-2. Additional rules adopted in 2005-2009 period.

Control Measure (Reg. – Rule) 2005 Ozone Strategy Control Measure #	Date Adopted	Emissions Reduced (tons per day)	
		ROG	NOx
FSM 2: Architectural Coatings (8-3)	7/1/09	5.4	
FSM 3: Commercial Broiling Operations (6-2) [1]	12/5/07	0.09	
FSM 15: Stationary IC Engines (9-8)	7/25/07		9.6
New Source Review / Toxic Air Contaminants (2-5)	6/15/05	Unknown	
Petroleum Refinery Flares (12-12) [2]	4/5/06	Unknown	
Large Confined Animal Sources (1, 2-1, 2-10)	7/19/06	Unknown	
Wood-burning Devices (6-3)	7/9/08	unknown	
Dry Cleaning Operations (11-16, 8-17)	3/4/09	unknown	
Total emission reductions		5.49	9.6

[1] In addition to reducing PM, Reg. 6-2 also reduces ROG emissions generated by cooking meat, thus helping to reduce ozone.

[2] Amendments to Reg. 12, Rule 12 were adopted on April 5, 2006 (in addition to the rule, first adopted on 7/20/05 pursuant to SSM 6.)

The PM rules described above were identified in the PM Implementation schedule adopted by the Air District Board of Directors in November 2005 in response to Senate Bill 656. SB 656 required CARB, in consultation with local air districts, to develop and adopt a list of the most feasible and cost-effective control measures that could be employed by CARB and local air districts to reduce PM10 and PM2.5. The bill required air districts to review the CARB list and develop implementation schedules for feasible PM control measures based on their local PM conditions. In response to SB 656, the Air District adopted the three PM rules listed above.

Implementation of Mobile Sources Measures in the 2005 Ozone Strategy

Table 3-3 summarizes implementation actions and progress in implementing the Mobile Source Measures in the Bay Area 2005 Ozone Strategy.

Table 3-3. Implementation of mobile source measures in 2005 ozone strategy.

Mobile Source Measures			
CM #	**Source Category**	**Description**	**Status**
MSM-1	Diesel Equipment Idling Model Ordinance	Reduce emissions from the idling of diesel equipment	BAAQMD has entered into an MOU with CARB and began implementing a Mobile Source Compliance Program in late 2009 to help enforce CARB diesel idling rules, with objective of establishing an ongoing presence in communities highly impacted by diesel truck traffic. BAAQMD provided approximately $47 million in grants to reduce diesel emissions in the 2005-2009 period.
MSM-2	Green Contracting Model Ordinance	Develop and promote a model ordinance to help local government agencies to encourage contractors to use clean vehicles, equipment and fuels.	BAAQMD provided grants to Sonoma and Marin Counties, and the Town of Hillsborough for development of local ordinances. This measure has been replaced by the new Mobile Sources Measures in the 2010 CAP.
MSM-3	Low Emission Vehicle Incentives	Encourage the purchase of new low-emission vehicles to reduce emissions from existing vehicles.	Between 2005 and 2009, BAAQMD awarded approximately $47 million in grants for the purchase of low-emission vehicles, cleaner engines and retrofit devices for transit buses, school buses, garbage trucks, public and private fleets. Reductions realized estimated at 0.04 tons per day (tpd) of ROG and 0.4 tpd of NOx.
MSM-4	Vehicle Buy Back Program	Accelerate the retirement of older, high emitting vehicles from the region's roadways by providing incentives to scrap them.	Between 2005 and 2008 BAAQMD provided incentives to retire approximately 20,500 passenger vehicles model year 1987 and older for a total cost of approximately $20 million. Reductions realized estimated at 1.03 tons per day (tpd) of ROG and 0.55 tpd of NOx.

Implementation of Transportation Control Measures in the 2005 Ozone Strategy

Table 3-4 summarizes implementation actions and progress in implementing the Transportation Control Measures in the Bay Area 2005 Ozone Strategy.

Table 3-4. Implementation of transportation control measures in 2005 ozone strategy.

CM#	Name/Source Category	Description	Implementation
TCM- 1	Support Voluntary Employer Based Trip Reduction Programs	Support and encourage voluntary efforts by Bay Area employers to promote the use of commute alternatives by their employees	BAAQMD has provided grants for 511 Regional Rideshare Program, Marin video-conferencing, Spare the Air employer program, Guaranteed Ride Home Programs in San Francisco, Solano, Napa, and West Contra Costa, other employer-based programs in San Ramon, West and East Contra Costa, Alameda, San Mateo. MTC is the primary funding source for the annual Bike To Work Day promotion.
TCM- 2	Adopt Employer Based Trip Reduction Rule (Deleted)	Deleted	Deleted per Health & Safety Code Section 40717.9.
TCM-3	Improve Local and Area wide Bus Service	Reduce motor vehicle trips, vehicle miles traveled, and mobile source.	MTC funded three express bus projects: Richmond Bridge, East Bay North, and East Bay South; and the Lifeline Transportation Program. BAAQMD provided grants for Tri-Delta, Muni, Napa, and LAVTA transit; and to improve bicycle parking at BART stations. Also, new Intermodal and Park & Ride lots opened in Petaluma, Windsor and Cotati (MTC/BAAQMD funded).
TCM-4	Upgrade and Expand Local and Regional Rail Service	Reduce motor vehicle trips vehicle miles traveled and mobile source emissions	MTC funded Third Street Light Rail Project (Phase 1), Caltrain Express/Rapid Rail Phase I, SCVTA Vasona light rail extension (adds 8 new stations and 5.3 miles), and the Oakland Airport Connector.
TCM-5	Improve Access To Rail and Ferries	Reduce motor vehicle trips, vehicle miles traveled and mobile source emissions by reducing auto trips	BAAQMD funded shuttle projects to connect to rail and ferry stations connecting Caltrain, Samtrans, SFO, SCVTA, West Berkeley, PresidGO, Mid-Day Menlo Park, UCSF, Ace Trains to Stoneridge Business Park and Dublin/Pleasanton BART, and from Benicia Industrial Park to Vallejo ferry.
TCM-6	Improve Inter-Regional Rail Service	Reduce motor vehicle travel and emissions for longer distance interregional trips	See TCM-5 for shuttles funded by BAAQMD connecting Ace Train, Caltrain. BAAQMD funded 4 locomotive engines for passenger service. Plans ongoing to improve and expand service underway (MTC funded).

Table 3-4 (continued). Implementation of transportation control measures in 2005 ozone strategy.

CM#	Name/Source Category	Description	Implementation
TCM-7	Improve Ferry Service	Reduce emissions from Transbay auto trips, which tend to be longer in length, and will also reduce auto traffic in highly congested bridge corridors	BAAQMD funded 11 ferry engine repower projects. MTC and WETA have ongoing plans to improve and expand ferry service
TCM-8	Construct Carpool/ Express Bus Lanes on Freeways	Reduce mobile source emissions by encouraging high occupancy vehicles	MTC funded new regional express bus service; completed HOV lanes on SR 87 in Santa Clara, 1-880/237 and 85/101, 580 in Alameda and I-80 in Solano. MTC funded ramp meters completed on 101 in San Mateo and under construction on 101 in Marin.
TCM-9	Improve Bicycle Access and Facilities	Reduce mobile source emissions by encouraging cycling	MTC adopted Resolution 3765 to encourage routine accommodation of cyclists and pedestrians in projects funded by MTC regional discretionary funds. MTC has provided funding ($8 million per year) via regional bicycle/pedestrian program. MTC and BAAQMD have funded 511 BikeMapper (part of 511 Rideshare). BAAQMD provided grants for bicycle parking or lanes in every Bay Area county. MTC has allocated $27 million from the first funding cycle of the new Federal transportation bill towards a regional bicycle program.
TCM-10	Youth Transportation	Reduce motor vehicle travel and mobile source emissions related to the transportation of youth and students for school and other activities	BAAQMD provided grants for clean school buses throughout region, including San Ramon, Lafayette, Milpitas, River Delta School District, West Sonoma, Pleasant Hill. BAAQMD subsidized transit passes for students in Sonoma and Marin Counties and San Ramon. MTC has allocated $10 million from the first funding cycle of the new Federal transportation bill towards a public outreach effort, including a focus on youth education.
TCM-11	Install Freeway Traffic Management System	Reduce emissions produced by stop and go congestion	MTC, CHP and Caltrans sponsor ongoing Freeway Service Patrols. MTC has allocated $105 million from the first funding cycle of the new Federal transportation bill towards the Freeway Performance Initiative.
TCM-12	Arterial Management Measures	Reduce vehicle idling and acceleration	Completed projects funded by BAAQMD include: San Tomas Expressway, Matilda in Sunnyvale, Lawrence Expressway, McDowell/Baywood in Petaluma, 14th Street arterial in Alameda County, Mowry, Stevenson, Blacow in Fremont, Light Rail Controller Upgrade Project in San Jose, and on Constitution Way/Lincoln in City of Alameda.

Table 3-4 (continued). Implementation of transportation control measures in 2005 ozone strategy.

CM#	Name/Source Category	Description	Implementation
TCM-13	Transit Use Incentives	Programs to increase transit use and reduce vehicle emissions	MTC funded Translink on AC Transit, BART, Golden Gate Transit, MUNI and other systems, and real-time transit info on Muni and BART. (See also TCM-3 for intermodal and Park & Ride facilities and TCM-1, TCM-16.)
TCM-14	Carpool and Vanpool Services and Incentives	Reduce motor vehicle emissions	MTC ongoing funding for 511 Regional Rideshare and rideshare short-term vanpool subsidy and "start-up" incentive subsidy. See also TCM-1.
TCM-15	Local Land Use Planning And Development Strategies	Reduce motor vehicle use and emissions by promoting land use patterns and new development that facilitate walking, bicycling and transit use	Via FOCUS, regional agencies have implemented partnership with local jurisdictions to define priority development areas (PDAs). In June 2008, MTC in partnership with AC Transit launched TransLink® for TOD, offering residents of select transit-oriented development (TOD) complexes around the East Bay unlimited free travel on AC Transit's local and transbay buses during a one-year pilot program. In 2009, MTC awarded $1.8 million in Station Area Planning Grants to six jurisdictions along the Sonoma-Marin Area Rail Transit (SMART) corridor. In addition, MTC has allocated $85 million from the first funding cycle of the new Federal transportation bill towards the Transportation for Livable Communities Program to support PDAs. See also TCM-3 thru TCM-7, TCM-17, 19 and 20.
TCM-16	Public Education / Intermittent Control Measures	Educate the public about air quality in the Bay Area	BAAQMD funded Spare the Air notices, webpage, banner, advertisements, and free transit rides; transit marketing in Sonoma; transit and bicycle marketing in Petaluma. MTC has allocated $10 million from the first funding cycle of the new Federal transportation bill towards a public education effort (see TCM-10)
TCM-17	Conduct Demonstration Projects	Promote demonstration projects to develop innovative approaches to reduce mobile source emissions	BAAQMD and MTC funded PATH demonstration of electronic bicycle lockers at Pleasant Hill BART Station. MTC funded Alameda County CMA Dynamic Ridesharing pilot projects. BAAQMD funded the Travel Choice program pilots in Fruitvale and the City of Alameda. This program was then implemented in Berkeley and San Leandro. BAAQMD funded the SF County Telecommute Pilot Project. See also TCM-15.

Table 3-4 (continued). Implementation of transportation control measures in 2005 ozone strategy.

CM#	Name/Source Category	Description	Implementation
TCM-18	Implement Transportation Pricing Reform	Improving air quality and addressing persistent congestion issues	MTC developed a regional High Occupancy Toll (HOT) lane network proposal included in T2035 regional transportation plan. MTC developed a best parking practices manual and technical resources to assist local governments in revising parking policies. San Francisco is studying congestion pricing and market-based parking pricing.
TCM-19	Improve Pedestrian Access and Facilities	Making pedestrian travel safer, more convenient and more attractive will promote walking, reduce the need to use autos, and therefore reduce mobile source emissions	MTC adopted Resolution 3765 to encourage routine accommodation of cyclists and pedestrians in projects funded by MTC regional discretionary funds. MTC has provided funding ($8 million per year) via regional bicycle/pedestrian program. BAAQMD funded Pedestrian Access projects in Suisun City, Bayview Gateway in SF, and Sunnyvale, and multi-use trails in Morgan Hill, Sebastopol, Suisun, Livermore, Mountain View, American Canyon, Contra Costa, Antioch, and Marin.
TCM-20	Promote Traffic Calming Measures	Reduce motor vehicle emissions	Palo Alto, Menlo Park, Mountain View and Cotati all have plans or studies ongoing. San Francisco has installed curb bulbs, median refuges, lighted crosswalks, ladder crosswalks, and fluorescent yellow crossing signs. Also see TCM 15 re: Station Area Planning Grants and Transportation for Livable Communities Program.

Status of Further Study Measures in the 2005 Ozone Strategy

Table 3-5 summarizes implementation actions and progress in implementing the Further Study Measures in the Bay Area 2005 Ozone Strategy.

Table 3-5. Status of further study measures in 2005 ozone strategy.

Further Study Measures					
FSM # (Reg #)	**Source Category**	**Description**	**Status**		
FSM-1 (8-51)	Adhesives and Sealants	Reduce VOC limits for architectural adhesives	Staff recommendation: Retain as FSM 1 in 2010 CAP.		
FSM-2 (8-3)	Architectural Coatings	Reduce VOC limits from architectural coatings	Adopted 7/1/09	5.4 tpd ROG	
FSM-3 (6-2)	Commercial Cooking Equipment	Reduce NOx and particulate from charboilers	Adopted 12/05/07	0.09 tpd VOC, 0.55 tpd PM10	
FSM-4	Composting Operations	Limit emissions of both VOC and ammonia	Staff recommendation: Retain as FSM 15 in 2010 CAP.		
FSM-5	Food Product Manufacturing and Processing	Reduce VOC limits for food-processing facilities that emit more than 440 pounds/month of organic compound emissions	Staff recommendation: Delete from Further Study Measures due to insufficient emissions reductions to warrant further action.		
FSM-6	Livestock Waste	Reduce emissions of particulate, ammonia (which forms aerosol particulate matter) and VOC	Staff recommendation: Develop into control measure SSM 3 for the 2010 CAP.		
FSM-7 (8-3 & 8-32)	Limitation on Solvents Based on Relative Reactivity	Consider replacing VOC limits in certain rules, measured in mass VOC per volume of product, with limits based on the relative contribution to ozone formation of each of the organic species that make up the VOC of a product.	Staff recommendation: Retain, with revisions, as FSM 2 in 2010 CAP.		
FSM-8 (8-16)	Solvent Cleaning and Degreasing	Reduce VOC limits	Staff recommendation: Retain as FSM 3 in 2010 CAP.		
FSM-9	Emission from Cooling Towers	Reduce organic emission limits	Staff recommendation: Retain as FSM 4 in 2010 CAP.		
FSM-10 (8-8)	Refinery Wastewater Treatment Systems	Reduction in ROG from refinery wastewater systems	Results of this FSM reported to Board of Directors 11/16/2005. No further action		
FSM-11	Vacuum Trucks	Reduce VOC emissions	Staff recommendation: Develop into control measure SSM 5 for the 2010 CAP.		
FSM-12 (8-18)	Valves and Flanges	Reduce emissions from valves and flanges typically found at refineries and chemical plants.	Staff recommendation: Retain as FSM 5 (Equipment Leaks) in 2010 CAP. More stringent standards for oil and gas production to be considered under SSM 4: Natural Gas Production and Distribution.		

Table 3-5 (continued). Status of further study measures in 2005 ozone strategy.

FSM # (Reg #)	Source Category	Description	Status		
FSM-13	Wastewater from Coke Cutting Operations	Reduce VOC emissions from coke cutting wastewater.	Staff recommendation: Retain as FSM 6 in 2010 CAP.		
FSM-14 (9-10)	NOx Reduction from Refinery Boilers	Reduce NOx emissions from refinery boilers.	Staff recommendation: Develop into control measure SSM 10 for the 2010 CAP. District staff is currently developing rule amendments.		
FSM-15 (9-8)	Stationary IC Engines	Reduce NOx limits for IC engines, reduce secondary particulate matter	Adopted 7/25/07		9.6 tpd NOx
FSM-16	Encourage Alternative Diesel Fuels	Exploration of the potential air quality benefits of using biodiesel fuel in place of conventional petroleum diesel	BAAQMD has awarded approximately $5.4 million in grants for emulsified diesel fuel in shipping and shore power projects. These projects are ongoing.		
FSM-17	Mitigation Fee for Federal Sources	Mitigation Fee Program, adopted into the South Coast AQMD's 2003 AQMP, but not yet implemented, would charge an air quality impact fee to sources pre-empted from State and local air district authority under the federal Clean Air Act	Staff recommendation: Delete as FSM due to lack of clear authority for local air districts to impose fees on these sources (ships, aircraft, locomotives).		
FSM-18	Indirect Source Mitigation Program	Reduce emissions from development projects that generate vehicle trips and thus indirectly cause air pollutant emissions	Staff recommendation: Develop into control measure LUM 2 for the 2010 CAP.		
FSM-19	Free Transit on Spare the Air Days	Reduce motor vehicle emissions by providing free transit service on STA days.	Free Transit on Spare the Air (STA) Days was implemented for three years and discontinued when funding ran out. Staff recommendation: Delete this FSM in the 2010 CAP due to lack of funding.		
FSM-20	Episodic Measures	Episodic measures are measures implemented only at times when pollution levels are projected to exceed air quality standards.	District continues to implement the Spare the Air (STA) program. STA is evolving to promote clean air choices on an everyday basis. The District's 2009 Summer slogan was "Any ride is worth sharing" (aimed at reducing ozone precursors from motor vehicles). The 2009 Winter campaign was "Check before you burn" and promoted awareness of the wood-burning rule to reduce PM. Both campaigns reduce emissions on an episodic basis.		

Air District Programs that Provide Foundation for the CAP

The 2010 CAP is rooted in long-standing core Air District programs, including air quality monitoring; regulation, permitting and enforcement of stationary sources; public outreach and education; and grants and incentives. In addition to these core programs, the Air District has developed new programs and initiatives in recent years to respond to the challenges of protecting public health and protecting our climate. The CAP control strategy described in Chapter 4 incorporates and reinforces the new initiatives underway at the Air District. The section below highlights the Air District's recent efforts in several key areas, including:

- Reducing health risks in impacted communities;
- Reducing emissions from seaports and the goods movement sector;
- Reducing wood-burning and wood smoke; and
- Reducing emissions of greenhouse gases and protecting the climate.

Reducing Health Risks in Impacted Communities

Protecting public health is a fundamental part of the Air District's mission and one of the key objectives of the 2010 CAP. The Air District strives to reduce public health impacts from air pollution throughout the Bay Area, by means of the New Source Review program and the Air Toxics Hot Spots program which are briefly described in Chapter 2. However, because it is clear that certain parts of the region experience higher levels of pollution than others, the Air District has developed several programs that focus on reducing health risks in disproportionately impacted communities. The Air District established the Community Air Risk Evaluation (CARE) program in 2004. In 2009 the District expanded upon the CARE program by creating the Clean Air Communities Initiative (CACI). The overall goal of these programs is to identify the communities most impacted by air pollution, and to develop and implement comprehensive strategies to reduce these impacts. Both programs are described below.

Clean Air Communities Initiative

The Clean Air Communities Initiative encompasses a multi-faceted effort to reduce health risks in impacted communities and to minimize the effects of land use and transportation decisions on cumulative air quality impacts. Certain communities are exposed to high levels of air toxics, especially diesel PM, resulting in elevated health risks. Addressing land use and transportation is critical to solving this problem because on-road and off-road motor vehicles are the largest source of diesel PM and other air toxics, and because land use decisions influence not only transportation patterns but also local exposures to these pollutants. CACI brings a wide range of tools and resources to bear on this important issue, as depicted in Figure 3-1, including regulations and guidance, air quality monitoring, public outreach and community dialogue, targeted

grants funding, enforcement of diesel air toxics control measures, and collaboration with county health departments and other local agencies.

The CARE program, described below, provides the foundation for the Clean Air Communities Initiative.

Community Air Risk Evaluation (CARE) Program

In 2004 the Air District initiated the Community Air Risk Evaluation (CARE) program to evaluate and reduce health risks associated with local exposures to air toxics in the Bay Area. The program examines air toxics emissions from point sources, area sources and on-road and off-road mobile sources with an emphasis on reducing population exposure to diesel exhaust. CARE combines technical analysis, outreach to impacted communities, and policy mechanisms to reduce emissions and health risks in those communities. The main objectives of the program are to:

- Characterize and evaluate potential cancer and non-cancer health risks associated with exposure to air toxics from both stationary and mobile sources throughout the Bay Area.
- Assess potential exposures to sensitive receptors including children, senior citizens, and people with respiratory illnesses.
- Identify significant sources of air toxics emissions and prioritize use of resources to reduce air toxics in the most highly impacted areas (i.e., priority communities).
- Develop and implement strategies - such as grants, guidelines, or regulations - to achieve cleaner air for the public and the environment, focusing initially on priority communities.

To help guide this program, the Air District formed a CARE Task Force composed of representatives from impacted communities, business, local public health agencies, and research institutions. The CARE program also includes a robust public outreach component. Air District staff conducts community meetings to provide health risk information, update Bay Area residents about the results of the CARE studies, and to receive public comment.

The technical analysis portion of the CARE program includes an assessment of the sources of air toxics emissions, modeling and monitoring to estimate concentrations of air toxics, and an assessment of exposures and health risks. Information derived from the technical analyses is used to focus emission reduction strategies in areas with high air toxics exposures and high density of sensitive populations.

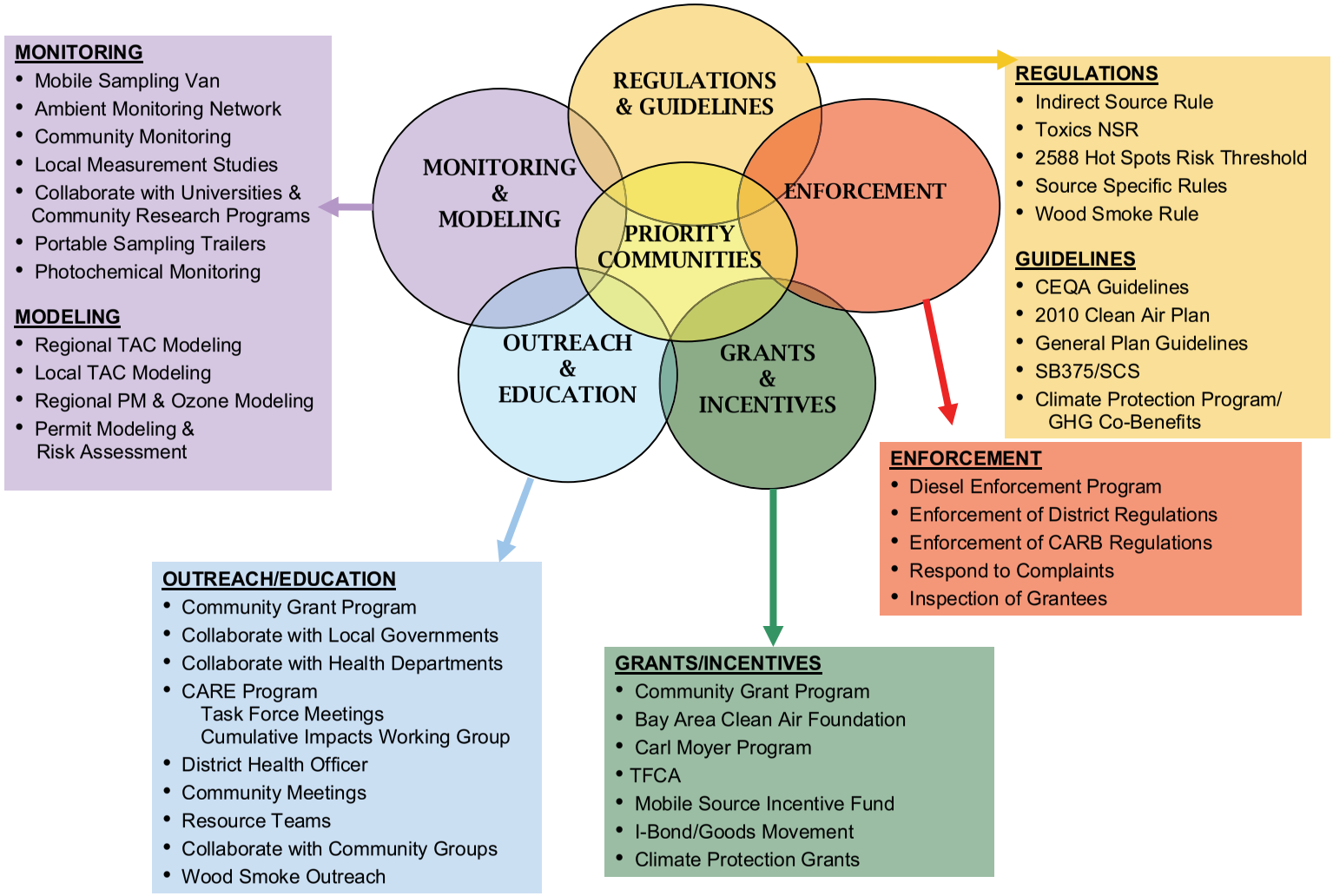


Figure 3-1. Clean Air Communities Initiative.

The Air District first developed a preliminary emissions inventory of air toxics for year 2000 that includes emissions from individual point source facilities, area sources, on-road mobile sources, and off-road sources (e.g., construction equipment, ships, and aircraft). This initial inventory was updated to include the most recent 2005 emission data as shown in Figures 2-18 and 2-19 in Chapter 2. The air toxics emission data was combined with demographic and health statistics data to create risk-weighted emissions maps to help the District identify communities with significant exposures that would most benefit from mitigation strategies, such as Air District grant programs.

The Air District also performed photochemical modeling to estimate pollutant concentrations and risks from diesel PM and other key air toxics, both locally and for the entire Bay Area, as described in Appendix D. This modeling was used to refine the identification of impacted communities where reductions in emissions and exposure are most needed. Six priority communities have been identified based on the following criteria: high exposure of youth and seniors to air toxics, high emissions of air toxics, and low income. The priority communities are shown in Figure 3-2.

In an example of local-scale modeling, the Air District partnered with CARB, the Port of Oakland, and the Union Pacific Railroad to estimate the health risks from diesel exhaust in West Oakland. Final results of the comprehensive health risk assessment (HRA) were made available in December 2008. The HRA found that residents of West Oakland are exposed to diesel PM concentrations that are almost three times higher than the average background diesel PM in the Bay Area. The findings of the HRA confirm findings of the CARE Program that there are certain parts of the Bay Area – such as West Oakland – where emission reductions are especially critical.

Through the Clean Air Communities Initiative, the Air District is focusing comprehensive emission reduction strategies in these communities. The Air District also is partnering with local governments in these areas to prepare community risk reduction plans, in order to allow a community-wide approach to reducing cumulative impacts of air toxics. As noted, these local air quality problems are often closely linked with land use and transportation decisions. The community risk reduction plans will provide a tool to support infill development, while protecting residents from high levels of pollution.

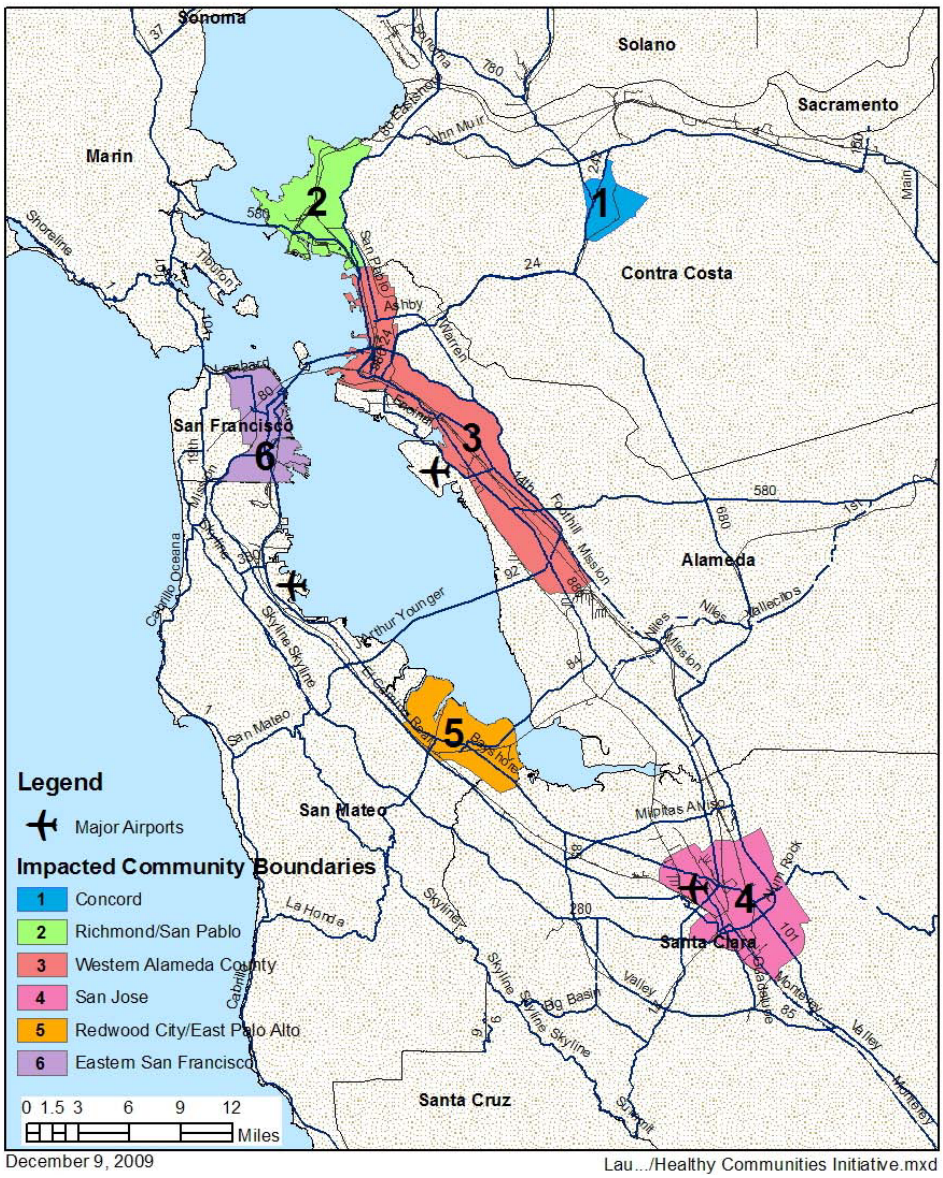


Figure 3-2. CARE impacted community boundaries.

Grant and Incentive Programs

The Air District operates several programs that provide grants and incentives for projects to provide "surplus" emissions reductions; i.e. reductions over and above regulatory requirements or standards. Key grant programs are summarized in Table 3-6.

The District awarded a total of $186 million in external grants during a five-year period covering FY 03/04 through FY 08/09. In aggregate, these projects provided estimated emission reductions of 1,522 tons of ROG, 12,482 tons of NOx, 1,136 tons of PM, and 763,473 tons of CO2 over the lifetime of these projects.

Table 3-6. Grant funding programs & eligible project types.

Grant Program	Eligible Equipment/Projects
Transportation Fund for Clean Air	• Shuttles • Ride-Sharing • Bicycle Facilities • Bicycle Facilities/ Lockers • Smart Growth • Arterial Management
Carl Moyer Program	• On-road Heavy-Duty Vehicles • Off-Road • Marine Engines • Shorepower for Ships • Locomotives • Agricultural
Goods Movement Diesel Emission Reduction Program	• Drayage Trucks • Other Trucks • Shorepower for Ships • Cargo Handling Equipment • Locomotives • Marine Engines
Low Emission School Bus Program	• School Buses
Alternative Fuel and Advanced Technology Program	• Trucks, Buses, and Light-Duty Vehicles • Alternative Fuel Infrastructure

One of the most direct and tangible ways to reduce emissions and exposures in impacted communities is to replace or retrofit dirty engines and vehicles that operate in these communities. The Air District has made a commitment to target its grant funds to projects in impacted communities. Table 3-7 summarizes lifetime emission reductions and funding awarded for projects in CARE impacted communities in the past five funding cycles. During this five-year period, approximately 48% of Air District grant funds have been directed to these communities.

Table 3-7. Grants provided to projects in impacted communities: FY 03/04 – FY 08/09.

Project Type	ROG Reduced	NOx Reduced	PM Reduced	CO2 Reduced (1)	Funding Amount
Clean Light-Duty Vehicles	5.93	4.17	11.55	0	$834,750
Ridesharing	33.77	24.93	18.93	23,636	$1,836,000
Arterial Mgmt/Signal Timing	8.97	9.37	3.18	5,871	$2,176,731
Smart Growth	22.24	19.02	24.80	258,185	$2,396,811
Bicycle Facilities	13.06	11.03	4.80	8,790	$1,889,922
Shuttles	37.92	90.68	28.46	81,978	$9,626,342
Transit Buses (2)	0.00	81.12	0.00	0	$528,750
School Buses	7.67	52.54	2.22	579	$1,179,641
On-Road Trucks (3)	5.89	1,071.32	167.72	28,152	$32,932,424
Off-Road Trucks (2)	11.63	169.84	8.18	0	$1,195,564
Marine Engines (2)	511.77	6,024.87	367.53	0	$27,991,629
Locomotive Engines (2)	22.38	586.05	10.67	0	$5,786,366
Total	**681.23**	**8,144.94**	**648.04**	**407,191**	**$88,374,930**

Notes

Emission reductions show estimated tons reduced over the life of the projects funded.

1. All emission reductions shown in short tons, except for CO2, which are shown in metric tons.
2. CO2 data is not available for this project type.
3. Data includes TFCA, Carl Moyer Program, and Goods Movement heavy-duty on-road truck projects

Table 3-8 summarizes lifetime emission reductions and funding awarded for projects in other (non-impacted community) areas.

Reducing Emissions from Seaports and Goods Movement

Goods movement is a major source of emissions in the CARE impacted communities and major freeway corridors. Therefore, reducing emissions from seaports and the goods movement sector has been another major focus of Air District efforts in recent years. To provide a technical foundation, the Air District has been developing detailed emissions inventories for each of the five Bay Area seaports.[67] Much of the effort has been directed at the Port of Oakland, since this port handles by far the greatest volume of goods and is located in proximity to the impacted community of West Oakland as well as the City of Alameda.

[67] Bay area seaports include the ports of Oakland, Richmond, Redwood City, Benicia, and San Francisco.

Table 3-8. Grants provided to non-impacted communities: FY 03/04 - FY 08/09.

Project Type	ROG Reduced	NOx Reduced	PM Reduced	CO2 Reduced (1)	Funding Amount
Clean Light-Duty Vehicles	1.44	0.82	0.00	0	$726,309
Ridesharing	288.09	304.84	178.80	273,244	$21,864,450
Arterial Mgmt/Signal Timing	166.20	162.17	57.44	5,150	$9,482,540
Smart Growth	42.15	30.70	14.46	7,053	$3,570,393
Bicycle Facilities	88.45	72.41	32.33	9,513	$12,871,293
Shuttles	85.76	102.84	44.46	31,443	$15,992,301
Transit Buses	14.34	603.01	16.74	9,216	$4,010,229
School Buses (2)	0.48	8.85	2.13	0	$324,750
Natural gas infrastructure (2)	1.10	1.55	0.30	0	$1,440,452
EV infrastructure (3)	0.00	0.00	0.00	0	$269,173
On-Road Trucks (4)	13.29	434.82	31.56	20,663	$11,759,793
Off-Road Trucks (2)	107.26	1,267.46	50.27	0	$12,537,234
Marine Engines (2)	22.01	1,265.88	56.14	0	$2,473,822
Agriculture Engines (2)	10.62	91.20	3.28	0	$336,472
Total	**841.19**	**4,346.55**	**487.91**	**356,282**	**$97,659,211**

Notes

* Emission reductions show estimated tons reduced over the life of the projects funded.

1. CO2 reductions are shown in metric tons.
2. CO2 data is not available for this project type.
3. Emission reductions data is not available for this project type.
4. Data includes TFCA and Carl Moyer Program heavy-duty truck projects.

To develop a comprehensive approach to reducing emissions from port operations, the Port of Oakland, in partnership with the Air District, the West Oakland Environmental Indicators Project, and representatives from the maritime industry, developed the Maritime Air Quality Improvement Plan (MAQIP). The MAQIP was adopted by the Port Commission in April 2009, with the overall goal of protecting the health of local residents and workers by reducing their exposure to diesel PM.

The Air District and the Port of Oakland have developed a joint work program that includes outreach to the regulated community to ensure compliance with state and federal regulations; securing authorization to enforce CARB rules and regulations; and cooperating to identify and implement specific projects such as replacement and retrofit of drayage trucks, shore power (dockside electrification) for ships, vessel speed reduction, and development of a "marine highway" between the Port of Oakland, and the Ports of West Sacramento and Stockton to help reduce on-road truck traffic between these ports.

The Port and its partners anticipate achieving the Plan's main goal through industry compliance with regulations adopted by CARB. The bulk of the needed emission reductions at the Port will occur in 2010 as ships use low-sulfur fuel and drayage trucks are equipped with diesel particulate filters. Additional benefits will be achieved by 2015 as engines in cargo-handling equipment and harbor craft are either replaced or retrofitted, and ships begin using shore power while at berth.

The Air District's Green Ports Initiative will be a significant part of the success of the MAQIP. Under this initiative, the Air District is committing resources for a robust program of financial incentives for early compliance and a joint enforcement program with ARB. The Air District is also undertaking additional air pollution monitoring and developing more refined predictive modeling of health impacts in West Oakland. These efforts will assist with future refinements of the MAQIP.

The Air District and its partners - CARB, US EPA, the Port of Oakland, and local stakeholders - have been making a concerted effort to reduce emissions from the approximately 2,000 drayage trucks that serve the Port of Oakland and constitute a major source of diesel emissions in West Oakland. Using a combination of funding from the District's Transportation Fund for Clean Air (TFCA) program, the Port, State Goods Movement bond funds, and federal stimulus funds, a total of $22 million in grant funding was awarded to port truckers from March through December 2009. These funds have been used to install retrofit devices on 817 trucks to reduce emissions of PM and NOx, as well as to replace 187 old trucks with new trucks that meet stringent emissions standards. In January 2010, the Air District and its partner agencies were successful in obtaining an additional $11 million in Goods Movement Bond funding to further address emissions from drayage trucks at the Port of Oakland. The additional funds will be used to install retrofit devices on as many as 1,000 additional trucks, and to assist in the replacement of up to 100 old trucks with new trucks that meet stringent emissions standards.

Mobile Source Compliance Plan

Enforcement of mobile source regulations has traditionally been under the purview of CARB. However, CARB's diesel PM air toxic control measures (ATCMs) allow air districts to enforce them. In fall 2009 the Air District initiated a Mobile Source Compliance Plan (MSCP) based on a Memorandum of Understanding (MOU) between the Air District and CARB which defines the roles and responsibilities of each agency. The Air District is the first air district in the state to enter into a comprehensive mobile source enforcement partnership agreement with CARB.

The MSCP lays out the Air District's comprehensive strategy for enforcement of specified CARB ATCMs and related mobile source statutes and/or agreements. The goal of the MSCP is to reduce diesel PM health risk in impacted communities, with special

focus on the Port of Oakland and West Oakland, using a robust enforcement program. The initial focus of the MSCP was to provide a strong enforcement presence at the Port of Oakland to ensure compliance with the January 1, 2010 Drayage Truck Rule (DTR) compliance deadline. By implementing the MSCP, the Air District will not only provide leadership on mobile source enforcement, but most important, will reduce diesel PM exposures and improve air quality for the communities we serve.

The MSCP is a key element in implementing the Clean Air Communities Initiative and the CARE program, as well as other efforts to reduce emissions from ports and goods movement.

Reducing PM from Wood Smoke

Although the Air District has been working hard to reduce exposure to diesel PM, particulate matter from wood-burning also poses health risks for Bay Area residents. Wood smoke is a major component of PM in the Bay Area, especially on winter days when exceedances of the 24-hour PM2.5 standard are most likely to occur. Reducing emissions from wood-burning is therefore a key component of the Air District's efforts to reduce PM levels in the Bay Area. The Air District has been implementing and strengthening its efforts to reduce wood smoke over the past two decades, as described below.

Public education and voluntary compliance were the early foundation of the Air District's efforts to reduce wood-burning. The District began implementing its *Winter Spare the Air* program in 1991, requesting that Bay Area residents voluntarily curtail wood-burning on days when an exceedance of PM standards is forecast.

In 1998, the Air District developed a model wood smoke ordinance for fireplaces and woodstoves as a guidance document for cities and counties to regulate sources of particulate matter in their communities. The model ordinance promotes the use of cleaner technologies that have been developed to effectively reduce wood smoke pollution. District staff have worked with health agencies and interested residents in the Bay Area to advocate for the adoption of the ordinance. To date, wood smoke ordinances have been adopted by 40 Bay Area cities and eight counties which encompass a large percentage of the region's population.

In 2006, US EPA significantly strengthened the national 24-hour PM2.5 standard, reducing the standard from 65 to 35 $\mu g/m^3$. Recognizing the need to more aggressively reduce PM from wood smoke, especially on days when the region is likely to exceed the standard, the Air District adopted a rule (and amended Regulation 5: Open burning) to limit wood-burning in July 2008, as described below. In addition, the Air District enhanced and expanded its wood smoke public outreach and education program, and

lowered the threshold for when to issue *Winter Spare the Air Alerts* to conform to the national standard.

Summary of Wood-Burning Rule

Key provisions of Regulation 6, Rule 3 include the following:

- Prohibits operation of any indoor fireplace, fire pit, wood or pellet stove or fireplace insert on specific days during the winter when the District forecasts that PM2.5 levels may exceed the 35 $\mu g/m^3$ national 24-hour PM2.5 standard. The rule provides limited exemptions from this provision for households whose sole source of heat is a wood-burning device, or in the event of an interruption in gas or electrical service. Regulation 5: Open burning prohibits outdoor recreational fires during periods of elevated PM2.5 levels
- Prohibits excessive visible emissions from wood-burning devices.
- Requires cleaner burning technology (EPA Phase II certified wood-burning device, pellet stove, or other approved device) when wood-burning devices are sold, resold or installed.
- Requires cleaner burning technology (EPA Phase II certified wood-burning device, pellet stove, or other approved device) if wood-burning devices are permitted for installation in new building construction and remodels.
- Prohibits the burning of garbage, non-seasoned wood, plastics and other inappropriate types of materials.
- Requires labeling and disclosure of the moisture content on wood sold for use within the boundaries of the District, including instructions on how to dry wood that has moisture content greater than 20 percent by weight.
- Requires a label on packages of wood and other solid fuels (such as pressed logs and pellets) instructing the user to check local air quality status before burning these products.

Promoting Compliance with the Wood-Burning Rule

The Air District conducted an energetic public education and outreach campaign regarding wood smoke in winters 2008/09 and 2009/10. The campaign focused on educating the public about the requirements of the rule, how to comply, and why it is important to curtail wood-burning to protect public health. The *Winter Spare the Air Alert* advertising and outreach campaign utilized TV, print, billboard, radio, direct mail, public events, door-to-door canvassing and the Air District website. The Air District's "No Burn" phone line received over 500,000 calls in 2008/2009.

For the 2009/2010 season, public outreach to educate Bay Area residents about the health effects of wood smoke and how to comply with the rule were again the primary focus the wood smoke reduction program. However, the Air District made several changes to improve the effectiveness of the program. For example, the District issued

Winter Spare the Air Alerts the day before the effective date in order to provide the public and the media with more advanced warning. The Air District also focused its enforcement efforts in areas with high wood-burning rates and public complaints.

As the District develops more experience and information regarding the wood smoke rule, additional refinements or enhancements may be considered to the wood smoke reduction program. Potential revisions are described in Further Study Measure 12 in CAP Volume II.

Results of 2008-09 Wood Smoke Reduction Program

The Air District has performed surveys of Bay Area residents every winter for the past five years to monitor trends in residential wood-burning. The surveys performed in winter 2008/09 found that Bay Area residents reduced wood-burning on both STA and non-STA days. Survey findings, corroborated by on-the-ground monitoring, indicate that the overall reduction in wood-burning was on the order of 33% in 2008/09 compared to the average over the prior three years. This data suggests that the wood smoke rule, in combination with the Air District's public outreach and education efforts, had a very significant impact in the first year of implementation.

The Air District continued and expanded its survey program during winter 2009-10 to gauge the on-going effectiveness of the wood smoke reduction program and to develop a better understanding of the impact in reducing wood burning within the Bay Area.

BAAQMD Climate Protection Program

As explained in Chapter 1, there is a strong connection between global warming, ozone formation and public health. Therefore, the Air District has made reducing GHGs and protecting the global climate an integral part of its mission. Since establishing a formal climate protection program in June 2005, the Air District has worked to integrate climate protection into all its core functions and initiated innovative climate protection programs. Some of the Air District's key climate protection programs and activities are summarized below.

- The Air District was the first local air district in the nation to develop a detailed regional greenhouse gas emissions inventory (November 2006; updated in December 2008).

- In November 2006, the Air District convened the first-ever Bay Area-wide summit on climate protection. The event was attended by over 500 local leaders from government, education, youth, business, research and the non-profit community and set the stage for wide-spread collaboration and action. A second summit was convened in May 2009 for over 400 local government planners and elected officials.

- In December 2007, the Air District awarded $3 million in grants to 53 local projects to reduce GHG emissions. The innovative grant program is funding such activities as the development of local climate action plans; seed funding for municipal energy officers; innovative approaches such as financing residential and commercial solar power through property tax bills; renewable energy programs; and youth-based projects. With this grant program, the Air District became the one of the largest climate protection funders in the nation to date.

- In May 2008 the Air District imposed a cost-recovery fee on stationary sources of greenhouse gases in the region to defray the costs of the Air District's climate protection work related to stationary sources. Industrial facilities and businesses currently subject to Air District permit requirements pay a fee of 4.4 cents per metric ton of greenhouse gas emissions.

- The Air District launched the Greenhouse Gas Reduction Grant Program in 2009, using $4.4 million in funds generated by a settlement between the California Attorney General's Office and ConocoPhillips for projects that reduce GHG emissions in the communities nearest the ConocoPhillips refinery: Rodeo, Crockett, Hercules and Pinole. Grants will be used to fund energy efficiency, cool roofs and onsite renewable energy projects on public facilities.

- The Air District created and implemented a $4^{th}/5^{th}$ grade curriculum on climate protection. The *Protect Your Climate* curriculum contains 16 lessons that address the science and causes of climate change and ways for students to take action. Through various activities, students learn how to reduce greenhouse gas emissions from energy, waste, and transportation uses in their daily lives. Since the curriculum was first piloted in 2007-2008, over 40 classrooms and 1,000 students across the nine Bay Area counties have participated in the program.

- The Air District convened a series of workshops for local governments to provide them with complete data sets and training on how to prepare a local GHG emissions inventory.

- The Air District developed a web portal, in conjunction with the Institute for Local Government, to share information and facilitate local government action regarding best practices to reduce GHGs: www.baaqmd.gov/climateplanning.

- The Air District led the development of an historic white paper for the California Air Pollution Control Officers' Association (CAPCOA) that lays out how local land use and development projects could address GHG mitigation under CEQA. Air District staff also collaborated on a CAPCOA resource document on addressing GHGs in local general plans.

- Air District staff has proposed to establish significance thresholds for GHG emissions in its update of the District's CEQA Guidelines.

In addition, the Air District works closely with its regional agency partners – the Metropolitan Transportation Commission (MTC), the Association of Bay Area Governments (ABAG), the Bay Conservation and Development Commission (BCDC) – along with the local governments, business groups, community organizations, and other stakeholders to develop new ways to reduce emissions of GHGs in the Bay Area and protect the climate.

External Plans that Complement the 2010 CAP

The 2010 CAP will not function in a vacuum. Rather, it is intended to be part of an interlocking set of complementary plans that together provide an integrated air quality, land use, transportation, and climate protection strategy for the Bay Area.

Land Use and Transportation Plans

In combination with the FOCUS program, MTC's recently adopted *T2035* regional transportation plan, ABAG's *Projections 2009*, and BCDC's Bay Plan amendments, the CAP is intended to help lay the groundwork for an effective Bay Area Sustainable Communities Strategy pursuant to SB 375 in the 2013 time frame and beyond, as discussed in Chapter 4.

FOCUS

FOCUS is a regional incentive-based development and conservation strategy for the Bay Area. FOCUS unites the efforts of ABAG, MTC, BCDC, and the Air District into a single program that encourages future growth in areas near transit and within the communities that surround the San Francisco Bay. Promoting future development in these areas provides a variety of housing and transportation choices for all residents, while helping to enhance existing neighborhoods and reduce emissions of air pollutants and GHGs by decreasing motor vehicle use. One of the key elements of FOCUS is the partnership between the regional agencies and local governments to identify Priority Development Areas where future growth should be encouraged and Priority Conservation Areas which should be protected from development.

Transportation 2035 Regional Transportation Plan

In April 2009 MTC adopted the Transportation 2035 regional transportation plan to guide regional transportation investments over the next 25 years. T2035 defined a set of performance targets under the rubric of "Three E's" – Economy, Environment, and Equity. In analyzing how well various investment scenarios would perform relative to

the performance targets, MTC concluded that, while the way we invest transportation dollars in the region is very important, we will need to make major changes in land use patterns and make use of pricing policies to manage travel demand in order for the region to make significant progress toward the environmental targets related to reducing vehicle miles of travel (VMT), and emissions of PM and greenhouse gases.

Projections 2009

In August 2009 ABAG issued its most recent biennial population and employment forecasts: *Projections and Priorities 2009: Building Momentum*. ABAG forecasts that that Bay Area population will increase by 1.7 million people over the next 25 years, and that the region will add 1.6 million new jobs and 600,000 housing units. *Projections and Priorities 2009* incorporates the same environmental performance targets as MTC's T2035 plan.

San Francisco Bay Plan Amendments

BCDC administers the *San Francisco Bay Plan*, which guides development on and around the shoreline of the Bay Area. BCDC staff is developing proposed amendments to the Bay Plan to update its policies addressing sea level rise, with the objective of directing development away from low-lying shoreline areas vulnerable to flooding. The proposed amendments are intended to support the region's FOCUS development and conservation strategy by ensuring we do not develop in ways that increase threats to public safety from flooding. The amendments will also outline a process for developing a regional adaptation strategy for areas vulnerable to sea level rise. The strategy will identify ways to integrate adaptation to climate change with the region's GHG reduction efforts.

SB 375

Recognizing the importance of integrating land use, transportation, and climate protection planning, the State of California adopted Senate Bill 375 in fall 2008. SB 375 calls for major metropolitan areas throughout California to develop and implement integrated land use and transportation plans, known as "Sustainable Communities Strategies" or SCS, to achieve greenhouse gas reduction targets established by CARB. The first Bay Area SCS must be developed and adopted by 2013. Development of the SCS is the primary responsibility of ABAG and MTC; however, the Air District will also play an important role in the development of the Bay Area SCS.

Climate Protection Plans

The District's climate protection program described above is intended to work in conjunction with CARB's AB 32 Scoping Plan to reduce greenhouse gases, as well as local Climate Action Plans adopted by many Bay Area cities and counties.

CARB's AB 32 Climate Scoping Plan

In September 2006, Governor Schwarzenegger signed the Global Warming Solutions Act (California Health and Safety Code, § 38500, *et seq*., commonly referred to as "AB32") establishing a statewide target of reducing greenhouse gas emissions to 1990 levels by 2020. This Act required CARB to prepare a scoping plan to lay out how the state will achieve these reductions. The AB 32 Scoping Plan, approved by the CARB Board in December 2008, sets forth the main strategies California will pursue to meet its 2020 climate protection goal.

The Scoping Plan has a range of actions, summarized in Table 3-9, which include direct regulations, alternative compliance mechanisms, monetary and non-monetary incentives, voluntary actions, and market-based mechanisms such as a "cap-and-trade" system. The recommended measures were developed to reduce greenhouse gas emissions from key sources and activities while improving public health, promoting a cleaner environment, preserving natural resources, and ensuring that the impacts of the reductions are equitable and do not disproportionately impact low-income and minority communities.

Most of the measures in the Scoping Plan will be implemented through the rulemaking processes at CARB or other agencies, including local air districts. Discrete Early Actions are expected to be adopted and implemented in the 2010 through 2012 time frame.

District Role in Implementing the CARB Scoping Plan

The Air District is prepared to assist in the implementation of the AB 32 Scoping Plan. Local air districts already implement and enforce stationary source regulations for criteria pollutants, so they are well-positioned to play this role for stationary source regulations that address GHG emissions. Not only are local air districts familiar with the individual facilities and their compliance history, but information contained in district permits can be used to confirm the accuracy of greenhouse gas emissions reported by sources subject to CARB mandatory reporting requirements.

Table 3-9. Recommended AB 32 Scoping Plan greenhouse gas reduction measures.

Recommended Reduction Measures	Estimated Year 2020 GHG Reductions *
California Light-Duty Vehicle Greenhouse Gas Standards	31.7
Energy Efficiency: buildings, appliances, solar water heating, etc.	26.3
Renewables Portfolio Standard (33% by 2020)	21.3
Low Carbon Fuel Standard	15
Regional Transportation-Related GHG Targets pursuant to SB 375	5
Vehicle Efficiency Measures	4.5
Goods Movement: Electric shore power at Ports & System-Wide Efficiency Improvements	3.7
Million Solar Roofs	2.1
Medium/Heavy Duty Vehicles: Aerodynamic Efficiency & Vehicle Hybridization	1.4
High Speed Rail	1.0
Industrial Measures: Refinery Measures, Energy Efficiency	0.3
Industrial Measures: Oil and Gas Extraction and Transmission	1.1
High Global Warming Potential Gas Measures	20.2
Sustainable Forests	5.0
Recycling and Waste (landfill methane capture)	1.0
Additional Reductions Necessary to Achieve the Cap	34.4
TOTAL REDUCTIONS COUNTED TOWARDS 2020 TARGET	**174**
Other Recommended Measures:	
State Government Operations	1.2
Local Government Operations	TBD
Green Buildings	26
Recycling and Waste: Mandatory Commercial Recycling & other measures	9
Water Sector Measures	4.8
Methane Capture at Large Dairies	1.0
Other Recommended Measures Subtotal	**42**

* GHG reductions are expressed in terms of million metric tons CO2-equivalent per year

The Air District will also continue to play a role in assisting local governments in contributing to the GHG reduction goals related to regional transportation and land use and energy efficiency, as described in the Transportation Control Measures, Land Use & Local Impacts Measures, and Energy and Climate Measures in the CAP control strategy.

Joint Policy Committee Climate Actions

Four regional agencies— BAAQMD, MTC, ABAG and BCDC – coordinate on climate change and other issues through the Joint Policy Committee (JPC). In May 2009, the JPC approved a set of 6 joint actions that the regional agencies will implement in 2009-10 to provide climate leadership for the Bay Area. Working together, the regional agencies will:

1. Begin to develop the Sustainable Community Strategy (SB 375). (ABAG/MTC)
2. Design and adopt an Indirect Source Review regulation. (Air District)
3. Develop and advance climate-friendly regional parking policies. (MTC)

4. Provide support for a coordinated public/private regional plan for electric vehicles. (Air District /MTC)
5. Design and implement a regional solar installation/energy efficiency financing program for existing residential/commercial buildings. (ABAG)
6. Coordinate a regional/local approach to climate adaptation. (BCDC/ABAG)

In addition, to help align and coordinate the many climate plans and initiatives underway in the Bay Area, the JPC in fall 2009 established a coordinating group made up of staff from key public, private and community stakeholders. This group, under the name of *Climate Bay Area,* will endeavor to ensure complementary action, reduce duplication, and bring resources to the common problems confronting all Bay Area climate efforts.

Local Government Actions

According to the AB 32 Scoping Plan, local governments are expected to reduce GHG emissions by 5 million metric tons through transportation and land use changes. In addition, local governments will play a key role in implementing many of the strategies contained in the Scoping Plan, such as energy efficient building codes, local renewable energy generation, and recycling programs. Fortunately, local governments in the Bay Area have led the nation in taking action to reduce greenhouse gas emissions. To date, 85 local jurisdictions had completed GHG emissions inventories for their communities, and 23 of these jurisdictions have completed comprehensive climate action plans. Additional jurisdictions are preparing to complete such plans in the near future.

Local governments will play a critical role in climate protection efforts in California. Local governments have primary authority over land use decisions. As discussed in Chapter 4, changes in land use to promote mixed-use, infill development in areas that are well-served by transit are a critical element of the CAP control strategy. To help support local efforts in this direction, and lay the groundwork for successful implementation of SB 375 in the Bay Area, the CAP control strategy includes several Transportation Control Measures and Land Use and Local Impacts Measures to promote focused land use and complementary transportation and parking policies.

Local governments also have the power to adopt building codes that exceed the energy efficiency requirements of the state's Title 24. Many local governments are innovators, testing new technologies or developing new approaches to achieving energy efficiency and emission reductions. For example, the City of Berkeley's innovative "Berkeley First" program offers low-interest financing to help home owners to cover the upfront cost of installing solar panels via property tax assessments. (The Air District provided a Climate Protection Grant to help fund this program.) The CAP will support local efforts to promote energy efficiency by means of the Energy and Climate Measures in the CAP control strategy.

State and National Mobile Source Programs

The state and federal governments are responsible for regulating emissions from mobile sources. Mobile source emissions are regulated by three basic approaches: by establishing emission standards for equipment, by regulating the fuel used in the equipment, and through vehicle in-use performance standards, such as the Inspection and Maintenance or "Smog Check" program. In California, mobile sources are regulated primarily by CARB. Under a provision of the federal Clean Air Act, CARB is authorized to adopt standards, rules and regulations to achieve the maximum degree of emission reduction possible from vehicular and other mobile sources in order to attain air quality standards at the earliest practicable date. The California standards cover motor vehicles (cars, motorcycles and trucks), heavy industrial and construction equipment, off-highway vehicles (dirt bikes and all-terrain vehicles) and lawn, garden and other utility engines. US EPA is responsible for regulating emissions from locomotives, ships and aircraft.

CARB standards for motor vehicle engines and fuels have great impact in reducing emissions of ozone precursors and other pollutants in the Bay Area. Among mobile source categories, passenger cars and light-duty trucks are the two largest contributors to the ROG emission inventory and are also significant contributors to the NOx emission inventory. CARB's Low Emission Vehicle (LEV) program has greatly reduced emissions of ROG and NOx throughout the state. The LEV I regulations reduced emissions in model year 1994-2003 vehicles. The more stringent LEV II program took effect in model year 2004, and will continue to provide major air quality benefits in future years.

State and federal regulations on off-road diesel construction equipment are also important in reducing ozone precursor emissions in the Bay Area. In 1998, US EPA adopted more stringent "Tier 2" and "Tier 3" emission standards for ROG, NOx, and PM from new non-road diesel engines. This program includes the first set of standards for non-road diesel engines less than 50 hp, including marine engines in this size range. The Tier 2 standards were phased in for all engine sizes from 2001 to 2006. The yet more stringent Tier 3 standards for engines between 50 and 750 hp were phased in from 2006 to 2008. EPA's tiered emissions standards for non-road diesel engines, along with CARB's in-use fleet and diesel fuel regulations will provide significant emissions reductions over the next decade.

The federal Clean Air Act directs US EPA to establish emission standards for aircraft engines, new locomotive engines and new non-road engines less than 175 horsepower used in construction or farm equipment. EPA has promulgated regulations or otherwise established programs to control emissions from these important source categories. Gas turbines, used in almost all commercial aircraft, became subject to United Nations International Civil Aviation Organization standards for ROG, NOx, CO and smoke in 1997.

The emission inventories provided in Table 2-3 (ROG and NOx) and Table 2-9 (PM) include the benefit of regulation that had been adopted by December 31, 2006. Since that date, CARB has been adopting additional regulations on mobile sources to implement the 2007 State Implementation Plan (SIP). Table 3-10 provides projected emission reductions of ROG, NOx and PM2.5 in the Bay Area from CARB regulations adopted since 2007. Because CARB rulemaking is ongoing, further emission reductions from measures described in the 2007 SIP are expected through future rulemaking. The ROG reductions will come primarily from on-road sources and consumer products. Most of the NOx reductions will come from CARB regulations on-road and off-road heavy-duty engines; these regulations will also require major reductions in diesel PM emissions, thus providing significant public health benefits.

Table 3-10. Projected Bay Area emission reductions from adopted 2007 state strategy measures (tons per day).

New SIP Measures	ROG		NOx		PM2.5	
	2014	2020	2014	2020	2014	2020
Passenger Vehicles	**4.8**	**3.6**	**--**	**--**	**--**	**--**
Smog Check Improvements (partial)	1.9	1.6	--	--	--	--
Modifications to Reformulated Gasoline Program	2.9	2.0	--	--	--	--
Heavy-Duty Trucks	**2.1**	**0.8**	**23.4**	**9.6**	**1.5**	**0.5**
Cleaner In-Use Heavy-Duty Trucks	2.1	0.8	23.4	9.6	1.5	0.5
Off-Road Equipment	**1.5**	**1.7**	**5.9**	**10.6**	**1.4**	**1.1**
Cleaner In-Use Off-Road Equipment (over 25hp)	1.5	1.7	5.9	10.6	1.4	1.1
Emission Reductions from Adopted New Measures	**8**	**6**	**29**	**20**	**3**	**2**

Source: CARB

In addition to tailpipe emission standards, mobile source emissions are also controlled through fuel regulations. CARB adopts fuel specifications for motor vehicle fuels: gasoline, diesel, alternative gasoline fuels, and alternative diesel. The most current gasoline regulations - the Phase 3 Reformulated Gasoline standards - went into effect on December 31, 2003, requiring lower evaporative compounds and prohibiting the use of the fuel additive MTBE. As of June 2006, the sulfur content in diesel fuel was reduced from 500 ppm to 15 ppm. The low sulfur content enables after-combustion exhaust abatement devices, such as diesel particulate filters, to operate at high levels of efficiency. CARB also conducts ongoing verification of alternative diesel fuel emission benefits.

More recently, CARB and the California Energy Commission have been developing regulations and incentive programs to lower the carbon content of fuels and transition California to renewable substitutes for gasoline and diesel in order to reduce emissions of greenhouse gases from mobiles sources. The centerpiece of this effort is the Low Carbon Fuel Standard (LCFS) Program adopted by CARB in April 2009 pursuant to the AB 32 and the Governor's Executive Order S-01-07. The LCFS, which goes into effect in 2011, calls for a reduction of at least 10 percent in the carbon content of California's transportation fuels by 2020.

Motor vehicle emissions are also controlled through in-use performance standards to ensure that the systems continue to operate properly. The State of California's Inspection and Maintenance (I&M) program operated by the California Bureau of Automotive Repair (BAR) since 1984, tests light-duty on-road gasoline powered vehicles every other year. An enhanced program which requires the use of a dynamometer to test the vehicle's emissions simulating on-road conditions began in the Bay Area in October 2003.

Although emission reductions from CARB and US EPA mobile source regulations and programs may not yet be fully reflected in the emissions inventory, these measures are expected to provide substantial emission reductions overall. A comprehensive summary of CARB's mobile source programs is provided below.

State Programs for Passenger Cars & Light-Duty Vehicles

Smog Check: Operational in California since 1984, the Bureau of Automotive Repair tests all on-road gasoline powered vehicles for compliance with in-use standards. Since October 2003, the Bay Area has been subject to the Enhanced Area Smog Check Program, which tests vehicle emissions while the vehicle is running.

In-Use Testing of Motor Vehicles: Tests in-use passenger cars and light duty vehicles for compliance with standards. In the event of violations, CARB works with the vehicle manufacturer to correct the problem, usually in the form of a recall or statewide repair. A protocol is being developed to test Heavy Duty Diesel Vehicles as well.

Voluntary Accelerated Vehicle Retirement Program: Pays owners of eligible vehicles to voluntarily retire their older, higher-emitting vehicle.

Low Emission Vehicle Program: Establishes improved emission reduction standards for automobiles. LEV II regulations are the most recent and are effective from 2004 through 2010. The new standards extend passenger car emission standards to heavier sport utility vehicles and pickup trucks (with gross vehicle weight up to 8,500 pounds) which formerly had been regulated under less-stringent emission standards.

On-Board Diagnostic (OBD) Program: OBD II systems monitor components in 1996 and newer vehicles less than 14,000 lbs to ensure that a vehicle remains as clean as possible over its entire life, and assists Smog Check repair technicians in diagnosing and fixing problems with the computerized engine controls. ARB is currently developing OBD requirements for heavy-duty vehicles over 14,000 lbs.

On-Road Motorcycle Regulation: Standards adopted in December 1998. Apply to motorcycles with engines over 280cc manufactured for the 2004 model year and later.

Zero Emission Vehicle Program: Creates incentives to promote zero emission vehicles such as battery and fuel cell vehicles. Also certifies vehicles as such.

California Hydrogen Highway: Program working toward a transition to a clean, hydrogen transportation economy in California.

HOV Lane Access: Allows single occupancy use of HOV lanes by zero-emission and alternative fuel vehicles.

Climate Change Emission Control Regulations: Pursuant to AB 1493 (Pavley), CARB regulation will require reduction of CO2 emissions from motor vehicles in California of approximately 30% between 2009 and 2014. CARB regulation adopted in September 2004 has been on hold pending approval of necessary waiver by US EPA. The waiver was finally approved by EPA in June 2009, so the CARB program should now be able to move forward to implement CO2 vehicle emission standards.

State Programs for Heavy-Duty On-Road & Off-Road Mobile Sources

Diesel Risk Reduction Program: After identifying diesel PM as a toxic air contaminant in 1998, CARB developed a comprehensive plan to reduce emissions from diesel engines and vehicles. In 2000 CARB approved a Diesel Risk Reduction Program (DRRP) to reduce diesel emissions from both new and existing diesel-fueled vehicles and engines. The DRRP established a goal of reducing diesel PM emissions, and the associated health risk, 75% by 2010 and 85% by 2020. In addition, recognizing that aggregate emissions from goods movement (shipping, cargo-handling, rail, truck, etc.) are a major source of diesel PM emissions the ARB Board approved a statewide *Emission Reduction Plan for Ports and Goods Movement* in April 2006. These programs are already having a beneficial impact; analysis of the carbon in ambient PM2.5 in the Bay Area suggests that diesel emissions have been cut substantially since 2000. The DRRP is made up of several strategies, including retrofits and control technology. Some of these strategies are part of other programs listed below.

Heavy-Duty Diesel In-Use Strategies Program: Reduces emissions from existing on- and off-road diesel engines, with a special emphasis on reducing particulate emissions through the following implementation programs: Retrofit Assessment and Implementation (solid waste collection vehicles and on-road heavy-duty public fleet vehicles); and Heavy-duty Testing and Field Support.

On-Road Heavy-Duty Diesel New Engine Program: Reduces emissions from new on-road heavy-duty diesel engines through emission control regulations and test procedures for these engines. The final tier of standards which bring truck emissions to near-zero levels become effective in 2010.

Heavy Duty Vehicle Inspection Program: Inspection of trucks and buses for excessive smoke. In June 1998, CARB resumed the Heavy Duty Vehicle Inspection Program (roadside and unannounced inspections). In July 1998 CARB began the Periodic Smoke Inspection Program, where diesel and bus fleet operators are required to annually self-inspect their vehicles and repair those with excessive smoke emissions.

Diesel Engine Software Upgrade: CARB is working with the California Trucking Association (CTA) to get low NOx software installed on every eligible, electronically-controlled engine registered in California. The Air District requires the software upgrades as a condition for receiving heavy-duty vehicles grants from the Carl Moyer Program and the Transportation Fund for Clean Air.

Public Transit Bus Program: This program reduces criteria pollutant emissions and toxic air contaminants from urban buses. In October 2005, CARB aligned urban bus standards for 2007-2009 with national standards for diesel truck engines.

Solid Waste Collection Vehicles: This airborne toxic control measure for diesel PM from on-road heavy-duty diesel-fueled residential and commercial solid waste collection vehicles is one in a series of rules designed to reduce diesel PM from most diesel-fueled heavy-duty vehicles in California.

Heavy-Duty Diesel Idling Control Measure: In July 2004, CARB adopted an idling control measure for heavy-duty diesel commercial motor vehicles, limiting idling to five minutes. In October 2005, this measure was extended to include trucks with sleeper cabs.

Idling Limits at Schools: Requires school buses and other heavy-duty diesel vehicles to turn off engines upon arriving at a school and prohibits restarting engines more than 30 seconds before departure from a school.

The Carl Moyer Program: Provides grants through participating air pollution control districts, including the Bay Area Air District, to cover the incremental cost of cleaner on-road, off-road, marine, and locomotive engines.

Border Inspection Program: CARB, in cooperation with the California Highway Patrol, will establish inspection protocols of heavy duty vehicles entering this state to ensure that each vehicle has a certified engine. While enforcement is expected to take place near California borders, the Bay Area will still benefit from this program.

State Programs for Off-Road Vehicles & Equipment

Off-Road Mobile Sources Emission Reduction Program: Exhaust emission standards have been adopted by CARB and/or U.S. EPA for off-road engines included in the following categories: Small Spark-Ignition Off-Road Engines and Equipment Less Than 25 Horsepower (including Lawn and Garden Equipment, and Small Industrial Equipment); Off-Road Recreational Vehicles (including Motorcycles and All-Terrain Vehicles); Off-Road Compression Ignition (Diesel) Engines and Equipment; Off-Road Large Spark Ignition (Gasoline and LPG) Engines and Equipment 25 Horsepower and Greater (including Industrial Equipment, Forklifts, and Portable Generators); Airport Ground Support Equipment; Commercial Marine Vessels; and Recreational Marine (including Personal Water Craft, Ski boats, Inboards, and Outboards). Ultra-low sulfur diesel fuel is now required for harbor crafts, ferries, and in-state locomotives. In December 2005 CARB adopted low-sulfur fuel standards for marine auxiliary engines and cargo handling equipment.

Recreational Marine Engines: Reduces emissions of ROG and NOx for certain marine vessels with proposed regulations for other spark-ignition engines used in boats for propulsion. In 2001, all new outboards sold in California were required to meet the U.S. EPA 2006 emission levels. In 2002, CARB adopted regulations governing emissions for all 2003 model year and later inboard engines.

ARB MOU with the Union Pacific and Burlington Northern Santa Fe Railroads: In June 2005 CARB entered into a Memorandum of Understanding (MOU) with Union Pacific Railroad (UP) Railroad and Burlington Northern Santa Fe (BNSF) Railway. The agreement is expected to achieve a 20 percent reduction in locomotive diesel particulate matter emissions at 17 major rail yards throughout the State, including five in the Bay Area. UP and BNSF agreed to phase out non-essential idling within 6 months and install idling reduction devices on California based locomotives within 3 years; identify and expeditiously repair locomotives with excessive smoke; ensure that at least 99 percent of locomotives operating in California pass smoke inspections; maximize the use of ultra low sulfur diesel fuel by January 1, 2007; conduct health risk assessments for 17 major rail yards and use these studies to identify risk reduction measures; and prepare a progress report on plans to implement feasible mitigation measures at all 17 rail yards. Participation from the Air District and local communities is an integral aspect of the MOU.

Chapter 4 – Overview of CAP Control Strategy

The control strategy is the heart of the Bay Area 2010 Clean Air Plan. It describes specific measures and actions that the Air District and its partners will implement to improve air quality, protect public health, and protect our climate. This chapter includes:

- A description of the scope and underlying rationale of the control strategy;
- A summary of the specific control measures that comprise the overall strategy;
- A discussion of key themes that are embedded in the strategy;
- Estimates of emissions reductions and cost-effectiveness for control measures; and
- A description of how the control strategy will be implemented.

As discussed in Appendix B, the control strategy has been developed pursuant to the "all feasible measures" provisions of Section 40914 of the California Health & Safety Code. The control strategy includes 55 measures which are described in detail in Volume II. The control measures that comprise the CAP control strategy are divided into five categories which are discussed below. This includes the three categories used in prior plans - Stationary Source Measures, Mobile Source Measures, and Transportation Control Measures - as well as two new control measure categories: Land Use & Local Impacts Measures, and Energy & Climate Measures.

In developing the control strategy for the 2010 CAP, Air District staff reviewed control measures in other air quality plans throughout California and elsewhere in the U.S., and solicited suggestions from Air District staff, staff of regional agency partners, members of the public, and diverse stakeholder groups. Staff also reviewed emissions inventory data and existing Air District rules and programs to identify emission reduction opportunities. As described in Appendix F, staff analyzed control measures based on the evaluation criteria set forth in the Health & Safety Code, as well as their potential to reduce the range of pollutants addressed in this plan.

Scope and Rationale

The CAP control strategy is designed as an integrated strategy to:

- Reduce emissions and transport of ozone precursors by developing a control strategy that includes all feasible measures to fulfill air quality planning requirements pursuant to the California Health & Safety Code;
- Reduce emissions of other pollutants, including particulate matter (PM), key air toxics, and key greenhouse gases, in addition to ozone precursors;

- Help to forge a multi-agency partnership to combat climate change by developing a regional strategy to address land use, transportation, and air quality.

The control strategy seeks to maximize co-benefits from control measures that reduce ozone precursors, and also to include additional measures that focus on reducing PM, air toxics, and GHGs. Most control measures proposed in the CAP will reduce ozone precursors along with other pollutants. However, the proposed control strategy does include several measures that are focused on reducing PM, air toxics, and/or greenhouse gases, while providing little or no direct ozone benefit.

Although the Air District has clear authority to regulate emissions from stationary sources, its regulatory power is very limited in some areas that have great impact on air quality, such as mobile sources, land use decision-making, energy-efficiency standards for building, etc. Therefore, in developing the control strategy, staff identified the full range of tools and resources available to the Air District, both regulatory and non-regulatory, and applied the most appropriate ones in crafting each measure. Implementation of each control measure will rely on some combination of the following:

- Adoption and enforcement of rules to reduce emissions from stationary sources, area sources, and indirect sources;
- Revisions to the Air District's permitting requirements for stationary sources;
- Enforcement of CARB rules to reduce emissions from heavy-duty diesel engines;
- Allocation of grants and other funding by the Air District and/or partner agencies;
- Promotion of best policies and practices that can be implemented by local agencies through guidance documents, model ordinances, etc.;
- Partnerships with local governments, other public agencies, the business community, non-profits, etc.;
- Public outreach and education;
- Enhanced air quality monitoring;
- Development of land use guidance and CEQA guidelines, and Air District review and comment on Bay Area projects pursuant to CEQA; and
- Leadership and advocacy.

Overview of CAP Control Strategy

The proposed 2010 CAP control strategy proposes a total of 55 control measures in five categories, including:

- 18 measures to reduce emissions from stationary and area sources
- 10 mobile source measures
- 17 transportation control measures

- 6 land use and local impact measures
- 4 energy and climate measures

In addition, to complement the formal control measures outlined above, a total of 17 Further Study Measures, as well as a Leadership Platform, are proposed.

Figure 4-1 provides an overview of the CAP plan framework.

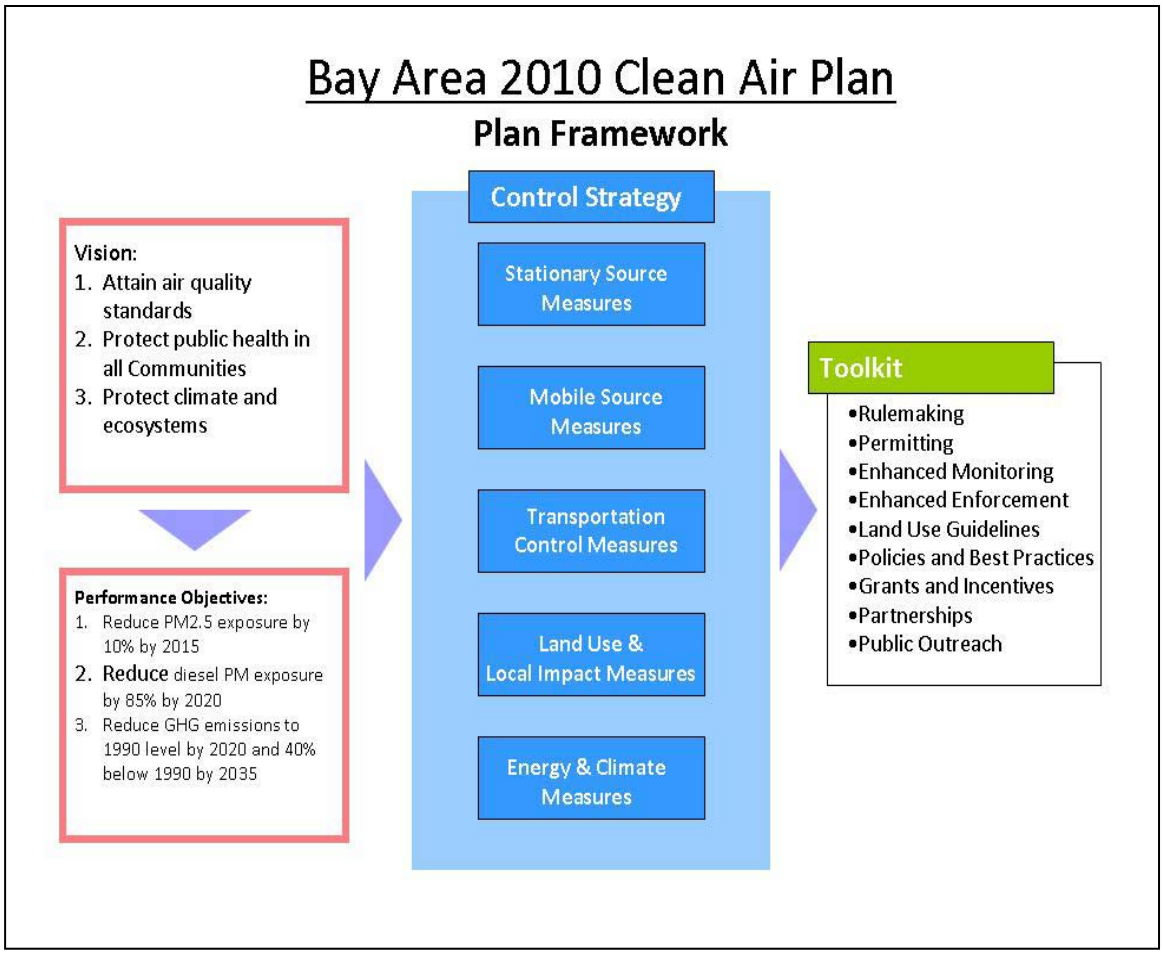


Figure 4-1. 2010 CAP Framework.

A brief summary of each category of control measures is provided in the section below. Detailed descriptions of the CAP control measures, FSMs, and Leadership Platform are provided in CAP Volume II. An overview of the control strategy and discussion of several key themes that run through the strategy are provided below.

Stationary Source Measures (SSMs) are measures that the Air District adopts and enforces pursuant to its authority to control emissions from stationary sources of air

pollution such as manufacturing facilities, refineries, dry cleaners, auto body shops, gas stations, etc. Since the adoption of its first state ozone plan in 1991, the Air District has adopted or amended 68 rules to reduce emissions from stationary sources; in aggregate, these rules have reduced ROG emissions by 70-72 tons per day and NOx emissions by 108-123 tons per day.

A total of 18 SSMs are proposed in the 2010 CAP control strategy to enhance the Air District's regulatory program and ensure that the Bay Area remains in the forefront in controlling emissions from stationary sources. The proposed SSMs will provide reductions in emissions of ozone precursors, direct PM and PM precursors, air toxics, and greenhouse gases. The SSMs are briefly summarized in Table 4-1.

Mobile Source Measures (MSMs) are measures that reduce emissions by accelerating the replacement of older, dirtier vehicles and equipment through programs such as the Air District's Vehicle Buy-Back and Smoking Vehicle Programs, and promoting advanced-technology vehicles that reduce emissions of criteria pollutants and/or greenhouse gases. Since CARB is responsible for establishing statewide motor vehicle emissions standards and fuel specifications, implementation of the 10 MSMs relies heavily upon incentive programs, such as the Carl Moyer Program and the Transportation Fund for Clean Air, to achieve voluntary emission reductions in advance of, or in addition to, CARB requirements. The MSMs are briefly summarized in Table 4-2.

Table 4-1. Stationary and area source measures.

Number	Title	Description
SSM 1	Metal Melting Facilities	Limit emissions of organic compounds, fine particulates, toxic compounds, and odors from foundry operations and metal melting facilities.
SSM 2	Digital Printing	Establish VOC limits or control requirements for inkjet, electro-photographic and other digital printing technologies.
SSM 3	Livestock Waste	Establish management practices to reduce ROG, ammonia, PM, GHG.
SSM 4	Natural Gas Processing and Distribution	Reduce emissions of VOCs and methane from natural gas production facilities.
SSM 5	Vacuum Trucks	Require carbon or other control technology on vacuum trucks to reduce emissions of VOCs.
SSM 6	General Particulate Matter Weight Rate Limitation	Reduce particulate weight limitation as a function of exhaust gas volume and/or as a function of process weight rate.
SSM 7	Open Burning	Further limit agricultural burning of some crops to be burned on a given day to reduce VOCs, NOx, and PM.
SSM 8	Coke Calcining	Reduce SOx emissions from coke calcining.
SSM 9	Cement Kilns	Further limit NOx and SOx from cement production and reduce toxic emissions.
SSM 10	Refinery Boilers and Heaters	Further reduce NOx emissions from refinery boilers, heaters, and steam generators.
SSM 11	Residential Fan Type Furnaces	Reduce allowable NOx limits for residential furnaces.
SSM 12	Space Heating	Establish NOx limits for industrial and commercial space heating.
SSM 13	Dryers, Ovens, Kilns	Establish NOx limits for industrial dryers, ovens, and kilns.
SSM 14	Glass Furnaces	Reduce NOx limits for glass furnaces.
SSM 15	Greenhouse Gases in Permitting – Energy Efficiency	Consider greenhouse gas (GHG) emissions during permitting of new or modified stationary sources. This may include (1) adopting GHG CEQA significance threshold for stationary sources, and (2) requiring GHG reduction measures in ministerial permits.
SSM 16	Revise Regulation 2, Rule 2: New Source Review	Amend Reg. 2, Rule 2 to address the District's anticipated non-attainment status of the 24-hour PM2.5 National Ambient Air Quality Standard.
SSM 17	Revise Regulation 2, Rule 5: New Source Review for Air Toxics	Implement more health-protective District permitting requirements in Regulation 2, Rule 5, New Source Review of Toxic Air Contaminants based on revisions to OEHHA risk factors and methodologies. For Priority CARE Communities, track the toxicity-weighted emissions from all sources in the identified communities.
SSM 18	Revise Air Toxics "Hot Spots" Program	Revise the District's Air Toxics Hot Spots program to incorporate more stringent risk reduction requirements from existing sources.

Table 4-2. Mobile source measures.

Mobile Source Control Measures (On-Road Light Duty Vehicles)		
Number	**Title**	**Description**
MSM A-1	Promote Clean, Fuel Efficient Light & Medium-Duty Vehicles	Expand the use of Super Ultra-low Emission (SULEV) and Partial - Zero emission (PZEV) light-duty passenger vehicles and trucks within the Bay Area.
MSM A-2	Zero Emission Vehicles and Plug-in Hybrids	Expand the use of Zero Emission (ZEV) and Plug-in Hybrid (PHEV) passenger vehicles and light-duty trucks within the Bay Area, working in partnership with the Bay Area Electric Vehicle Corridor coalition.
MSM A-3	Green Fleets (Light, Medium & Heavy-Duty Vehicles)	Develop a green fleet certification component of the Bay Area Green Business program, promote best practices for green fleets, and evaluate existing grant programs to ensure incentive funding is directed towards fleets and vehicles that meet stringent fuel economy standards.
MSM A-4	Replacement or Repair of High-Emitting Vehicles	Enhance the Air District's Vehicle Buy Back program to increase participation from car owners; e.g., via higher cash payments and/or increased marketing. Consider including motorcycles in the VBB programs, or other potential enhancements, e.g. implementing a vehicle repair program. Pursue improvements to the Air District's Smoking Vehicle program.
Mobile Source Control Measures (On-Road Heavy Duty Vehicles)		
MSM B-1	HDV Fleet Modernization	Provide incentives to accelerate the replacement or retrofit of on-road heavy-duty diesel engines in advance of requirements for the CARB in-use heavy-duty truck regulation.
MSM B-2	Low NOx Retrofits for In-Use Engines	Provide cash incentives to install retrofit devices that reduce NOx emissions from MY 1994-2006 heavy-duty engines. Continue requiring software updates to engine control modules in model year 1993-1998 diesel trucks as a condition of all heavy duty vehicle retrofit grants.
MSM B-3	Efficient Drive Trains	Encourage development and demonstration of hybrid drive trains for medium- and heavy-duty vehicles, in partnership with CARB, CEC and other existing programs.
Mobile Source Control Measures (Off-Road Equipment)		
MSM C-1	Construction and Farming Equipment	Reduce emissions from construction and farming equipment by 1) cash incentives to retrofit construction and farm equipment with diesel particulate matter filters or upgrade to a Tier III or IV off-road engine; 2) work with CARB, CEC and others to develop more fuel efficient off-road engines and drive-trains; 3) work with local communities, contractors and developers to encourage the use of renewable alternative fuels in applicable equipment.
MSM C-2	Lawn & Garden Equipment	Reduce emissions from lawn and garden equipment through voluntary retirement and replacement programs.
MSM C-3	Recreational Vessels	Reduce emissions from recreational vessels through voluntary retirement and replacement programs.

Transportation Control Measures (TCMs) are strategies to reduce vehicle trips, vehicle use, vehicle miles traveled, vehicle idling, or traffic congestion for the purpose of reducing motor vehicle emissions. The draft Control Strategy includes 17 TCMs to improve transit service; encourage walking, bicycling, and transit use; improve efficiency of the regional transit and roadway systems; support focused growth; and develop and implement pricing strategies. The TCMs for the 2010 Clean Air Plan were developed by reviewing the 2005 Ozone Strategy measures, and modifying and expanding them based on new investment and policy decisions and public input. In particular, the TCMs have been updated to reflect the policy and investment decisions made in MTC's regional transportation plan, *Transportation 2035: Change in Motion*.

The TCMs are organized into five categories:

- Improve Transit Services
- Improve System Efficiency
- Encourage Sustainable Travel Behavior
- Support Focused Growth
- Implement Pricing Strategies

New TCMs have been added to:

- Emphasize the importance of "smart driving" and the need to reduce high-speed driving (TCM C-5)
- Encourage parking policies that will help to reduce motor vehicle travel (TCM E-2)
- Advocate that the Air District and its regional agency partners join forces to develop a regional transportation pricing strategy (TCM E-3)

In preparing the Transportation 2035 Plan, MTC defined performance objectives related to the "Three E's" – Economy, Environment, and Equity – and evaluated how various investment and policy scenarios would perform relative to these objectives. MTC concluded that implementation of innovative pricing and land use policies will be the most effective means of achieving the T2035 objectives.[68] Transportation pricing and parking policies are both potentially potent tools to reduce motor vehicle use, while also generating revenues that can be used to support alternative transportation modes. The plan includes TCM E-1 (value pricing), TCM E-2 (parking), and TCM E-3 (other pricing measures). TCM E-3 calls for the Bay Area regional agencies to join forces to establish a regional pricing task force to define goals, evaluate transportation pricing policy options, develop a recommended regional transportation pricing strategy, and pursue implementation of the strategy. The TCMs are briefly summarized in Table 4-3.

[68] See MTC Transportation 2035 Plan, pages 21-30.

Table 4-3. Transportation control measures.

Number	Title	Description
TCM A-1	Improve Local and Areawide Bus Service	Improve transit by providing new Express Bus or Bus Rapid Transit on major travel corridors, funding the replacement of older and dirtier buses, and implementing Transit Priority Measures on key transit routes.
TCM A-2	Improve Local and Regional Rail Service	Improve rail service by sustaining and expanding local and regional rail services and by providing funds to maintain rail-cars, stations, and other rail capital assets.
TCM B-1	Implement Freeway Performance Initiative	Improve the performance and efficiency of freeway and arterial systems through operational improvements, including implementing the Freeway Performance Initiative, the Arterial Management Program, and the Bay Area Freeway Service Patrol.
TCM B-2	Improve Transit Efficiency and Use	Improve transit efficiency and use through continued operation of 511 Transit, and full implementation of TransLink® fare payment system and the Transit Hub Signage Program.
TCM B-3	Bay Area Express Lane Network	Introduce roadway pricing on Bay Area highways through the implementation of an express lane network, also known as a High Occupancy Toll (HOT) lane network.
TCM B-4	Goods Movement Improvements and Emission Reduction Strategies	Improve goods movement and reduce emissions from diesel equipment through implementation of the Bay Area's Trade Corridors Improvement Fund (TCIF) projects and various funding programs to replace or retrofit diesel equipment.
TCM C-1	Support Voluntary Employer-Based Trip Reduction Program	Support voluntary employer trip-reduction programs through the implementation of the 511 Regional Rideshare Program and Congestion Management Agency rideshare programs, the Spare the Air Program, encouraging cities to adopt transit benefit ordinances, and supporting Bay Area shuttle service providers.
TCM C-2	Implement Safe Routes to Schools and Safe Routes to Transit	Facilitate safe routes to schools and transit by providing funds and working with transportation agencies, local governments, schools, and communities to implement safe access for pedestrians and cyclists.
TCM C-3	Promote Rideshare Services and Incentives	Promote rideshare services and incentives through the implementation of the 511 Regional Rideshare Program and Congestion Management Agency rideshare programs including marketing rideshare services, operating rideshare information call center and website, and providing vanpool support services.
TCM C-4	Conduct Public Outreach and Education	Educate the public about the air quality, environmental, and social benefits of carpooling, vanpooling, taking public transit, biking, walking, and telecommuting, through the Spare the Air campaign and Transportation Climate Action Campaign.
TCM C-5	Promote Smart Driving/Speed Moderation	Educate the public about the air quality and climate protection benefits of reducing high-speed driving and observing posted speed limits.

Table 4-3 (continued). Transportation control measures.

Number	Title	Description
TCM D-1	Improve Bicycle Access and Facilities	Expand bicycle facilities serving transit hubs employment sites, educational and cultural facilities, residential areas, shopping districts, and other activity centers.
TCM D-2	Improve Pedestrian Access and Facilities	Provide funding for projects to improve pedestrian access to transit hubs, employment sites, educational and cultural facilities, residential areas, shopping districts, and other activity centers.
TCM D-3	Support Local Land Use Strategies	Promote land use patterns, policies, and infrastructure investments that support mixed-use, transit-oriented development that reduce motor vehicle dependence and facilitate walking, bicycling and transit use.
TCM E-1	Value Pricing Strategies	Implement value pricing (congestion pricing) on Bay Bridge; consider expanding value pricing to other Bay Area toll bridges to manage travel demand during congested periods. Measure may also include value pricing in the City of San Francisco.
TCM E-2	Parking Pricing and Management Strategies	Promote policies to implement market-rate pricing of parking facilities, reduce parking requirements for new development projects, parking "cash-out", unbundling of parking in residential and commercial leases, shared parking at mixed-use facilities, etc.
TCM E-3	Implement Transportation Pricing Reform	Develop a regional transportation pricing strategy that includes policy evaluation and implementation. Pricing policies to be evaluated include gasoline taxes, bridge tolls, congestion pricing, parking pricing, HOT lanes, VMT or carbon fees, pay-as-you-drive insurance, etc.

Land Use and Local Impacts Measures (LUMs) are a new category of measures designed to (1) promote mixed-use, compact development to reduce motor vehicle travel and emissions, and (2) ensure that we plan for focused growth in a way that protects people from exposure to air pollution from stationary and mobile sources of emissions. Building on the Air District's CARE program and Clean Air Communities Initiative, this component of the Control Strategy puts a special emphasis on the need to monitor and reduce population exposure to hazardous pollutants in communities that are most heavily impacted by emissions. The measures in this category draw upon the full range of tools available to the Air District, including rulemaking, notably development of a new indirect source review rule; revised CEQA guidelines and enhanced CEQA review by the Air District; working with local jurisdictions to encourage and assist them in developing Community Risk Reduction Plans to reduce population exposure to air toxics and PM; providing incentives to reduce emissions from heavy-duty diesel equipment; targeted enforcement of CARB diesel control rules; land use guidance; and enhanced air quality monitoring. The LUMs are briefly summarized in Table 4-4.

Table 4-4. Land use and local impacts measures.

Land Use and Local Impact Control Measures		
Number	**Title**	**Description**
LUM 1	Goods Movement	Reduce diesel PM and GHG emissions from goods movement in the Bay Area through targeted enforcement of CARB diesel ATCMs in impacted communities, partnerships with ports and other stakeholders, increased signage indicating truck routes and anti-idling rules, shifts in freight transport mode, shore-side power for ships, and improvements in the efficiency of engine drive trains, distribution systems (roadways, logistic systems) and land use patterns.
LUM 2	Indirect Source Review Rule	Develop an indirect source review rule to reduce construction and vehicular emissions associated with new or modified land uses.
LUM 3	Enhanced CEQA Program	1) Develop revised CEQA guidelines and thresholds of significance and 2) expand District review of CEQA documents.
LUM 4	Land Use Guidelines	Provide guidance to local governments re: 1) air quality and greenhouse gases in General Plans, and 2) how to address and mitigate population exposure related to land use development.
LUM 5	Reduce Risk in Impacted Communities	Establish a system to track cumulative health risks from all emissions sources in impacted communities (as identified by the District's CARE program) in order to monitor progress in reducing population exposure.
LUM 6	Enhanced Air Quality Monitoring	Expand monitoring program to provide better local air quality monitoring data in impacted communities.

Energy and Climate Measures (ECMs) are a new category of measures designed to reduce ambient concentrations of criteria pollutants, reduce emissions of CO2, and protect our climate by:

- Promoting energy conservation and energy efficiency in homes, schools, and commercial and industrial buildings;
- Promoting renewable forms of energy production, such as solar panels and solar thermal;
- Reducing "urban heat island" effects by increasing reflectivity of roofs and parking lots, in order to decrease energy consumption by air conditioning, reduce evaporative emissions from motor vehicles, and help offset temperature increases associated with global warming; and
- Promoting the planting of (low-VOC emitting) trees in order to reduce biogenic emissions from trees, lower air temperatures, provide shading to reduce energy use, and absorb CO2 and other air pollutants.

The ECMs are briefly summarized in Table 4-5.

Table 4-5. Energy and climate measures.

Energy and Climate Control Measures		
Number	**Title**	**Description**
ECM 1	Energy Efficiency	Provide 1) education to increase energy efficiency; 2) technical assistance to local governments to adopt and enforce energy- efficient building codes; and 3) incentives for improving energy efficiency at schools.
ECM 2	Renewable Energy	Promote distributed renewable energy generation (solar, micro wind turbines, cogeneration, etc.) on commercial and residential buildings, and at industrial facilities
ECM 3	Urban Heat Island Mitigation	Mitigate the "urban heat island" effect by promoting the implementation of cool roofing, cool paving, and other strategies.
ECM 4	Tree-Planting	Promote planting of low-VOC-emitting shade trees to reduce urban heat island effects, save energy, and absorb CO2 and other air pollutants.

These new Energy & Climate measures are proposed in recognition of the fact that promoting energy efficiency, renewable energy, and green building standards are essential for purposes of both air quality and climate protection. However, the Air District has very limited direct regulatory authority in the area of energy or building standards. A well-defined regulatory structure is already in place via regulations and programs developed by the California Energy Commission, the California Public Utilities Commission, and other entities, and California has the most stringent energy efficiency standards in the nation. Energy efficiency and renewable energy use in the buildings sector also play a major role in the AB 32 Scoping Plan. Therefore, in crafting energy and climate measures for the CAP, the challenge is to identify where gaps may exist in the current structure and how the Air District can play a useful role in this arena within the constraints of its authority and resources.

The four ECMs focus on promoting voluntary action, largely by local governments, to adopt best practices and model policies to further energy conservation. The Air District can play an important role in facilitating the spread of best practices, for example, by drawing on the experience gained from projects funded by the District's Climate Protection Grant Programs. The District can also build on its relationships with the local planning community, via CEQA commenting, supporting the development of local climate action plans, and other activities, to promote these measures at the local level.

The ECMs focus on reducing GHG emissions and offsetting anticipated temperature increases related to global warming; this will have the effect of mitigating ozone increases that would occur with increased temperatures. To the extent that these measures are successful in reducing energy use, they will also contribute to reducing emissions of pollutants such as NOx, PM, and air toxics.

Further Study Measures: In reviewing potential control measures for the CAP, District staff identified 17 potential measures that appear to have merit but are not yet ready to be included as formal control measures. These measures have been included as further study measures (FSMs), as described in CAP Volume II. Measures have been classified as FSMs for a variety of reasons, including lack of emissions data for the targeted source, uncertainty as to the cost-effectiveness of a measure, or because the proposed control technology has not been adequately demonstrated. By designating measures as FSMs, the District commits to continue to evaluate these measures. However, the District makes no commitment to actually adopt or implement any FSM as a control measure unless and until a given measure has been demonstrated to be feasible pursuant to the control measure evaluation criteria specified in the Health & Safety Code. The FSMs are briefly summarized in Table 4-6.

Table 4-6. Further study control measures.

Further Study Measures		
Number	**Title**	**Description**
FSM 1	Adhesives and Sealants	Research the emission inventory for this source category, reconcile discrepancies with the inventories of other districts in the State, and determine if some VOC limits found in South Coast Rule are feasible in the Bay Area.
FSM 2	Reactivity in Coating and Solvents	Consider replacing VOC limits in certain rules, measured in mass VOC per volume, with limits based on the relative contribution to ozone formation of each of the organic species that make up the VOC content of a product.
FSM 3	Solvent Cleaning and Degreasing Operations	Consider reducing VOC emissions from solvent cleaning and degreasing operations based on CARB's statewide study.
FSM 4	Emissions from Cooling Towers	Research ways to reduce VOC emissions from cooling towers in refineries.
FSM 5	Equipment Leaks	Research ways to reduce VOC emissions from equipment leaks through remote sensing technologies and other methods.
FSM 6	Wastewater from Coke Cutting	Review coke cutting operations to determine if emissions reductions can be achieved from the resulting wastewater.
FSM 7	SO2 from Refinery Processes	Review refinery processes to identify opportunities to reduce SO2 emissions.
FSM 8	Reduce Emission from LPG, Propane, Butane, and other Pressurized Gases	Reduce emissions of LPG, propane, butane and other pressurized organic gases by requiring tanks and relief valves to be gas tight, prohibiting venting during tank filling, and establishing a leakage allowance for hoses.
FSM 9	Greenhouse Gas Mitigation in BACT and TBACT Determinations	Consider flexibility in BACT/TBACT determinations in order to reduce secondary green house gas (GHG) emissions from abatement devices.
FSM 10	Further Reductions from Commercial Cooking Equipment	Consider reducing emissions from commercial wok cooking, and solid fueled cooking devices such as wood-fired pizza ovens.

Table 4-6 (continued). Further study control measures.

Number	Title	Description
FSM 11	Magnet Source Rule	Explore the viability of developing a magnet source rule to reduce mobile source emissions from facilities such as airports, seaports, warehouses, distribution centers, shopping centers, and other facilities that generate mobile source emissions of criteria air pollutants, toxic air contaminants and greenhouse gases.
FSM 12	Wood Smoke	Study the impacts of existing Air District rules regarding wood burning and open burning, in order to develop more effective methods to implement, promote, enforce, and possibly expand, existing rules.
FSM 13	Energy Efficiency and Renewable Energy	Review the results of ECM1 and ECM 2 in 2010 CAP, and consider potential enhancements to promote energy efficiency and renewable energy.
FSM 14	Winery Fermentation	Review emissions generated by fermentation at wineries to determine if reductions in VOC emissions can be achieved.
FSM 15	Composting Operations	Review emissions generated by composting operations and consider reductions in emissions from composting.
FSM 16	Vanishing Oils and Rust Inhibitors	Research VOC emissions reductions from vanishing oils and rust inhibitors.
FSM 17	Ferry System Expansion	Work with MTC and the Water Emergency Transportation Authority to ensure that expansion of the regional ferry network will provide the greatest possible air quality benefit.

Leadership Platform: Some of the most potentially beneficial measures to improve air quality will require action by other agencies such as CARB or US EPA, or adoption of new legislation. Therefore, the CAP also includes a Leadership Platform, summarized in Table 4-7, which identifies policies and actions by other entities to complement the CAP control strategy.[69] The control measures that these actions would complement are identified in parentheses.

[69] The Leadership Platform is intended to help define the District's priorities for legislation and advocacy over the term of the CAP. However, it is not intended to preempt or supplant the Legislative Agenda that the District's Board of Directors defines each year.

Table 4-7. CAP leadership platform.

#	Advocacy Area	Actions
1	Cleaner Vehicles & Equipment	1. Advocate for more enforcement by CARB in Bay Area of diesel air toxics control measures and snap-idle inspection program. (MSM A-1) (LUM 1) 2. Support major revisions to the Smog Check program to improve its performance, such as using on-board diagnostics and remote sensing technologies to diagnose and repair vehicle emission malfunctions more quickly. (MSM A-4) 3. Support improvements to existing Smog Check program: older vehicles and newer high-mileage vehicles should be checked annually; also test for exhaust particulate matter (PM). (MSM A-4) 4. Support a motorcycle SmogCheck program. (MSM A-4) 5. Advocate for CARB to allow BAAQMD to include motorcycles and heavy-duty trucks in VAVR. (MSM A-4) 6. Support the phase out of new and in-use two-stroke engines. (MSM C-2, C-3) 7. Support public sector light- and heavy-duty green fleets. (MSM A-2) 8. Seek an on-going source of funding to provide incentives to reduce emissions from light-duty off-road equipment, such as lawn & garden and recreational watercraft. (MSM C-2, C-3)
2	Land Use/Building Standards	1. Support legislation to expand "parking cash-out." (TCM E-2) 2. Support enforcement of "parking cash-out." (TCM E-2) 3. Support legislation to require un-bundling of parking in leases. (TCM E-2) 4. Advocate for local building code requirements to exceed Title 24 requirements for commercial & residential multi-family housing to meet "cool roof" standards. (ECM 3) 5. Advocate for local zoning ordinances for "cool paving" standards and adding shade trees when existing parking lots undergo re-surfacing; also require shade trees in new lots. (ECM 3, 4) 6. Encourage CARB to provide credits for local government land use actions that can be used in GHG cap & trade system.
3	Pricing & Tax Policy	1. Support congestion pricing to reduce motor vehicle emissions. (TCM B-3, E-1) 2. Support a regional parking fee for privately owned lots, more cash-out incentives. (TCM E-2) 3. Support mileage-based vehicle and registration and/or license fees. (TCM E-3) 4. Support gas taxes or fees, and/or floor price for gasoline & diesel. (TCM E-3) 5. Support "pay as you drive" insurance. (TCM E-3) 6. Support cash incentives for the purchase of fuel efficient vehicles "feebates." (TCM E-3) 7. Support container fees at Ports. (LUM 1)

Table 4-7 (continued). CAP leadership platform.

#	Advocacy Area	Actions
4	Trip Reduction / Alternative Modes	1. Support legislation to empower air districts and local governments to adopt employer-based trip reduction requirements. (TCM C-1) 2. Support legislation to expand incentives for employer-based trip reduction programs, such as tax deductions and credits. (TCM C-1) 3. Encourage local governments to replicate San Francisco Commute Benefits Ordinance (allow employees to purchase transit passes with pre-tax $$). (TCM C-1) 4. Advocate for more diverse ways to measure Level of Service (LOS) than solely based on vehicle service volume to capacity ratios. (TCM D-1, D-2)
5	Other	1. Advocate with Caltrans and CHP for better enforcement of speed limits on freeways. (TCM C-5)

Key Themes Embedded in CAP Control Strategy

The CAP control strategy described above is wide-ranging and ambitious. To further explain the underlying rationale for the control strategy, we discuss in this section several key themes that are embedded in the strategy, including:

- Efficiency
- Reducing motor vehicle emissions
- Land use and community design
- Transportation pricing
- Goods movement

Efficiency

To date, most pollution control efforts have focused on reducing smokestack or tailpipe emissions, primarily by means of installing emission control devices. However, to address today's air quality and climate challenges, we need to address the root causes of air pollution and greenhouse gas emissions by analyzing energy consumption and emissions of air pollutants on a cradle-to-grave basis, promoting efficiencies, and making fundamental changes in fuels and/or production processes.

Incomplete combustion of fossil fuels results in emissions of ROG, NOx, PM, and air toxics.[70] To date, emissions of these pollutants have been reduced primarily by installing abatement devices on smokestacks and motor vehicle engines. Although this approach has generally been effective in reducing emissions of air pollutants, it does not

[70] NOx emissions result from combustion in the presence of nitrogen. NOx emissions have been reduced by using abatement devices or by reducing combustion temperatures.

address fundamental causes. Moreover, emission control devices often consume energy or affect efficiency, and thus may indirectly increase CO2 emissions.

CO2, the principal greenhouse gas, presents an entirely new problem. Unlike the pollutants discussed above which are emitted as byproducts of incomplete combustion, emissions of carbon dioxide are the direct and unavoidable product of complete combustion of fossil fuels. We cannot reduce emissions of CO2 simply by installing emission control devices. Ensuring more complete combustion, which might work to reduce ROG, PM, and air toxics, will increase CO2 emissions.

The most fundamental solution to reduce emissions of criteria pollutants, air toxics, and CO2 is to reduce the amount of fossil fuels that we burn. Thus, we need to make our vehicles, our buildings, and our production processes more efficient, and we need to find alternative ways to produce energy that do not rely on fossil fuels.

To attain our greenhouse gas and air quality goals, we need to pursue efficiency in all sectors, including:

- Energy generation and transmission
- Community design and building design
- Goods movement and distribution
- Motor vehicles propulsion systems
- Transportation infrastructure and systems

In addition to improving air quality, promoting efficiency and reducing energy consumption provides economic benefits in the form of cost savings and increased productivity. The concept of promoting efficiency is integrated into the CAP control strategy, and is expressed most directly in SSM 5, MSM A-1, MSM B-3, TCMs B-1 through B-4, and ECMs 1 and 3.

Reducing Motor Vehicle Emissions

Motor vehicles and other mobile sources are the primary source of ROG, NOx, air toxics, and greenhouse gas emissions in the Bay Area, as well as substantial contributors of PM emissions.

The CAP control strategy includes a comprehensive set of measures to reduce emissions from mobile sources. Overall, the CAP measures are based on the idea that we need to:

- Drive cleaner
- Drive smarter
- Drive less

Driving Cleaner

Driving cleaner – that is, reducing tailpipe emissions via technological controls - has been the primary strategy to improve air quality over the past several decades. Fleet-wide emission rates decline as older, more-polluting vehicles are replaced by newer, cleaner ones that meet more stringent emissions standards. The CAP includes Mobile Source Measures to accelerate the retirement or retrofit of older vehicles and to encourage the introduction of new, advanced technology vehicles, especially vehicles that use alternative (non-fossil) fuels, including electric vehicles and plug-in hybrid vehicles. These measures will help to reduce emissions of criteria pollutants and greenhouse gases from motor vehicles.

Driving Smarter

There are many easy, low-tech ways that we can reduce emissions by driving smarter, as described in TCM C-5. We can greatly reduce emissions of air pollutants and greenhouse gases and improve fuel economy by keeping tires properly inflated and vehicles well maintained, and by practicing sensible driving habits such as avoiding hard accelerations and braking.

Speed moderation is perhaps the most important aspect of smart driving. Emission rates of ROG, NOx, PM, and CO2 all increase significantly at high speed. As shown in Figure 4-2, emission factors for all these pollutants are lowest in the range of 35 mph to 50 mph. A vehicle driven at 75 mph consumes approximately 40% more fuel and emits 35% more emissions than one driven at 60 mph. Approximately 60% of Bay Area driving (VMT) takes place on the freeway system and, according to Caltrans data, 34% of freeway driving occurs at speeds in excess of 65 mph. Observing posted speed limits can have a major impact in reducing emissions, conserving energy, decreasing expenditures on gasoline and diesel, and saving lives by reducing traffic accidents.

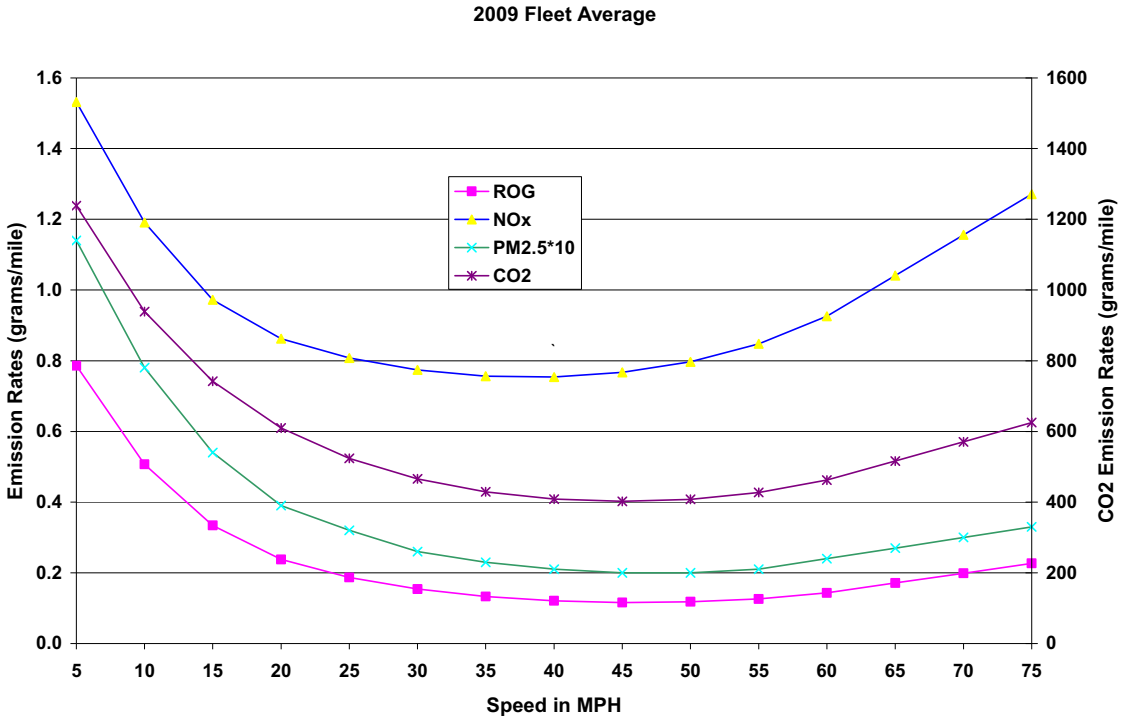


Figure 4-2. Emission rates vs. speed. Note: PM2.5 emission rates have been multiplied by a factor of 10 so as to best fit on the y-axis using the scale provided.

Driving Less

California has the most stringent motor vehicle tailpipe emission standards in the world. This accounts for much of our air quality progress to date. But it also means that once older vehicles have been replaced by new ones, and all the vehicles on the road meet these stringent standards, it will be difficult to squeeze more emissions reductions out of the Bay Area fleet. Motor vehicles will likely continue to be the primary source of air pollution in the future, so it will be imperative to continue to reduce motor vehicle emissions. Simply put, this means that we will need to drive less in the years to come to continue to improve air quality and protect our climate. However, experience to date shows that this will be difficult to accomplish. Reducing motor vehicle use will require an integrated strategy based on revising land use patterns, transportation pricing, providing viable alternatives to auto use, and public education.

VMT and Vehicle Ownership

Considerable effort is being invested at both the State and regional level to better integrate land use, transportation, air quality, and climate planning. Much of this effort is focused on the need to reduce the amount that we drive, often expressed by the term *vehicle miles of travel* (VMT). As shown in Figure 4-3, vehicle ownership and VMT have both doubled since 1970, and vehicle ownership and VMT have both increased significantly faster than population.

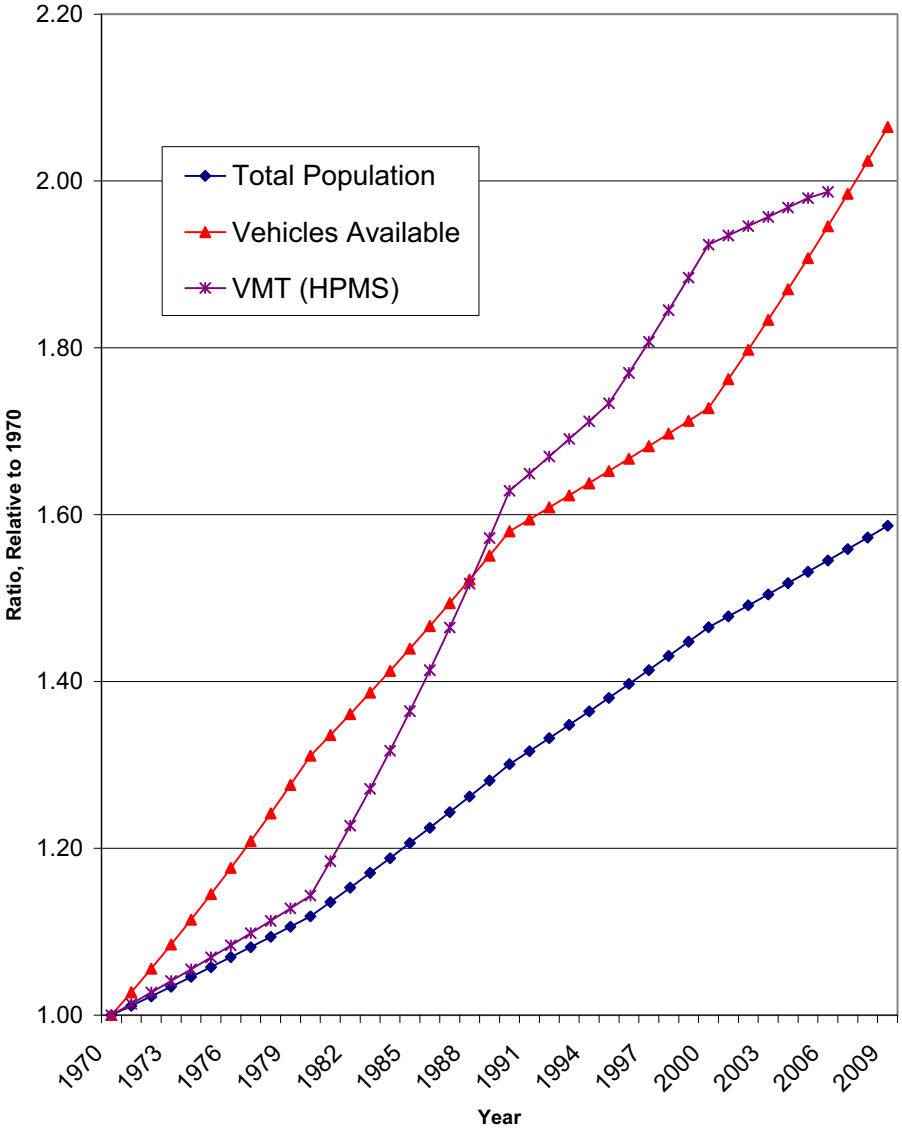


Figure 4-3. Growth in Bay Area population and motor vehicle use: 1970-2009.

This trend is expected to continue in the future. MTC forecasts that vehicle ownership and vehicle miles of travel (VMT) will both increase by approximately 30% in Bay Area [71] over the next 25 years; this is slightly faster than the rate of increase in population. An increase of this magnitude will translate into 1.25 million more vehicles driving an additional 40 million miles per day on our already-congested roadways. This projected

[71] See MTC Travel Forecasts for Transportation 2035 Vision Analysis (November 2007). Per capita vehicle ownership is projected to increase from 638 per 1000 persons to 650 vehicles per 1000 persons by 2030. Household vehicles in Bay Area will increase from 4.33 million to 5.69 million by year 2030, an increase of 31.5% in 30 years.

growth in vehicle ownership and VMT will lead to a wide range of negative impacts: more emissions of criteria pollutants and greenhouse gases, pressure to make costly investments to expand the roadway network and the supply of parking, increased water and noise pollution, and urban heat island effects that contribute to ozone formation.

A wide range of policies, many of which have been incorporated in the 2010 CAP control strategy, are proposed to reduce VMT. However, reducing motor vehicle ownership is rarely discussed as a means to reduce VMT, let alone as a legitimate objective in its own right. Yet there are good reasons to focus on reducing vehicle ownership, both on its own merits and as one of the most effective ways to reduce VMT.

- Motor vehicles can and do pollute even when they are not in use. On hot summer days, diurnal evaporative emissions from parked cars account for a significant amount of ROG, the key ozone precursor in the Bay Area.[72]
- Vehicle ownership rates are a strong predictor of VMT. Research indicates that at least 80% of the difference in VMT per household can be traced to differences in household vehicle ownership rates.[73]
- Once someone makes an investment to purchase and insure a motor vehicle, that vehicle generally becomes their default mode of transportation. In fact, having invested the money to purchase a car, it makes perfect economic sense for the owner to use the vehicle in order to maximize his or her return on that investment.

Even a modest reduction in vehicle ownership could provide significant benefit. For example, if the projected rate of increase in vehicle ownership could be reduced by 10% (i.e., from 1% per year to 0.9% per year) this would prevent the addition of 125,000 more vehicles on Bay Area roads in the coming decades. The potential benefits of reducing vehicle ownership include:

- Reduced VMT and reduced tailpipe emissions;
- Reduced evaporative emissions of ROG which contribute to ozone formation on hot days;
- Reduced need for parking, thus freeing space for other uses and helping to reduce urban heat island impacts (see control measure ECM 3);
- Reduced traffic congestion;
- Increased transit ridership, and thus a better return on capital investment in transit;
- Reduced roadway maintenance costs;
- Less need to expand the region's roadway network;

[72] In the Bay Area, diurnal evaporation accounts for 18.8 tons of ROG on a typical summer day. This represents 15% of the estimated 126.0 tons of ROG per day emitted by on-road motor vehicles (EMFAC2007, November 2006) and approximately 5% of the total ROG inventory.

[73] "Location Efficiency: Neighborhood and Socio-Economic Characteristics Determine Auto Ownership and Use" John Holtzclaw et al, *Transportation Planning and Technology*, March 2002

- Better water quality (due to reduction in run-off of pollution from non-point sources);
- Reduced household transportation costs;[74] this could be especially beneficial for low-income households, for whom vehicle ownership costs may represent a major burden.[75]

The objective of reducing vehicle ownership is not to be punitive or to actively discourage any one from owning a car; on an individual level, motor vehicle ownership can provide important economic and social benefits. Rather, the objective is to create communities where people have a viable choice as to whether they want to own a vehicle or not. This requires fostering policies and conditions that make it possible, or even more advantageous, for people to choose a reduced-car or car-free option.

The CAP control strategy includes a number of measures to help reduce the need for vehicle ownership, such as promoting infill, mixed-use development (TCM D-3); improving transit service and efficiency (TCMs A-1, A-2, and B-2); promoting other modes including walking and bicycling (TCM D-1 and D-2); promoting ride-sharing and car-sharing (TCM C-3); and implementing transportation pricing strategies (TCMs E-1, E-2, and E-3).

Land Use and Community Design

There is a growing recognition in the Bay Area and beyond that current land use patterns, and the transportation infrastructure needed to serve those land uses, are core causes of some of our most fundamental problems, including air quality, water quality, climate change, high energy consumption, reliance on imported oil, and public health and fitness. A key long-term solution is to channel future growth into vibrant urban communities where goods and services are close at hand, and people have a range of viable transportation options.

To a great extent, community design dictates individual travel mode. For people who live (and/or work) in low-density, car-oriented development, the motor vehicle is often the only viable transportation option. In such situations, even the most robust strategy to promote alternative modes of travel can have, at best, only a very modest effect. In contrast, compact communities with a mix of land uses make it much easier to walk, cycle, or take transit for at least some daily trips.

[74] On average, Bay Area household spend approximately 15% of household income on transportation. A November 2009 Urban Land Institute study entitled "Bay Area Burden" documents that on average Bay Area residents who live in the urban core spend significantly less on transportation than people who live in outlying parts of the region.

[75] Low-income Bay Area households spend 27% of their income on transportation; compared to 11% for high- income households. See MTC's Equity Analysis Report for T2035: Appendix E, Table E-2.

Focused growth needs to address *where we work* as well as where we live. Over the past 40 years, Bay Area job growth has increasingly migrated to suburban areas. The percentage of jobs located in core business districts that are well-served by transit has declined significantly. Today, the central business districts of San Francisco, Oakland, and San Jose collectively account for only 10% of total regional employment.[76] This suggests that policies to promote job growth in core areas well served by transit should be an important part of a comprehensive land use strategy to reduce VMT and emissions of air pollutants.

In addition to reduced air pollution, the benefits of focused development include reduced infrastructure costs, protection of open space and agricultural land, and encouraging vibrant communities with a strong retail tax base. Bay Area regional agencies are collaborating with local governments to promote infill development and identify priority development areas through the FOCUS program described in Chapter 3. But a stronger effort will likely be needed to build consensus in support of a sustainable plan for future Bay Area development in response to SB 375.

Senate Bill 375

Recognizing the importance of integrating land use, transportation, and climate protection planning, the State of California adopted SB 375 in fall 2008. SB 375 mandates that major metropolitan areas throughout California develop and implement integrated land use and transportation plans, known as "Sustainable Communities Strategies" or SCS, to achieve greenhouse gas reduction targets established by CARB. The first Bay Area SCS must be developed and adopted by 2013. Development of the SCS is the primary responsibility of ABAG and MTC. However, the Air District can also play an important role in the development of the Bay Area SCS. The Air District for many years has worked with cities and counties on air quality issues, providing technical information and policy guidance, In addition, the Air District enjoys a strong working relationship with its regional agency partners; can exercise policy levers that influence new development, such as its CEQA guidelines and a forthcoming indirect source review regulation; and can provide technical expertise to ensure that the region and local jurisdictions pursue focused development in a way that protects public health.

Promoting Focused Development and Protecting Public Health

Promoting focused development in core areas of the region is essential in order to reduce emissions of criteria pollutants, air toxics and greenhouse gases from motor vehicles, and thus achieve our air quality and climate protection goals. However, there is a potential tension, at least in the short term, between promoting focused development and protecting public health. Some areas that are well-suited for focused

[76] See March 2009 issue of *Urbanist*, published by the San Francisco Planning & Urban Research Association (SPUR).

infill development, including areas designated as "priority development areas" by the region's FOCUS program, are in close proximity to heavily traveled roadways, industry, distribution centers, and ports. As a result, these areas currently experience high levels of emissions and/or population exposure to air pollutants on a localized level. To address this tension, Bay Area regional agencies and local governments will need to work together to nurture infill development that provides long-term benefits to the region as a whole, without exposing residents of the infill areas to undue exposure and health risk.

This issue was a key concern in developing the CAP control strategy. Building on the CARE program and the District's Clean Air Communities Initiative described in Chapter 3, the control strategy established the new category of Land Use and Local Impacts measures, as described above, to address this issue. See additional discussion in the "Reducing Impacts of Air Toxics in Local Communities" section in Chapter 5.

Pricing Strategies

While land use and community design are critical solutions over the long term, these strategies will take time to implement. To reduce motor vehicle emissions in the near term, pricing strategies are potentially the most effective tool. Motor vehicle travel imposes a variety of costs on society, including air pollution, that are not fully reflected in the price that drivers currently pay to own and operate a vehicle. There is widespread agreement among economists and planners that pricing policies could be a powerful means to reduce hidden subsidies that increase motor vehicle use, as well as to encourage more efficient use of our transportation systems.

There are a wide range of potential pricing policies and mechanisms, as described in TCM E-3. Both the conceptual framework and the technical capabilities to implement pricing measures are available, and real world examples have been successfully implemented for many pricing mechanisms. There are, however, significant differences among potential pricing policies in terms of their impacts on motor vehicle use and vehicle emissions, their socio-economic impacts, their revenue-generating potential, and their degree of political acceptability.

Pricing measures have, in fact, been indentified as important elements in Bay Area air quality and transportation plans for the past two decades, but relatively little progress has been achieved to date. No single agency has the resources and authority to develop and implement a pricing strategy on its own. The real challenge is how to develop and execute a clear strategy to implement transportation pricing in the Bay Area. As noted above, TCM E-3 calls for the Bay Area regional agencies to join forces to establish a regional pricing task force to develop a recommended regional transportation pricing strategy and pursue implementation of the strategy. Forging support to implement transportation pricing policies will require political leadership, public outreach, and

education, strategies to minimize impacts on low-income households, and coordination among the Bay Area's regional agencies and local jurisdictions.

Reducing Emissions from New Development

Although the Air District has no direct authority over land use decisions, the District can play an important role in helping to reduce the air quality and climate change impacts of new development and protect public health in impacted communities by means of indirect source review, CEQA, and guidelines for local land use plans (see LUMs 2, 3, and 4), as discussed below.

CEQA and Land Use Guidelines

The Air District is developing proposed revised guidelines and thresholds of significance for lead agencies to use in reviewing the air quality and greenhouse gas impacts of new projects under the California Environmental Quality Act (CEQA). The guidelines are intended to ensure that the appropriate level of environmental review occurs and that meaningful mitigation measures are implemented to reduce a project's emissions of criteria pollutants, air toxics, and greenhouse gases by:

- Adding the first-ever significance thresholds for GHGs;
- Adding a new threshold for localized PM2.5 impacts;
- Adding a new threshold for cumulative air toxics impacts;
- Recommending preparation of Community Risk Reduction Plans; and
- Recommending preparation of greenhouse gas reduction plans.

Air District staff will work closely with local agencies to help them implement the CEQA guidelines, and provide training and support in the use of the guidelines.

Indirect Source Review Regulation

Pursuant to Health & Safety Code Section 40716, air districts in California have authority to regulate emissions from indirect sources. The term "indirect source" refers to development that attracts or generates motor vehicle trips, such as housing, office parks, shopping centers, universities. As described in LUM 2, Air District staff will develop a proposal, for consideration by the District's Board of Directors, to adopt and implement an indirect source review regulation in order to reduce emissions associated with new or modified land use development. The rule may also achieve co-benefits by reducing emissions of greenhouse gases. The measure is intended to encourage projects to be sited, designed, and constructed so as to reduce construction and operating emissions from motor vehicles as well as area sources, such as fireplaces, heating and cooling, and landscape maintenance equipment. In developing the ISR regulation, the Air District will work with its regional agency partners and local agencies

to ensure that the regulation will serve to complement and support regional focused growth development programs.

Reducing Emissions from the Goods Movement Sector

Goods movement, a key function of the regional transportation system, is a critical component of the Bay Area economy. Nearly 40 percent of the region's economic output is in manufacturing, freight transportation, and the warehouse and distribution businesses, and goods movement accounts for over 10 percent of regional employment. The Port of Oakland is one of the nation's busiest container ports. Although cargo volumes are currently down due to the economic recession, projections show cargo volumes at the Port and throughout the region and state will grow significantly over the next 20 years. The Port of Oakland also plays an important role in supporting the state's agricultural sector, providing the primary means of transporting produce from the Central Valley to the Pacific Rim.

Despite its economic contributions, the goods movement sector is a significant source of air pollution, primarily PM and NOx. Exposure to diesel emissions from goods movement impacts the health of residents near ports, rail yards, distribution centers, and roads with high truck volumes. Diesel engines directly emit fine PM, and their NOx emissions contribute to formation of ozone and secondary PM2.5.

The 2010 CAP proposes a comprehensive strategy to reduce emissions and population exposure to diesel emissions, based upon the following principles:

- Promote greater efficiency and/or mode shift in order to move freight with less energy and fewer environmental impacts;
- Promote the use of the cleanest, most efficient mode of transportation (alternative fuels/ hybrid technologies);
- Ensure that any conventional vehicles and equipment used in goods movement are equipped with the most effective emission control systems available;
- Ensure that all vehicles and equipment used in goods movement are fully compliant with applicable State or federal regulations; and
- Encourage local land use decisions that do not expose sensitive populations to high levels of diesel emissions.

The CAP goods movement strategy will be implemented through a combination of actions. Key elements of the implementation include the following:

- Providing grants and incentives for the use of clean heavy-duty vehicles, as described in MSMs B-1, B-2, and B-3, and TCM B-4;
- Improving goods movement infrastructure in key corridors, as described in TCM B-4;
- Reducing local population exposure to diesel exhaust through enforcement, signage, and other measures described in LUM 1; and

- Pursuing partnerships with key stakeholders and promoting best practices to enhance efficiency and reduce emissions, as discussed in LUM 1.

Emission Reductions, Costs, and Benefits

Air District staff developed estimated emission reductions and implementation / compliance costs for the CAP control measures, as described below.[77] Per the requirements of the Health & Safety Code Section 40922, staff calculated the cost-effectiveness of control measures based upon reductions in ozone precursors (ROG and NOx). In addition, staff used the MPEM (described in Chapter 1) to estimate the public health and climate protection benefits of CAP control measures in monetary terms.

Emission Reductions: Air District staff estimated the emission reductions for all categories of control measures. In addition to ROG, NOx, and direct emissions of PM2.5, emission reductions were estimated, wherever possible, for SO2 and ammonia (precursors to secondary PM2.5 formation), the five air toxics addressed in the CAP, and the "Kyoto 6" greenhouse gases (CO2, methane, N2O, etc.).[78] Emission reductions could not be estimated for several control measures, either because the measure would not directly reduce emissions (e.g., LUM 5, LUM 6) or because additional analysis will be required during the rule development process (SSM 1, SSM 2, SSM 15, SSM 16, SSM 17, SSM 18).

Emissions reduction estimates for TCMs were calculated using CARB's most recent emissions inventory model, EMFAC2007, operating in the "BURDEN" mode. The BURDEN mode produces detailed reports on mobile source, on-road emissions at the county, air basin, and regional level, distributed by 13 distinct "speed bins" based upon time of day, which were forecast as a part of the Transportation 2035 travel forecasts.

The task of estimating emission reductions was complicated by the fact that the various control measures address a wide range of emissions sources and rely upon a diverse set of implementation mechanisms. In addition, many of the measures, especially measures that address land use, transportation pricing, and energy and climate, will rely heavily on partnerships and collaboration with other stakeholders, and/or preparation of guidance documents; it is difficult to quantify the emissions reductions for these measures. Because of these uncertainties, staff used relatively conservative emission reduction assumptions, so as not to over-estimate the reductions that the plan can deliver.

Analysis Years: Emissions reductions were estimated for years 2012 and 2020. The year 2012 was selected in order to evaluate the impact of control measures over the short-

[77] MTC staff played a major role in developing emission reduction and cost estimates for the Transportation Control Measures.
[78] For some types of control measures, emission factors were not available for all pollutants.

term, three-year horizon of the plan. However, because some measures will take longer to implement, 2020 was also selected to analyze longer term emissions reductions.

Costs: Many of the challenges in estimating emission reductions described above also apply in trying to estimate implementation costs for the various control measures. The types of the potential costs vary greatly among the measures. For stationary source measures, costs are based on the compliance cost to regulated industries. For many of the mobile source measures, costs are based on anticipated grants and incentives awarded by District programs and/or the incremental cost of cleaner, advanced-technology vehicles. For transportation control measures, there are various types of costs, depending upon the measure: e.g., capital costs to expand transit; costs to operate pubic outreach and information programs; or potential user fees as in the case of TCMs B-3, E-1, E-2, and E-3. It should also be noted that some measures that promote energy efficiency or the use of fuel-efficient engine technologies may provide significant user savings over the life of a project, which may offset or exceed the initial capital investments.

To provide additional information on cost impacts, the District also commissioned the preparation of a report entitled *Bay Area 2010 Clean Air Plan: Socio-Economic Analysis* to evaluate the potential impacts of control measures on regulated industries, public agencies, Bay Area households, and the regional economy as whole. Key findings of this report, which is available on the Air District website, include the following:

- The CAP control strategy as a whole will have a net positive economic impact on the Bay Area.
- Some regulated industries would potentially experience economic impacts if proposed rules are adopted, but compliance costs for proposed stationary source measures would not be deemed significant, based on the threshold defined in the report.
- The CAP control measures would not impose significant costs or unfunded mandates on local governments in the Bay Area.

For the proposed control measures that will be adopted as rules by the Air District Board of Directors, such as the stationary source measures and the Indirect Source Review regulation, additional analysis regarding potential costs and socio-economic impacts will be developed during the rule-making process for each measure.

Benefits: Evaluation of control measures has traditionally focused on the cost-effectiveness of measures in reducing ozone precursors, by dividing compliance costs by the tons of ROG and NOx reduced. However, for purposes of this plan, the Air District also evaluated control measures on the basis of their potential to reduce multiple pollutants. In addition, using the multi-pollutant evaluation method (MPEM) described in Chapter 1, certain benefits of the various control measures have also been estimated; i.e., their potential to reduce negative health impacts, including premature mortality, and impacts related to climate change. It should be noted, however, that the MPEM

does not fully consider all benefits related to improving air quality. Nor does the MPEM include other co-benefits for certain measures such as improved mobility, reduced traffic congestion, enhanced safety for pedestrians and bicyclists, reduced water pollution, etc.[79]

The 2010 CAP breaks new ground in attempting to quantify the benefits of control measures in monetary terms. From the standpoint of policy-making, Air District staff believes that it makes sense to consider health and climate protection benefits, in addition to compliance costs, in the evaluation of control measures.

The Air District estimates that, summing the benefits of the individual control measures, the control strategy as a whole will provide health and climate protection benefits with a monetary value in the range of $270 million to $1.5 billion per year, with a likely value on the order of $770 million per year. Roughly 80% of the estimated economic benefits from the CAP control measures can be attributed to reductions in PM2.5 (66% non-diesel PM2.5 and 14% diesel PM2.5). Reductions in greenhouse gases account for approximately 20% of the economic benefits.

As discussed in Chapter 1, there is uncertainty involved in the assumptions and methods incorporated in the MPEM. To address this issue, Air District staff has performed a MPEM Probability Analysis[80] to evaluate the uncertainty in the estimated benefits calculated by the MPEM. The Probability Analysis is used to find a range of likely values for each control measure and for the CAP control strategy as a whole, and to determine whether the differences in the estimated benefits of the various control measures are statistically significant. As described in the Probability Analysis, for each variable or parameter, a set of 1,000 values was simulated according to the appropriate distribution, resulting in 1,000 vectors of simulated parameter values. The methodology is designed so that, even though there may be considerable uncertainty in the estimated "bottom line" benefit for each of the control measures, it is possible to determine with confidence that the benefit for one measure is significantly greater than the benefit of another measure. An example comparing two control measures is provided in Section 6.1 of the Probability Analysis.

Summary of Emission Reductions, Costs, and Benefits: Table 4-8 shows the estimated emission reductions for ROG, NOx, PM2.5, and greenhouse gases (CO2-e), as well as:

[79] The MPEM does not include all pollutants or all health effects, nor the benefits of improvements in air quality beyond the boundaries of the Air District due to reduced emissions in the Bay Area. Nor does it consider economic benefits such as reduced damage to agricultural crops and to property (tires, building surfaces, paints, etc.), the benefit of clean air for property values, tourism, ecosystems protection, water quality etc. Finally, the MPEM does not include the potential co-benefits of transportation measures such as improved transit service, reduced traffic accidents, etc.

[80] The MPEM Probability Analysis is available on the Resource and Technical Documents tab of the 2010 CAP web page at www.baaqmd.gov/Divisions/Planning-and-Research/Plans/Clean-Air-Plans/Resources.aspx.

- the estimated annual cost of each measure
- the cost-effectiveness in reducing ozone precursors (ROG & NOx reductions combined)
- the weighted cost-effectiveness based on MPEM weighting factors[81]
- estimated annual benefit in reducing health and climate-related impacts, and
- the ratio of estimated benefit to estimated cost

A more detailed version of this table which also shows estimated emission reductions for other pollutants, including ammonia, SO2, benzene, butadiene, acetaldehyde, formaldehyde, and methane is provided on the Resource and Technical Documents tab of the 2010 CAP web page.

[81] The weighted multi-pollutant cost-effectiveness is calculated by multiplying the estimated emission reductions for each pollutant by the MPEM weighting factor shown in Table 1-2, and then dividing the annual weighted emission reductions by the annual cost of the control measure.

Table 4-8. Emission reduction, cost, and benefit summary table.

DRAFT CONTROL STRATEGY EMISSIONS REDUCTIONS (tons per day)			ROG	NOx	PM2.5	CO2-e (See note #11)	Cost/Yr	C-E for ROG & NOx	Weighted Multi-Pollutant C-E	$ Benefit/Yr from MPEM
Stationary Source Measures		***Notes***								
SSM1	Metal Melting Facilities	2								
SSM2	Digital Printing	2								
SSM3	Livestock Waste		0.3000			65	$1,200,000	$11,000	$1,500	$1,126,000
SSM4	Natural Gas Processing	1,4	0.3000			120				$1,636,000
SSM5	Vacuum Trucks		6.0000				$21,900,000	$10,000	$10,000	$10,459,000
SSM6	General PM Weight Rate Limitation	1			0.2870					$47,811,000
SSM7	Open Burning		0.0400	0.0100	0.0900					$15,089,000
SSM8	Coke Calcining	1					$5,700,000		$760	$35,993,000
SSM9	Cement Kilns	1		4.3800			$2,800,000	$1,800	$1,100	$11,641,000
SSM10	Refinery Boilers & Heaters	1		2.9000						$7,709,000
SSM11	Residential Fan Type Furnaces	7		4.2000			$5,000,000	$3,300	$2,100	$11,163,000
SSM12	Large Space Heating	7		1.2000			$6,833,333	$15,600	$10,200	$3,191,000
SSM13	Dryers, Ovens, Kilns	1		0.2000			$570,000	$7,800	$5,100	$532,000
SSM14	Glass Furnaces			0.3800			$760,000	$5,500	$3,600	$1,197,000
SSM15	GHG in Permitting - Energy Efficiency	2								
SSM16	Revise Reg 2 Rule 2 NSR	2								
SSM17	Revise Reg 2 Rule 5 NSR TAC	2								
SSM18	Changes to Toxic Hot Spots Program	2								
	Stationary Source Subtotal		6.640	13.270	0.377	184.800				$147,547,000

Table 4-8 (continued). Emission reduction, cost, and benefit summary table.

DRAFT CONTROL STRATEGY EMISSIONS REDUCTIONS (tons per day)			ROG	NOx	PM2.5	CO2-e (See note #11)	Cost/Yr	C-E for ROG & NOx	Weighted Multi-Pollutant C-E	$ Benefit/Yr from MPEM
Mobile Source Measures		***Notes***								
MSM A-1	Promote Clean Fuel Efficient Vehicles		0.0500	0.0300	0.0050	0.0001	$10,000,000	$342,000	$48,000	$1,005,000
MSM A-2	Zero Emissions Vehicles & Plug-In Hybrids		0.0100	0.0100	0.0050	0.0001	$14,400,000	$1,973,000	$78,000	$883,000
MSM A-3	Green Fleets		0.0200	0.0200	0.0200	0.0002	$550,000	$38,000	$800	$3,422,000
MSM A-4	Reduce High-Emitting Vehicles		4.3700	2.0600	0.0200	44.1425	$333,000	$140	$80	$17,279,000
MSM B-1	HDV Fleet Modernization		0.1000	5.0000	0.0330	0.6390	$58,333,000	$31,000	$9,300	$30,042,000
MSM B-2	Software/Catalytic Convertors			0.9900			$12,500,000	$35,000	$23,000	$2,632,000
MSM B-3	Efficient Drive Trains		0.0100	0.2900	0.0095	0.2274	$6,667,000	$61,000	$13,300	$2,374,000
MSM C-1	Construction & Farming Equipment		0.0400	0.7200	0.0190		$2,400,000	$9,000	$2,200	$5,149,000
MSM C-2	Lawn & Garden Equipment		0.0400	0.0090	0.0060	0.0008	$2,000,000	$112,000	$8,700	$94,000
MSM C-3	Recreational Vessels		0.0600	0.0090	0.0090	0.4156	$1,000,000	$40,000	$2,900	$1,632,000
	Mobile Source Subtotal		4.700	9.138	0.127	45.426				$64,511,000
Transportation Control Measures		***Notes***								
TCM A-1	Improve Local & Area-Wide Bus Service		0.0279	0.0316	0.0010	23	$340,433,000	$15,670,000	$1,018,000	$617,000
TCM A-2	Improve Local & Regional Rail Service	3	0.1386	0.1520	0.0280	516	$1,200,000,000	$11,315,000	$165,000	$12,430,000
TCM B-1	Implement Freeway Performance Initiative		0.9216	3.3150	0.1190	2,451	$51,667,000	$33,000	$1,500	$54,387,000

Table 4-8 (continued). Emission reduction, cost, and benefit summary table.

DRAFT CONTROL STRATEGY EMISSIONS REDUCTIONS (tons per day)			ROG	NOx	PM2.5	CO2-e (See note #11)	Cost/Yr	C-E for ROG & NOx	Weighted Multi-Pollutant C-E	$ Benefit/Yr from MPEM
Transportation Control Measures		***Notes***								
TCM B-2	Improve Transit Efficiency & Use		0.0039	0.0045	0.0003	6.13	$25,667,000	$8,377,000	$296,000	$152,000
TCM B-3	Bay Area Express Lane Network		0.8603	1.3617	0.2750	1,892	$108,000,000	$133,000	$3,400	$70,685,000
TCM B-4	Goods Movement Improvements	1	0.5850	4.8175	0.0613	4,045	$40,000,000	$20,000	$700	$82,172,000
TCM C-1	Voluntary Employer Trip Reduction		0.0761	0.0943	0.0040	97	$3,600,000	$88,000	$4,100	$2,240,000
TCM C-2	Safe Routes to School and Transit		0.0084	0.0082	0.0004	8.18244	$13,333,000	$3,361,000	$172,000	$211,000
TCM C-3	Promote Rideshare Services		0.0837	0.1051	0.0080	153	$5,667,000	$125,000	$4,000	$3,808,000
TCM C-4	Public Outreach and Education		0.0200	0.0200	0.0020	40.42	$4,333,333	$297,000	$7,600	$981,000
TCM C-5	Smart Driving/Speed Moderation		0.0744	0.1683	0.0090	180	$1,000,000	$11,000	$400	$3,753,000
TCM D-1	Improve Bicycle Access and Facilities		0.0037	0.0041	0.0002	4.44	$1,500,000	$527,000	$24,000	$110,000
TCM D-2	Improve Pedestrian Access and Facilities		0.0028	0.0020	0.0001	1.76	$40,000	$23,000	$1,500	$49,000
TCM D-3	Support Local Land Use Strategies		0.2418	0.3111	0.1450	873.63	$5,866,667	$29,000	$400	$36,598,000
TCM E-1	Value Pricing Strategies		0.0000	0.0105	0.0030	9.87	$26,000,000	$6,784,100	$107,300	$733,000
TCM E-2	Parking Pricing & Management Strategies		0.1800	0.1882	0.0164	294	$1,478,171,000	$10,996,900	$354,000	$7,268,000
TCM E-3	Implement Transportation Pricing Reform		0.1152	0.1204	0.0105	188	$471,143,000	$5,478,100	$165,000	$5,561,000
	TCM Subtotal		3.343	10.714	0.683	10,783.543				$281,755,000

Table 4-8 (continued). Emission reduction, cost, and benefit summary table.

DRAFT CONTROL STRATEGY EMISSIONS REDUCTIONS (tons per day)			ROG	NOx	PM2.5	CO2-e (See note #11)	Cost/Yr	C-E for ROG & NOx	Weighted Multi-Pollutant C-E	$ Benefit/Yr from MPEM
Land Use Measures		***Notes***								
LUM1	Goods Movement		0.0120	1.7188	0.2207	2,561	$1,449,000	$2,000		$65,101,000
LUM2	Indirect Source Review Rule		0.3020	0.2441	0.1076	340	$1,412,000	$7,100	$100	$52,864,000
LUM3	Enhanced CEQA Program	1	0.4400	0.3500	0.1600	447				$76,216,000
LUM4	Land Use Guidelines		0.0774	0.0810	0.0070	139				$2,805,000
LUM5	Reduce Risk in Impacted Communities	2								
LUM6	Enhanced Air Quality Monitoring	2								
	LUM Subtotal		0.831	2.394	0.495	3,487.504				$196,986,000
Energy and Climate Measures		***Notes***								
ECM1	Energy Efficiency	1	0.05	0.52		543.06	-$20,086,000	-$97,000	-$1,100	$65,906,000
ECM2	Renewable Energy	1	0.000004	0.000049		0.056488	$11,392,000	$584,159,000	$6,273,000	$6,000
ECM3	Urban Heat Island Mitigation		0.002	0.025		30	-$39,649,000	-$4,023,000	-$42,600	$3,137,000
ECM4	Tree Planting		0.0050	0.072000		76	$71,049,000	$2,528,000	$27,000	$9,093,000
	ECM Subtotal		0.0570	0.6170		649.5099				$78,142,000
Total for All Measures			15.5718	36.1334	2.0611	15,151				$768,942,000

Notes:

1. These emission reductions are estimates for year 2020. No information available for year 2012.
2. At this time, emission reductions cannot be determined for this control measure.
3. Emission reductions and costs are for year 2020.
4. Control Measure SSM-4 presents emission reductions as a range between 6 and 9 TOG. The most conservative reduction is represented here.
5. Unable to calculate costs for this measure.
6. CO2-e includes the "Kyoto 6" greenhouse gases (including CO2, methane, and N2O) weighted by their global warming potential.
7. Estimated NOx reductions for this measure represent reductions that will be achieved upon full implementation of the measure. Full implementation is not anticipated until year 2030 or 2040.

Implementing the CAP Control Strategy

Stationary source measures in the 2010 CAP, along with LUM 2 (Indirect Source Review Regulation), will be developed and adopted through the District's rule development process, as described below. The other types of control measures (MSMs, TCMs, LUMs, and ECMs) will be implemented via a variety of mechanisms, including partnerships, grants and incentives, public outreach, developing guidance documents for local agencies, etc. The specific mechanisms for each control measure are specified in the "Implementation Actions" section of the control measures descriptions provided in Volume II.

Progress in implementing the MSMs, TCMs, LUMs, and ECMs will depend upon the availability of resources among the many parties who have a role in implementing the control measures, as well as success in further enhancing existing partnerships among regional agencies, local governments, the business community, community groups, and other stakeholders. In particular, significant resources will be needed on the part of the Air District and/or other partners to implement measures such as an indirect source review regulation, an enhanced CEQA program, land use guidelines for local agencies, urban heat island mitigation, and assisting local governments in the development of Community Risk Reduction Plans and climate action plans.

Summary of the Air District's Rule Development Process for Stationary Source Measures

The Air District goes through a detailed process to adopt rules and regulations to impose standards on and limit emissions from stationary and area sources in the Bay Area. The legal authority for these regulations and many of the requirements that establish the process are found in the California Health and Safety Code.[82] The Air District follows a set of guiding principles for the rule development program:

- Strengthen and refine rules to do a better job of protecting the public health, environment and economy of the Bay Area
- Meet environmental goals in the most efficient and effective manner
- Respect all different points of view and knowledge
- Identify stakeholders with an interest in the outcome of our regulations
- Provide businesses maximum flexibility to meet air quality goals in a way that works best for them, allowing them to be cleaner at a lower cost

Air District staff undertakes a rigorous process to prepare a new rule or rule amendment for consideration by the Board of Directors. Following is a brief summary of the steps involved in developing a new or modified rule:

- **Internal Scoping Meeting**: Staff conducts an internal meeting to discuss an identified air pollution problem, including divisions that may have relevant expertise. For

[82] See e.g. California Health and Safety Code § 40702, 40703, 40725 *et seq.*

example, the source test and laboratory departments in the Technical Services Division have input on appropriate test methods to create enforceable standards.

- **Technical Assessment Memorandum**: Staff performs an analysis of the various options for addressing the problem, including technology available to achieve controls, cost effectiveness, and potential environmental impacts. A technical assessment memorandum may precede or may be derived from a control measure.
- **Stakeholders Meetings:** Staff conducts meetings with the affected businesses and other interested parties to discuss issues, exchange information, and ensure effective communication among the various parties. In some cases stakeholder meetings precede and assist in development of technical assessment memoranda.
- **Initial Draft of the Proposed Rule:** After technical assessment, stakeholders meetings, and consultation with affected parties, if staff determines that a new rule or rule amendment is warranted, the District develops a draft rule.
- **Workshops**: Staff conducts one or more public meetings for each new rule or rule modification so that all affected and interested parties can discuss, comment on, and ask questions about a proposed rule.
- **CEQA Determination:** As a draft rule is developed, a CEQA (California Environmental Quality Act) analysis is prepared to determine whether a rule or rule amendment might have any adverse environmental impacts.
- **Socioeconomic Impact Analysis:** Staff researches and prepares cost estimates for implementation of the control strategy and calculates cost effectiveness on a dollars/ton of emissions reduced basis. An analysis of the socioeconomic impact of the rule proposal is prepared to assess the impact of the costs of the rule on the impacted industry and the Bay Area economy, including jobs.
- **Staff Report:** The results of the CEQA determination and socioeconomic analysis are incorporated into a staff report. The staff report explains the technical basis for the rule. It contains emission estimates, a description of the industry, control requirements, as well as rule amendments, costs, incremental costs, impacts on Air District staff resources, and the rule development process, and makes legal findings necessary for rule adoption. Comments and responses on the rule proposal and on the CEQA analysis are also included.
- **Public Hearing:** Staff presents the rule or amendments to the Air District's Board of Directors at one of the Board's regularly scheduled meetings. These meetings are always open to the public, and notice is provided 30 days in advance. Anyone may comment on the proposed rule or amendments during the meeting. At the conclusion of the hearing, the Board decides whether to adopt the rule or amendments.

Subsequent to rule adoption by the Board, staff implements the rule by preparing inspection protocols, policies, and procedures and issuing compliance advisories to

notify affected parties of the rule and compliance dates. Staff also forward the rule to CARB and, if appropriate, prepare a State Implementation Plan (SIP) submittal to EPA.

Rule Adoption Schedule

Table 4-9 shows the proposed schedule for rule adoption during 2010, 2011, and 2012. Factors that were considered in developing this schedule include the estimated emission reduction benefit of each measure, the potential of measures to reduce localized health risks and impacts, the expected amount of time required to complete the rule development process for each measure based on data needs and other technical factors, as well as the need for participation in the rule development process by affected and interested parties.

Consistent with the CAP's emphasis on protecting public health, the proposed rule adoption schedule places high priority on developing regulations that reduce emissions of PM 2.5, as well as air toxics in impacted communities.

The schedule is as expeditious as practicable. Any particular control measure may be advanced or delayed based on information discovered in the rule development process or Air District staff allocation priorities. Also, during the rule development process, it may be determined that a measure may not provide sufficient emission reductions to warrant regulation or may not be cost effective.

Table 4-9. Rule adoption schedule, 2010-2012.

2010 Regulatory Agenda		
CM #	Control Measure (Regulation and Rule)	ER Potential
SSM 1	Metal Melting Facilities	TBD PM [1]
SSM 5	Vacuum Trucks	6.0 tpd ROG
SSM 6	General Particulate Matter (Reg. 6-1)	2.87 PM
SSM 9	Cement Kilns	4.38 tpd NOx [2]
SSM 10	NOx from Petroleum Refinery Boilers and Heaters (Reg. 9-10)	2.9 tpd NOx
SSM 17	New Source Review for Toxic Air Contaminants (Reg. 2-5)	n/a [4]
SSM 18	Air Toxics Hot Spots	TBD

2011 Regulatory Agenda		
CM #	Control Measure (Regulation and Rule)	ER Potential
SSM 4	Natural Gas Production and Distribution (Reg. 8-37)	0.3 – 0.4 tpd ROG [3]
SSM 7	Open Burning	0.04 ROG
SSM 8	Petroleum Coke Calcining	2.6 tpd SO2
SSM 11	NOx from Residential Fan Furnaces (Reg. 9-4)	4.2 tpd NOx
SSM 12	NOx from Large Residential and Commercial Space Heating	1.2 tpd NOx
SSM 16	New Source Review for PM2.5	n/a [4]
LUM 2	Indirect Source Review Rule	0.3 ROG, 0.24 NOx, 0.47 PM10 [2]

Table 4-9 (continued). Rule adoption schedule, 2010-2012.

2012 Regulatory Agenda		
CM #	Control Measure (Regulation and Rule)	ER Potential
SSM 2	Digital Printing	TBD ROG
SSM 3	Livestock Waste	0.3 tpd ROG [3]
SSM 13	NOx from Dryers, Ovens and Kilns	0.2 tpd NOx
SSM 14	NOx from Glass Furnaces (Reg. 9-12)	0.38 tpd NOx
SSM 15	GHG in Permitting	n/a [4]

1 Control Measure would also reduce toxic air contaminants.
2 Control Measure would also reduce toxic air contaminants, SOx and PM.
3 Control Measure would also reduce methane, a potent greenhouse gas.
4 New Source Review and permitting decisions mitigate emissions from future sources; consequently, no reductions from baseline are projected.

Chapter 5 – Summary and Looking Forward

The 2010 CAP updates the state ozone plan for the Bay Area and also applies a multi-pollutant framework to develop an integrated control strategy to:

- Attain air quality standards;
- Protect public health; and
- Protect the climate.

This chapter summarizes how the CAP fulfills the goals and objectives described in Chapter 1.

Updating the Bay Area's State Ozone Plan

The 2010 CAP serves as the triennial update to the Bay Area ozone plan for state air quality planning purposes, pursuant to the requirements of the California Health & Safety Code. Key requirements are that the plan must include all feasible control measures and must mitigate the transport of ozone and its precursors to neighboring air basins. A complete description of state air quality planning requirements and how the 2010 CAP fulfills all requirements is provided in Appendix C, State Air Quality Planning Requirements.

CAP Performance Objectives

As described in Chapter 1, the CAP defines numerical performance objectives related to the plan's goals of protecting public health and protecting the climate. The CAP performance objectives are as follows:

- Reduce PM2.5 exposure by 10% by 2015
- Reduce diesel PM exposure by 85% by 2020
- Reduce GHG emissions to 1990 levels by 2020 and 40% below 1990 by 2035

Air District staff performed an analysis, described in Appendix G, as to how well the CAP, in combination with state measures to reduce these pollutants, will achieve these performance objectives. This analysis finds that the Bay Area will reach the performance objective to reduce PM2.5 by 10% by 2015, but that it will fall short of the diesel PM and the greenhouse gas reduction objectives.

In the case of the diesel PM objective, EPA and CARB set emissions standards for most diesel engines, including trucks, buses, construction equipment, harbor craft, etc. For the past decade, CARB has been adopting and implementing ambitious air toxics control measures (ATCMs) to reduce emissions from all types of diesel engines, both new and existing, with a goal of reducing diesel PM by 85% by 2020. To implement recent changes in State law intended to address the current severe economic recession, CARB

has modified compliance timelines for the construction equipment diesel ATCM (i.e., the in-use off-road diesel vehicle regulation). CARB is currently also considering changes to the requirements for in-use on-road trucks and further changes to the in-use off-road diesel vehicle regulation, to account for emission reductions occurring due to the current economic downturn. However, none of the recent or proposed changes to the in-use off-road and in-use on-road regulations would result in fewer reductions of diesel PM by 2020. Combined diesel emissions from all sources should still ultimately be reduced by 85%, although achievement of this objective may not occur by 2020. Nevertheless, the Bay Area should still see a very significant reduction in diesel PM emissions.

In support of the desired 85% reduction of diesel PM emissions by 2020, the Air District will continue to aggressively implement its effort to reduce diesel PM emissions and exposure via enhanced monitoring and analysis of impacted communities, targeted enforcement of CARB regulations in impacted communities, and targeting its grant programs to projects in impacted communities.

The CAP GHG performance objective is based on state goals articulated in AB 32 and the Governor's Executive Order S-3-05. The analysis described in Appendix G indicates that additional measures will be needed to achieve the CAP GHG performance objective, beyond the measures defined and quantified in the CARB AB 32 Scoping Plan and the 2010 CAP. The additional reductions may be obtained via some combination of future actions at the state level, the Sustainable Communities Strategy that will be developed by Bay Area regional agencies in cooperation with local governments pursuant to SB 375, local climate action plans, future Air District actions, and voluntary actions by Bay Area residents and businesses. All these efforts will be vitally important in reducing the region's GHG emissions, but their potential impact cannot yet be quantified.

Multi-Pollutant Planning

Chapter 1 presented the rationale for the Air District's decision to expand the scope of the 2010 CAP as a multi-pollutant plan. Because little or no guidance is yet available on how to prepare a multi-pollutant plan, the Air District grappled with fundamental questions about the scope and content of such a plan. Nonetheless, the effort to devise a multi-pollutant plan did yield tangible results and achievements, including:

- Development, for the first time, of an integrated control strategy to reduce ozone, PM, air toxics, and greenhouse gases in the Bay Area;
- Evaluation of co-benefits and trade-offs among pollutants in analyzing potential control measures; and
- Development of a powerful analytic tool, the Multi-Pollutant Evaluation Method (MPEM), to compare the relative benefits of reducing the various pollutants, and to estimate in dollar terms the health and climate protection benefits of each control measure.

Multi-Pollutant Planning: Future Enhancements and Directions

In developing the Multi-Pollutant Evaluation Method and preparing the CAP, the District made use of the best technical data and tools at its disposal: emissions inventory data, monitoring data, air quality modeling results, and public health data. The effort to develop a multi-pollutant plan and create the MPEM helped Air District staff to understand both the strengths and limitations of its current tools and information, and to identify areas for future improvements.[82]

The experience of developing a multi-pollutant plan should provide on-going benefit to the Air District in the years to come. Developing a multi-pollutant plan has motivated Air District staff to analyze air quality issues from a broader perspective, and to consider, if not yet fully resolve, the many technical and policy issues that multi-pollutant planning raises. From this perspective, the process of developing the plan has been just as valuable as the plan itself. Ideally, the 2010 CAP can serve as a platform for introducing a multi-pollutant perspective into the full spectrum of Air District programs and the District's overall approach to air quality and climate protection. For example, looking forward, the Air District may explore the idea of applying a multi-pollutant framework in programs such as stationary source permitting, New Source Review, and Best Available Control Technology (BACT). However, any move in this direction would require serious analysis of the technical and policy implications, and would likely entail revisions in state and federal laws and guidelines.

The Bay Area 2010 Clean Air Plan represents an effort to demonstrate that multi-pollutant planning is both feasible and worthwhile. The Air District hopes that this plan provides a useful example that other agencies, including US EPA, CARB, and other air districts, can build upon to advance the multi-pollutant approach to air quality planning.

Protecting Public Health

Protecting public health is a core element of the Air District's mission, and a key objective of the 2010 CAP. The CAP builds upon on-going Air District efforts to identify and protect impacted communities through the CARE program and Clean Air Communities Initiative. Key ways that public health is addressed in the CAP include:

- Developing a control strategy to reduce PM, air toxics, and greenhouse gases, in addition to ozone;
- Establishing numerical performance objectives for reducing population exposure to PM2.5 and diesel PM;
- Developing a Multi-Pollutant Evaluation Method to quantify the health benefits of potential control measures and express these benefits in monetary terms;

[82] Plans to develop an integrated platform for multi-pollutant air quality modeling are described in Appendix E. Potential enhancements to the MPEM are described in Section 6 of the MPEM Technical Document (June 2009).

- Analyzing the overall health burden of air pollution on Bay Area residents, and comparing the past burden to the current burden;
- Comparing the health benefit of reducing the various air pollutants, to help guide policy-making;
- Explaining how climate change threatens to increase air pollution and damage public health;
- Emphasizing reductions in population exposure and health impacts, both at the regional scale and in localized communities, in developing the measures that comprise the CAP control strategy;
- Prioritizing measures that will provide the greatest public health benefit in the rule-making calendar for stationary source measures; and
- Creating a new category of Land Use & Local Impact Measures. These measures focus on reducing local exposures, recognize the need for additional monitoring and risk assessment in impacted communities, and highlight the need to protect public health as the region promotes focused development.

The Importance of Reducing PM

As discussed in Chapter 1 and in Appendix A, exposure to PM2.5 poses the greatest public health risk from air pollution in the Bay Area. There has been a great deal of focus in recent years on the need to reduce emissions of diesel PM. However, analysis of the relative health risk associated with air pollutants in the Bay Area highlights the importance of reducing emissions and ambient concentrations of types of fine particulate matter, including direct emissions of PM2.5, as well as precursors that contribute to the secondary formation of PM2.5. Residential wood-burning is a major source of PM in winter months. The Air District's program to reduce residential wood-burning in winter months, described in Chapter 3, is an important means of reducing PM concentrations and population exposure to wood smoke, and a critical element of the effort to attain state and national PM standards.

Because of the health risks related to PM, measures that reduce PM have been given high priority in the implementation schedule for CAP control measures. The CAP control strategy includes several measures to further reduce direct PM emissions from stationary sources, including SSM 6 to increase the stringency of the general PM weight rate limitation, SSM 7 to amend the open burning regulation, and SSM 16 to amend the New Source Review rule to reduce PM. In addition, many of the other SSMs, such as SSM 8 (coke calcining) and SSM 9 (cement kilns), will reduce emissions of NOx, SO2, or ammonia, which are precursors to the secondary formation of PM.

In terms of reducing PM from mobile sources, the Air District already operates the Vehicle Buy-Back Program to accelerate the retirement of old vehicles, and the Smoking Vehicle Program, as well as grant programs such as the Carl Moyer Program and Low Emission School Bus Program. The District will continue to operate and enhance these

programs, as described in the Mobile Source Measures in the CAP control strategy. In addition, the Air District will help to enforce CARB regulations to reduce emissions from heavy-duty easel engines by means of its Mobile Source Compliance Program described in Chapter 3.

All TCMs in the CAP that reduce motor vehicle travel should also reduce PM emissions. Measures in the CAP that should be especially effective in reducing PM emissions from mobile sources include MSMs A-4, B-1, B-2, B-3, and C-1, as well as TCM B-4 and LUM 1, both of which address goods movement. Development of a new Indirect Source Review regulation (see LUM 2), as well as the District's revised CEQA guidelines (see LUM 3), which establish thresholds of significance for local PM2.5 impacts, will provide important mechanisms to limit PM emissions from new development.

The CAP also describes several Further Study Measures, including FSM 7 (to reduce SO2 from refinery processes), FSM 10 (commercial cooking), FSM 11 (magnet source measure), and FSM 12 (wood smoke), all of which may provide opportunities for additional PM reductions.

Reducing Impacts of Air Toxics in Local Communities

The Air District and its partners must also continue to reduce population exposure to air toxics to protect public health. Reducing local impacts of air pollutants in the most heavily impacted communities, especially those communities identified by the CARE program, will continue to be a major focus of Air District efforts in the years to come.

Reducing diesel PM must continue to be a high priority. Analysis performed for the Air District's CARE program indicates that diesel PM is by far the leading air toxic in the Bay Area in terms of cancer risk, both at the regional scale and in the most impacted communities. Recent regulations to reduce emissions from heavy-duty diesel engines in trucks, cargo-handling equipment, construction machinery, and other equipment will greatly reduce emissions of diesel PM over the next 5-10 years. Building on regulations adopted pursuant to CARB's Diesel Risk Reduction Program, the Air District will work with all concerned stakeholders, including regional agencies, local cities, community groups, county health officers, and industry to analyze potential risks and develop effective mitigation measures to reduce population exposure to diesel PM and other air toxics.

As described in Chapter 3, the Air District has been striving to protect public health in recent years through programs such as the CARE Program, the Clean Air Communities Initiative, and the Goods Movement Emission Reduction Program to reduce emissions from port drayage trucks. Building on these efforts, the CAP control strategy includes measures to reduce population exposure to PM and to air toxics, and emphasizes the need to improve the Air District's ability to track cumulative risks in impacted communities and to enhance air quality monitoring capabilities at the local scale.

Protecting public health in impacted communities is a complex issue. Most of the health risk in these communities is due to emissions from mobile sources generated by freeways and major arterials, ports, distribution centers, etc. The region's transportation and goods movement infrastructure is well established and cannot easily be relocated. Although CARB regulations will greatly reduce emissions from diesel engines over the next 5-10 years, some of the benefit of these regulations may be offset by the projected increase in goods movement activity, as well as the overall volume of motor vehicle traffic, in future years. Reducing emissions and exposures in impacted communities will require a sustained effort based upon promoting cleaner and more efficient vehicles and equipment, ensuring full compliance with regulations to reduce emissions from mobile sources, sound land use planning and site-design, and site-specific mitigation measures.

In conjunction with proposed revisions to its CEQA Guidelines, the Air District is encouraging local governments to develop Community Risk Reduction Plans. Such plans are potentially one of the most effective ways to reduce overall health risk in impacted communities, because they provide an opportunity to develop a comprehensive strategy to reduce population exposure and health risk on a community-wide basis, while taking account of local needs and priorities regarding community development.

Protecting the Climate

Protecting the climate is another key objective of the 2010 CAP. There are many compelling reasons to protect the climate and combat global warming, but from the standpoint of the Air District's mission, the primary reason is to protect our hard-won improvements in air quality. The CAP addresses climate protection by:

- Explaining that air quality and climate change are closely related, and that higher temperatures are expected to exacerbate air quality problems;
- Incorporating the State of California GHG reduction targets in the CAP performance objectives;
- Including the estimated social benefit of GHG emissions reductions in the Multi-Pollutant Evaluation Method; and
- Considering the potential reduction (or increase) of GHG emissions, and their estimated monetary value, in evaluating the benefits of CAP control measures.

Protecting air quality is the Air District's core mission. From this perspective, the best way to protect air quality and the climate is to develop control measures that simultaneously reduce both traditional air pollutants as well as greenhouse gases. All measures in the CAP control strategy that reduce fossil fuel consumption by decreasing motor vehicle use, by promoting the use of fuel-efficient vehicles, or by other means of improving energy efficiency, should help to reduce GHG emissions.

In addition, many measures in the control strategy will have the additional benefit of reducing short-lived climate forcers, such as black carbon, methane and hydroflourocarbons (HFCs). For example, measures that reduce fine PM, by limiting burning and by reducing diesel PM, will also reduce the production of black carbon. The lifespan of these climate forcers in the atmosphere is relatively short (days to weeks, compared to over 100 years for CO2), so they do not accumulate in the atmosphere like CO2 does. However, because they are potent GHGs with high global warming potential, reducing emissions of these short-lived climate forcers can have an immediate impact in terms of reducing global warming.

The CAP also proposes control measures that will help to reduce GHG emissions from stationary sources, including

- SSM 3: Livestock Waste (methane)
- SSM 4: Natural Gas Processing & Distribution (methane)
- SSM 15: Greenhouse Gases in Permitting (CO2)

In addition, the CAP contains new Energy and Climate Measures, including two measures to reduce GHGs from the energy sector, and two measures that focus on offsetting or mitigating temperature increases.

- ECM 1: Energy Efficiency (CO2)
- ECM 2: Renewable Energy (CO2)
- ECM 3: Urban Heat Island Mitigation
- ECM 4: Tree-planting

Finally, the CAP includes two important measures that will reduce emissions of greenhouse gases from new development: CEQA Guidelines and Indirect Source Review.

CEQA Guidelines: As described in LUM 3, the Air District expects to issue revised CEQA Guidelines in 2010, including new and revised thresholds of significance. The current staff proposal includes new thresholds of significance for greenhouse gas emissions; if adopted, the proposed GHG thresholds would be the most comprehensive and stringent thresholds of any air district in California, and would place the Bay Area at the forefront of the effort to reduce GHG emissions from new development.

Indirect Source Review (ISR) Regulation: As described in LUM 2, the CAP includes a measure to develop and implement an Indirect Source Review regulation to reduce emissions of criteria pollutants from new development. This regulation is expected to provide reductions in GHG emissions as a co-benefit. The ISR regulation will be developed in consultation with regional agencies partners, local governments, and other interested stakeholders. Whereas the CEQA guidelines will rely on implementation by local lead agencies, the ISR regulation would be implemented by the Air District as the lead agency, and would be structured to complement the CEQA Guidelines.

In addition to reducing GHGs through the CAP control strategy, the Air District will continue to facilitate the implementation of the state's AB 32 Scoping Plan. The District will contribute to the implementation of AB 32 in the following ways:

- Using its experience and expertise in regulation and rule enforcement to help CARB implement AB 32 climate measures that target GHGs from stationary sources;
- Working with regional agencies and cities and counties to promote land use development that minimizes energy use and motor vehicle travel; and
- Encouraging actions by local government and other Bay Area stakeholders to facilitate implementation of AB 32 by organizing meetings such as the Air District's 2006 and 2009 regional climate protection summits; providing incentives, such as the Climate Protection Grant Program; and providing technical expertise, such as its local government GHG inventory workshop series.

Looking Forward

Clean air, healthy communities, and a stable climate are essential to the continued vitality and economic strength of the Bay Area. As the Air District's first multi-pollutant plan, the 2010 Clean Air Plan provides a comprehensive strategy to improve air quality, protect public health in all Bay Area communities, and protect the climate. The CAP anticipates and responds to the challenges and opportunities that the Bay Area will face in coming years, emphasizing the need to promote energy efficiency, to reduce motor vehicle use, and to promote focused development as key long-term solutions.

The 2010 CAP is designed to complement a broader set of plans and programs adopted and implemented by CARB, US EPA, regional agency partners, and local governments, as well as voluntary actions on the part of the business community, non-profit organizations, and Bay Area residents. Successful implementation of the CAP control strategy will require internal and external resources, public support, and partnerships and collaboration among many agencies and stakeholders.

To fulfill its objectives of attaining air quality standards, protecting public health, and protecting the climate, the Air District will implement the CAP control strategy; enhance its multi-pollutant planning capabilities; continue and expand its efforts to reduce health risk in impacted communities; engage local governments and stakeholders to promote focused development in a way that protects public health; and refine and strengthen its efforts to reduce emissions of greenhouse gases.

To build upon this plan in future years, the Air District will continue its efforts to achieve the CAP goals and to build its multi-pollutant planning capacity by:

- Developing an integrated emissions inventory that includes all pollutants;
- Developing an integrated air quality modeling platform;
- Enhancing the Multi-Pollutant Evaluation Method developed for the 2010 CAP to include a wider range of pollutants and health effects;

- Enhancing its capacities to measure and analyze ambient concentrations and population exposure in impacted communities;
- Developing better measurements of population exposure to pollutants on a region-wide basis;
- Evaluating the potential benefits and policy and technical issues related to extending the risk-weighted multi-pollutant approach to programs such as stationary source permitting and New Source Review; and
- Better integrating strategies to reduce criteria pollutants and greenhouse gases.

The Air District elected to develop the 2010 CAP as a multi-pollutant plan as a matter of choice. However, future challenges are likely to make multi-pollutant planning a necessity in years to come. In addition to serving as a blueprint for the Bay Area, the Air District offers the 2010 CAP as one example of a multi-pollutant plan that other agencies can build on to advance this concept.

Chapter 6 – Source Documents

BAAQMD documents

Base Year 2005 Emissions Inventory Summary Report, BAAQMD Special Projects Section, December 2008.

Bay Area 2005 Ozone Strategy, BAAQMD, January 2006.

CARE Phase I Findings and Policy Recommendations Related to Toxic Air Contaminants in the San Francisco Bay Area, BAAQMD, September 2006.

The Effects of Climate Change on Emissions and Ozone in Central California, by Su-Tzai Soong, Cuong Tran, David Fairley, Yiqin Jia, and Saffet Tanrikulu. Paper #590 presented in the 101st Annual Meeting, Air and Waste Management Association, June 2008 Portland OR.

(Draft) *Fine Particulate Matter Data Analysis and Modeling in the Bay Area*, BAAQMD Research & Modeling Section, October 2009. Pub. # 200910-02-PM

Multi-Pollutant Evaluation Method Technical Document, BAAQMD, June 2009.

Multi-Pollutant Evaluation Method Probability Analysis, BAAQMD, March 2010.

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Recommended Methods for Screening and Modeling Local Risks and Hazards

Bay Area Air Quality Management District
939 Ellis Street
San Francisco, CA 94109

May 2011

Version 2.0

BAY AREA AIR QUALITY MANAGEMENT DISTRICT

EXECUTIVE SUMMARY

The purpose of the "Recommended Methods for Screening and Modeling Local Risks and Hazards" (document) is to assist lead agencies in conducting a risk and hazard analysis as part of their CEQA environmental review for proposed land use projects. The Report provides detailed guidance on how to screen projects for potential risk and hazards impacts and, if necessary, how to conduct site-specific computer modeling.

This document compliments and helps implement the Bay Area Air Quality Management District's (BAAQMD or District) 2010 CEQA Guidelines (Guidelines) and thresholds of significance for particulate matter and toxic air contaminants (TACs). The thresholds were developed to encourage focused infill development in the region, reduce vehicle emissions, and protect public health by raising awareness regarding the effects of siting people near existing and/or new sources of toxic air containments. The Guidelines also outline a methodology for analyzing potential risk and hazard impacts to sensitive receptors from proposed land use developments. This document, used in conjunction with the Guidelines, provides greater detail on how to perform preliminary screening, and if needed, detailed computer modeling of potential risk and hazard impacts from a new source of toxic emissions on existing receptors, or from existing sources of toxic emissions to new receptors.

When applying the methods presented in this document, the user should first apply the recommended screening process to their proposed project to determine whether air quality modeling is necessary. The screening tools are described in Section 3.0. For new receptor projects, lead agencies should review the risks from nearby roadways, freeways, and stationary sources. This document describes in detail how to screen for potential risk and hazards from TAC sources using the following tools:

- **Surface Street Screening Tables:** Through the use of computer models, the District estimated particulate matter equal to or less than 2.5 microns in diameter ($PM_{2.5}$) concentration and cancer risk values for roadways based on annual average daily traffic (AADT) for each of the nine Bay Area counties. The county specific tables provide estimated $PM_{2.5}$ concentration and cancer risk by distance away from the roadway. The hazard index was found to be minimal for all surface streets and is therefore not included in the tables. Local planners can use these tables to determine if a project may be adversely impacted from local roadways and decide if further modeling is needed.

- **Freeway Screening Analysis Tool:** The District developed a Google Earth™ application that maps each State highway link in the Bay Area, where highway links are defined by Caltrans mileposts. For each link, District modeled $PM_{2.5}$ concentration, cancer risk, and hazard index, values at various distances from the edge of each side of the highway. This information is available at elevations of six feet and 20 feet to represent sensitive receptors on the first and second floors of buildings. Local planners can use this application to determine if a project may be adversely impacted from freeways and determine if further modeling is needed.

- **Stationary Source Risk and Hazard Screening Analysis Tool:** The District developed a Google Earth™ application that maps the locations of all the stationary sources in the region that the District permits, such as back-up generators, gas stations, dry cleaners, and auto body shops. For each source, the application lists the name of the source and conservative screening level cancer risk and $PM_{2.5}$ concentration values. Users can use this application to estimate the potential risks from stationary sources to particular project sites and determine if proposed projects may be adversely impacted and if further modeling is needed.

The assumptions and modeling parameters used for these screening tools are detailed in this Report in Section 3.0. These tools reflect the most current data available as of May 1, 2011. For a detailed step-by-step reference guide outlining the screening process, see Figure ES-1 below, the "BAAQMD Risk and Hazard Screening Analysis Process Flow Chart".

If after the screening process, a project is found to have potential risk and hazard impacts that exceed the District's recommended thresholds of significance, the user may choose to conduct site specific modeling for the proposed project. In this case, the user should apply the recommended modeling approach described in Section 4.0 of this document. The District provides a step-by-step approach to selecting the appropriate modeling tools, modeling parameters, and responding to project-specific conditions. These modeling guidelines are based on standard procedures developed by the California Office of Environmental Health Hazard Assessment (OEHHA) for toxicity values and age sensitivity, and are consistent with the most current risk assessment methodology and toxicity factors used in the District's Regulation 2, Rule 5: New Source Review of Toxic Air Contaminant. Users may deviate from the methods described in the document as found necessary, for example, to factor in the amount of time that receptors spend indoors verses out-of-doors, provided such deviations are justified with scientific documentation.

Figure ES-1: Risk and Hazard Screening Analysis Process Flow Chart

BAAQMD Risk and Hazard Screening Analysis Process Flow Chart:

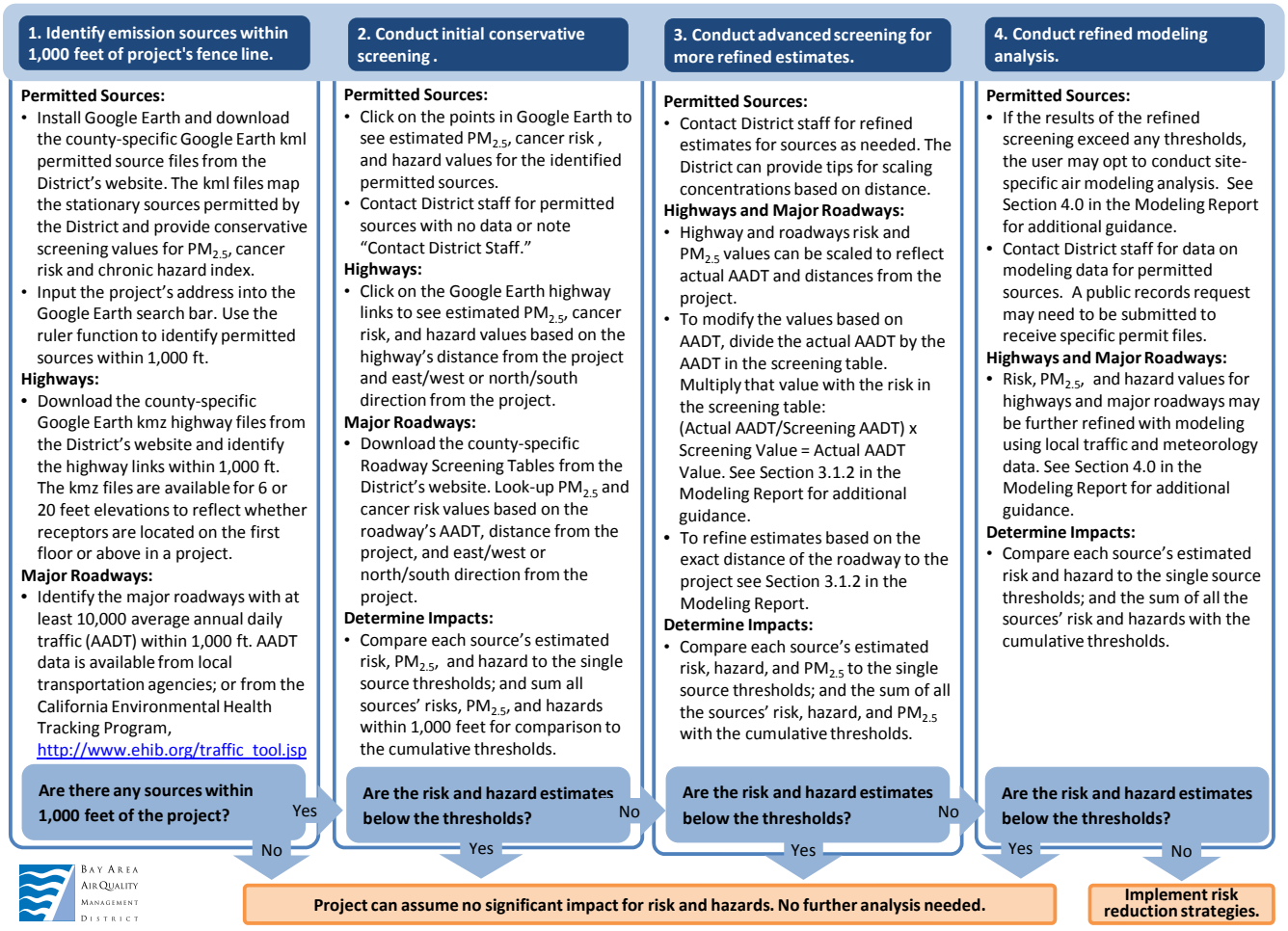


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1.0 INTRODUCTION

This document is a companion document to the Bay Area Air Quality Management District's (BAAQMD; District) *California Environmental Quality Act (CEQA) Air Quality Guidelines* (BAAQMD 2010a) and to the *California Environmental Quality Act Thresholds of Significance* (BAAQMD 2010b). The purpose of this document is to provide a recommended methodology for assessing risks and hazards at a local, or community, scale from air pollutants emitted from common urban source types to nearby receptors. The methodology can be used to assess single-source impacts from either an individual new source or impacts on new receptors (such as new residents in a housing project) from existing sources of toxic emissions.

The methodology follows a tiered approach. The level of effort and requirements for more site specific information generally increases as the user progressively moves through each tier. Each tier provides concentrations and risks that are directly comparable to the applicable Thresholds of Significance, although it is important to note that the use of more site specific modeling input data produces more accurate results. Also, progression from one tier to the next in a sequential fashion is not necessary and a refined modeling analysis can be conducted at any time.

The following sections describe:

- **Screening Tables** provide an easy-to-use initial comparison to determine if nearby sources or roadways may have a significant impact to a receptor. The section describes how to use the screening tables to determine if a site specific modeling analysis and risk assessment are warranted. The section also identifies sources that are likely to have low emissions such that their health impacts are below the thresholds.

- **Refined Modeling Approach** describes the recommended methodology for performing dispersion modeling and estimating emission factors if the project exceeds the thresholds based on the screening analysis.

- **Cancer Risks** describes methodology for estimating the incremental lifetime cancer risk using age-sensitivity factors.

- **Chronic Hazard Health Impacts and Acute Hazard Health Impacts** describes the methodology for estimating short term one hour acute exposures and long term chronic noncancer health impacts.

The modeling methodology presented in this document are based on the California Air Pollution Control Officers Association (CAPCOA)'s Health Risk Assessments for Proposed Land Use Projects (July, 2009 – available through www.CAPCOA.org). While the District has relied heavily on the CAPCOA report for much of the detailed modeling methodology, they have been modified in certain instances as noted in each section to address specific Bay Area air quality modeling issues.

The Exposure Assessment components are based on the procedures developed by the California Office of Environmental Health Hazard Assessment (OEHHA). These calculation methodologies may change over time as OEHHA further refines its exposure guidelines. **It is important that the user apply the most current risk assessment methodology and toxicity factors from OEHHA's health risk assessment guidelines.**

1.1 Health Concerns

The focus of this guidance is to provide a methodology for evaluating local community risk and hazard impacts associated with toxic air contaminants (TACs) and particulate matters with diameters equal to or less than 2.5 microns ($PM_{2.5}$). TACs are a defined set of airborne pollutants that may pose a potential hazard to human health. Sources of TACs include industrial and mobile sources and similar to $PM_{2.5}$, can be emitted directly to the atmosphere or through reactions with different pollutants. This report presents methods for assessing the potential health impacts from direct $PM_{2.5}$ and TACs emissions, not those formed through secondary reactions in the atmosphere.

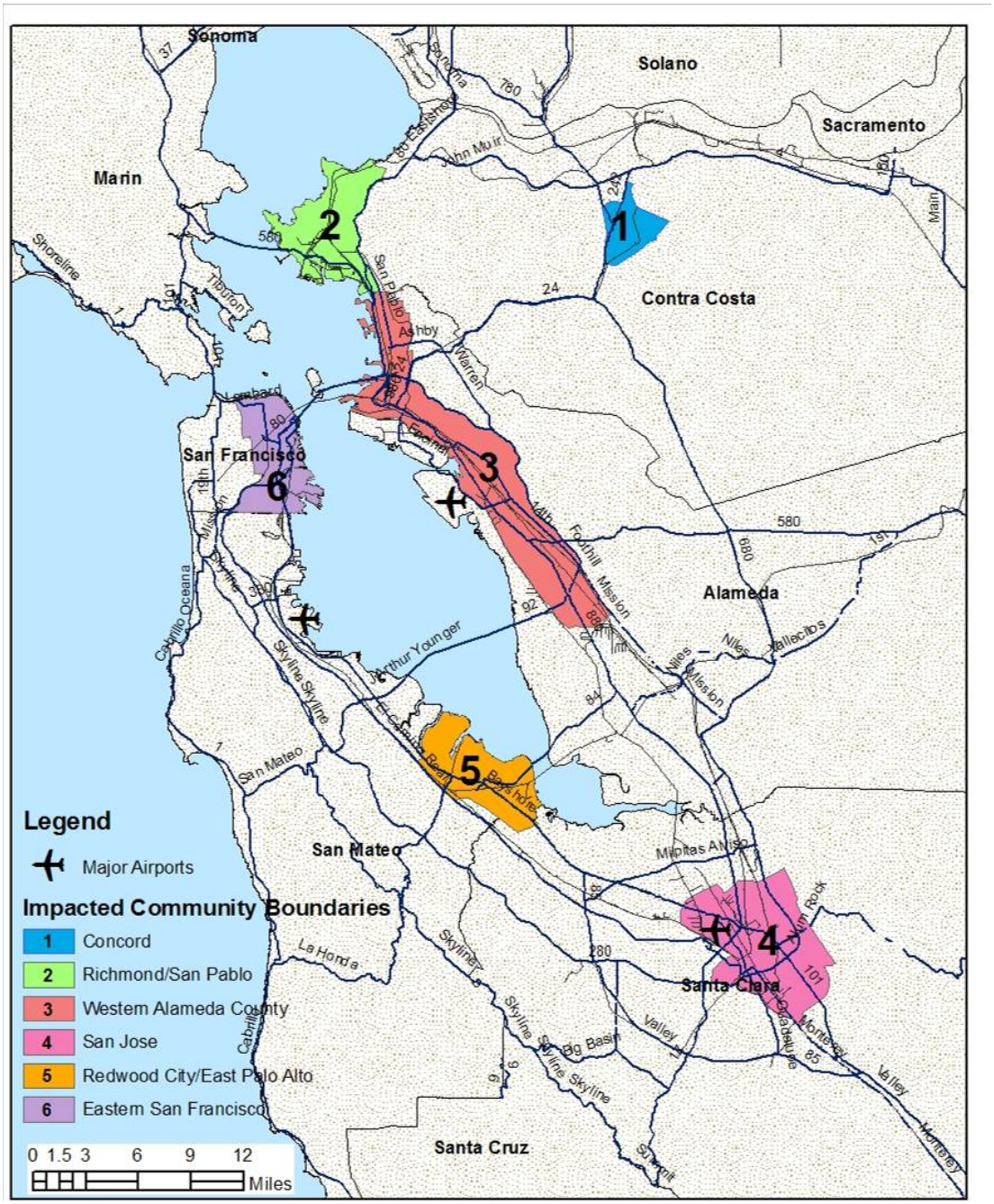
The potential health effects associated with TACs include both long term health impacts including cancer, birth defects, neurological damage, asthma, bronchitis or genetic damage and short term effects such as eye watering, persistent cough, running nose, throat pain, and headaches. Many scientific studies have linked fine particulate matter and traffic-related air pollution to respiratory illness and premature mortality. In the Bay Area, there are number of urban and industrialized communities where the exposure to TACs is relatively high in comparison to others. These same communities are often faced with other environmental and socio-economic hardships that further stress their residents and results in poor health outcomes. To address community risk from air toxics, the District initiated the Community Air Risk Evaluation (CARE) program in 2004 to identify locations with high levels of risks from TACs co-located with sensitive populations. Using year 2005 emission inventory combined with demographic and health statistics, the CARE program identified impacted communities based on a combination of high TAC concentrations, presence of significant sources, and proximity to low-income, sensitive populations. Figure 1 shows the impacted communities (December 2009), which include Western Alameda County, Concord, eastern San Francisco, Redwood City/East Palo Alto, Richmond/San Pablo, and San Jose.

The air quality conditions in the impacted communities are partially the result of past decisions related to land use and transportation planning. The District has developed this document to help identify and avoid land use conflicts by providing a methodology for assessing the potential health impacts to new residents from existing sources and from new sources on existing residents within a community. The objective is to ensure that future growth in a community is health protective and effective mitigations are implemented to reduce potential adverse impacts.

In addition to the guidance provided herein, local jurisdictions also have the option of developing Community Risk Reduction Plans (CRRPs) as a means of reducing the overall exposure to TAC and PM2.5 emissions and concentrations in an entire community from new and existing sources. The goal of a CRRP is to bring TAC and $PM_{2.5}$ concentrations for the entire community covered by the Plan down to acceptable levels as identified by the local jurisdiction and approved by the

Air District. This approach provides local agencies a proactive alternative to addressing communities with high levels of risk on a project-by-project approach. This proactive approach is encouraged for all communities, and especially those within a CARE impacted community.

Figure 1 – CARE Impacted Communities (December, 2009)



1.2 CEQA Thresholds

Under the CEQA guidance, the District developed thresholds of significance for air pollutants emitted from a new project and for cumulative exposures that includes emissions from a new project in combination with existing sources. The goal of the thresholds is to ensure that no source creates, or receptor endures, a significant adverse impact from any individual project, and that the total exposure from all nearby sources does not result in a significant adverse impact. If a project exceeds the identified significance thresholds, its emissions in concert with contributions from all nearby sources may result in significant adverse air quality impacts.

The thresholds for local risks and hazards from TAC and $PM_{2.5}$ are intended to apply to all sources of emissions, including both permitted stationary sources and on- and off-road mobile sources, such as sources related to construction, busy roadways, or freight movements. The thresholds of significance for TAC and $PM_{2.5}$ are listed in Table 1.

Table 1. Threshold of Significance for Local Community Risk and Hazard Impacts

Analysis	New Source	New Receptor
Individual Project	Compliance with qualified community risk reduction plan OR To the nearest receptor (resident) regardless of distance: Increased Cancer Risk > 10 in a million Increased Chronic and Acute Hazard Index > 1.0 Ambient $PM_{2.5}$ concentration increase > 0.3 ug/m^3	Compliance with qualified community risk reduction plan OR From the source with the highest cancer risk, $PM_{2.5}$ concentration, or hazard in comparison to other sources within the 1,000 foot radius of the receptor: Increased Cancer Risk > 10 in a million Increased Chronic and Acute Hazard Index > 1.0 Ambient $PM_{2.5}$ concentration increase > 0.3 ug/m^3
Cumulative Impacts	Compliance with qualified community risk reduction plan OR Common sources within 1,000 foot radius of the individual project modeled to the maximum likely exposed individual (resident) based on the individual source analysis: Cancer Risk > 100 in a million Chronic Hazard Index > 10.0 $PM_{2.5}$ concentration > 0.8 ug/m^3	Compliance with qualified community risk reduction plan OR Major sources within 1,000 foot radius of the receptor: Cancer Risk > 100 in a million Chronic Hazard Index > 10.0 $PM_{2.5}$ concentration > 0.8 ug/m^3

1.3 Overview Process

The District recommends a tiered approach where at each successive step, the project's $PM_{2.5}$ and TAC cancer risk and hazards are compared to the CEQA thresholds. A tiered approach addresses health impacts from two of the most common types of projects: (1) a new source of TAC or $PM_{2.5}$ is proposed for a community (see Figure 2) and (2) a new residential development is proposed that may be impacted from existing sources (see Figure 3).

Examples of new sources of TAC emissions include gasoline dispensing facilities (i.e., gasoline stations), dry cleaners, and autobody shops. Less obvious sources of TAC include diesel back-up generators that are housed in the basement of hospitals, governmental agencies, and fire stations, in case of power outages. Examples of projects that may be impacted from existing nearby TAC sources such as roadways, stationary sources, railyards, airports, and ports include residential developments, mixed use commercial-residential developments, commercial buildings, and daycare centers.

The flow charts (Figures 2 and 3) show how to proceed with the CEQA process to determine if a project is impacting or being impacted by sources of TAC. The initial step is to determine whether the project is categorically exempt from CEQA. For some cases, a project may not be exempt because the health risk may trigger an exception (CEQA §15300.2).

For projects that are not exempted and considered significant, the project site-specific characteristics and surrounding conditions are used to evaluate the potential cancer risk, hazard, and $PM_{2.5}$ concentrations posed by the project or to a new receptor. For these projects, the project sponsors must determine the project radius and identify significant sources and receptors within the project radius. The project sponsor can initially screen the project by comparing the screening values based on distances to the nearest major roadway and/or emissions from significant sources to the CEQA thresholds. The District provides screening tables for California designated highways and certain existing permitted, stationary sources as an initial screen to determine if nearby sources or roadways may have a significant impact on a project. The District is recommending that in additional to evaluating the individual impact from a single source, the project sponsor should also evaluate the cumulative impacts from all TAC and $PM_{2.5}$ sources. The cumulative impacts are the summation of the cancer risks, hazards, and $PM_{2.5}$ concentrations from all significant sources identified within 1,000 foot radius of the project.

If the screening values from the project exceed the single source or cumulative thresholds, the project sponsor can conduct more refined modeling analysis by incorporating additional site-specific information. Project sponsors can also implement all feasible measures to mitigate the potential health impacts. This document discusses several tiers of refined modeling analysis that may be performed with each successive tier requiring more site-specific information. For the first tier, a screening model is recommended that requires minimal site-specific data. More complex modeling analysis can be conducted based on the available source specific data.

Figure 2 – Tiered Approach for Estimating Community Risks and Hazards from New Sources

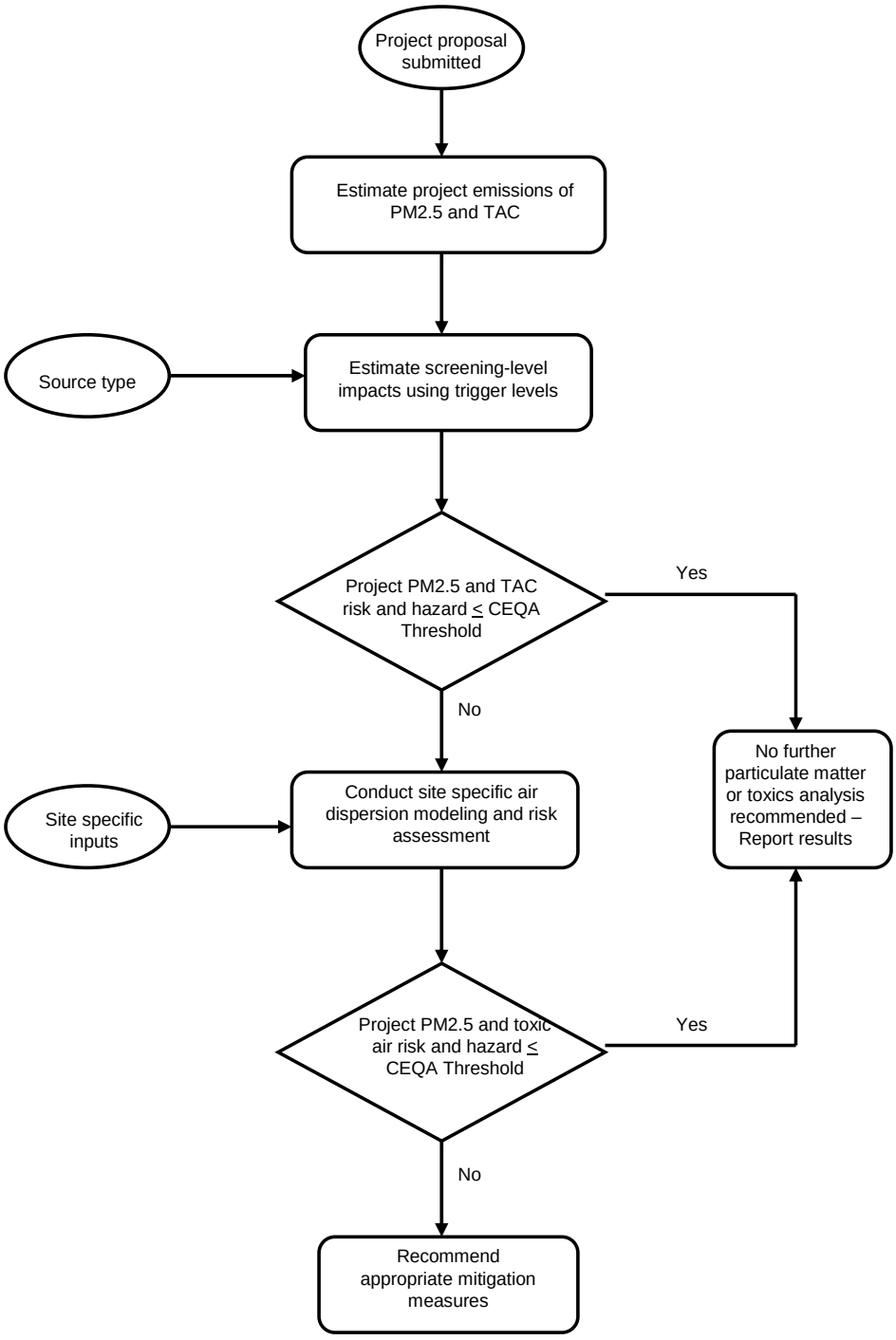
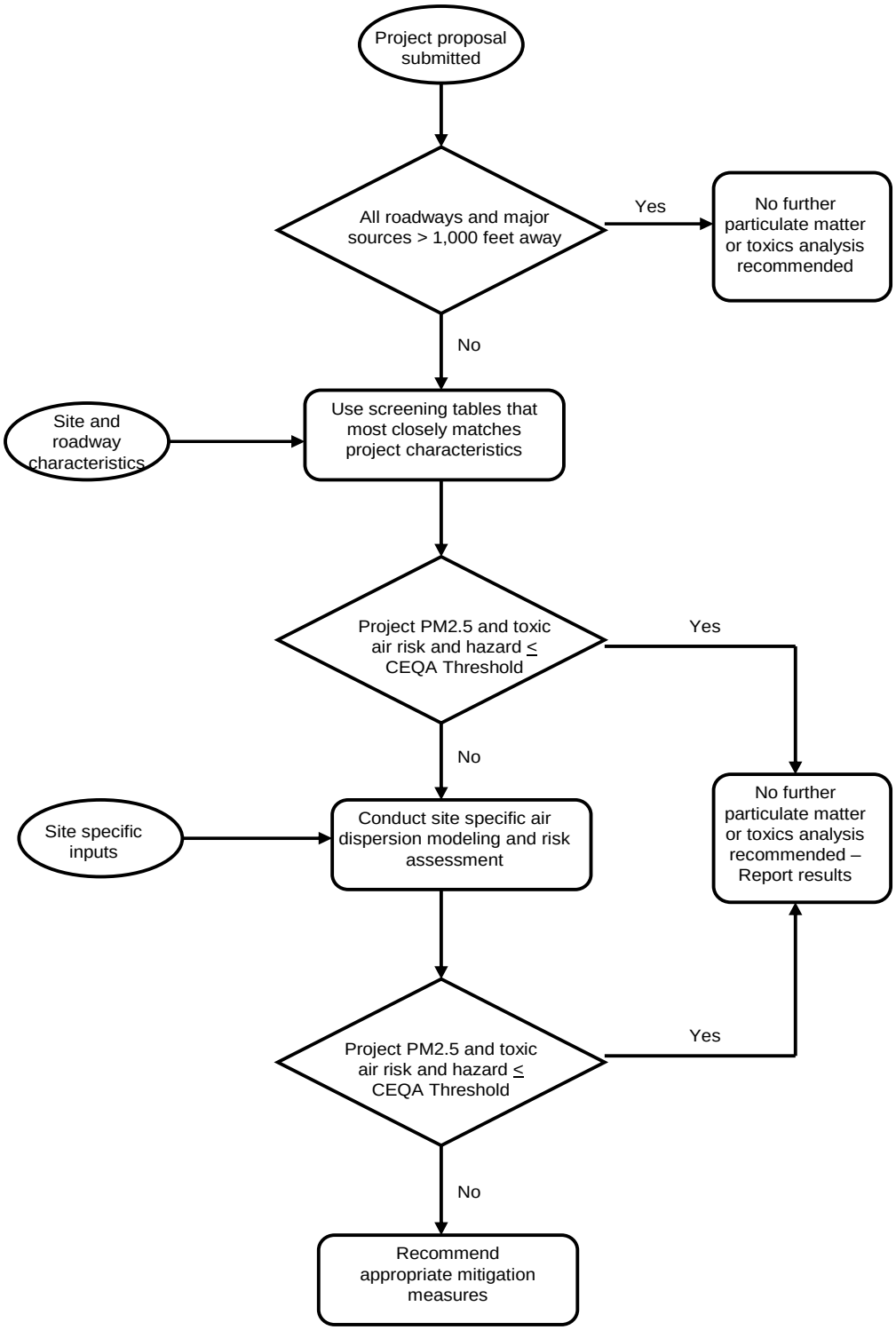


Figure 3 – Tiered Approach for Estimating Community Risks and Hazards from New Receptors



1.4 Starting Point

The most current documentation (including this document), datasets for screening and modeling, and District staff contact information are available on-line at http://www.baaqmd.gov/Divisions/Planning-and-Research/CEQA-GUIDELINES/Tools-and-Methodology.aspx. This URL serves as the starting point for all CEQA tools, methodology documentation, and data related to District recommended screening and modeling of local risks and hazards. For questions on data availability and screening and modeling methods, please contact the District's Planning, Rules, and Research Division at (415) 749-4995.

2.0 IDENTIFYING SOURCES, RECEPTORS, AND IMPACT AREA

The screening methods for local risks and hazards recommended in this document rely upon several key definitions to identify the pollution sources and the receptors of potential concern and to establish the area where potential impacts are evaluated.

- What emissions sources should be analyzed?
- What receptors should be considered?
- How should cumulative impacts of toxic air contaminants and particulate matter be determined and over what area?

This section provides some key definitions and recommended methods for making these preliminary determinations.

2.1 Identifying Sources

For the purposes of this methodology document, the District defines three types of sources:

- *Common sources* whose emissions of TACs or $PM_{2.5}$ are significant enough to warrant consideration when siting new receptors or when determining cumulative impacts but simple enough as to lend themselves to simplified risk screening tools;

- *Complex sources* whose emissions may pose significant risks but that are complex, or otherwise unique in nature, such that they do not lend themselves to simplified screening tools or even modeling analysis that can be easily generalized; and

- *Minor, low-impact sources* that are unlikely to pose a significant risk.

Each of these three types is defined in this section. Focus is given to the common sources because they generally pose the greatest risks in the Bay Area. Complex sources are important to consider if the proposed project is sited nearby; but they will require specific and specialized analysis. A detailed methodology for assessing risk from complex sources is beyond the scope of this document. Minor, low-impact sources can be neglected from risk and hazard assessments for new projects.

2.1.1 Common Sources

Common sources may be significant sources of local risk and hazards from TAC or $PM_{2.5}$ and, for the purposes of this document are defined to include the following:

- Freeways and major roadways;
- Gas stations;
- Stationary diesel engines, such as stand-by back up generators;
- Dry cleaners;
- Crematories;
- Spray-booths;
- Construction projects; and
- Railroad tracks for trains with diesel engines.

Risk screening tables or risk screening tools are provided for some of these common sources. This risk may expand as screening tools are developed in the future.

2.1.2 Complex Sources

The District regulates and permits stationary sources of air pollution and administers incentive funds to reduce pollution from mobile sources. The mobile sources are not directly regulated or permitted by the District; however, they may contribute a significant portion of the emissions attributed to non-permitted facilities. Quantification of emissions from these types of sources is complex and requires comprehensive knowledge on the sources of emissions (i.e., trucks, locomotives, construction equipment, airplanes, etc.), number of sources, and the types of pollutants emitted. In addition, District has permitted several single facilities that have numerous permits such as in the case of oil refineries which make TAC and $PM_{2.5}$ quantification difficult. Examples of complex sources that generate significant pollution include:

- Major ports, including the Port of Oakland;
- Railyards;
- Distribution centers and truck-related businesses;
- Airports;
- Oil refineries;
- Power plants;
- Metal melting facilities; and
- Cement plants.

The modeling approach for these types of sources are beyond the scope of this document and it is recommend that the project sponsor contact their lead agency for further information on how to address emissions from these sources if they are located within the project radius.

2.1.3 Minor, Low-Impact Sources

The District has identified several sources that do not pose a significant health impact even in combination with other nearby sources. These determinations were made through extensive modeling, source tests, and evaluation of their TAC emissions. The minor, low-impact sources include:

- Roads with less than 10,000 total vehicles per day and less than 1,000 trucks per day;
- Non-diesel boilers;
- Soil-vapor extraction wells; and
- Cooking (excluding under-fired charbroilers) and space-heating equipment.

Sources that meet these criteria can be excluded from the CEQA process.

2.2 Identifying Receptors

For the purpose of this document, receptors are defined as people—children, adults, and seniors—occupying or residing in:

- Residential dwellings, including apartments, houses, condominiums;
- Schools, colleges, and universities;
- Daycares;
- Hospitals; and
- Senior-care facilities.

Modeling should assume that these dwellings and facilities shelter receptors. At this time, the methodology does not include significant thresholds for on-site and off-site worker exposures. The Occupation Safety and Health Administration (OSHA) is the main federal agency that adopts laws and regulations for ensuring safe and healthful work environment to prevent injuries and protect the health of workers. All employers must follow OSHA regulations to ensure the health and well being of their employees. As part of the District's permitting process, exposures to off-site workers and residents are evaluated prior to issuing any permits.

2.3 Determining the Project Radius

For assessing community risks and hazards, the District recommends that a region around the proposed project be defined by a *project radius* for assessing potential impacts on new receptors and cumulative impacts of new sources. More specifically, a 1,000 foot radius is generally recommended around the project property boundary to identify existing sources that may individually or cumulatively impact new receptors and to identify existing sources that may contribute to the cumulative impact of new sources. The following section provides details on the purpose of and methods for setting the project radius.

2.3.1 New Receptors

For any proposed project that includes the siting of new receptors, assess impacts from sources of toxic air contaminants and $PM_{2.5}$ within 1,000 feet of the proposed project. The 1,000 foot radius is recommended for assessing risks and hazards from both individual sources and the cumulative effects of multiple nearby sources (i.e., proposed project plus existing and foreseeable future projects).

For large, complex sources, such as those listed in Section 2.1 above, a larger radius may be appropriate, but the specifics should be determined on a case-by-case basis.

2.3.2 New Sources

For assessing the project alone impacts of a new source or new sources, no project radius is recommended. In this case, the location of maximum risk, hazard, and $PM_{2.5}$ concentration affecting a receptor should be identified.

For assessing the *cumulative* impacts of a new source or sources in combination with existing sources, a project radius is recommended. Assessment of impacts from existing sources within 1,000 feet of the new source(s) in combination with risks and hazards from the new source(s) is recommended. Once the location of the maximally impacted receptor is identified for the new source(s), additional cumulative impacts are assessed at that location from other sources within the radius of the project (i.e. not the receptor). Assessments should sum individual hazards or risks to find the cumulative impact at the location of the maximally impacted receptor from the new source(s).

2.3.3 Constructing the Project Radius

To construct the project radius, a polygon should be formed that is 1,000 feet from the property boundary of the new development. GIS programs provide a proximity feature for constructing such polygons based on linear distance. The polygon may be constructed by hand following the steps below (see Figure 4):

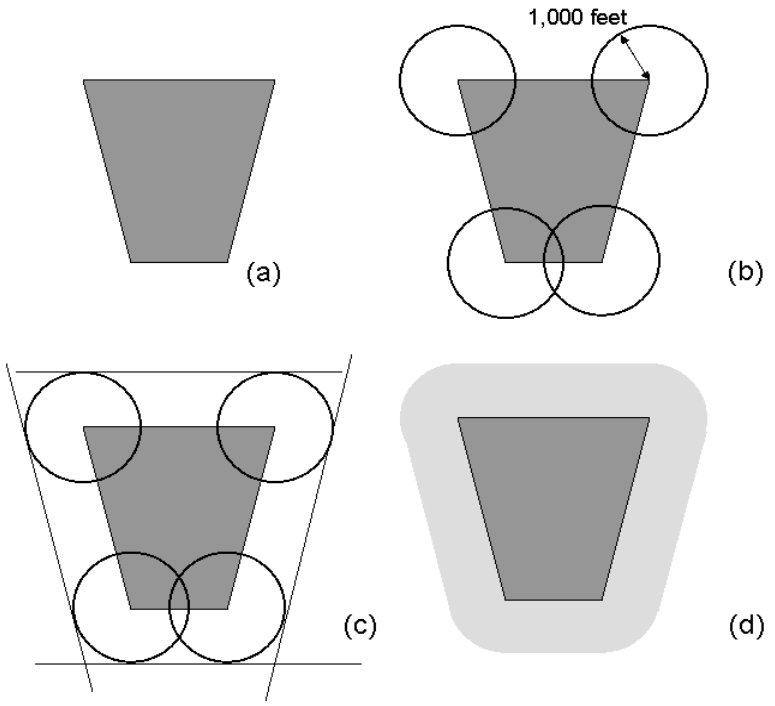
1. Create a map to scale representing the property boundary of the proposed project.
2. On the map, construct circles centered on the corners of the property boundary.
3. Form a polygon by drawing straight lines that are tangent to adjacent circles.

2.3.4 Selecting an Approach

As outlined in Section 1.0, the recommended methodology follows a tiered sequence of analysis, with the level of effort and requisite site-specific information increasing as the user progresses from screening to site specific modeling. Since the data requirements and screening or modeling tools differ with the approach, the user is encouraged to plot his or her approach in advance and select the appropriate tools as needed. The following list provides an outline of the data,

screening tools, or models necessary for each of the tiered approaches. Subsequent sections describe the data, screening tools, and models—as well as where to find them—in more detail.

Figure 4. Constructing the project radius. The shaded polygon (a) represents the property boundary. Circles of 1,000 foot radius (b) are constructed with centers at the polygon corners. Line segments (c) are drawn tangent to the circles. Line segments are truncated at the points of tangency to create the project radius (d).



Approach: Check source locations relative to the 1,000 foot project radius
Data:

- 1,000 foot project radius
- Source locations

Approach: Project Screening
Data/Tools:

- 1,000 foot project radius
- Source locations
- Screening tables (stationary, roadway, railroad tracks)
- Screening tool (construction)
- Receptor locations (for new sources)

Approach: Detailed Modeling
Data/Models:

- 1,000 foot project radius
- Stationary source: locations, emissions, release parameters
- On-road mobile: Roadway locations, traffic counts for cars and trucks, emission factors
- Off-road mobile: location data, activity estimates, load factors, emission factors
- Meteorological data
- Receptor locations (for new sources)
- One or more of the following models: SCREEN3, ISC, AERMOD, CAL3QHCR

3.0 SCREENING TABLES

The methodology outlined here provides a stepwise process that indicates the need for and approach for conducting a more detailed risk analysis. In the first step, project characteristics and distances from common sources are used to screen projects using District-provided screening tables for surface streets, highways, and permitted sources. This section describes how to use the screening tables and the methodology used to develop the tables.

3.1 Roadways

The District developed roadway screening tables for all California highways and surface streets. Surface street screening tables are based on annual average daily traffic (AADT) counts. In order to use the tables, project sponsors must first gather vehicle count information for all major roadways within 1,000 foot radius of the proposed project. Only roadways that have over 10,000 vehicles per day should be included in the evaluation.

3.1.1 Traffic Counts

The Traffic Data Branch of the California Department of Transportation (Caltrans) collects and disseminates on-line (http://traffic-counts.dot.ca.gov/) traffic counts in various formats for freeways and roadways that are part of the State Highway System. State Highways are signed Interstate, California, and US, as shown in the examples in Figure 5 below. Caltrans does not collect traffic count information on locally maintained surface streets. Count information for locally maintained streets is available from the City or County Public Works Department, Traffic Engineers office, in the area where the street is located or from the County-specific Congestion Management Authority.

Caltrans makes available the following data sets:

- **Traffic Volumes** (Annual Average Daily Traffic; AADT) for all vehicles on California State highways. Searches by route of these data sets are available on-line (http://traffic-counts.dot.ca.gov/). Data sets include traffic count estimate for highway segments relative to milepost markers or major cross streets. For projects south or west of the nearest milepost location, select counts designated as “back”. For projects north or east of the nearest milepost location, select “ahead”.

- **Truck Traffic** (Annual Average Daily Truck Traffic) on California State highways. Annual average daily truck traffic is estimated as the total truck traffic for the year divided by 365 days. Counts are provided relative to the post mile markers. For projects south or west of the nearest milepost, select counts designed as "B" for back leg. Projects north or east of a mile post, select "A" for ahead. The "O" designation is used for cases in which the counts along the back and ahead legs are equal.

Figure 5. Caltrans collects and disseminates traffic counts for State Highways, which are signed as Interstate, California, and US.







Annual average daily traffic is the total volume for the year divided by 365 days. The traffic count year is from October 1st through September 30th. Only a few locations in California are actually counted continuously, but most counts are verified periodically. Traffic counting is generally performed by electronic counting instruments moved from location throughout the State in a program of continuous traffic count sampling. The resulting counts are adjusted to an estimate of annual average daily traffic by compensating for seasonal influence, weekly variation and other variables. Each count location is identified by the post mile which corresponds to a point on a highway. The post mile increases from the beginning of a route within a county to the next county line generally increasing from south to north and west to east directions. The post miles are reset at each county line. All traffic volume figures listed include traffic in both directions unless otherwise indicated. Included in the data is an estimate of the "peak hour" traffic at all points on the State highway system. This value is intended for use in estimating the amount of congestion experienced and indicates how near to capacity the highway is operating. Peak hour traffic normally occurs on the roadway every weekday and on a few rare occasions, the peak hour counts are exceeded a few hours each year.

In addition to the highway counts, California Environmental Health Tracking Program (CEHTP) has developed a traffic volume linkage tool that allows user to obtain traffic volumes near specific locations. The CEHTP is a program within the California Department of Public Health and is funded by the Centers for Disease Control and Prevention. The traffic counts are estimated using the Caltrans Highway Performance Monitoring System (HPMS) data for California based on the year 2004. The web connection to the site can be found at: http://www.ehib.org/page.jsp?page_key=136. The tool can be used to determine the number of vehicles that travel daily near a proposed project. The user enters the latitude and longitude of a site location and the radius of influence for which roadway traffic are needed. The tool includes a program that geocodes individual street address to a latitude and longitude coordinate system or the coordinates may be determined through Google Earth™ as well. The tool provides AADT along each roadway and a summation of all traffic within the radius of influence. The advantage of this program is that it provides surface street counts for most major surface streets in the Bay Area. However, the data are from 2004 and may not be reflective of current site conditions. The

data are appropriate for screening purposes, but the District recommends contacting the County Public Works Department or Congestion Management Authority for site-specific modeling analysis. For projects in San Francisco, the San Francisco Transportation Agency maintains a program called SFCHAMPS that contains the projected traffic volume for all surface streets in San Francisco.

3.1.2 Surface Streets

Surface streets are defined as any road in the Bay Area that is not designated a California highway. Surface streets include both roads on rural and urban lands that have been incorporated into a city's jurisdiction or are un-incorporated and are part of the county. Proximity to the roadway and the vehicle traffic on that roadway are key factors in determining whether the impact from a local surface street is significant under CEQA. To determine the impact from local surface streets, the District developed county specific surface street screening tables based on the AADT on a roadway.

The tables were developed using the following methodology:

- $PM_{2.5}$ concentrations were estimated using the base year 2014. For the 70 year cancer risk analysis, annual average emissions were estimated using the latest version of California Air Resources Board's (CARB) EMission FACtors (EMFAC2007) for 2014 through 2040. Because EMFAC2007 does not estimate emissions beyond 2040, the emissions from year 2040 where then applied to remaining years (2041 through 2084).

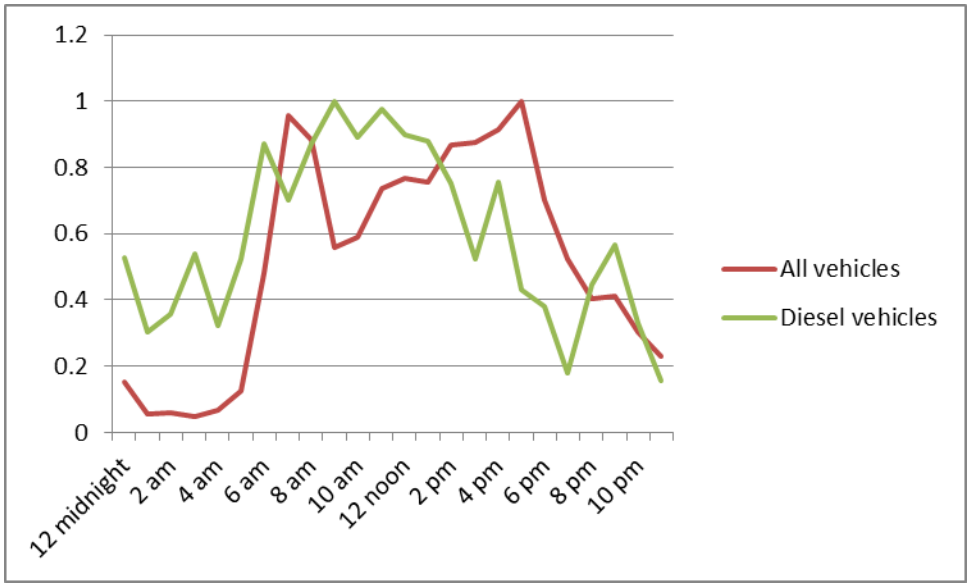
- Modeling was completed for AADT ranging from 10,000 to 100,000 vehicles per day. The AADT and annual emissions were scaled by the hourly diurnal factor derived using the VMT for $PM_{2.5}$ and diesel particulate matter (see Section 4.3.3.1). The diurnal scaling factor was developed by dividing each hourly VMT by the total VMT estimated for the day. The AADT and emissions were then multiplied by the scaling factor for each hour to develop hourly vehicle volumes and emissions. Figure 6 presents the diurnal scaling factors for Alameda County as an example of what was used in the model. The two different diurnal factors were derived depending on whether the model was estimating concentrations from all vehicles versus diesel trucks alone. As illustrated in the figure, there are two peak emissions point corresponding to the morning and evening commute times. For the diesel exhaust, the peak appears to occur at 9 am. All of the nine Bay Area counties have similar diurnal patterns.

- The District averaged the county-specific emissions from EMFAC2007 for speeds of 0 mph to 35 mph based on a temperature of 60 degrees Fahrenheit and humidity of 60%.

- Hourly vehicle volume and emissions were input into roadway model CAL3QHCR to estimate annual average concentrations. All roadways were assumed to be at ground level and receptors were set at six feet (1.8 meters). The model was run for to estimate $PM_{2.5}$, total organic gases, and diesel exhaust concentrations. The percentage of trucks traveling on surface streets was estimated using the California Motor Vehicle's Stock Travel and Fuel Forecast (MVSTAFF) report (http://www.dot.ca.gov/hq/tsip/tab/mvstaff.html) for 2006. This annual report estimates,

and forecasts the annual statewide and countywide number of vehicles, vehicle miles of travel, vehicle fuel consumption, and vehicle fuel economy. The fraction of trucks traveling on surface streets was estimated by weighing the truck VMT by the total VMT for all vehicles on non-State highways per county (see Table 2). MVSTAFF defines trucks as vehicles with at least two axles and six tires. EMFAC2007 county total diesel emission factors (which include all diesel vehicles) were adjusted to match the MVSTAFF definition of truck counts.

Figure 6. Example Diurnal Scaling Factor for Alameda County (relative to peak-hour traffic)



- Meteorological data collected from the District's monitoring stations were input to the CAL3QHCR model. The meteorological station and year the data were collected are noted in the screening tables. Each roadway was modeled assuming a link length of one kilometer.

- Age sensitivity factors (ASF) were applied in estimating the cancer risk to yearly emissions starting in 2014 through 2030. ASFs are used to account for the increased susceptibility of infants and children to carcinogens, as compared to adults. A factor of 10 was applied for exposures that occur from the third trimester of pregnancy to two years of age, and by a factor of three for exposures that occur from two years through 15 years of age (see Section 4.3.3.1 for how these age sensitivity values were applied).

Table 2. Truck Percentage on Non-State Highways using MVSTAFF 2006

County	Estimated Truck % along non-state highways
Alameda	4.09
Contra Costa	3.59
Marin	2.84
Napa	3.91
San Francisco	2.85
San Mateo	3.13
Santa Clara	3.51
Solano	3.63
Sonoma	4.32

- The screening tables were further refined to account for anticipated diesel reductions from CARB's On-road Heavy Duty Diesel Vehicles (In-Use) Regulation[1]. The District estimated a percentage of diesel reduction anticipated per year based on phased in compliance dates specified in the diesel regulations adopted by CARB. Table 3 presents a summary of the diesel reduction anticipated per year for all diesel vehicles.

Table 3. Percent Reduction Anticipated per Year Based on CARB's Diesel Regulations

Year	Emission Reduction % based on CARB diesel regulations
2014	0.22
2015	0.37
2016	0.39
2017	0.41
2018	0.41
2019	0.4
2020	0.38
2021	0.38
2022	0.38
2023	0.36
2024	0.34
2025	0.31
2026	0.29
2027	0.267
2028	0.244
2029	0.221
2030	0.198
2031	0.175
2032	0.152
2033	0.129
2034	0.106
2035	0.083
2036	0.06
2037	0.037
2038	0.014
≥ 2039	0

The screening tables present the $PM_{2.5}$ concentrations and cancer risks for roads with 10,000 to 100,000 vehicles per day at specified distances away from the edge of the nearest travel lane of a road to the project. Each table presents concentrations for north/south or east/west roadway configurations. These sets of tables correspond to projects located upwind or downwind of the roadway with respect to the prevailing wind direction. Concentrations were estimated 10 feet, 50 feet, 100 feet, 200 feet, 500 feet, 700 feet, and 1,000 feet from the edge of the roadway (farthest lane) closest to the project. Roadways with less than 10,000 vehicles per day are consider minor, low-impact sources and inclusion of these roads in CEQA evaluation is not warranted. In addition, the tables do not include acute or chronic noncancer hazards since the maximum hazards estimated from the highest AADT were significantly below the thresholds.

The first step in using the tables is to download the county specific tables in which the project will be located. The screening surface street tables are located at the District web site: http://www.baaqmd.gov/Divisions/Planning-and-Research/CEQA-GUIDELINES/Tools-and-Methodology.aspx. Prior to using the tables, the user must know: (1) which roads exceed 10,000 AADT within 1,000 foot radius of the project and their associated AADT and (2) the distance from the project to the roadway.

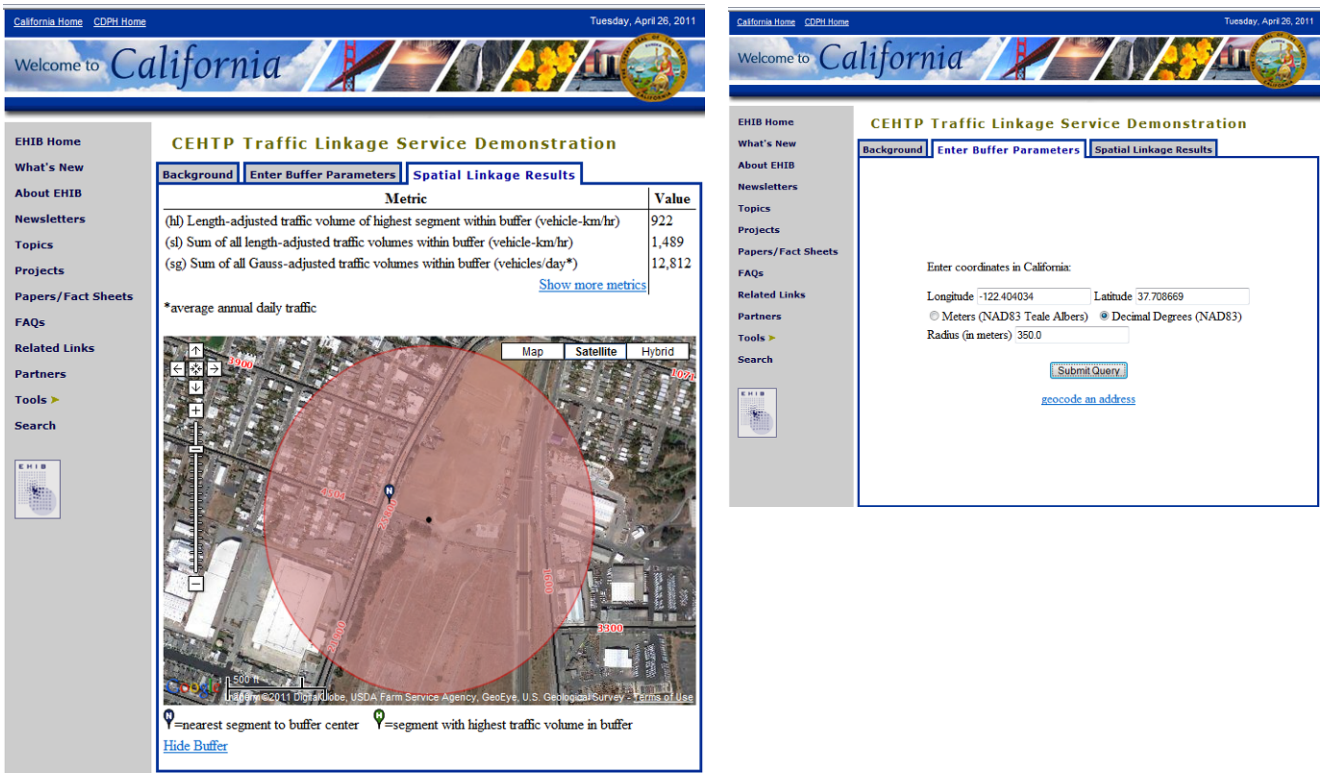
To identify roads with greater than 10,000 AADT near a project site, the District recommends using CEHTP's traffic volume tool (see Section 3.1.1 for further discussion). The web connection to the site can be found at: http://www.ehib.org/page.jsp?page_key=136. The tool can be used to determine the number of vehicles that travel daily near a proposed project. The user enters the latitude and longitude (in degrees) of a project location and the radius of influence for which roadway traffic are needed. The tool includes a program that geocodes individual street address to a latitude and longitude coordinate system or the coordinates may be determined through Google Earth™ by selecting "option" in the "tools" bar and clicking on "show lat/long in decimal degrees". The tool then provides an aerial map of the project site with the AADT along all roadways within a user defined radius around the project. An example is shown below in Figure 7 for a hypothetic

[1] Information available online at http://www.arb.ca.gov/msprog/onrdiesel/onrdiesel.htm

project in San Francisco. The latitude and longitude coordinates were taken from Google Earth™. In this example, only the main road going through the center of the circle has AADT greater than 10,000 vehicles (i.e., 25,800).

To determine the distance from the project to the roadway, the project sponsor can use the ruler tool in any mapping program. District routinely uses the ruler tool in Google Earth™ to measure the distance from the edge of the project to the nearest traffic lane. Continuing with the example in Figure 7, Plant Number 3520 is located approximately 276 feet west of the roadway that has 25,800 vehicles per day (see Figure 8).

Figure 7. Example of the CEHTP's Traffic Count



The user then opens the county-specific surface street screening table in which the project is located. Based on the predominant direction of the roadway, the user selects either the north-south or east-west directional tables. For the example in Figure 8, the roadway is located in San Francisco in a north-south direction, has 25,800 vehicles per day, and is approximately 276 feet from the source. To estimate the risks and hazards, the user matches the AADT in the row header with the distance from the project to the roadway in the column header. For cases in which the exact AADT or distances are not estimated in the table, the user should select the more conservative value between the two estimated values. In Table 4, the estimated cancer risk for the example is 2.31 cases per million and the $PM_{2.5}$ concentration is 0.092 ug/m^3.

Figure 8. Example of Google Earth™ Ruler Tool



The cancer risk and $PM_{2.5}$ concentrations can be further refined by linearly interpolating the AADT and the distance between the project and the roadway. For example, the user can average the values between 20,000 and 30,000 AADT to estimate the values for a roadway has an AADT of 25,800. In the example, the $PM_{2.5}$ concentration for 25,000 AADT at 200 feet would be 0.077 ug/m^3 (the average between 0.061 ug/m^3 at 20,000 AADT and 0.092 ug/m^3 at 30,000 AADT). To further refine the estimate, the user can also linearly interpolate based on the distance. In the example above, the project is located approximately 300 feet west of the roadway with an AADT of about 25,000. The first step is to determine the $PM_{2.5}$ concentrations at 200 and 500 feet for an AADT of 25,000 by averaging the values at 20,000 and 30,000 AADT (see Table 5). The next step is to then ratio the $PM_{2.5}$ concentrations for 25,000 AADT by the difference between the values at 200 feet and 500 feet as shown in the calculation below.

$$PM_{2.5\ 300\ feet} = PM_{2.5\ 200\ ft} - (PM_{2.5\ 200\ ft} - PM_{2.5\ 300\ ft}) \times (200\ ft - 300\ ft) / (200\ ft - 500\ ft)$$
$$= 0.077 - (0.077 - 0.027) \times (-100\ ft)/(-300\ ft)$$
$$= 0.060\ ug/m^3$$

Another way to interpolate the concentration between distances is to determine the incremental change in concentrations over even distances. In the example above, the user can estimate the $PM_{2.5}$ concentrations for every 100 feet increments from 200 to 500 feet. The user subtracts the difference between the two distances in the table (in this example, it would be 0.077 ug/m^3 – 0.027 ug/m^3 = 0.050 ug/m^3) and divides by the number of 100s between the distances (i.e, three). The incremental difference for each progression of 100 feet is 0.017 ug/m^3. This implies that for every 100 feet that a project moves further away from that roadway, the $PM_{2.5}$ concentration decreases by 0.017 ug/m^3. In this example, the $PM_{2.5}$ concentration at 300 feet is then 0.060 ug/m^3 ($PM_{2.5}$ concentration of 0.080 at 200 feet subtracted by the increment of 0.017 ug/m^3) and is 0.043 ug/m^3 at 400 feet.

Table 4. Example Cancer Risk and $PM_{2.5}$ Estimation for Surface Street

NORTH-SOUTH DIRECTIONAL ROADWAY							
Annual Average Daily Traffic	Distance East or West of Surface Street - Cancer Risk (per million)						
	10 feet	50 feet	100 feet	200 feet	500 feet	700 feet	1,000 feet
1,000	No analysis required						
5,000							
10,000	2.13	2.10	1.49	0.65	0.36	0.27	0.22
20,000	2.22	2.49	2.22	1.55	0.62	0.51	0.38
30,000	3.37	3.56	3.28	2.31	0.97	0.75	0.55
40,000	4.26	4.46	4.27	3.10	1.33	1.06	0.79
50,000	5.79	6.49	5.78	4.00	1.68	1.33	0.96
60,000	7.81	8.55	7.34	4.76	1.95	1.55	1.15
70,000	9.82	10.60	8.90	5.52	2.22	1.77	1.33
80,000	11.22	12.12	10.17	6.31	2.53	2.02	1.52
90,000	12.63	13.63	11.44	7.10	2.85	2.27	1.71
100,000	14.03	15.15	12.71	7.88	3.17	2.53	1.90

NORTH-SOUTH DIRECTIONAL ROADWAY							
Annual Average Daily Traffic	Distance East or West of Surface Street - PM2.5 Concentration (ug/m^3)						
	10 feet	50 feet	100 feet	200 feet	500 feet	700 feet	1,000 feet
1,000	No analysis required						
5,000							
10,000	0.080	0.063	0.044	0.016	0.012	0.000	0.000
20,000	0.092	0.101	0.092	0.061	0.021	0.016	0.012
30,000	0.129	0.147	0.129	0.092	0.032	0.022	0.017
40,000	0.166	0.193	0.175	0.120	0.051	0.037	0.024
50,000	0.249	0.267	0.239	0.166	0.064	0.050	0.029
60,000	0.341	0.359	0.304	0.198	0.076	0.057	0.039
70,000	0.433	0.451	0.368	0.230	0.087	0.064	0.050
80,000	0.495	0.516	0.421	0.263	0.099	0.074	0.057
90,000	0.557	0.580	0.474	0.296	0.111	0.083	0.064
100,000	0.618	0.645	0.526	0.329	0.124	0.092	0.071

Table 5. Linearly Interpolated $PM_{2.5}$ Concentrations Based on Distance and AADT

AADT	200 feet	300 feet	500 feet
20,000	0.061	NA	0.021
25,000	0.077	0.060	0.027
30,000	0.092	NA	0.032

A similar methodology can be applied to cancer risk. In this example, the project in San Francisco did not exceed the $PM_{2.5}$ threshold or cancer risk. However, if the thresholds for either cancer risk or $PM_{2.5}$ were exceeded, the user can determine whether additional modeling is warranted or implementation of mitigation measures is appropriate. It should be noted that these screening tables are conservative because they are based on selecting meteorology from a single station as being representative for the entire county. If the user chooses to conduct a more refined modeling analysis by including more site-specific meteorology and truck fractions, the District recommends the following general procedures outlined in Section 4.0.

3.1.3 California Highways

This two part section describes a set of on-line tables that are available for estimating local, air quality-related, risks and hazards in the San Francisco Bay Area generated by motor vehicles traveling on the California State highway network. The first part of this section briefly discusses the data sources and technical approach used to produce the tables, including assumptions made in the technical approach. The second part of this section includes the location of the tables, presents recommended methods for applying the on-line tables, and provides an example application for a Bay Area location.

Data Sources and Technical Approach

To assess the air pollution from on-road motor vehicles on the State highways, an air quality modeling system was developed. This section describes the data sources and technical approach used within the modeling system. The main data sources and model inputs include the roadway network, the emissions, meteorological inputs, receptor locations, and risk factors and reference exposure levels for the emitted pollutants. Each of these elements is briefly described below.

Modeling Period

- The on-line tables for risks and hazards from motor vehicles on California freeways and highways in the Bay Area used emissions from year 2014. All $PM_{2.5}$ concentrations and hazard indices were calculated for year 2014. Cancer risk values were calculated for a seventy year period using emissions starting in year 2014 and continuing to year 2084.

- Meteorological data used were the latest year available for each of 64 stations in the Bay Area. Most of the observed meteorological data were from the period 2000 to 2008, but earlier years were used to maximize spatial coverage. The earliest data set used was from 1970. These years were all assumed to be representative of current meteorological conditions.

Freeway and Highway Network

- A representation of the State roadway network in the Air District boundaries (Figure 9) was developed by reconciling the National Highway Planning Network (NHPN) spatial database with the 2008 Topographically Integrated Geographic Encoding and Referencing (TIGER) Line spatial database. Both these data sources were available as geographical information system (GIS) shapefiles. The NHPN shapefile was adopted as

the primary data source. Road links missing from the NHPN data were filled in using data from the TIGER shapefile. The highway network was divided into segments, *links*, based on the availability of traffic counts on each roadway. There are 1236 links (numbered 0 through 1235) in the Bay Area network for which emissions were calculated and risks and hazards were estimated.

The number of lanes of traffic were developed starting with the number of lanes in the NHPN database. However, NHPN data did not include lane numbers for all highway links. For those links without assigned lane numbers, data were manually collected from Google Earth™ maps.

Emissions

To estimate emissions from on-road motor vehicles, vehicle activity (vehicle miles travelled) was first estimated on each roadway link, then activity-based emission factors were applied to estimate daily average emission totals on each link. Developing these emissions required a variety of data, including traffic volumes (activity), vehicle speeds, fleet mixes, emission factors, diurnal profiles, and growth and control factors (for projecting baseline traffic volumes and emission factors to future years). Sources of data used to estimate emissions are described below[2].

- Traffic activity on the State highway system was represented using 2009 Annual Daily Traffic (AADT) counts from the California Department of Transportation (Caltrans). AADT values represent the total traffic volume for the year divided by 365 days, and these counts are reported for state highway segments defined using milepost values. Caltrans provides AADT data for total traffic and for trucks only, with trucks classified by axle number (the two-axle class excludes pickups and vans with only four tires).

- Year 2009 traffic volumes were forecast to 2012 using county-level growth factors from the EMFAC2007 mobile source emissions model. EMFAC2007 was run for all Bay Area counties for 2009 and 2012, and vehicle miles of travel (VMT) output data were used to calculate the growth factors needed to project 2009 traffic volumes to 2012. Year 2012 activity data was assumed for all subsequent years.

- Vehicle speeds by highway segment were based on 2010 and 2015 outputs from the Metropolitan Transportation Commission's (MTC) BAYCAST-90 travel demand model.

- Link-level composite emission factors for trucks and light-duty vehicles were derived from EMFAC2007's Impact Rate Detail output (*.rtl files). EMFAC2007 was run for each year from 2012 to 2040, and details on calculating composite emission factors are provided in the section that follows. (Emissions past year 2040 were assumed to be constant at year 2040 levels.)

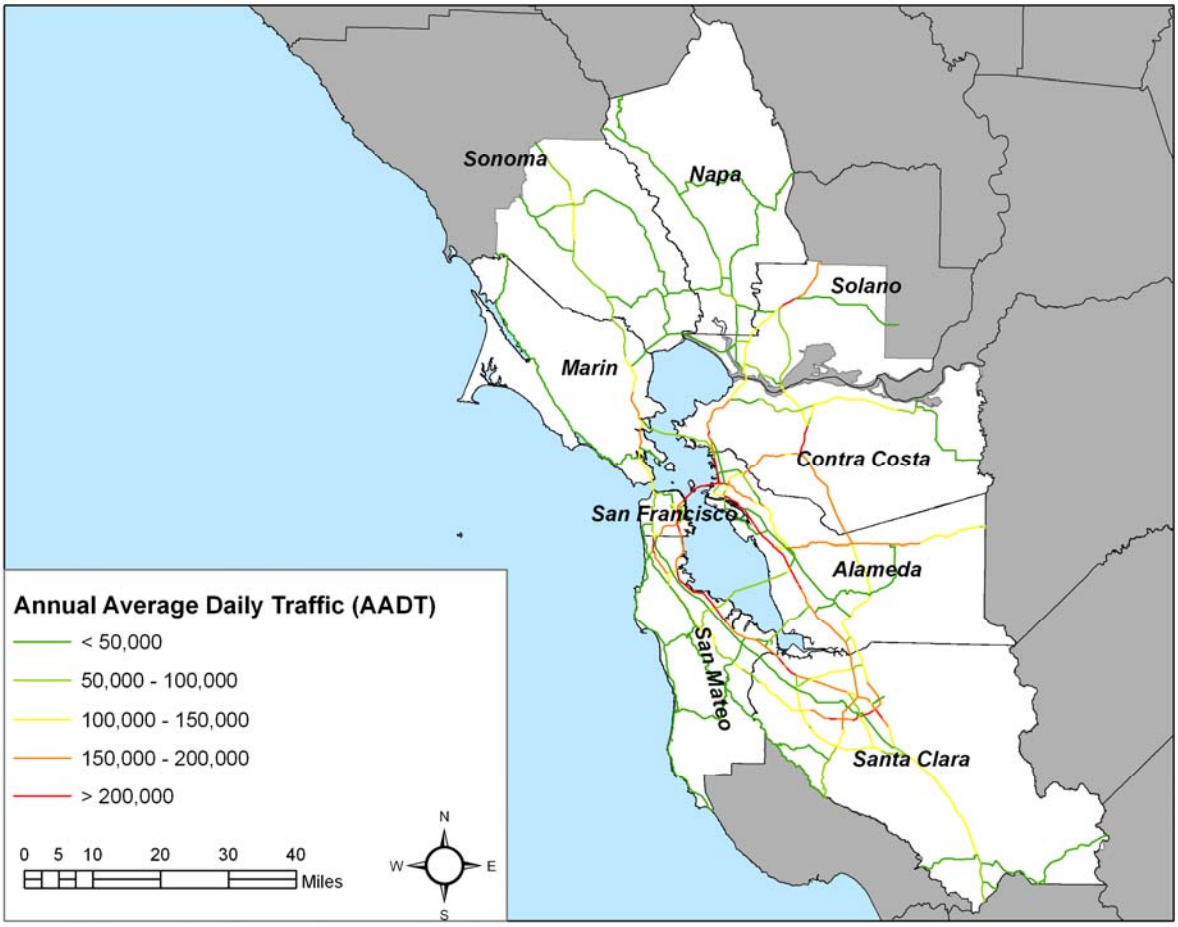
- County-specific diurnal profiles for trucks and light-duty vehicles were derived from EMFAC2007 (see Figure 6; Section 3.1.2).

[2] D. Yuan and S. Reid.Sonoma Technology, Inc., Technical Memorandum, Emissions estimates for State highways. April 27, 2011. STI-910044-TM, under contract to the Bay Area Air Quality Management District.

- Growth and control factors from CARB, including the impacts of the On-Road truck rule, were applied to estimates of emissions from on-road heavy duty trucks (see Table 4; Section 3.1.2).

The activity and speed data described above were linked to the GIS shapefile for the highway network. The base year AADT and truck percentages for each highway segment were joined as attributes to the State highway shapefile based on milepost values and roadway descriptions. Figure 9 shows a map of AADT-derived traffic volumes for the State highways in the Bay Area.

Figure 9. State highway network in the Bay Area Air Quality Management District, showing annual average daily traffic (AADT) on each highway link.



Once traffic volume and speed data were prepared, composite emission factors were developed for each highway link based on the associated truck percentage and average speed. Emission factors were generated for running exhaust and running losses only, as emissions for other modes (e.g., vehicle starts) are not relevant to the state highway system or are negligible compared to exhaust and running loss emissions. This general approach is consistent with the CT-EMFAC model, which is used by Caltrans to estimate transportation project emissions.

However, composite emission factors from CT-EMFAC could not be used directly because CT-EMFAC's truck emission factors include medium-duty vehicles (weight class of 5751 to 8500 lbs), while analysis of MVSTAFF[4] data for the state highway system indicated that Caltrans' AADT truck counts reflect heavy-duty truck (>8500 lbs) activity primarily. As a result, new composite emission factors for NOx, CO, TOG, SO2, CO2, PM, PM10, and PM2.5 were developed directly from EMFAC2007 runs for 2012 through 2040.

Meteorological information

Observed meteorological data from 64 sites in the Bay Area were used to supply wind speed and direction, mixing heights, and stability type information for dispersion modeling. These 64 sites provide reasonable approximations of common meteorological conditions for the 1236 roadway links. Most of the meteorological data are from the period 2000 to 2008, but some of the data were from the 1980's and 1990's. One site located near Moffet Field provided data from 1970. Recent wind measurements are available on-line, in a model-ready format at http://hank.baaqmd.gov/tec/data.

Receptor locations

Receptor locations were defined for locations at right angles to the center of each roadway link at distances of 10, 25, 50, 75, 100, 200, 300, 400, 500, 750, and 1,000 feet from the edge of the roadway (see Figure 10). Two sets of receptor heights were defined: 6 feet, which corresponding to typical breathing heights, and 20 feet, corresponding to a typical second-story height.

Dispersion Model

Emissions estimates, meteorological observations, and receptor locations were input to an air quality dispersion model to estimate near-roadway pollution concentrations. For modeling the State highway network, the model Rcaline[5] was applied. Rcaline is run within the statistical analysis and programming language R[6]. Rcaline provides an interface to the CALINE3[7] model developed by the California Department of Transportation (CalTrans). Given the same inputs, Rcaline has been tested to produce identical outputs CALINE.

Rcaline removes significant limitations found in previous implementations of CALINE. For example, it can be used to model large number of roadway links and a large number of receptors, limited only by available memory and CPU resources. By providing access to CALINE within the R environment, Rcaline facilitates running CALINE using contemporary data sources, such as GIS shapefiles, as input. Rcaline also provides full machine-precision access to CALINE model results in a convenient format. Rcaline facilitates the use basic R commands or third-party

[4] California Motor Vehicle Stock Travel and Fuel Forecast (see http://www.dot.ca.gov/hq/tsip/smb/mvstaff.html).
[5] D. Holstius. Rcaline: Modeling traffic-related pollution with R and the CALINE3 dispersion model. January 24, 2011. (Available on-line at http://169.229.208.128/groups/rcaline/).
[6] The R statistical analysis and programming language and documentation are freely available on-line at http://cran.r-project.org/.
[7] P.E. Benson. A review of the development and application of the CALINE3 and 4 models. *Atmospheric Environment*. Part B. Urban Atmosphere, 26(3):379-390, 1992.

R packages to visualize, compare, and export model results, for example producing shapefiles or Keyhole Markup Language (".kml") files as output.

Figure 10. Receptor locations (shown as white circles) to the west and east of a roadway link (shown as a red line). Receptor distances were taken from the edge of the roadway.



Estimating Risks and Hazards

- Unit risk factors and reference exposure levels for estimating cancer risk and hazard indices from diesel particulate matter and from gasoline exhaust and evaporative running losses were applied (see Sections 4 and 6).

- Age sensitivity factors (ASF) were applied in estimating the cancer risk to yearly emissions starting in 2014 through 2030 (see Table 11 in Section 4).

Output Format

The output from Rcaline used for the highway network is a compressed ".kml" file (".kmz"). A file was produced for each county and for each of the two sets of receptor heights (six feet and 20 feet). For example, two ".kmz" files are available for Alameda County, one at a typical receptor height (Alameda-6ft.kmz) and one at a typical 2nd story receptor height (Alameda-20ft.kmz). These files can be viewed using the Google Earth^{TM} mapping software freely available online at http://www.google.com/earth/index.html. Each file shows a map of the highway network for the county. Selecting a link on the map will bring up a table with $PM_{2.5}$ concentrations in, units of micrograms per cubic meter; cancer risk, in units of expected risk per million; chronic hazard index, a unitless ratio; and acute hazard index, also a unitless ratio, at distances on either side of the highway.

Application of the Tables

The purpose of the highway screening tables is to provide an easy-to-use initial analysis to determine if nearby highway impacts to a new receptor are below the thresholds of significance. The outcome of the screening may be used to assess a determination of no further action or it may indicate that a more refined analysis is warranted.

The highway screening analysis tool present $PM_{2.5}$ concentrations, cancer risks, and chronic and acute hazard index for all State highway segments in the Bay Area at specified distances away from the edge of each highway link within a county. Each highway link includes a table with concentrations for north/south or east/west roadway configurations. Concentrations, risks, and hazards in the tables are provided at 10 feet, 25 feet, 50 feet, 75 feet, 100 feet, 200 feet, 300 feet, 400 feet, 500 feet, 750 feet, and 1,000 feet from the edge of the roadway closest to the project. Concentrations were estimated at two different heights, six feet and 20 feet. The six feet height estimates represent concentration levels when receptors are located on the ground floor of a building; and the 20 feet height estimates concentration levels, risks, and hazards at a eight typical of the second floor of a building. To apply these tables, the following steps are recommended:

1. Download the county-specific ".kmz" files in which the project will be located. The Google Earth™ ".kmz" tables are located at the District web site: http://www.baaqmd.gov/Divisions/Planning-and-Research/CEQA-GUIDELINES/Tools-and-Methodology.aspx. Prior to using the tables, the user must know the distance from the project to the highway. To determine the distance from the project to the roadway, the users can use the ruler tool in any mapping program. The District routinely uses the ruler tool in Google Earth™ to measure the distance from the edge of the project to the nearest traffic lane, see example in Figure 8 (Section 3.1.2) above. For new residential developments, the receptor should be placed at the edge of the property boundary.

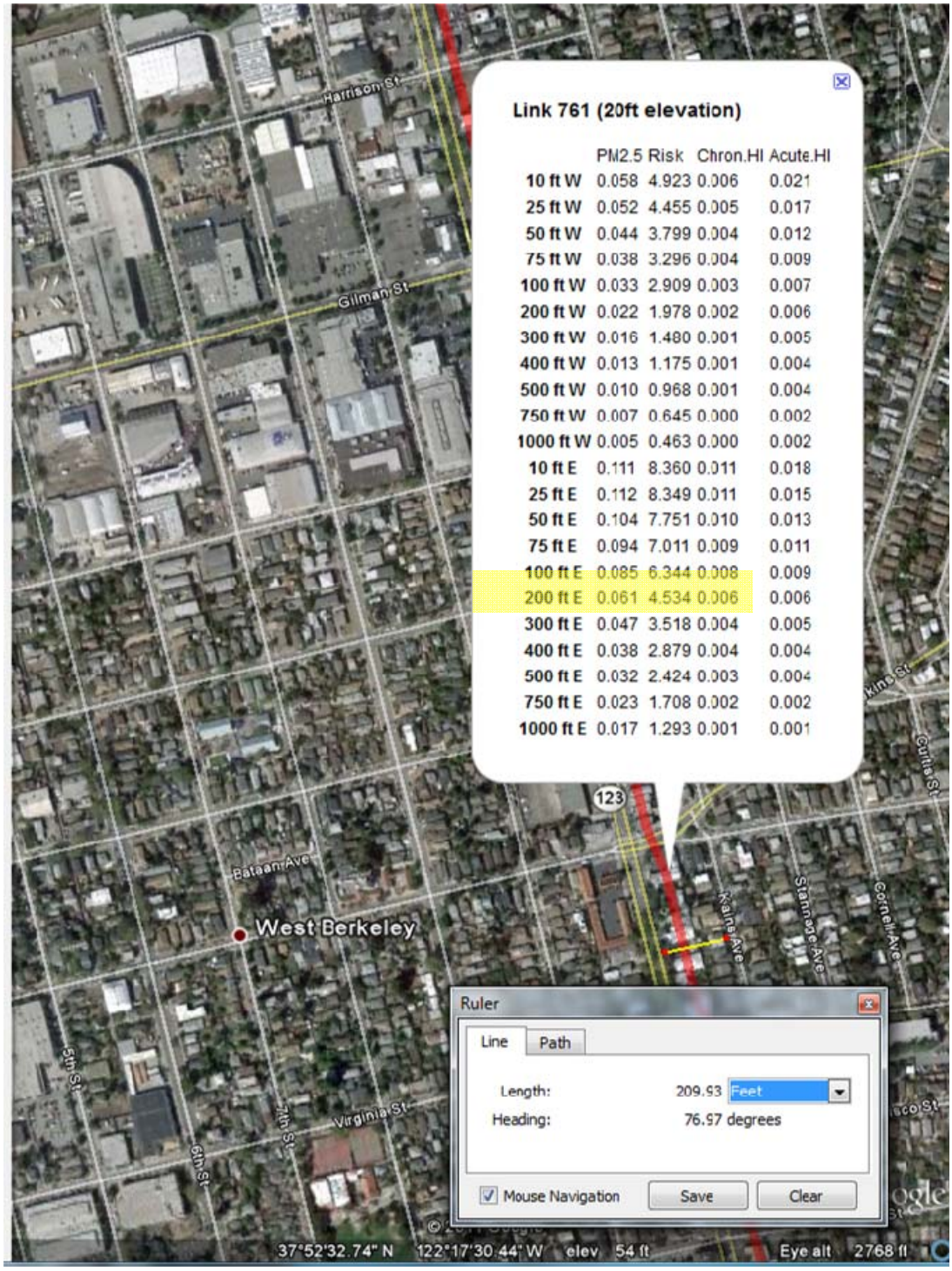
2. If the receptor does not have any significant highway sources within 1,000 foot radius, then the proposed project meets the distance requirements and no further single-source roadway-related air quality evaluation is recommended.

3. If there are highway segments within 1,000 feet of the roadway, the user then clicks on the highway segments within a 1,000 foot radius of the project. As an example, if a proposed project is located 200 feet east of San Pablo Avenue (Highway 123) in Berkeley, and it is known that the ground floor of the project will not house any receptors, the Alameda county ".kmz" file for 20 feet should be downloaded from the BAAQMD website.

4. Once opened in Google Earth™, the closest Highway 123 link to the project should be clicked on for a summary of the estimated risk and hazard impacts at that highway segment. A user would then use the risk and hazard impacts listed at 200 feet east of the freeway in its project analysis. In this case, the highway link table indicates that at 200 feet east of the highway, the $PM_{2.5}$ concentration is estimated at 0.061 ug/m^3, the cancer risk at 4.524 per million, the chronic hazard index at 0.006, and the acute hazard index at 0.006. Figure 11 below illustrates this example using a snapshot from Google Earth™.

5. If a project is located between two highway links for the same roadway, the higher values between the two highway links or distance points should be used.

Figure 11. Example of Applying the Highway Screening Tables



6. If the project is between two distances, tabulated values may be further refined by linearly interpolating between values in the table. The same linear interpolating

methodology outlined for roadways in Section 3.1.2 (see Table 5) may be used for highways.

7. If the user chooses to conduct a more refined modeling analysis by including more site-specific meteorology and truck fractions, the District recommends the following general procedures outlined in Section 4.0.

3.2 Permitted Sources

The District has developed a geographical database of cancer risks, hazards, and $PM_{2.5}$ concentrations for most stationary sources permitted by the District in the year 2008. This database is in the form of a set of compressed Keyhole Markup Language (kml) files that can be viewed with the Google Earth™ software package. The values represent concentrations near the fence-line of the plant.

Note that the screening-level impacts for health risk and $PM_{2.5}$ concentration in the permitted source geographical database are upper-bound estimates. **These values do not represent the true risk values from a plant.** Rather, because the estimates are conservative by design, if a plant passes screening, it can be assumed that it would pass a more site-specific, detailed modeling analysis.

For a few sources, the District modeled the emissions from all sources at the plant as part of its permit and has included the site-specific cancer risk, $PM_{2.5}$ concentrations, and hazards estimated from the health risk assessment in the database. These plants are noted in the database with an "*" at the end of their plant names.

The permitted source screening table contains all the plants in the Bay Area that have permits to operate and that emit one or more toxic air contaminants. The types of permitted sources include, but are not limited to: refinery sources, gasoline dispensing facilities, dry cleaners, diesel internal combustion engines, natural gas turbines, crematories, landfills, waste water treatment facilities, hospitals and coffee roasters. The screening table contains the following information:

- Unique Plant Number used by the District to identify them (Plant Number starting with "G" are gasoline dispensing facilities that be retail or non-retail)
- Plant name
- Geocoded location for the Plant (Universal Transverse Mercador (UTM) coordinates)
- Conservatively estimated health risk impacts due to emissions from the plant that are to be used for screening purposes only: Cancer risk (in millions) and chronic hazard index impacts unless an "*" has been added to the end of the plant name, in which case, the values were derived from a site-specific health risk assessment. Please note that the screening values do not include acute hazard index since the maximum values are significantly below the thresholds.
- Conservatively estimated $PM_{2.5}$ concentrations (in units of micrograms per cubic meters)

The screening-level health risk impacts in the permitted source screening table are calculated using health effect values adopted by the Office of Environmental Health Hazard Assessment

(OEHHA); health-protective assumptions relating to the extent of an individual's exposure, including age sensitivity factors; and a conservative modeling procedure to establish the extent to which a TAC is dispersed in the atmosphere after its release from the source.

For permitted source categories other than gasoline dispensing facilities, the screening-level impacts for health risk and $PM_{2.5}$ concentrations in the permitted source screening table are based on the same screening-level dispersion modeling procedure that was used to develop the trigger levels in District Regulation 2, Rule 5, Table 2-5-1, Toxic Air Contaminant Trigger Levels (http://www.baaqmd.gov/Divisions/Planning-and-Research/Rules-and-Regulations.aspx). This modeling uses a cavity effects screening procedure where dispersion is affected by aerodynamic downwash from a nearby building and relates emission rate to one-hour average ambient air concentrations. The cavity region occurs immediately adjacent to the lee side of the building and is often the "worst-case" dispersion scenario where receptor areas are in close proximity to the source being evaluated. The cavity effects equation is provided in EPA's Screening Procedures for Estimating the Air Quality Impact of Stationary Sources (EPA, 1992), and is incorporated into the EPA SCREEN3 model (EPA, 1995).
The cavity equation is as follows:

$$\text{Conc}_{\text{1 Hour Max}} = Q / (1.5 \times A \times u)$$

Where:
Conc = One hour maximum exposure concentration at the fenceline of the plant (ug/m^3);
Q = Emission rate (g/sec);
A = Cross section area of the building normal to the wind (m^2); and
u = Wind speed (m/sec).

The cavity effects equation requires the selection of the crosswind building area and the average wind speed. A value of 92.7 square meters was used for the crosswind building area (e.g., a building approximately 25 feet high x 40 feet wide). The average wind speed was taken to be two meters per second, based on EPA screening modeling guidelines. The cavity equation was used to estimate maximum one hour concentration. In order to estimate the annual average concentration for chronic exposure, a multiplying factor representing the ratio between annual average and one-hour maximum concentrations of 0.1 was used. This is the high-end value of the range of multiplying factors provided in EPA screening modeling guidelines (EPA, 1982).

Evaluating gasoline dispensing facilities (GDFs) are more complex because emissions come from spills, vents, and the dispensing pumps. For this source categories, the screening health risk calculations were further refined. EPA's AERMOD atmospheric dispersion model was used to develop worst-case ground-level concentrations and to develop distance adjustment multipliers. AERMET processed meteorological data sets used in the matrix of modeling runs include those for Concord, Hunters Point, Oakland Airport, Petaluma Airport, UC Richmond and San Jose Airport. Over two dozen different building dimensions were modeled to include downwash effects. GDF were conservatively modeled as a point source for the storage tank vent with a 10-feet high two inch diameter stack, 0.00035 m/s exhaust gas velocity and 294^oK exhaust gas temperature; and a single volume source for the refueling and spillage at the dispenser with

an initial lateral dimension of 2.3 feet. The fraction of emissions out the vent and at the dispenser was estimated at 0.073 and 0.927, respectively.

The screening health risk values calculated for GDFs are based on the worst-case concentrations determined through the AERMOD modeling results. Distance adjustment multipliers were developed to adjust (lower) the screening health risk values for GDF when the distance from the receptor location to the source is greater than 60 feet. The District followed the same methodology to estimate downwind multipliers for diesel engines since they are ubiquitous throughout the Bay Area. These distance adjustment multipliers are to be used only in conjunction with the screening health risk values for diesel engines and GDFs and may not be used for other source types. The user should contact the District Planning Division to receive copies of the downwind multipliers for these sources.

The screening-level impacts for health risk and $PM_{2.5}$ concentrations in the permitted source screening table do not represent actual impacts. Rather, the values are upper-bound estimates used as a screening tool to determine whether or not a refined modeling analysis is required and to identify those plants that may warrant further analysis to determine actual risk. The calculations used to determine the screening table impacts do not include source specific exhaust information such as stack height, exhaust gas exit velocity, exhaust gas temperature, nor do they account for the distances to actual receptors. A more refined analysis using source specific exhaust parameters, site specific meteorological data, site specific building dimensions and locations, and actual location of source and receptors is expected to result in significantly lower and more accurate values than those found in the permitted source screening table.

The permitted source screening table may be used to determine which plants to include in a refined modeling analysis for a project. The impacts for the plants identified can then be summed and compared to the trigger levels in the CEQA guidance document to determine if further analysis is required. Note that the UTM coordinates represent only a single point at a plant, which may not be the point closest to the project. Also, the reference points (North American Datum, NAD) for the UTM coordinates in the screening table may not be the same for all plants. UTM coordinates for some facilities may be reference to NAD27, while others are reference to NAD83. Potential distance offsets may be as great as 220 meters. In order to ensure that all relevant plants are included, the distance used to identify facilities from the permitted source screening table should extend a reasonable distance beyond the distance specified in the CEQA guidance document and actual locations should be verified.

All plant information within each of the nine Bay Area county were then converted to kml file format (format compatible with Google Earth™) that retained site-specific plant information and geocoded the plant coordinates. Each of the county files can be found at: http://www.baaqmd.gov/Divisions/Planning-and-Research/CEQA-GUIDELINES.aspx.

The Google Earth™ application is a free mapping software package that can be downloaded at: http://earth.google.com/. To use the application, a user should complete the following steps:

- Install Google Earth™ on user's computer;

- Download the county-specific permitted source data in kml file format from the District web site (see link above) onto a user's hard drive;
- Double click on the kmz file on the user's hard drive and it will automatically open Google Earth™ and plot the permitted sources as colored dots on a map; and
- Point to any source and a dialog box will open containing the plant number, GDF number, facility name, and estimates of risk, hazards, and $PM_{2.5}$ concentrations.

The user then uses the "polygon" tool in Google Earth™ to plot the 1,000 foot radius around the plant or the receptor to determine which sources should be included in the single source and cumulative analysis. As previously discussed, the estimates shown in these screening tables are conservative and do not account for dilution of the concentrations further downwind of the source. The District recommends initially summing the values for cancer risk, hazards, and $PM_{2.5}$ from all sources within 1,000 foot radius of the project to estimate cumulative impacts. In the example shown in Figure 12, a rough 1,000 radius (highlighted in yellow) is shown for Plant 10927. For the cumulative analysis, the District recommends summing the values for the two other sources found within 1000 foot radius, namely values for plants G9452 and 15416.

Figure 12. Example Stationary Source Inventory and Boundary



For plants that have "Contact District Staff" in the values, the user should download the "Stationary Source Inquiry Form" located at: http://www.baaqmd.gov/Divisions/Planning-and-Research/CEQA-GUIDELINES/Tools-and-Methodology.aspx. Instructions are provided in the form as to how to fill out and send the form to the District. If any single source exceeds the single source impact thresholds or the sum of all sources exceeds the cumulative impact thresholds then the user should consider possible mitigations that can reduce the potential air quality impacts.

4.0 REFINED MODELING APPROACH

If the screening analysis shows that a proposed project or new development may exceed the $PM_{2.5}$, risk, or hazard threshold, then a more refined modeling analysis may be prepared. A refined analysis is generally more accurate since it incorporates site-specific conditions that are not accounted for the screening approach.

There are several air dispersion models available that can be used in the refined analysis. The choice of model will vary depending on the modelers experience and the available site-specific information. The first tiers of models are screening models that are available through free downloads from US EPA web site. These models are easy to use and require limited site specific information including the types of source (point, area, or volume), dimensions of source, and emissions. These models simulate one source at a time and include default worst case meteorological data to predict the maximum one hour concentrations at a specific distance downwind of the source.

More sophisticated models are highlighted in the next tier of analysis where multiple sources and site-specific meteorological data can be used. The models require some familiarity with air dispersion modeling concepts and site conditions and emission release characteristics of the sources to be modeled. Note that the user is not required to conduct the analysis following this tiered approach; at any time, he or she can skip ahead to perform a more refined analysis.

4.1 General Air Dispersion Modeling Concepts

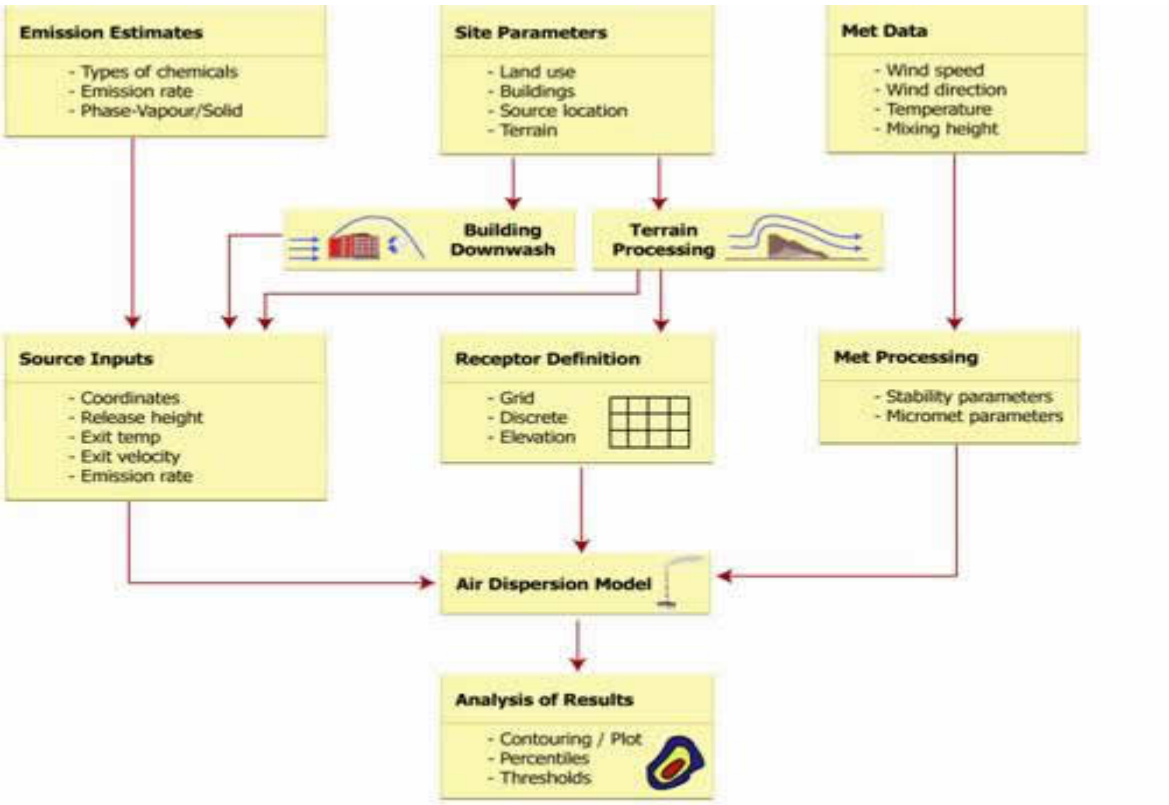
Air dispersion modeling is the mathematical estimation of pollutant impacts from emissions sources within a project radius. Several factors impact the fate and transport of pollutants in the atmosphere including, but not limited to meteorological conditions, site configuration, emission release characteristics, and surrounding terrain. Figure 13[11] presents a general overview of the process typically followed for performing an air dispersion modeling assessment. Highlighted in the figure are some key concepts that need to be defined prior to conducting an air dispersion modeling analysis.

4.1.1 Coordinate System

Any modeling assessment requires a coordinate system of the project radius to be defined in order to assess the relative distances from sources to receptors and, where necessary, to consider other geographical features. Using a standard coordinate system for a project increases the efficiency of the review process while providing real-world information about the site location. For screening purposes, a simple straight line of receptors that are spaced equal distances from the source may suffice. More refined models places receptors along a Cartesian grid or on radial distances from a center point.

[11] CAPCOA, 2009. Health Risk Assessments for Proposed Land Use Projects. Prepared by CAPCOA Planning Managers. Released July 2009.

Figure 13. Generalized Process for Performing a Refined Air Dispersion Modeling Analysis



Source: CAPCOA, 2009.

Most air models use the UTM coordinates. The UTM system uses meters as its basic unit of measurement and allows for more precise definition of specific locations than latitude/longitude. The project sponsor should ensure that the same horizontal datum is used throughout the project to define all objects (sources, buildings, and receptors). Defining some objects based on a NAD27 (North American datum of 1927) while defining others within a NAD83 (North American datum of 1983) can lead to significant errors in relative locations of up to 220 meters. The Google Earth™ mapping application can be used to determine UTM or latitude/longitude coordinates for the project area.

For a localized assessment, the user may use local coordinates that are relative to local set datum and not based on a geographic standard. For example, a facility may reference the northwest corner of the perimeter of the property boundary as the origin (0,0) of the coordinate system and have all other locations identified based on its location relative to this defined local datum. All plant buildings and sources are then related spatially to this origin as well as all site measurements are estimated relative to the local coordinate system.

The only caveat to using the local coordinate system is that it cannot be compared or spatially mapped to other sources or receptors in the actual world. For this reason, it is advantageous to

consider a geographic coordinate system that can specify the location of any object anywhere in the world with precision.

4.1.2 Receptor Grid

A receptor is defined as a point where an actual person (residential) may be located for a given period of time and may include:

- Residential dwellings, including apartments, houses, condominiums;
- Schools, colleges, and universities;
- Daycares;
- Hospitals; and
- Senior-care facilities.

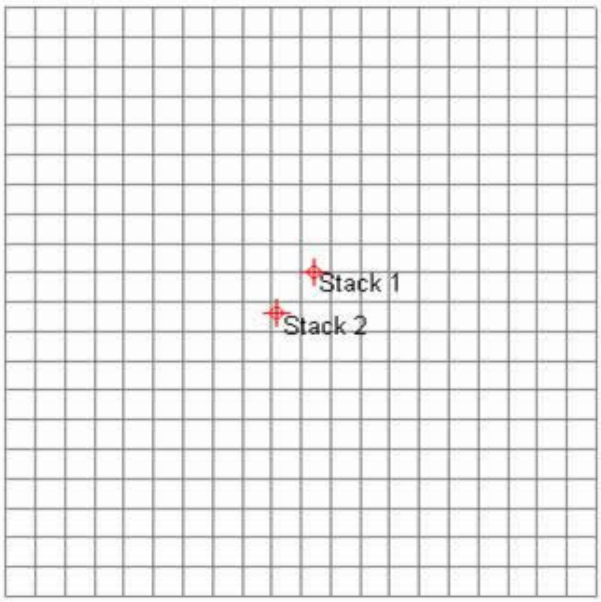
For CEQA evaluations, the length of time can vary from one hour for acute hazard evaluation, one year for $PM_{2.5}$ exposures, and 70 years for chronic cancer risk and hazard assessments. For each of these evaluations, the District is recommending that all sensitive receptors be identified within the project radius. Motels, trailer parks, residential camp grounds, and other places where people reside for long periods should also be considered sensitive, residential receptors.

The receptor grid identifies a series of receptor locations in which the model will estimate air concentrations. The grid does not necessary corresponds to actual home locations, but is a means of developing isopleths that illustrate the dispersion pattern of the source emissions and anticipated downwind concentration in the community or project radius. Discrete receptors that represent actual individualized locations (discrete receptors) where people reside can be added to the model. Fenceline receptors, which correspond to the placement of receptors along the perimeter of the project's property, should only be employed if there are existing or reasonably anticipated future sensitive receptors who will be residing in this area. Receptor grids do not always cover precise locations that may be of interest in modeling projects.

There are several techniques that can be used in air dispersion modeling for defining a receptor grid. The most commonly used receptor grid is the Cartesian grid, which is defined by an origin with receptor points evenly (uniform) or unevenly (non-uniform) spaced around the origin. Figure 14 illustrates a sample uniform Cartesian receptor grid. The grid should encompass the entire area of the project radius and be spaced appropriately to identify the most impacted receptor. For cases with emissions from short stacks or vents and a close property line, a receptor spacing of 10 meters may be sufficient. For taller stacks and greater distances to the property boundary, a receptor spacing greater than 25 meter, but less than 50 meters may be appropriate to ensure adequate coverage of the project area.

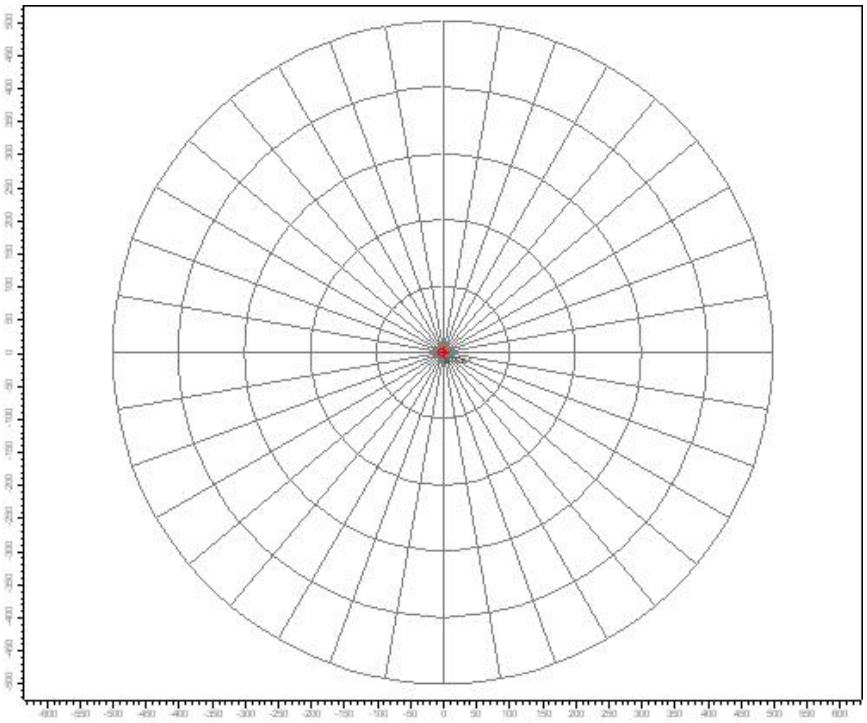
Another less commonly used receptor grid is polar grid system, which are characterized by an origin with receptor points defined by the intersection of concentric rings, which have defined distances in meters from the origin, with direction radials that are separated by specified degree spacing. Figure 15 illustrates a sample uniform polar receptor grid.

Figure 14. Example of a Cartesian Grid



Source: CAPCOA, 2009

Figure 15. Example of a Polar Grid



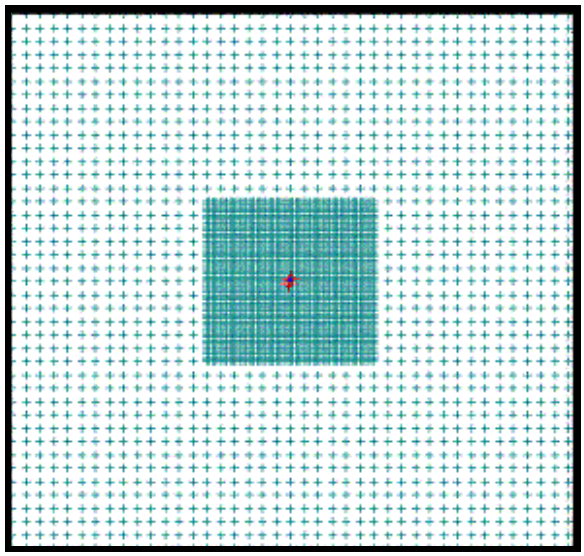
Source: CAPCOA, 2009

Polar grids are used when only one source or one dominant source is being modeled. However, for facilities with a number of significant emissions sources, receptor spacing can become too

coarse (receptor points are too far apart) when using polar grids such that the maximum impacted area is not clearly identified. As a result, polar grids should generally be used in conjunction with Cartesian grid to ensure adequate spacing.

The model estimates a concentration for each point of a grid which requires extensive computational time. For large modeling domains, project sponsors can use a combination of coarse and fine grids in one modeling run to encompass the project area. As illustrated in Figure 16, a fine grid receptor of tightly spaced receptors is defined near the source and larger grid spacing is defined for the area outside of the fine grid. The advantage of this approach is that it reduces the number of receptors, but maintains sufficient resolution such that the maximum impact area is well defined. Receptors should also be placed along the property boundaries. The spacing of these receptors depends on the distance from the emission sources to the facility boundaries. It is the responsibility of the user to demonstrate that adequate receptor grid spacing has been used and that the modeling results have captured all areas that may potentially be impacted from the project where the toxic thresholds may be exceeded.

Figure 16. Sample Combination Grid System with Two Types of Receptor Spacing



Source: CAPCOA, 2009

4.1.3 Averaging Times

A key advantage of the refined modeling analysis is the ability to select the appropriate averaging time with which to compare to the CEQA thresholds. The District has defined different thresholds depending on the health effects and time of exposure. For example, cancer risks and chronic noncancer hazard are assessed for long term exposures over 70 years. Acute noncancer health effects are usually based on a maximum one hour exposure. $PM_{2.5}$ concentrations are based on annual average exposures. The ability to assess air quality using the most appropriate effects-based averaging time means the refined air dispersion models provide a more representative assessment of health and environmental impacts of air emissions from a plant.

In addition to enabling the use of appropriate model averaging times, refined models allow the input of project-specific conditions such as variable source emission rates and hours of operation, to more accurately assess the concentrations over different averaging times. That is, a source that operates only during certain hours of the day can be modeled using only those hours of meteorological data. The averaging time should also reflect the time during which a receptor would be exposed. For example, suppose a construction project that is anticipated to start in 2010 and complete at the end of 2012 is projected to house new residents in 2013. The construction analysis should be performed for two years and compared to the appropriate thresholds. For the residential evaluation, the anticipated air concentrations from roads should be reflective of 2013 for $PM_{2.5}$, diesel exhaust, and acute hazard while the long term cancer exposures should be averaged over 2013 to 2083 (70 year exposure period).

4.1.4 Terrain

Terrain elevation is defined as the elevation relative to the facility base elevation. Terrain elevations can have a large impact on the air dispersion and deposition modeling results and therefore on the estimates of potential risk and hazard to human health and the environment. The terrain type is based on the project area and can be characterized as either being simple or complex described as follows:

- Complex Terrain: the terrain elevations within 50 kilometers of the stack are above the top of the source stack being evaluated in the air modeling analysis (see Figure 17).

- Simple Terrain: the terrain elevations within 50 kilometers of the stack are below the top of the source stack being evaluated in the air modeling analysis. The "Simple" terrain can be divided further into two categories:

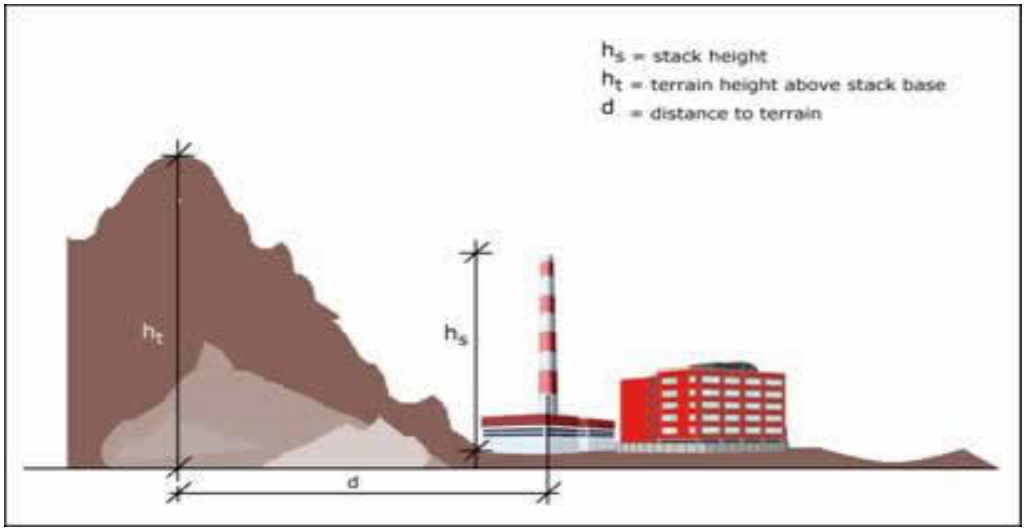
    - Simple Flat Terrain is used where terrain elevations are assumed not to exceed stack base elevation. If this option is used, then terrain height is considered to be zero meters (0.0 m).
    - Simple Elevated Terrain, as illustrated in Figure 18 is used where terrain elevations exceed stack base but are below stack height.

The identification of accurate terrain conditions is the responsibility of the user. It should be remembered that complex terrain is any terrain within the study area that is above the source release height. The appropriate terrain environment can be determined through the use of digital elevation data or other geographic data sources. Digital elevation terrain data is available from a variety of vendors in several different formats. Digital elevation model (DEM) data are available for free from Lakes Environmental's Web GIS web page http://www.webgis.com and USGS DEM files are available from CARB at http://www.arb.ca.gov/toxics/harp/maps.htm. USGS DEMs are in 7.5-minute format for use in the CARB's HARP program and from Lakes Environmental in either 7.5 minute or 1 degree formats.

The District recommends using 7.5-minute data in air dispersion modeling rather than the coarse resolution 1 degree data. The project sponsor should also be mindful that the USGS DEMs are available in two horizontal datums. Older DEMs were commonly in NAD27 (North American

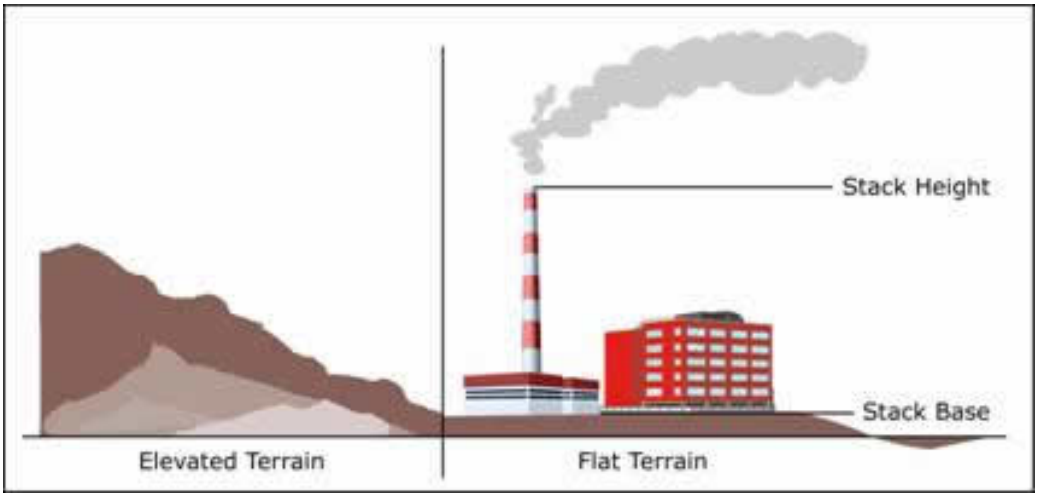
Datum of 1927) while many of the latest versions are in NAD83 (North American Datum of 1983).

Figure 17. Complex Terrain Conditions



Source: CAPCOA, 2009

Figure 18. Two Types of Simple Terrain Conditions



Source: CAPCOA, 2009

There are different requirements for importing DEMs file into refined air models. The user should review the air model's User's Manual to determine if the format is compatible or if files need to exported to another program for preprocessing (i.e., AERMAP must be used to pre-process the digital terrain data to make it compatible for AERMOD).

4.1.5 Urban or Rural Conditions

Refined modeling takes into account different types of land use categories: rural or urban. The classification of a site as urban or rural can be based on the Auer method specified in the EPA document *Guideline on Air Quality Models (40 CFR Part 51, Appendix W)*[12]. From the Auer's method, areas typically defined as Rural include:

- Residences with grass lawns and trees
- Large estates
- Metropolitan parks and golf courses
- Agricultural areas
- Undeveloped land
- Water surfaces

Auer suggests that an area can be classified as urban if it has less than 35% vegetation coverage or the area falls into one of the following use types:

Table 6. Urban Land Use

Type	Use and Structures	Vegetation
I1	Heavy industrial	Less than 5%
I2	Light/moderate industrial	Less than 5%
C1	Commercial	Less than 15%
R2	Dense single / multi-family	Less than 30%
R3	Multi-family, two-story	Less than 35%

Follow the Auer's method, explained below, for the selection of either urban or rural dispersion coefficients:

Step 1: Draw a circle with a radius of three kilometers from the center of the stack or centroid of the polygon formed by the facility stacks. Overlay a grid on top of the circle as illustrated in Figure 18.

Step 2: Identify each square as primarily being urban or rural under the land use classifications in Table 4. If over 50% of all the squares within the circle are I1, I2, C1, R2, and R3, then the area is classified as urban, otherwise the area is classified as rural.

Another approach to selecting the urban versus rural classification is to use the Population Density Procedure where the average population density, p, per square kilometer is determined.

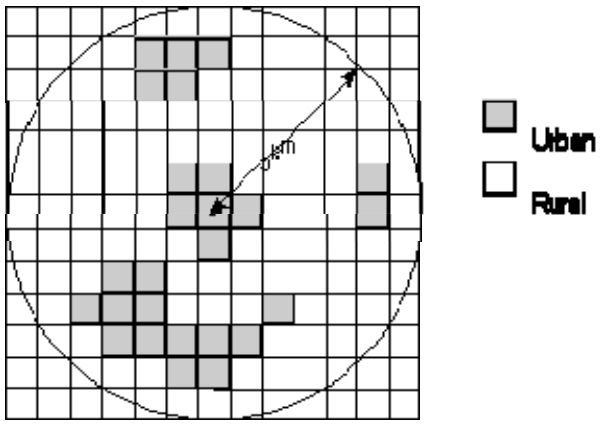
- If $p > 750$ people/km^2, select the Urban option,

[12] U.S. Environmental Protection Agency, 2001. Appendix W to Part 51 Guideline on Air Quality Models, 40 CFR Part 51. U. S. Environmental Protection Agency, Research Triangle Park, NC.

- If p <= 750 people/km^2, select the Rural option.

Of the two methods above, the land use procedure is considered a more definitive criterion. The population density procedure should be used with caution and should not be applied to highly industrialized areas where the population density may be low and thus a rural classification would be indicated, but the area is sufficiently built-up so that the urban land use criteria would be satisfied. In this case, the classification should be urban and urban dispersion parameters should be used. For simplicity, the project sponsor can model both urban and rural land uses and use the most conservative concentrations predicted from the two analyses. In most cases, the rural conditions will produce the highest downwind concentrations.

Figure 18. Example of How to Determine Land Use Designation



Source: CAPCOA, 2009

4.1.6 Building Impacts

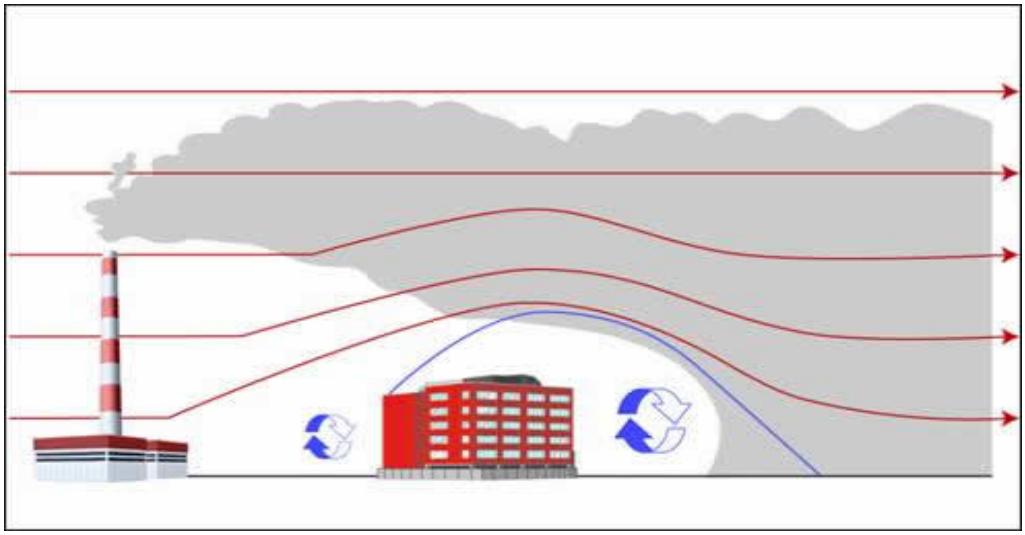
Buildings and other structures near a relatively short stack can have a substantial effect on plume transport and dispersion, and on the resulting ground-level concentrations that are observed. When the airflow meets a building (or other obstruction), it is forced up and over the building. On the lee side of the building, the flow separates, leaving a closed circulation containing lower wind speeds. Farther downwind, the air flows downward again. In addition, building increases the amount of *wind shear* and, as a result, more turbulence, such *as turbulent wake zone* (see Figure 19).

If a plume gets caught in the *cavity* caused by buildings, very high concentrations can result. If the plume escapes the cavity, but remains in the turbulent wake, it may be carried downward and dispersed more rapidly by the turbulence. This can result in either higher (reduced mixing) or lower concentrations (enhanced mixing) than would occur without the building, depending on whether the reduced height or increased turbulent diffusion has the greater effect.

There has long been a “rule of thumb” that a stack should be at least 2.5 times the height of adjacent buildings. This is called the “good engineering practice” (GEP) stack height. The US

EPA[13] states that "If stacks for new or existing major sources are found to be less than the height defined by the US EPA's refined formula for determining GEP height, then air quality impacts associated with cavity or wake effects due to the nearby building structures should be determined."

Figure 19. Dispersion Pattern due to Building Downwash



Source: CAPCOA, 2009

The US EPA's refined formula for determining GEP stack height is:

GEP Stack Height = H + 1.5L

where,

GEP = Good Engineering Practice

H = Building/Tier Height measured from ground to the highest point

L = Lesser of the Building Height (PB) or Projected Building Width (PBW)

US EPA recommends evaluating building downwash only when the building is considered sufficiently close to a stack to cause wake effects. Building effects should only be considered when the distance between the stack and the nearest part of the building is less than or equal to five (5) times the lesser of the building height or the projected width of the building.

$$Distance_{stack\text{-}bldg} <= 5L$$

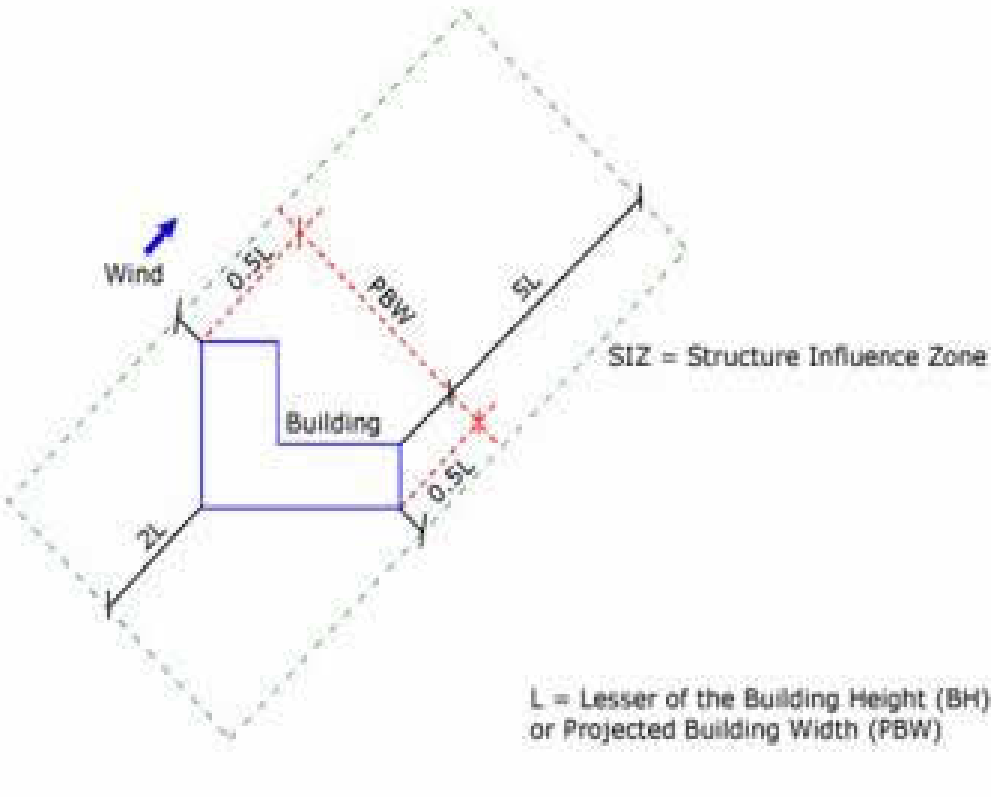
The user can use algorithms in US EPA's Building Profile Input Program – Plume Rise Model Enhancements (BPIP-PRIME) to estimate the directional-specific building heights and widths. For downwash analyses with direction-specific building dimensions, wake effects are assumed to occur if the stack is within a rectangle composed of two lines perpendicular to the wind

[13] U.S. Environmental Protection Agency, 1990. Stack Heights, Section 123, Clean Air Act, 40 CFR Part 51. U. S. Environmental Protection Agency, Research Triangle Park, NC.

direction, one at 5L downwind of the building and the other at 2L upwind of the building, and by two lines parallel to the wind direction, each at 0.5L away from each side of the building, as shown below. L is the lesser of the height or projected width. This rectangular area has been termed a Structure Influence Zone (SIZ). Any stack within the SIZ for any wind direction is potentially affected by GEP wake effects for some wind direction, or range of wind directions (see Figures 20 and 21).

It is the responsibility of the user to identify whether any building in the vicinity of the project meet the GEP requirements and building downwash effects should be considered. The recommended refined models incorporate algorithms to handle building downwash. The screening model, SCREEN3, considers the effects of a single building and the user is prompted to enter the building height, minimum horizontal building dimension, and maximum horizontal building dimension in meters. If using automated distances or discrete distances option in the SCREEN3 model, wake effects are included in the calculations. Cavity calculations are made for two building orientations, first with the minimum horizontal building dimension along wind, and second with the maximum horizontal dimension along wind. For more information regarding the cavity calculations, the user is referred to Section 3.6 of the SCREEN3 User's Guide[15] Section 3.6 (or see Section 3.2).

Figure 20. GEP 5L and Structure Influence Zone (SIZ) Areas of Influence



Source: CAPCOA, 2009.

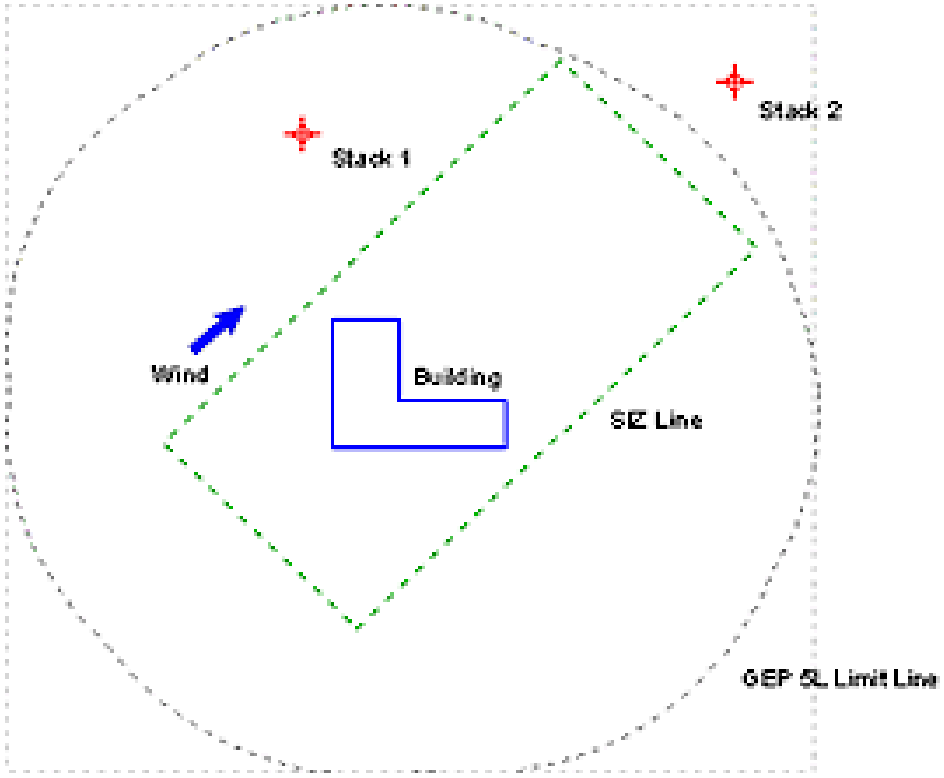
[15] U.S. Environmental Protection Agency, 1995. SCREEN3 Model User's Guide. EPA-454/B-95-004. Office of Air Quality Planning and Standards, Research Triangle Park, NC.

The more refined models (such as AERMOD and ISCST3/ISC-PRIME) can model the effects of complicated sites consisting of up to hundreds of buildings. The inclusion of the PRIME (Plume Rise Model Enhancements) algorithm[16] to compute building downwash produces more accurate results. The following information is required to perform building downwash analysis within BPIP:

- X and Y location for all stacks and building corners.
- Height for all stacks and buildings (meters). For building with more than one height or roofline, identify each height (tier).
- Base elevations for all stacks and buildings.

For a more detailed technical description of the EPA BPIP-PRIME model see the Addendum to ISC3 User's Guide[17]. The BPIP User's Guide[18] provides details on how to input building and stack data to the program.

Figure 21. GEP 360° 5L and Structure Influence Zone (SIZ) Areas of Influence



Source: CAPCOA, 2009

[16] Schulman, L.L., D.G. Strimaitis and J.S. Scire, 2000: Development and evaluation of the PRIME plume rise and building downwash model. Journal of the Air & Waste Management Association, 50:378-390.

[17] Schulman, et al., 1997. Addendum - User's Guide for the Industrial Source Complex (ISC3) Dispersion Models, Volume 1. Office of Air Quality Planning and Standards, Research Triangle Park, NC.

[18] U.S. Environmental Protection Agency, 1995. User's Guide to the Building Profile Input Program, EPA-454/R-93-038, Office of Air Quality Planning and Standards, Research Triangle Park, N.C.

4.1.7 Multiple Sources

In a proposed project, multiple sources may be present, especially when modeling to evaluate cumulative impacts from all nearby sources to a receptor. When the plumes from multiple sources emerge, the plume rise can be enhanced, due to combined wake effects, and the downwind concentrations can be somewhat modified compared to summing individual simulations of the same sources. Source groups in refined models (i.e, AERMOD and ISC) enable the creation of source groups "ALL" that considered all the sources at the same time. Analysis of individual groups of sources in either model can be performed by using the SRCGROUP option. One example may be assigning each source to a separate source group to determine the maximum concentration generated by each individual source.

For screening models, only one source can be simulated at a time. For a screening model analysis, the District recommends summing the concentrations estimated from each source run to assess cumulative impacts from the proposed project.

4.2 Tier 1 SCREEN3

The District recommends the use of SCREEN3 as a first step in the screening analysis. The SCREEN3 model[19] was developed to provide an easy-to-use method of obtaining pollutant concentration estimates. The model is a single source Gaussian plume model which provides maximum ground-level concentrations from point, area, flare, and volume sources as well as concentrations in the cavity zone, and concentrations due to inversion break-up and shoreline fumigation. The SCREEN3 model is designed as a screening version of the Industrial Source Complex (ISC) model described in Tier 2. Worst-case default meteorological data is provided in the model which incorporates the full combinations of wind speeds and stability classes.

The main limitation of the model is that it only estimates concentrations from one source at a time and, consequently, the output from multiple runs must be summed if more than one source is impacting a project or receptor (i.e., sum the maximum concentration from individual source runs to determine impacts from multiple sources). The concentrations are estimated following the procedures outlined in EPA's document "Screening Procedures for Estimating the Air Quality Impact of Stationary Sources"[20].

The SCREEN3 model can be downloaded from the US EPA web site at http://www.epa.gov/scram001/dispersion_screening.htm. A user-friendly interface is also available for SCREEN3 as a free download from Lakes Environmental web site at http://www.weblakes.com/download/us_epa.html.

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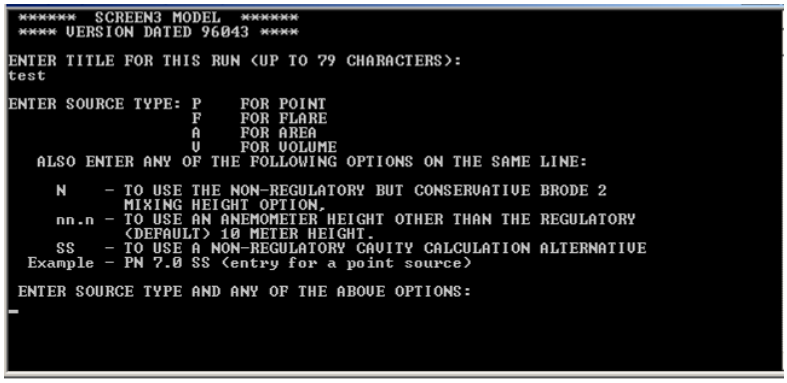
[19] U.S. Environmental Protection Agency, 1995. SCREEN3 Model User's Guide. EPA-454/B-95-004. Office of Air Quality Planning and Standards, Research Triangle Park, NC.

[20] U.S. Environmental Protection Agency, 1992: Screening Procedures for Estimating the Air Quality Impact of Stationary Sources, Revised, October 1992 (EPA-450/R-92-019), User's Guide for the Industrial Source Complex (ISC2) Dispersion Models: Volume II—Description of Model Algorithms. U.S. Environmental Protection Agency, OAQPS, Research Triangle Park, NC 27711. Publication No. EPA-450/4-92-008b.

The input requirements of SCREEN3 are minimal for a screening analysis. Refined models such as ISC, AERMOD, and CAL3QHCR discussed in the Section 4.3, require much more site-specific information allowing for greater characterization and more representative results. To perform a modeling study using SCREEN3, the user must first identified the type of sources to be modeled. As shown in Figure 22, the SCREEN3 can model a point, flare, area, or volume source. For modeling flare sources, the District recommends consulting CAPCOA's Health Risk Assessments for Proposed Land Use Projects (July 2009). Based on the type of source selected, the user will enter the physical and emissions characteristics that includes the emissions rates, stack heights, etc. The model also allows for inputs on meteorological conditions, building downwash, terrain, and fumigations. The most commonly used options are discussed in further detail below.

The District is in the processes of developing a database that contains modeling parameters for some permitted gasoline dispensing facilities, crematoriums, dry cleaners, and prime and back-up diesel generators. Until this information becomes available via the District web site, users should contact the District's Planning Division to obtain such parameters for permitted sources.

Figure 22. Source Types Modeled in SCREEN3



4.2.1 Point Sources

A point source is a single, identifiable source of air emissions. Point sources are typically used when modeling releases from sources like stacks and isolated vents. Typically, vents from gas dispensers at gasoline stations, vent stack from dry cleaner using perchloroethylene, diesel prime and backup generators, boilers, coffee roasters, cremetariums, paint strippers, tanks, and soil extraction units are modeled as point emissions. Each of these sources are a single point where emissions are released into the atmosphere and in some cases, the outlet may be located on the roof of the building while the source itself is located at ground level, such is the case for most diesel back-up generators. Input requirements for point sources in SCREEN3 include:

- **Emission Rate** [g/sec]: The emission rate of the pollutant.
- **Stack Height** [m]: The stack height above ground.
- **Stack Inside Diameter** [m]: The inner diameter of the stack.

- **Stack Gas Exit Velocity** [m/s] or Stack Gas Exit Flow Rate [m3/s]: Either the stack gas exit velocity or the stack gas exit flow rate should be given. The exit velocity can be determined from the following formula:

  $V_s = 4*V/(\pi*(d_s\text{^}2))$

  Where,

  V_s = Exit Velocity
  V = Flow Rate
  d_s = Stack Inside Diameter

- **Stack Gas Temperature** [K]: The temperature of the released gas in degrees Kelvin.
- **Ambient Air Temperature** [K]: The average atmospheric temperature (K) in the vicinity of the source. If no ambient temperature data are available, assume a default value of 293 degrees Kelvin (K). For non-buoyant releases, the user should input the same value for the stack temperature and ambient temperature.

4.2.2 Area Source

An area source is a two-dimensional source of diffused air pollutant emissions such as a landfill, storage pile, slag dump, and lagoon. SCREEN3 allows definition of a rectangular area, aligned with the north-south axes while area sources selected in the more complex models have the ability to handle other shapes and can be rotated relative to the north-south axis. The District typically models emissions from landfills as an area source.

- **Emission Rate** [g/(s-m^2)]: The emission rate of the pollutant. The emission rate for area sources is input as an emission rate per unit area (g/(s-m^2)).
- **Source Release Height** [m]: The source release height above ground.
- **Longer Side Length of Rectangular Area** [m]: The longer side of the rectangular source in meters.
- **Shorter Side Length of Rectangular Area** [m]: The shorter side of the rectangular source in meters.
- **Receptor Height Above Ground** [m or ft]: This may be used to model impacts at "flagpole" receptors where the receptor is located above ground level, e.g., to represent the roof or second story of a building. The default value is assumed to be 0.0 m (i.e., ground-level receptors), but the user may enter 1.5 meter to represent the height of an average adult.
- **Wind Direction Search Option**: Since the concentration at a particular distance downwind from a rectangular area is dependent on the orientation of the area relative to the wind direction, the SCREEN model provides the user with two options for treating wind direction. The regulatory default option is "yes" which results in a search of a range of wind directions (see Section 4.2.4 for more details).

4.2.3 Volume Source

A volume source is a three-dimensional source of diffuse air pollutant emissions that is used to model releases from a variety of industrial sources, such as building roof monitors, fugitive leaks

from an industrial facility, multiple vents, conveyor belts, and roads. Another example would be the emissions from an automobile paint shop with multiple roof vents or multiple open windows. Typically, the District uses the volume source option to model emissions from gas dispensers at gasoline stations, vehicle emissions from roadways, and fugitive emissions from dry cleaners that use perchloroethylene. Default parameters for gasoline stations are described in Section 4.3.2. Parameters required to model volume source include:

- **Emission Rate** [g/sec]: The emission rate of the pollutant in grams per second (g/s).
- **Source Release Height** [m]: The source release height above ground surface at the center of the volume.
- **Initial Lateral Dimension** [m]: See Table 5 for guidance on determining initial dimensions. Units are meters.
- **Initial Vertical Dimension** [m]: See Table 5 below for guidance on determining initial dimensions. Units are meters.
- **Receptor Height Above Ground** [m or ft]: This may be used to model impacts at "flagpole" receptors where the receptor is located above ground level, e.g., to represent the roof or second story of a building. The default value is assumed to be 0.0 m (i.e., ground-level receptors), but the user may enter 1.5 meter to represent the height of an average adult.

Table 7. Recommended Procedures for Estimating Dimensions of Volume Sources

Type of Source	Procedure for Obtaining Initial Dimension
Initial Lateral Dimension ($_{yo}$)	
Single Volume Source	S_{yo} = (side length)/4.3
Line Source (Represented by Adjacent Volume Sources)	S_{yo} = (side length)/2.15
Line Source (Represented by Separated Volume Sources)	S_{yo} = (center to center distance)/2.15
Initial Vertical Dimension ($_{zo}$)	
Surface-Based Source ($h_e \sim 0$)	S_{zo} = (vertical dimension of source)/2.15
Elevated Source ($h_e > 0$) on or Adjacent to a Building	S_{zo} = (building height)/2.15
Elevated Source ($h_e > 0$) not on or Adjacent to a Building	S_{zo} = (vertical dimension of source)/4.3

4.2.4 Meteorology

Meteorology plays an important role in determining the downwind concentration. Not only does the meteorology (i.e, prevailing wind direction) determine the location of the highest impacted receptor, it also determines the concentration. The amount of turbulence in the atmosphere increases the entrainment and mixing of unpolluted air into the plume and thereby acts to reduce the concentration of pollutants in the plume (i.e, enhances the plume dispersion). The amount of atmospheric turbulence is categorized into six stability classes: A, B, C, D, E and F. Class A is the most unstable, or most turbulent, class, and class F the most stable, or least turbulent, class. Table 8 lists the six classes and Table 9 provides the meteorological conditions that define each class.

Table 8. Stability Classes

Stability class	Definition	Stability class	Definition
A	very unstable	D	Neutral
B	Unstable	E	slightly stable
C	Slightly unstable	F	Stable

Table 9. Meteorological Conditions that Define Each Stability Class

Surface windspeed		Daytime incoming solar radiation			Nighttime cloud cover	
m/s	mi/h	Strong	Moderate	Slight	> 50%	< 50%
< 2	< 5	A	A – B	B	E	F
2 – 3	5 – 7	A – B	B	C	E	F
3 – 5	7 – 11	B	B – C	C	D	E
5 – 6	11 – 13	C	C – D	D	D	D
> 6	> 13	C	D	D	D	D

SCREEN3 allows the user to either select a combination of stability class and wind speeds or input a single stability class and wind speed combination. Each option is described as:

- *Full Meteorology (All Stability Classes and Wind Speeds):* uses a combination of all six stability classes (five for urban sources) and their associated wind speeds to identify the "worst case" meteorological conditions, i.e., the combination of wind speed and stability that results in the maximum ground level concentrations.

- *Single Stability Class:* uses a selected stability class to be used (A through F) with a range of wind speeds to determine ground level concentrations.

- *Single Stability Class and Wind Speed:* uses a selected stability class and wind speed to estimate the ground level concentrations.

The District recommends running the SCREEN3 model using the full meteorological data. The user should be aware that SCREEN3 provides the maximum one hour concentrations at each receptor locations. The one hour concentrations are then multiplied by 0.1 to convert to annual concentrations for comparison to the thresholds. For using the annual average conversion factor, SCREEN3 must be run using the full meteorological dataset.

4.2.5 Additional Parameters

SCREEN3 model also considers building downwash, terrain heights, and fumigation effects. The building downwash option is only applicable to point and flare source types. Downwash occurs when the aerodynamic turbulence induced by nearby buildings cause a pollutant emitted from an elevated source to be mixed rapidly toward the ground (downwash), resulting in higher ground-level concentrations. The user must input the building dimensions (height, length, and width) to use this option.

SCREEN3 supports flat, elevated and complex terrain (see Section 4.1.4 for more information). If the simple flat terrain is selecting, the terrain heights must not exceed stack base elevation. In most cases, the terrain height is considered at ground level (0 meters). In a simple elevated terrain where the terrain heights exceed the stack base but are below stack height, the terrain height above stack base should be entered. If elevated or complex terrain is used, distance and terrain heights must be provided.

The last option available through SCREEN3 is fumigation. Fumigation occurs when a plume that was originally emitted into a stable layer is mixed rapidly to ground level when unstable air below the plume reaches plume level. The fumigation option is only available for point and flare source types if:

- The rural dispersion coefficient was selected (for rural inland sites), and
- The stack height >= 10 meters

The fumigation option can also be used to model shoreline fumigation effects by entering the distance to the shoreline.

4.3 Tier 2 Complex Model Input Data

More refined modeling is recommended for projects in which the screening analysis exceeds the thresholds or a more site specific characterization is required because it is complex with multiple sources. Refined models such as ISC, AERMOD, and CAL3QHCR require much more site-specific information, but yields greater characterization of the project and more representative results.

4.3.1 Recommended Models

The recommended models for use in refined modeling analysis include:

Refined Models:
- ISCST3 and
- AERMOD

Roadway Model:
- CAL3QHCR

Both ISC and AERMOD follow similar modeling methodologies for conducting air dispersion analysis. The primary differences are the preprocessors used to develop the meteorological data and the terrain elevations. The District already processes meteorological data from numerous stations throughout the Bay Area in ISC-compatible format (available on-line at http://hank.baaqmd.gov/tec/data/). At this time, only a limited number of stations have AERMET processed data; though such data can be requested from the District through a public records request. (Public records requests for AERMET-processed data can be made online at http://www.baaqmd.gov/Divisions/Legal/Public-Records-Request.aspx.) Both ISC and AERMOD include non-regulatory options; however, at this time, the District is recommending that all regulatory options be selected for conducting CEQA evaluations.

Alternative models may be used; however, the user should consult with the lead agency to ensure that conditions warrant their use. A brief overview of each of the recommended models is provided below.

Industrial Source Complex (ISC)

The Industrial Source Complex – Short Term (ISCST3) dispersion model is a steady-state Gaussian plume model, which can be used to assess pollutant concentrations and/or deposition fluxes from a wide variety of sources including volume, point, and area sources. The ISCST3 dispersion model from the U.S. EPA was designed to support the EPA's regulatory modeling options, as specified in the Guidelines on Air Quality Models (Revised)[21]. The model also accepts pre-processed site-specific meteorological data that is available through the District web site at: http://hank.baaqmd.gov/tec/data/.

The ISC models requirements include:

- Meteorological Data Processing - PCRAMMET or District provided preprocessed data
- Obtain Digital Terrain Elevation Data (If terrain is being considered)
- Building Downwash Analysis (BPIP-PRIME) – Project requires source and building information

[21] U.S. Environmental Protection Agency, 1986. Guidelines on Air Quality Models (Revised) and Supplement A. EPA-450/2-78-027R. U.S. Environmental Protection Agency, Research Triangle Park, NC.

- Final site characterization – complete source and receptor information
- ISC – Run the ISC model.
- Visualize and analyze results.

Unlike AERMOD (described in below), the ISC models do not contain a terrain pre-processor. As a result, receptor elevation data must be obtained through alternative means. The use of an inverse distance algorithm for interpolating representative receptor elevations is an effective method. The ISC model can be downloaded from US EPA web site at http://www.epa.gov/scram001/dispersion_alt.htm.

AERMOD

The American Meteorological Society/EPA Regulatory Model Improvement Committee (AERMIC) Regulatory Model, AERMOD[22,23,24] was specially designed to support the U.S. EPA's regulatory modeling programs. AERMOD is the next-generation air dispersion model that incorporates concepts such as planetary boundary layer theory and advanced methods for handling complex terrain. AERMOD was developed to replace the Industrial Source Complex Model-Short Term (ISCST3) as U.S. EPA's preferred model for most small-scale regulatory applications.[25,26] AERMOD can be downloaded from the US EPA web site at http://www.epa.gov/scram001/dispersion_prefrec.htm.

The AERMOD program is comprised of three programs: (1) AERMET – preprocessor for making compatible meteorological data sets, (2) AERMAP - preprocessor for digital terrain data, and (3) AERMOD – air dispersion model. Files generated from AERMET and AERMAP are then read by AERMOD in estimating downwind concentrations. Steps for using AERMOD are as follows:

- Meteorological Data Processing (AERMET is used for this)
- Obtain Digital Terrain Elevation Data (If terrain is being considered)

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[22] U.S. Environmental Protection Agency, 1998. Revised Draft - User's Guide for the AMS/EPA Regulatory Model – AERMOD. Office of Air Quality Planning and Standards, Research Triangle Park, NC.

[23] Paine, R.J., R.W. Brode, R.B. Wilson, A.J. Cimorelli, S.G. Perry, J.C. Weil, A. Venkatram, W.D. Peters and R.F. Lee, 2003. AERMOD: The Latest Features and Evaluation Results. Paper # 69878 presented at the Air and Waste Management Association 96th Annual Conference and Exhibition, June 22-26, 2003. Air and Waste Management Association, Pittsburgh, PA 15222.

[24] Cimorelli, A.J., S.G. Perry, A. Venkatram, J.C. Weil, R.J. Paine, R.B. Wilson, R.F. Lee, W.D. Peters, R.W. Brode, J.O. Paumier, 2002: AERMOD: Description of Model Formulation. U.S. Environmental Protection Agency, EPA-454/R-02-002d (draft dated October 31, 2002). Available from http://www.epa.gov/scram001.

[25] U.S. Environmental Protection Agency, 1995. User's Guide for the Industrial Source Complex (ISC3) Dispersion Models (Revised), Volume 1. EPA-454/B-95-003a. Office of Air Quality Planning and Standards, Research Triangle Park, NC.

[26] U.S. Environmental Protection Agency, 1995. User's Guide for the Industrial Source Complex (ISC3) Dispersion Models, Volume II – Description of Algorithms. U.S. Environmental Protection Agency, Research Triangle Park, NC 27711. Available from website http://www.epa.gov/scram001 as of January 2003.

- Building Downwash Analysis (BPIP-PRIME is used for this) – Project requires source and building information
- Final site characterization – complete source and receptor information
- AERMAP – Perform terrain data pre-processing for AERMOD air dispersion model if required.
- AERMOD – Run the model.
- Visualize and analyze results.

Overall, AERMOD was designed to be the next generation model that builds on the formats already established in the ISC models. ISC and AERMOD are both steady state plume models and the input and output files are similar.

CAL3QHCR

CAL3QHCR is a refined version of the original CALINE (California Line Source Dispersion Model) that was developed as a modeling tool to predict roadside PM or CO concentrations. The model is designed to estimate total air pollutant concentrations from highways from both moving and idling vehicles. The model can process a full year of hourly meteorological data and incorporate emissions, traffic, and signalization data for each hour of a week. The model can be obtained from EPA at http://www.epa.gov/scram001/dispersion_prefrec.htm.

Refined models such as ISC, AERMOD, and CAL3QHCR have many input options, and are described further throughout this document as well as in their respective technical documents[27,28,29,30]. Both ISC and AERMOD support a variety of source options similar to SCREEN3. For each type of sources, the requirements are identical for ISC and AERMOD regardless of the model being used. The following section outlines the inputs required for each source type. Detailed descriptions on the input fields for these models can be found in supporting documents for ISC[31,32] and for AERMOD[33]. The CAL3QHCR model is a roadway

[27] Cimorelli, A.J., S.G. Perry, A. Venkatram, J.C. Weil, R.J. Paine, R.B. Wilson, R.F. Lee, W.D. Peters, R.W. Brode, J.O. Paumier, 2002: AERMOD: Description of Model Formulation. U.S. Environmental Protection Agency, EPA-454/R-02-002d (draft dated October 31, 2002). Available from http://www.epa.gov/scram001.

[28] U.S. Environmental Protection Agency, 1995. User's Guide for the Industrial Source Complex (ISC3) Dispersion Models (Revised), Volume 1. EPA-454/B-95-003a. Office of Air Quality Planning and Standards, Research Triangle Park, NC.

[29] U.S. Environmental Protection Agency, 1995. User's Guide for the Industrial Source Complex (ISC3) Dispersion Models, Volume II – Description of Algorithms. U.S. Environmental Protection Agency, Research Triangle Park, NC 27711. Available from website http://www.epa.gov/scram001 as of January 2003.

[30] U.S. Environmental Protection Agency, 1997. Addendum to ISC3 User's Guide – The Prime Plume Rise and Building Downwash Model. Submitted by Electric Power Research Institute. Prepared by Earth Tech, Inc., Concord, MA.

[31] U.S. Environmental Protection Agency, 1995. User's Guide for the Industrial Source Complex (ISC3) Dispersion Models (Revised), Volume 1. EPA-454/B-95-003a. Office of Air Quality Planning and Standards, Research Triangle Park, NC.

[32] U.S. Environmental Protection Agency, 1997. Addendum to ISC3 User's Guide – The Prime Plume Rise and Building Downwash Model. Submitted by Electric Power Research Institute. Prepared by Earth Tech, Inc., Concord, MA.

model and is not designed to model other types of sources such as point and volumes sources typically used in AERMOD and ISC. However, the other models can model roadways in additional to various other types of sources. For this reason, discussions on the CAL3QHCR input are presented in the roadway modeling section 4.3.3.

The user is not required to complete the screening tables or SCREEN3 analysis prior to conducting a refined analysis. An overview of the modeling approach and general steps for using each refined model are provided below.

4.3.2 Stationary Source Types

POINT SOURCES

Point sources are generally used to model emissions from stacks or vents. Typically, vents from gas dispensers at gasoline stations, vent stack from dry cleaner using perchloroethylene, diesel prime and backup generators, boilers, coffee roasters, cremetariums, paint strippers, tanks, and soil extraction units are modeled as point emissions. Each of these sources are a single point where emissions are released into the atmosphere and in some cases, the outlet may be located on the roof of the building while the source itself is located at ground level, such is the case for most diesel back-up generators. The data required to model point source include:

- **Source ID**: An identification name for the source being defined, up to 8 characters in length.
- **X Coordinate**: The x (east-west) coordinate for the source location in meters (center of the point source).
- **Y Coordinate**: Enter here the y (north-south) coordinate for the source location in meters (center of the point source).
- **Base Elevation** [m]: The source base elevation. The model only uses the source base elevation if elevated terrain is being used.
- **Release Height above Ground** [m]: The source release height above the ground in meters.
- **Emission Rate** [g/sec]: The emission rate of the pollutant in grams per second.
- **Stack Gas Exit Temperature** [K]: The temperature of the released gas in degrees Kelvin.
- **Stack Gas Exit Velocity** [g/sec]: The stack gas exit velocity in meters per second or the stack gas flow rate. The exit velocity can be determined from the following formula:

  $Vs = 4*V/(\pi*(d_s\text{^}2))$

  Where,

  V_s = Exit Velocity
  V = Flow Rate
  d_s = Stack Inside Diameter

- **Stack Inside Diameter** [m]: The inner diameter of the stack.

[33] Cimorelli, A.J., S.G. Perry, A. Venkatram, J.C. Weil, R.J. Paine, R.B. Wilson, R.F. Lee, W.D. Peters, R.W. Brode, J.O. Paumier, 2002: AERMOD: Description of Model Formulation. U.S. Environmental Protection Agency, EPA-454/R-02-002d (draft dated October 31, 2002). Available from http://www.epa.gov/scram001.

The District is developing a database containing some of the modeling parameters for gasoline dispensing facilities, dry cleaners, and prime and back-up diesel generators. Until the data becomes available through the District web site, users can contact the District's Planning Division for more information.

AREA SOURCES

An area source is a two-dimensional source of air pollutant emissions, used for modeling sources such as a landfill, storage pile, slag dump, or lagoon. The District typically models emissions from landfills as an area source. Area source modeling can also be used to simulate emissions from roadways although they are more commonly modeled as volume sources. Discussion on how to address roadway emissions using ISC or AERMOD is presented in Section 4.3.4. The parameters required to model area sources include:

- **Source ID**: An identification name for the source being defined, up to 8 characters in length.
- **X Coordinate**: The x (east-west) coordinate for the vertex (corner) of the area source that occurs in the southwest quadrant of the source. Units are in meters.
- **Y Coordinate**: The y (north-south) coordinate for the vertex (corner) of the area source that occurs in the southwest quadrant of the source. Units are in meters.
- **Base Elevation** [m]: The source base elevation. The model only uses the source base elevation if elevated terrain is being used. The default unit is meters.
- **Release Height above Ground** [m]: The release height above ground in meters. The ISC and AERMOD models can estimate concentrations from receptors located within the area source by integrate only the portion of area that is upwind of the receptor. However, the District does not recommend placement of receptors within the area source since concentrations may be underestimated by not accounting for emissions emitted directly beneath the receptor.
- **Emission Rate** [g/(s-m^2)]: Enter the emission rate of the pollutant. The emission rate for area sources is input as an emission rate per unit area. The same emission rate is used for both concentration and deposition calculations.
- Options for Defining Area: In ISC, the shape of the area source must be a rectangle or square. The maximum length/width aspect ratio for area sources is 10 to 1. If this is exceeded, then the area should be divided to achieve a 10 to 1 aspect ratio (or less) for all sub-areas. See ISC Documentation[34] for more details on inputting area data. In addition to the rectangular area, AERMOD can have circular or polygon areas defined (see AERMOD documentation[35] for details).

[34] U.S. Environmental Protection Agency, 1995. User's Guide for the Industrial Source Complex (ISC3) Dispersion Models (Revised), Volume 1. EPA-454/B-95-003a. Office of Air Quality Planning and Standards, Research Triangle Park, NC.

[35] Cimorelli, A.J., S.G. Perry, A. Venkatram, J.C. Weil, R.J. Paine, R.B. Wilson, R.F. Lee, W.D. Peters, R.W. Brode, J.O. Paumier, 2002: AERMOD: Description of Model Formulation. U.S. Environmental Protection Agency, EPA-454/R-02-002d (draft dated October 31, 2002). Available from http://www.epa.gov/scram001.

The District recommends submitting a public records request to receive emissions estimates and modeling parameters for permitted landfills.

VOLUME SOURCES

A volume source is a three-dimensional source of diffuse air pollutant emissions that is used to model releases from a variety of industrial sources. The District uses the volume source option to model emissions from gas dispensers at gasoline stations, vehicle emissions from roadways, and fugitive emissions from dry cleaners that use perchloroethylene. Parameters required to model volume source include:

- **Source ID**: An identification name for the source being defined, up to 8 characters in length.
- **X Coordinate**: The x (east-west) coordinate for the source location in meters. This location is the center of the volume source.
- **Y Coordinate**: The y (north-south) coordinate for the source location in meters. This location is the center of the volume source.
- **Base Elevation** [m]: The source base elevation. The model only uses the source base elevation if elevated terrain is being used. The default unit is meters.
- **Release Height above Ground** [m]: The release height above ground surface in meters (center of volume).
- **Emission Rate** [g/s]: The emission rate of the pollutant in grams per second. The same emission rate is used for both concentration and deposition calculations.
- **Length of Side** [m]: The length of the side of the volume source in meters. The volume source cannot be rotated and has the X side equal to the Y side (square).
- **Building Height** (If On or Adjacent to a Building) [m]: If the volume source is elevated and is on or adjacent to a building, then specify the building height. The building height can be used to calculate the Initial Vertical Dimension of the source. Note that if the source is surface-based, then this is not applicable.
- **Initial Lateral Dimension** [m]: This parameter is calculated by choosing the appropriate condition in Table 5 in Section 4.3.3. This table provides guidance on determining initial dimensions. Units are in meters.
- **Initial Vertical Dimension** [m]: This parameter is calculated by choosing the appropriate condition in Table 5 in Section 4.3.3. This table provides guidance on determining initial dimensions. Units are in meters.

Refueling emission and spillage from gas dispensing stations at gas stations and fugitive emissions from dry cleaning machines are modeled as volume sources by the District. For gas dispensing stations, the horizontal and vertical dimensions represent the actual shape of the dispenser. The release height when modeling emissions from refueling is the height of the hose nozzle. For emissions related to spillage, the horizontal and vertical dimensions are the same as when modeling refueling emissions except that the release height is set as zero (ground floor release). To simply the method, the District also collected information from over 450 stations and have consolidated the data to provide general default parameters for modeling in cases where only the number of dispensers are known. The average height of dispenser is approximately 7.3 feet and the initial vertical dimension is 3.4 feet (7.3 feet divided by model factor 2.15). The

lateral dimension is related to the number of dispensers at the gas station. Based on the survey responses sent out by the District, the lateral dimension (L) is equal to:

$$L = -0.0129 \times n^2 + 1.0845 \times n + 2.3943$$

Where:
L = lateral dimension (feet)
n = number of gasoline dispensers

For example, for a station that has five dispensers, the initial lateral dimension is 7.5 feet.

For the dry cleaner, most of the emissions are released through the vent stack; however, a small fraction of emissions are released from the dry cleaning machine as fugitive emissions. To model these fugitive emissions, the District recommends using the dimensions of the room that houses the machine. For more information regarding modeling parameters, contact the District's Planning Division.

4.3.3 Roadway Sources

There are a number of air dispersion models that can be used to predict concentrations from roadway emissions. CAL3QHCR is a preferred/recommended US EPA model for roadway modeling that relies on local meteorology. Both ISC and AERMOD models can be used to model roadways as a line of volume sources (see Section 4.3.3.3) for more details). When all three models (ISC, AERMOD, and CAL3QHCR) were modeled for the same scenario[36], the concentrations predicted from all three models were consistent and consequently, any of the three models could be used effectively to predict pollutant concentrations from roadway emissions.

The first section discusses how to estimate emission rates for roads that can then be used in the refined models. The methodology for running the CAL3QHCR is presented in Section 4.3.3.2 and the following Section 4.3.3.3 presents the approach to modeling roadways using ISC and AERMOD. The step by step guidance demonstrates how to use the CAL3QHCR model to estimate $PM_{2.5}$ emissions and cancer risks from total organic gases and diesel particular matter. The example calculations are taken from CAPCOA's Health Risk Assessments for Proposed Land Use Projects. For additional guidance, consult the User's Guide to CAL3QHCR, Version 2.0 [37].

4.3.3.1 EMFAC Emissions Data

In order to model roadway impacts, the emissions and number of vehicles must be estimated on an hourly basis as input into CAL3QHCR. Caltrans does not provide hourly traffic counts. To

[36] CAPCOA. 2009. Health Risk Assessments for Proposed Land Use Projects. Prepared by CAPCOA Planning Managers. Released July 2009. Available at: http://www.capcoa.org/.
[37] User's Guide to CAL3QHC Version 2.0, EPA-454/R-92-006 (Revised, with CAL3QHCR addendum), September 1995.

obtain hourly estimates of traffic volumes used for modeling, the hourly profiles from CARB's EMFAC model can be used. The current version of EMFAC is 2007 version 2.30; however, the user is recommended to check the CARB web site at: http://www.arb.ca.gov/msei/onroad/latest_version.htm to ensure that the latest version is downloaded. The web site also contains a detailed user's manual that illustrates how to use the program. The model combines information on the type of vehicle class, number of vehicles, and distance traveled by the vehicle to estimate emissions factors for variety of pollutants including total organic gases (TOG), reactive organic gases (ROG), and $PM_{2.5}$. The vehicle fleet currently modeled is categorized into 13 classes (ranging from passenger cars to heavy duty trucks) that represent type of vehicle, weight class, and fuel types (i.e, gas, diesel, and electric) that operate on highways, freeways, and local roads in California. The number of vehicles in each class is based on an analysis of the Department of Motor Vehicles (DMV) registration data. The vehicle fleet is specific to the year and county selected.

The CAL3QHCR requires that for every roadway link the user enters hourly data on the number of vehicles per hour and the emissions per vehicle mile traveled. The user can also assume a constant value for both inputs, but the resulting $PM_{2.5}$ concentrations would be overly conservative. EMFAC provides, for each California County, an hourly profile of vehicle miles travelled (VMT) by vehicle class (cars and trucks). The total daily VMT can be used to normalize the hourly VMT by dividing each hourly value by the total VMT, which creates a diurnal scaling factor (also commonly referred to as normalization factor) for estimating hourly traffic volumes. The diurnal scaling factor is then multiplied by the AADT (from the Caltrans counts for highways or CEHTP's traffic volume spatial linkage tool for local streets) to obtain an estimate of the hourly traffic counts. Hourly emissions per vehicle mile traveled are estimated by dividing the hourly emissions from EMFAC by the corresponding hourly VMT. This process can be followed for both cars and trucks. Details for estimating each of these emissions from the EMFAC output files are provided below.

Input parameters to the EMFAC model include:

- Year: first year of project build out or when residents are living in the development. The model can estimate emissions between 1970 to 2040,
- Season: Select annual average,
- Geographic Area: select use average, San Francisco for Air Basin, and Bay Area for Air District.
- Model Years: The model years of vehicles to be used in developing the emissions for the year. Select all.
- Vehicle Class: Types of vehicle classes to be included in the emission estimates. Select all.
- I/M Program Schedule: select default.
- Mode and Output: these options allow the user to select the output format for the emissions data. The District recommends select Burden: Area planning inventory because it provides emissions data in units of tons per day.
- BURDEN inventory files: Select Detailed Planning Inventories (CSV), which will produce an emission file that is Microsoft Excel comma separated values (csv) file compatible to any spreadsheet program.
- Output Frequency: select hourly

- Output Particulate as: select $PM_{2.5}$ for comparison to applicable thresholds
- Output Hydrocarbons as: select TOG

Selecting these parameters, the EMFAC model produces an output file that contains:

- VMT/1000 for each hour,
- $PM_{2.5}$ emissions for each hour
- Total organic gas emissions for each hour

Figure 22 is a screen shot of the first page of the EMFAC Burden output file, which shows the first hour of emissions applicable to 12:00 midnight. The boxed hourly data is the data that will be used in to develop the input data for CAL3QHCR.

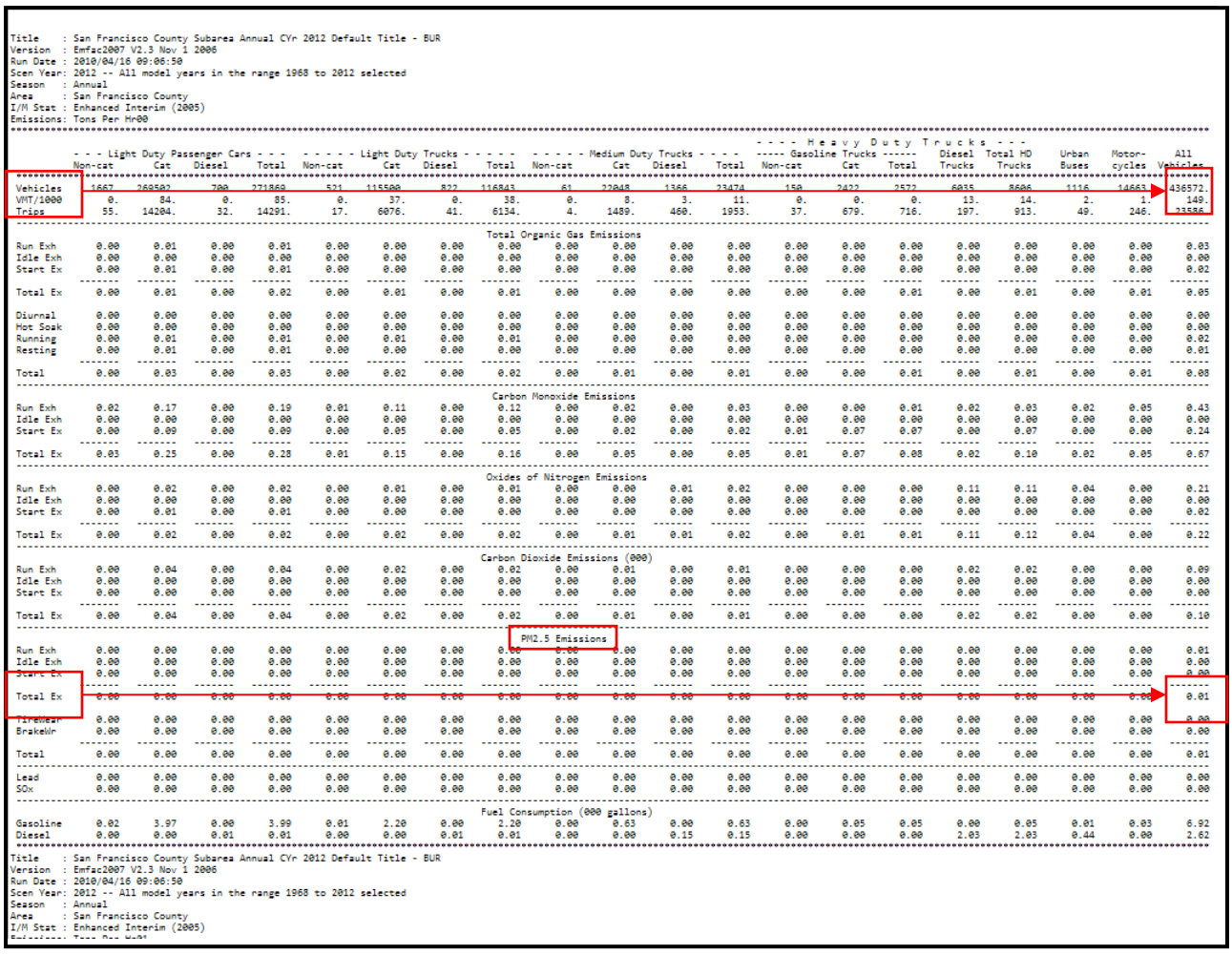
In this first example, the methodology is shown to estimate the $PM_{2.5}$ concentrations from all vehicles traveling on roadways. The following section shows a similar methodology for estimating cancer risk and hazard associated with diesel trucks and gasoline vehicles. It should be noted that the District recommends setting up two modeling runs to fully characterize roadway impacts: one file for $PM_{2.5}$ and organic gas emissions from all vehicles and a second file for diesel alone. The reason is that the diurnal scaling factors shown in Figure 6 for the two source groups are significantly different and will produce different results when coupled with the hourly meteorological data.

PREPARING HOURLY DATA FOR $PM_{2.5}$ ESTIMATIONS

Step 1. To develop hourly traffic count values needed by CAL3QHCR, the first step is to estimate a diurnal scaling factor that will be used to determine the number of vehicles per hour. The user must first enter the total VMT/1000 corresponding to each hour from the EMFAC output file. By reviewing the list of hourly VMT, select the highest hourly VMT count reported by EMFAC. Figure 23 shows an example. In this example, the highest hourly VMT count is 2,618,000 miles, which falls on Hour 17, 5:00 pm. Next, divide each hourly VMT value from EMFAC by the highest hourly VMT count (2,618,000 miles), resulting in a diurnal hourly scaling factors.

Step 2. The next step is to estimate the number of vehicles that travel on the roadway on hourly basis. This is accomplished by multiplying each diurnal scaling factor times the road's peak hour traffic count. The peak hour represents the highest number of vehicles that normally occurs on a weekday. The peak hour traffic count nearest to the proposed receptors should be used. The peak hour traffic count is available on Caltrans's website at http://www.dot.ca.gov/hq/traffops/saferesr/trafdata/index.htm. The user should select *back peak* hour for projects south or west of the nearest milepost location. For projects north or east of the nearest milepost location, select *ahead peak* hour. Table 8 provides an example calculation where the diurnal scaling factors from Figure 18 are multiplied by the peak hour of 11,900 vehicles per hour. It should be noted that peak hour of traffic should match the exact time in which the highest VMT occurs (for this example, it is hour 17 at 5:00 pm). In addition, the sum of all the hourly counts should approximately equal the AADT for the roadway.

Figure 22. Example Scenario EMFAC Output for Estimating $PM_{2.5}$ Emissions



Title : San Francisco County Subarea Annual CYr 2012 Default Title - BUR
Version : Emfac2007 V2.3 Nov 1 2006
Run Date : 2010/04/16 09:06:50
Scen Year: 2012 -- All model years in the range 1968 to 2012 selected
Season : Annual
Area : San Francisco County
I/M Stat : Enhanced Interim (2005)
Emissions: Tons Per Hr00

	Light Duty Passenger Cars				Light Duty Trucks				Medium Duty Trucks				Heavy Duty Trucks						
	Non-cat	Cat	Diesel	Total	Non-cat	Cat	Diesel	Total	Non-cat	Cat	Diesel	Total	Gasoline Trucks Non-cat	Gasoline Trucks Cat	Gasoline Trucks Total	Diesel Trucks	Total HD Trucks	Urban Buses	Motor-cycles	All Vehicles
Vehicles	1667	269502	700	271869	521	115500	822	116843	61	22048	1366	23474	150	2422	2572	6035	8606	1116	14663	436572.
VMT/1000	0.	84.	0.	85.	0.	37.	0.	38.	0.	8.	3.	11.	0.	0.	0.	13.	14.	2.	1.	149.
Trips	55.	14204.	32.	14291.	17.	6076.	41.	6134.	4.	1489.	460.	1953.	37.	679.	716.	197.	913.	49.	246.	23586
Total Organic Gas Emissions																				
Run Exh	0.00	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03
Idle Exh	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Start Ex	0.00	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02
Total Ex	0.00	0.01	0.00	0.02	0.00	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.01	0.00	0.05
Diurnal	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hot Soak	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Running	0.00	0.01	0.00	0.01	0.00	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02
Resting	0.00	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
Total	0.00	0.03	0.00	0.03	0.00	0.02	0.00	0.02	0.00	0.01	0.00	0.01	0.00	0.00	0.00	0.01	0.00	0.01	0.00	0.08
Carbon Monoxide Emissions																				
Run Exh	0.02	0.17	0.00	0.19	0.01	0.11	0.00	0.12	0.00	0.02	0.00	0.03	0.00	0.00	0.00	0.01	0.02	0.03	0.02	0.05	0.43
Idle Exh	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Start Ex	0.00	0.09	0.00	0.09	0.00	0.05	0.00	0.05	0.00	0.02	0.00	0.02	0.01	0.07	0.07	0.00	0.07	0.00	0.00	0.24
Total Ex	0.03	0.25	0.00	0.28	0.01	0.15	0.00	0.16	0.00	0.05	0.00	0.05	0.01	0.07	0.08	0.02	0.10	0.02	0.05	0.67
Oxides of Nitrogen Emissions																				
Run Exh	0.00	0.02	0.00	0.02	0.00	0.01	0.00	0.01	0.00	0.00	0.01	0.02	0.00	0.00	0.00	0.11	0.11	0.04	0.00	0.21
Idle Exh	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Start Ex	0.00	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02
Total Ex	0.00	0.02	0.00	0.02	0.00	0.02	0.00	0.02	0.00	0.01	0.01	0.02	0.00	0.01	0.01	0.11	0.12	0.04	0.00	0.22
Carbon Dioxide Emissions (000)																				
Run Exh	0.00	0.04	0.00	0.04	0.00	0.02	0.00	0.02	0.00	0.01	0.00	0.01	0.00	0.00	0.00	0.02	0.02	0.00	0.00	0.09
Idle Exh	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Start Ex	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total Ex	0.00	0.04	0.00	0.04	0.00	0.02	0.00	0.02	0.00	0.01	0.00	0.01	0.00	0.00	0.00	0.02	0.02	0.00	0.00	0.10
PM2.5 Emissions																				
Run Exh	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
Idle Exh	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Start Ex	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total Ex	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
Tirewear	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
BrakeWr	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
Lead	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SOx	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fuel Consumption (000 gallons)																				
Gasoline	0.02	3.97	0.00	3.99	0.01	2.20	0.00	2.20	0.00	0.63	0.00	0.63	0.00	0.05	0.05	0.00	0.05	0.01	0.03	6.92
Diesel	0.00	0.00	0.01	0.01	0.00	0.00	0.01	0.01	0.00	0.00	0.15	0.15	0.00	0.00	0.00	2.03	2.03	0.44	0.00	2.62

Title : San Francisco County Subarea Annual CYr 2012 Default Title - BUR
Version : Emfac2007 V2.3 Nov 1 2006
Run Date : 2010/04/16 09:06:50
Scen Year: 2012 -- All model years in the range 1968 to 2012 selected
Season : Annual
Area : San Francisco County
I/M Stat : Enhanced Interim (2005)

Step 3. The next step is to estimate the hourly emission rates in grams per vehicle miles traveled. $PM_{2.5}$ emissions data are reported by EMFAC in tons/hour and need to be converted to grams/hour. The grams/hour values are then divided by hourly VMT (as reported by EMFAC), to obtain grams per vehicle mile per hour for input into CAL3QHCR.

For the $PM_{2.5}$ analysis, the annual average concentrations predicted from the model are directly compared to the thresholds. The $PM_{2.5}$ analysis does not use toxicity factors, exposure pathway, or exposure duration common in risk assessments. Instead, the annual average $PM_{2.5}$ concentrations predicted from the model are compared to the thresholds.

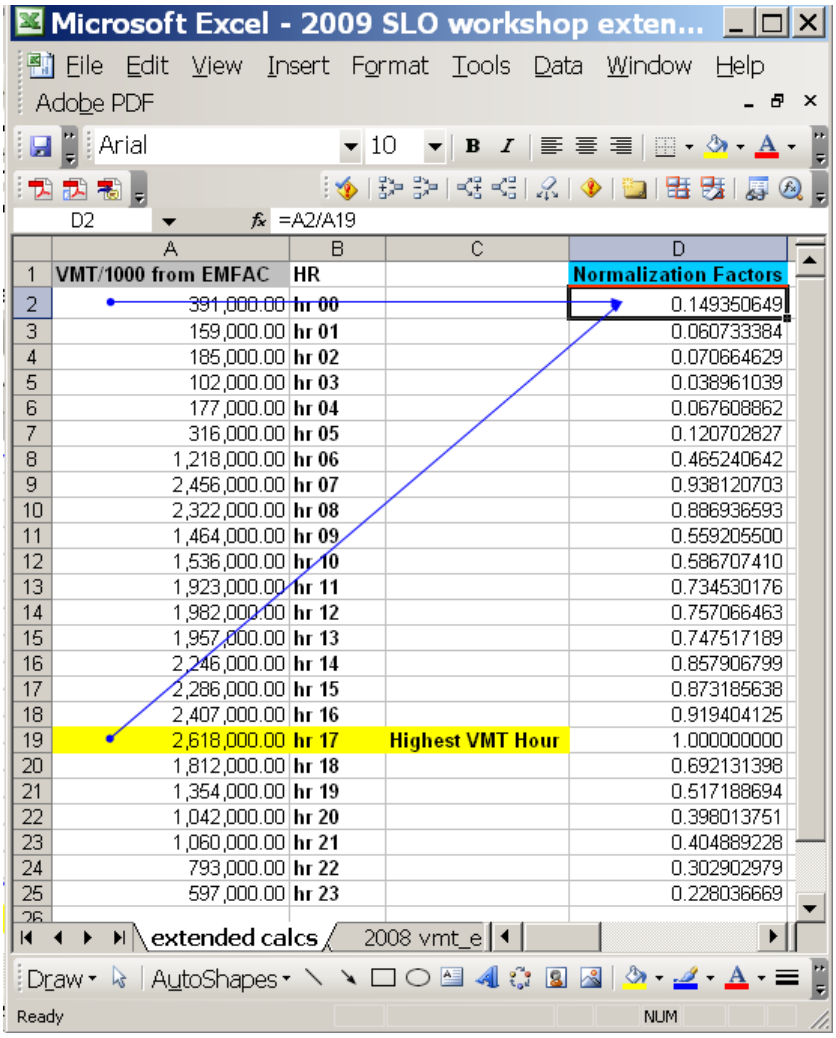
PREPARING HOURLY DATA FOR CANCER RISK AND HAZARD ESTIMATIONS

In estimating cancer risks and hazards associated with roadway emissions, the District considered:

- Diesel $PM_{2.5}$ emissions from all diesel vehicles (passenger cars, trucks, and buses);

- Total organic gas (TOG) emissions from tailpipes of non-diesel vehicles; and
- TOG emissions from evaporative running losses from non-diesel vehicles.

Figure 23. Calculating the Diurnal Scaling Factor (i.e, Normalization Factor)



	A	B	C	D
1	VMT/1000 from EMFAC	HR		Normalization Factors
2	391,000.00	hr 00		0.149350649
3	159,000.00	hr 01		0.060733384
4	185,000.00	hr 02		0.070664629
5	102,000.00	hr 03		0.038961039
6	177,000.00	hr 04		0.067608862
7	316,000.00	hr 05		0.120702827
8	1,218,000.00	hr 06		0.465240642
9	2,456,000.00	hr 07		0.938120703
10	2,322,000.00	hr 08		0.886936593
11	1,464,000.00	hr 09		0.559205500
12	1,536,000.00	hr 10		0.586707410
13	1,923,000.00	hr 11		0.734530176
14	1,982,000.00	hr 12		0.757066463
15	1,957,000.00	hr 13		0.747517189
16	2,246,000.00	hr 14		0.857906799
17	2,286,000.00	hr 15		0.873185638
18	2,407,000.00	hr 16		0.919404125
19	2,618,000.00	hr 17	Highest VMT Hour	1.000000000
20	1,812,000.00	hr 18		0.692131398
21	1,354,000.00	hr 19		0.517188694
22	1,042,000.00	hr 20		0.398013751
23	1,060,000.00	hr 21		0.404889228
24	793,000.00	hr 22		0.302902979
25	597,000.00	hr 23		0.228036669

Source: CAPCOA, 2009

VMT and emissions from these sources are quantified in the detailed summary provided by EMFAC. The user must select the appropriate data from EMFAC output (csv file) in order to quantify emissions from these sources. The procedures for developing the emission files follow steps similar to those for $PM_{2.5}$ emissions except that two separate emissions files will be developed–one for TOG from non-diesel vehicles and one for diesel vehicles to account for the differences in VMT and emissions from diesel versus gasoline vehicles.

Table 8. Example Calculation for Estimating Hourly Traffic Count

Time of day	Traffic Count (vehicles/hour)
Hr 00	1777
Hr 01	723
Hr 02	841
Hr 03	464
Hr 04	805
Hr 05	1436
Hr 06	5536
Hr 07	11164
Hr 08	10555
Hr 09	6655
Hr 10	6982
Hr 11	8741
Hr 12	9009
Hr 13	8895
Hr 14	10209
Hr 15	10391
Hr 16	10941
Hr 17	**11900**
Hr 18	8236
Hr 19	6155
Hr 20	4736
Hr 21	4818
Hr 22	3605
Hr 23	2714

Source: CAPCOA, 2009

Step 1. The first step is to develop hourly traffic counts for vehicles reflective of non-diesel TOG and diesel $PM_{2.5}$ emissions. Similar to the PM estimation, the user must first develop diurnal scaling factors to order to estimate the hourly traffic counts. The user first runs the EMFAC model to generate Burden inventory files. The base year in which the EMFAC model is run should be projected to the year in which residents are anticipated to occupy the development. The user creates two files: one for diesel $PM_{2.5}$ and the other for non-diesel TOG. For the TOG file, the user enters the total VMT/1000 and emissions from total exhaust ("Total Ex") from tailpipe emissions and running evaporative losses ("Running"). Figure 24 has the corresponding categories highlighted in red squares with the corresponding values circled in blue. For diesel $PM_{2.5}$ emissions, the user must sum the individual diesel contributions from each diesel vehicle category (i.e., light duty passenger cars, light duty trucks, medium duty trucks, and heavy duty trucks). The easiest method for summing each of the individual diesel contributions is to use a spreadsheet program that adds user defined cells containing emissions and VMT data. The user

can then copy the formula to the next hour of emissions. Figure 25 shows an example of the TOG and diesel emissions for each hour based on emissions in 2009 for San Francisco County.

To develop the diurnal scaling factor for TOG and diesel $PM_{2.5}$ emissions, the user normalizes each hourly VMT by the highest VMT (Table 9). For TOG, the highest VMT is at Hour 17, 5:00 pm of 1,038,000. The scaling factor for each hour is estimated by dividing each hour VMT per hour by 1,038,000. At hour 17, the scaling factor will be one. Next, the user follows the same procedures for diesel emissions. In the example provided, the highest VMT occurs at 9:00 am (Hour 9) of 44,000. Each hour VMT is then divided by 44,000 to produce the scaling factors for diesel exhaust.

Step 2. The next step is to estimate the number of vehicles that travel on the roadway each hour by multiplying each normalization factor times the road's peak hour traffic count. For TOG emissions, the peak hour of traffic represents the highest number of vehicles that normally occurs on a weekday. The data are available through Caltrans's website (http://www.dot.ca.gov/hq/traffops/saferesr/trafdata/index.htm). The peak hour traffic count nearest to the proposed receptors should be used. The user should select back peak hour for projects south or west of the nearest milepost location. For projects north or east of the nearest milepost location, select ahead peak hour.

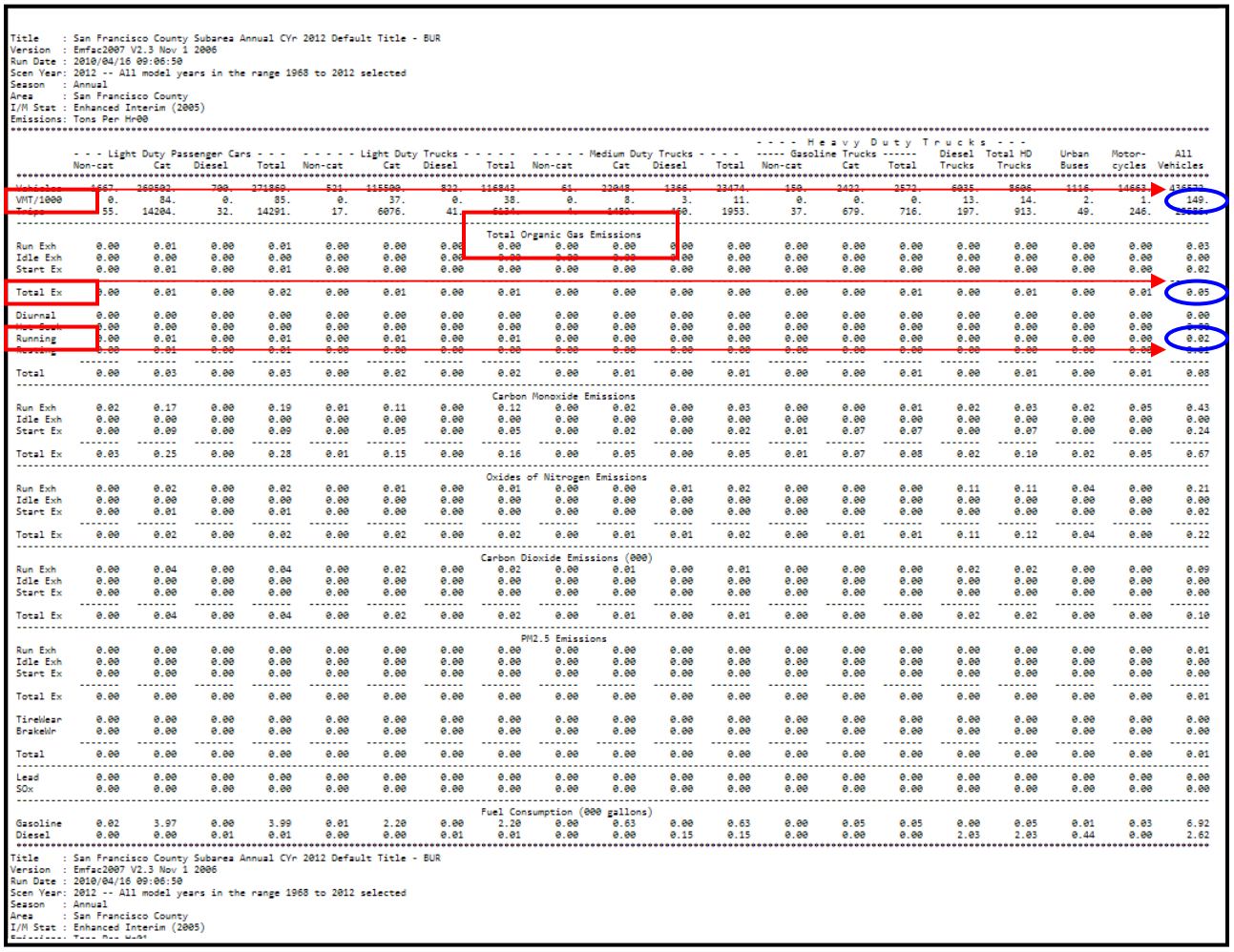
For diesel emissions, the process is more complex since the numbers of diesel trucks traveling on the roadway are not readily available. The District recommends estimating the number of diesel trucks by determining the percentage of vehicles on the road that are trucks. Caltran's web site reports the annual average daily truck traffic on California State Highway System. If the percentage of trucks is not available through Caltrans, the user may use a conservative default of 10% to represent the highest percentage of diesel trucks on the roadway.

In this example, approximately 1.7% of the vehicles on Highway 280 at the intersection of Highway 101 in San Francisco are trucks. The peak one hour of vehicles at the same location is 14,400 vehicles. Assuming 1.7% of the vehicles are trucks, the peak hour of trucks is 245 trucks. The number of vehicles that travel each hour on the road is then estimated by multiplying the hourly diurnal scaling factor by the peak hour of vehicles or trucks.

The sum of all the hourly counts should approximately equal the AADT (vehicles or trucks) for the roadway.

Step 3. The last step is to develop the hourly emission rates in grams per vehicle miles traveled for TOG and diesel. The hourly emissions for TOG and diesel were taken from the EMFAC output files as described in Step 1. For TOG, the emissions from tailpipe and evaporative losses are summed to produce a combined TOG emission per hour. Both emissions estimates from EMFAC are reported in tons per hour and needs to be converted to gram/hour. The grams/hour emissions are then divided by the VMT per hour for each hour (as reported by EMFAC), to obtain grams per vehicle mile per hour for input into CAL3QHCR.

Figure 24. Example EMFAC Output File for Estimating TOG Emissions



```
Title    : San Francisco County Subarea Annual CYr 2012 Default Title - BUR
Version  : Emfac2007 V2.3 Nov 1 2006
Run Date : 2010/04/16 09:06:50
Scen Year: 2012 -- All model years in the range 1968 to 2012 selected
Season   : Annual
Area     : San Francisco County
I/M Stat : Enhanced Interim (2005)
Emissions: Tons Per Hr00

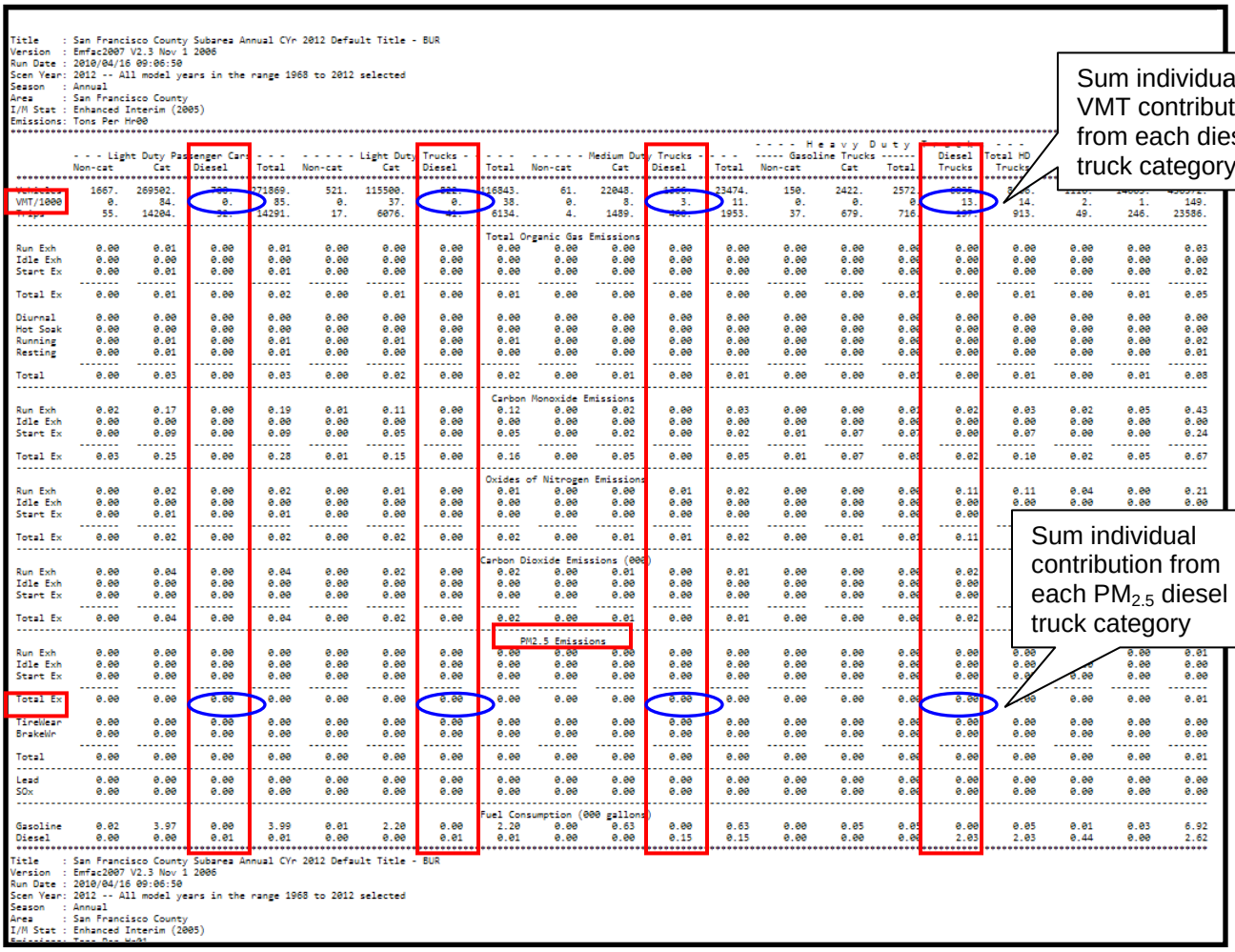
                - - - Light Duty Passenger Cars - - -   - - - - - Light Duty Trucks - - - - -   - - - - - Medium Duty Trucks - - - -   - - - - Heavy Duty Trucks - - -
                                                                                                 ----- Gasoline Trucks -----   Diesel  Total HD    Urban    Motor-     All
                Non-cat     Cat   Diesel    Total   Non-cat     Cat   Diesel    Total   Non-cat     Cat   Diesel    Total   Non-cat     Cat   Total   Trucks   Trucks   Buses   cycles  Vehicles
Vehicles        1667.  260502.     700.  271869.     521.  115500.     822.  116843.      61.   22048.    1366.   23474.     150.    2422.    2572.    6035.    8606.    1116.   14663.  436572.
VMT/1000           0.      84.       0.      85.       0.      37.       0.      38.       0.       8.       3.      11.       0.       0.       0.      13.      14.       2.       1.     149.
Trips             55.   14204.      32.   14291.      17.    6076.      41.    6134.       2.    1480.      60.    1953.      37.     679.     716.     197.     913.      49.     246.   23686.
-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------
                                                                        Total Organic Gas Emissions
Run Exh         0.00    0.01    0.00    0.01    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.03
Idle Exh        0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00
Start Ex        0.00    0.01    0.00    0.01    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.02
Total Ex        0.00    0.01    0.00    0.02    0.00    0.01    0.00    0.01    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.01    0.00    0.01    0.00    0.05
Diurnal         0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00
HotSoak         0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00
Running         0.00    0.01    0.00    0.01    0.00    0.01    0.00    0.01    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.02
Resting         0.00    0.01    0.00    0.01    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.01
Total           0.00    0.03    0.00    0.03    0.00    0.02    0.00    0.02    0.00    0.01    0.00    0.01    0.00    0.00    0.01    0.00    0.01    0.00    0.01    0.08
-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------
                                                                        Carbon Monoxide Emissions
Run Exh         0.02    0.17    0.00    0.19    0.01    0.11    0.00    0.12    0.00    0.02    0.00    0.03    0.00    0.00    0.01    0.02    0.03    0.02    0.05    0.43
Idle Exh        0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00
Start Ex        0.00    0.09    0.00    0.09    0.00    0.05    0.00    0.05    0.00    0.02    0.00    0.02    0.01    0.07    0.07    0.00    0.07    0.00    0.00    0.24
Total Ex        0.03    0.25    0.00    0.28    0.01    0.15    0.00    0.16    0.00    0.05    0.00    0.05    0.01    0.07    0.08    0.02    0.10    0.02    0.05    0.67
-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------
                                                                        Oxides of Nitrogen Emissions
Run Exh         0.00    0.02    0.00    0.02    0.00    0.01    0.00    0.01    0.00    0.00    0.01    0.02    0.00    0.00    0.00    0.11    0.11    0.04    0.00    0.21
Idle Exh        0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00
Start Ex        0.00    0.01    0.00    0.01    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.02
Total Ex        0.00    0.02    0.00    0.02    0.00    0.02    0.00    0.02    0.00    0.01    0.01    0.02    0.00    0.01    0.01    0.11    0.12    0.04    0.00    0.22
-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------
                                                                        Carbon Dioxide Emissions (000)
Run Exh         0.00    0.04    0.00    0.04    0.00    0.02    0.00    0.02    0.00    0.01    0.00    0.01    0.00    0.00    0.00    0.02    0.02    0.00    0.00    0.09
Idle Exh        0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00
Start Ex        0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00
Total Ex        0.00    0.04    0.00    0.04    0.00    0.02    0.00    0.02    0.00    0.01    0.00    0.01    0.00    0.00    0.00    0.02    0.02    0.00    0.00    0.10
-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------
                                                                        PM2.5 Emissions
Run Exh         0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.01
Idle Exh        0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00
Start Ex        0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00
Total Ex        0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.01
TireWear        0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00
BrakeWr         0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00
Total           0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.01
-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------
Lead            0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00
SOx             0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00
-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------
                                                                        Fuel Consumption (000 gallons)
Gasoline        0.02    3.97    0.00    3.99    0.01    2.20    0.00    2.20    0.00    0.63    0.00    0.63    0.00    0.05    0.05    0.00    0.05    0.01    0.03    6.92
Diesel          0.00    0.00    0.01    0.01    0.00    0.00    0.01    0.01    0.00    0.00    0.15    0.15    0.00    0.00    0.00    2.03    2.03    0.44    0.00    2.62
*************************************************************************************************************************************************************************************
Title    : San Francisco County Subarea Annual CYr 2012 Default Title - BUR
Version  : Emfac2007 V2.3 Nov 1 2006
Run Date : 2010/04/16 09:06:50
Scen Year: 2012 -- All model years in the range 1968 to 2012 selected
Season   : Annual
Area     : San Francisco County
I/M Stat : Enhanced Interim (2005)
```

The above discussion presents the methodology for estimating annual average concentrations for a particular year, but for cancer risk where the threshold is based on 70-year exposure period, additional refinements are necessary to translate the single year exposure to 70-year average lifespan exposure. The user will run the CAL3QHCR model using the inputs specified above, but additional spreadsheet calculations are required to weight the annual average concentration over a 70-year exposure duration.

An added complication in the analysis is that not only do the VMT and emissions vary per year, but in addition, the District has adopted OEHHA's age sensitivity factors (ASF) (see the District's Regulation 2, Rule 5). ASFs are used to account for the increased susceptibility of infants and children to carcinogens, as compared to adults. The ASF calculation procedure includes the use of age-specific weighting factors in calculating cancer risks from exposures of infants, children and adolescents, to reflect their anticipated special sensitivity to carcinogens. OEHHA recommends weighting cancer risk by a factor of 10 for exposures that occur from the third trimester of pregnancy to two years of age, and by a factor of three for exposures that occur

from two years through 15 years of age. These weighting factors are applied equally to all carcinogens.

Figure 25. Example EMFAC Output File for Estimating Diesel Emissions



Title : San Francisco County Subarea Annual CYr 2012 Default Title - BUR
Version : Emfac2007 V2.3 Nov 1 2006
Run Date : 2010/04/16 09:06:50
Scen Year: 2012 -- All model years in the range 1968 to 2012 selected
Season : Annual
Area : San Francisco County
I/M Stat : Enhanced Interim (2005)
Emissions: Tons Per Hr00

	Light Duty Passenger Cars Non-cat	Cat	Diesel	Total	Light Duty Trucks Non-cat	Cat	Diesel	Total	Medium Duty Trucks Non-cat	Cat	Diesel	Total	Heavy Duty Gasoline Trucks Non-cat	Cat	Total	Diesel Trucks	Total HD Trucks
Vehicles	1667.	269502.	200.	271869.	521.	115500.	845.	116843.	61.	22048.	1366.	23474.	150.	2422.	2572.	6030.	8.
VMT/1000	0.	84.	0.	85.	0.	37.	0.	38.	0.	8.	3.	11.	0.	0.	0.	13.	14.
Trips	55.	14204.	32.	14291.	17.	6076.	41.	6134.	4.	1489.	460.	1953.	37.	679.	716.	127.	913.
Total Organic Gas Emissions																	
Run Exh	0.00	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Idle Exh	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Start Ex	0.00	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total Ex	0.00	0.01	0.00	0.02	0.00	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
Diurnal	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hot Soak	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Running	0.00	0.01	0.00	0.01	0.00	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02
Resting	0.00	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
Total	0.00	0.03	0.00	0.03	0.00	0.02	0.00	0.02	0.00	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.08
Carbon Monoxide Emissions																	
Run Exh	0.02	0.17	0.00	0.19	0.01	0.11	0.00	0.12	0.00	0.02	0.00	0.03	0.00	0.00	0.01	0.02	0.03
Idle Exh	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Start Ex	0.00	0.09	0.00	0.09	0.00	0.05	0.00	0.05	0.00	0.02	0.00	0.02	0.01	0.07	0.07	0.00	0.07
Total Ex	0.03	0.25	0.00	0.28	0.01	0.15	0.00	0.16	0.00	0.05	0.00	0.05	0.01	0.07	0.08	0.02	0.10
Oxides of Nitrogen Emissions																	
Run Exh	0.00	0.02	0.00	0.02	0.00	0.01	0.00	0.01	0.00	0.00	0.01	0.02	0.00	0.00	0.00	0.11	0.11
Idle Exh	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Start Ex	0.00	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total Ex	0.00	0.02	0.00	0.02	0.00	0.02	0.00	0.02	0.00	0.01	0.01	0.02	0.00	0.01	0.01	0.11	0.11
Carbon Dioxide Emissions (000)																	
Run Exh	0.00	0.04	0.00	0.04	0.00	0.02	0.00	0.02	0.00	0.01	0.00	0.01	0.00	0.00	0.00	0.02	0.02
Idle Exh	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Start Ex	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total Ex	0.00	0.04	0.00	0.04	0.00	0.02	0.00	0.02	0.00	0.01	0.00	0.01	0.00	0.00	0.00	0.02	0.02
PM2.5 Emissions																	
Run Exh	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Idle Exh	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Start Ex	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total Ex	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TireWear	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
BrakeWr	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Lead	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SOx	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fuel Consumption (000 gallons)																	
Gasoline	0.02	3.97	0.00	3.99	0.01	2.20	0.00	2.20	0.00	0.63	0.00	0.63	0.00	0.05	0.05	0.00	0.05
Diesel	0.00	0.00	0.01	0.01	0.00	0.00	0.01	0.01	0.00	0.00	0.15	0.15	0.00	0.00	0.00	2.03	2.03

Title : San Francisco County Subarea Annual CYr 2012 Default Title - BUR
Version : Emfac2007 V2.3 Nov 1 2006
Run Date : 2010/04/16 09:06:50
Scen Year: 2012 -- All model years in the range 1968 to 2012 selected
Season : Annual
Area : San Francisco County
I/M Stat : Enhanced Interim (2005)

The first step in developing the 70-year average concentration is to run the EMFAC model to produce annual VMT and emissions of TOG and diesel $PM_{2.5}$ for every year from the start date of occupancy of the development or when new source is operational to 2040, the last year of emissions forecast by EMFAC. In the EMFAC model under Input 1, the user can select Step 2 – Calendar Years where the list of available years for which the emissions will be estimated can be included in the analysis (see Figure 26).

Each year of emissions of TOG and diesel PM2.5 and VMT should then be extracted from the EMFAC output file using the methodology described in Step 1 above. Table 10 presents an example table generated for San Francisco County that includes emissions and VMT from EMFAC for the years 2010 through 2080. Note: the EMFAC model only estimates emissions to 2040 and the user must then apply 2040 emissions for the remaining years.

Table 9. Example TOG and Diesel Emissions and Diurnal Scaling Factor

SAN FRANCISCO COUNTY 2009							
	TOG Emissions				Diesel Only		
Hours	VMT/1000	Total Ex (tons/hour)	Running (tons/hr)	Diurnal Scaling Factor	VMT/1000	PM2.5 (tons/hour)	Diurnal Scaling Factor
0	145	0.06	0.02	0.14	17	0	0.39
1	55	0.03	0.01	0.05	12	0	0.27
2	45	0.03	0.01	0.04	7	0	0.16
3	22	0.01	0	0.02	3	0	0.07
4	57	0.02	0.01	0.05	4	0	0.09
5	110	0.05	0.02	0.11	11	0	0.25
6	477	0.18	0.07	0.46	27	0	0.61
7	976	0.4	0.18	0.94	23	0	0.52
8	904	0.42	0.17	0.87	40	0.01	0.91
9	564	0.31	0.12	0.54	44	0.01	1.00
10	592	0.28	0.12	0.57	35	0.01	0.80
11	751	0.35	0.16	0.72	41	0.01	0.93
12	784	0.34	0.18	0.76	39	0.01	0.89
13	768	0.32	0.15	0.74	37	0.01	0.84
14	895	0.35	0.18	0.86	36	0.01	0.82
15	907	0.37	0.18	0.87	30	0	0.68
16	940	0.38	0.19	0.91	40	0.01	0.91
17	1038	0.43	0.2	1.00	25	0	0.57
18	720	0.29	0.14	0.69	14	0	0.32
19	541	0.23	0.11	0.52	7	0	0.16
20	412	0.17	0.07	0.40	17	0	0.39
21	423	0.16	0.07	0.41	28	0	0.64
22	316	0.12	0.05	0.30	18	0	0.41
23	235	0.1	0.04	0.23	4	0	0.09

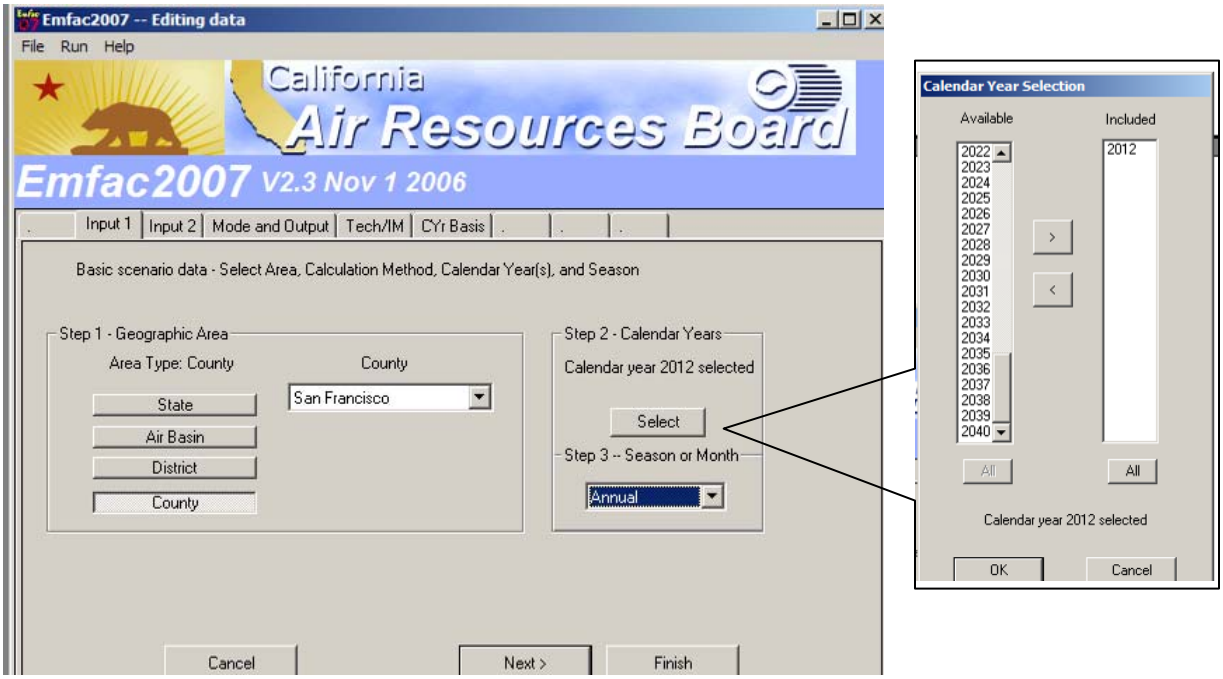
To estimate the 70-year average emissions, the user would generally average the emissions extracted from the EMFAC model. However, because of the age sensitivity factors (ASFs) for cancer risk estimates, more calculation is required. Because both the emissions and ASFs vary per year, the method for estimating 70-year average concentrations must account for variations in both. For estimating cancer risk where the emissions do not vary by year, concentrations can simply be multiplied by a cumulative ASF of 1.7 that incorporates the overall variations in ASFs.

Step 1. The first step is to develop sensitivity weighting factors (SWF) that are the age sensitivity values multiplied by the duration of the exposure by the lifetime of the exposure. This is expressed as:

Sensitivity Weighing Factor = ASF x Length of Exposure (year) / 70 year lifespan

Table 11 summarizes the SWF for every year of exposure up to 70 years.

Figure 26. Example EMFAC 70 Year Emissions and VMT



Step 2. The user then estimates 70-year average emission rates by multiplying each SWF by the corresponding emissions (grams/vehicle mile) for that year. Table 12 presents an example calculation for diesel $PM_{2.5}$ for San Francisco County using the values presented in Tables 10 and 11.

The 70-average emission rate is then the sum of the individual sensitivity weighted emission rates. In this example presented in Table 12, the 70-year average emission rate is 0.262 grams/vehicle mile.

Step 3. To predict the 70-year average concentrations at downwind receptor locations, the user must scale the emissions used in the base year run using CAL3QHCR by the 70-year average emissions. For example, suppose the diesel $PM_{2.5}$ emissions for San Francisco County in 2014 were 0.22 grams/vehicle miles along Highway 101. Using this emission rate in the CAL3QHCR model, the annual average downwind concentration 100 feet east of the freeway is estimated as 10 ug/m^3. To estimate the 70-year average concentration of diesel PM2.5 at this receptor location, the user must ratio the predicted concentration at the receptor by the base emissions from 2014 and the 70-year emissions as follows:

70 yr Avg Conc (ug/m^3) = Annual Avg Conc (ug/m^3) x [70-year SWF Emission (g/mile) / Base Yr Emissions (g/mile)]

Or

$$11.8 \text{ ug/m}^3 = 10 \text{ ug/m}^3 \times [0.262 \text{ ug/m}^3 / 0.22 \text{ ug/m}^3]$$

Table 10. Example VMT and Emissions for 70 Year Exposure

SAN FRANCISCO COUNTY

	Emissions from Total Organic Gases			Diesel Only	
Year	VMT/1000	Total Exhaust (tons/day)	Evaporative Losses (tons/day)	VMT/1000	Diesel PM2.5 (tons/day)
2014	13343	3.65	1.92	570	0.11
2015	13500	3.41	1.85	572	0.11
2016	13634	3.23	1.79	576	0.11
2017	13778	3.03	1.73	577	0.11
2018	13928	2.85	1.67	580	0.1
2019	14081	2.7	1.62	585	0.1
2020	14235	2.52	1.57	593	0.1
2021	14392	2.41	1.53	597	0.1
2022	14550	2.31	1.49	600	0.11
2023	14711	2.23	1.45	604	0.11
2024	14875	2.16	1.41	610	0.11
2025	15039	2.1	1.38	613	0.1
2026	15244	2.07	1.35	619	0.09
2027	15448	2.02	1.32	625	0.09
2028	15656	1.98	1.3	629	0.1
2029	15869	1.77	1.27	641	0.09
2030	16086	1.73	1.24	647	0.09
2031	16303	1.69	1.22	655	0.1
2032	16524	1.66	1.19	663	0.1
2033	16749	1.63	1.17	669	0.1
2034	16979	1.61	1.15	676	0.09
2035	17212	1.59	1.14	683	0.09
2036	17448	1.57	1.13	691	0.09
2037	17683	1.56	1.12	696	0.09
2038	17921	1.56	1.12	704	0.09
2039	18160	1.55	1.11	712	0.08
2040-2084	18405	1.55	1.11	721	0.08

As noted above, the age sensitivity values increased the predicted 70-year average concentrations predicted by the model to account for the anticipated special sensitivity experienced by infants and children to carcinogens. The methodology presented above would also be applied to estimating 70-year concentrations from tailpipe exhausts and evaporative losses. For the cancer risk estimates alone, the user can further reduce the diesel exhaust concentrations by accounting for the expected reductions based on CARB's on-road regulations. Table 3 presents the percent reductions expected from all diesel vehicles based on the on-road regulations. These percentages can be directly applied to the respective concentrations estimated through modeling. The risk calculations to account for the toxic components in TOG are further detailed in Section 5.2.

Table 11. Sensitivity Weighting Factors

Risk Year	Year Used in Roadway Modeling	Period (years)	Age Sensitivity Factor	Sensitivity Weighting Factor
1	2014	1	10	0.143
2	2015	1	10	0.143
3*	2016	1	4.75	0.068
4	2017	1	3	0.043
5	2018	1	3	0.043
6	2019	1	3	0.043
7	2020	1	3	0.043
8	2021	1	3	0.043
9	2022	1	3	0.043
10	2023	1	3	0.043
11	2024	1	3	0.043
12	2025	1	3	0.043
13	2026	1	3	0.043
14	2027	1	3	0.043
15	2028	1	3	0.043
16	2029	1	3	0.043
17**	2030	1	1.5	0.021
18	2031	1	1	0.014
19	2032	1	1	0.014
20	2033	1	1	0.014
21	2034	1	1	0.014
22	2035	1	1	0.014
23	2036	1	1	0.014
24	2037	1	1	0.014
25	2038	1	1	0.014
26	2039	1	1	0.014
27	2040 – 2084	44.25	1	0.632

Note: at age 2*, the factors are weighted for 0.25 years by 10 and 0.75 years by 3; at age 16**, the factor is weighted by 0.25 years at 3 and 0.75 by 1.

Table 12. Example 70 Year Average Emissions for Diesel $PM_{2.5}$ in San Francisco County

Emission Year	Sensitivity Weighting Factor	VMT (miles) /1000	Diesel PM2.5 (tons/day)	Emission Rate (g/vehicle-mile)	Sensitivity Weighted Emission Rate (g/vehicle-mile)
2014	0.14	567	0.14	0.224	0.032
2015	0.14	567	0.12	0.192	0.027
2016	0.068	569	0.12	0.191	0.013
2017	0.043	572	0.12	0.19	0.008
2018	0.043	572	0.12	0.19	0.008
2019	0.043	570	0.11	0.175	0.008
2020	0.043	572	0.11	0.174	0.007
2021	0.043	576	0.11	0.173	0.007
2022	0.043	577	0.11	0.173	0.007
2023	0.043	580	0.1	0.156	0.007
2024	0.043	585	0.1	0.155	0.007
2025	0.043	593	0.1	0.153	0.007
2026	0.043	597	0.1	0.152	0.007
2027	0.043	600	0.11	0.166	0.007
2028	0.043	604	0.11	0.165	0.007
2029	0.043	610	0.11	0.164	0.007
2030	0.021	613	0.1	0.148	0.003
2031	0.014	619	0.09	0.132	0.002
2032	0.014	625	0.09	0.131	0.002
2033	0.014	629	0.1	0.144	0.002
2034	0.014	641	0.09	0.127	0.002
2035	0.014	647	0.09	0.126	0.002
2036	0.014	655	0.1	0.139	0.002
2037	0.014	663	0.1	0.137	0.002
2038	0.014	669	0.1	0.136	0.002
2039	0.014	676	0.09	0.121	0.002
2040 - 2084	0.632	683	0.09	0.12	0.076

4.3.3.2 CAL3QHCR Data Files

The US EPA's CAL3QHCR model is an air dispersion model for predicting air quality impacts of pollutants near roadways. The CAL3QHCR is a refined version of the original California Line Source Dispersion Model (CALINE) that was developed as a modeling tool to predict

roadside carbon monoxide (CO) concentrations. The CAL3QHCR model not only predicts CO concentrations, but also can be used to estimate ambient $PM_{2.5}$ concentrations from idling or moving motor vehicles. The model processes up to one year of hourly meteorological data and vehicular emissions and traffic volumes can be specified for every hour.

The CAL3QHCR model requires the following inputs:

- **One year of meteorological data** – the model can be run using ISC compatible meteorological data if the filename extension is changed to ".asc",
- **Hourly traffic volumes** (in units of vehicles per hour) that can be derived using Caltrans data and normalization factors,
- **Hourly vehicle emissions** (in units of grams per vehicle mile) are derived from EMFAC,
- **Receptor locations** - location to the nearest sensitive receptor from the edge of the travel lane, in addition to the generic receptor grid (for example, 1,000 meters by 1,000 meters grid with 50 meter grid spacing) in X-Y coordinates, and
- **Surface roughness** - depending on the land use can range from 3 cm to 400 cm,
- **Roadway orientation** in terms of its X-Y coordinates (arbitrary origin/0,0), including length and width.

An example scenario is described below to illustrate how to develop the input files necessary for running CAL3QHCR model. Further details regarding the model can be found in CAPCOA's Health Risk Assessments for Proposed Land Use Projects (where this example was presented) and in US EPA's User's Manual for CAL3QHCR.

The CAL3QHCR input file requires data be defined in the calculational domain such that the X-Y coordinates at the beginning and at the end of the roadway section are defined. These have an arbitrary origin, with the positive y axis aligned toward north. For the example presented in this section, nine potential receptors are assumed to lie directly south of an east-west free-flow freeway with a peak hour traffic count of 11,900 vehicles. The freeway is assumed to be 120 feet wide, with an additional 10 feet on each side to account for the wake of moving vehicles[38], making for a total link width of 140 feet. If modeling diesel emissions from trucks, the District recommends using a source height of 2.3 meters (10 feet).

This example scenario relies on basic information needed to complete the modeling using CAL3QHCR model. The width (mixing zone) of the roadway is defined as the width of the freeway including all of the lanes of traffic and the shoulders. If the road does not have a shoulder, then it is recommended that an additional 10 feet be added to the edge of the nearest travel lane to the receptor to account for the wake of moving vehicles. The length of the roadway to be modeled should be at a minimum of one kilometer. The District does not recommend modeling more than five kilometers of a roadway for estimating local-scale impacts, unless the proposed project itself exceeds five kilometers in length.

CAL3QHCR requires that the elevation of the roadway in comparison to the surrounding area be specified in the input files. For most projects, the elevation of the roadway is at grade and consequently, the height of the road is set at zero. For elevated roadways such as an overpass,

[38] The mixing zone is an area where dispersion results are considered to be inaccurate.

the relative height is positive; and for depressed roadways such as an underpass, the relative height is negative.

The z-coordinate (receptor breathing height) for the receptor grid must be specified. In most cases, the default recommendation is 1.5 meters or 6 feet, which approximates an average receptor height. There are special instances where the residents are living on the second floor with commercial/retail areas on the ground level. Even in these instances, the District recommends using the default height of 1.5 meters.

Figure 27 illustrates the example scenario described in this section. The freeway is 120 feet wide, and after accounting for the wake of 10 feet on each side of the freeway, the total link width to be used in the model is 140 feet. The length of the roadway modeled is three kilometers, or 1.5 kilometers on each side from the center point. The roadway is at grade. A receptor has been placed at the edge of the roadway to define the roadway dimensions; however the dispersion results for this receptor should be discarded as they are not accurate at roadway edges. The District recommends using a receptor grid that encompasses the length of the roadway and has receptors spaced every 50 to 100 meters. Other parameters and recommended defaults required by the model are listed in Table 13.

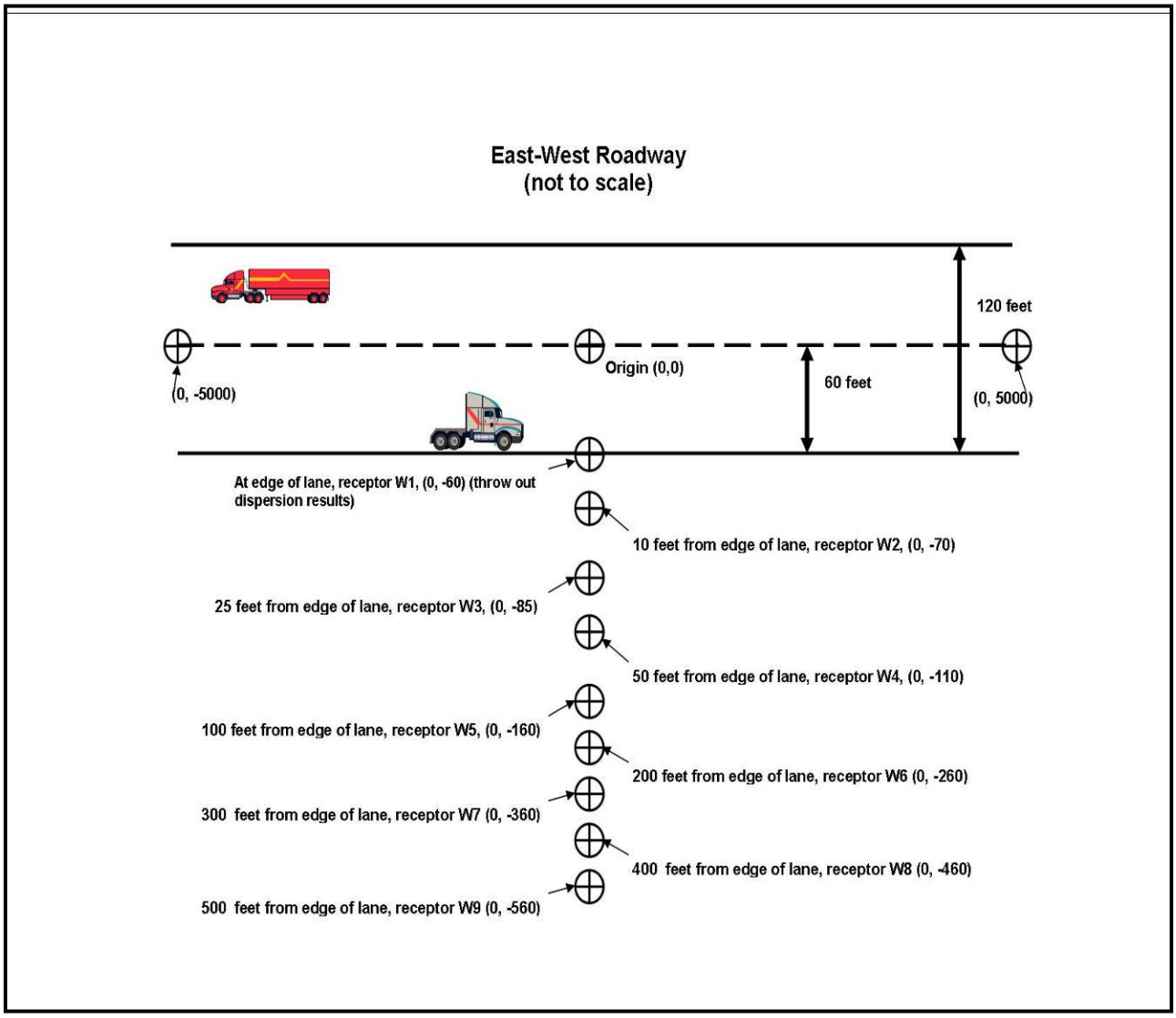
Downloading CAL3QHCR Model:

The CAL3QHCR model can be downloaded from EPA's Preferred/Recommended Dispersion Models website (http://www.epa.gov/scram001/dispersion_prefrec.htm). There are five files needed to run the program:

- input file (.inp),
- batch file (.bat),
- control file (.ctl),
- meteorological data file (.met), and
- executable file (.exe).

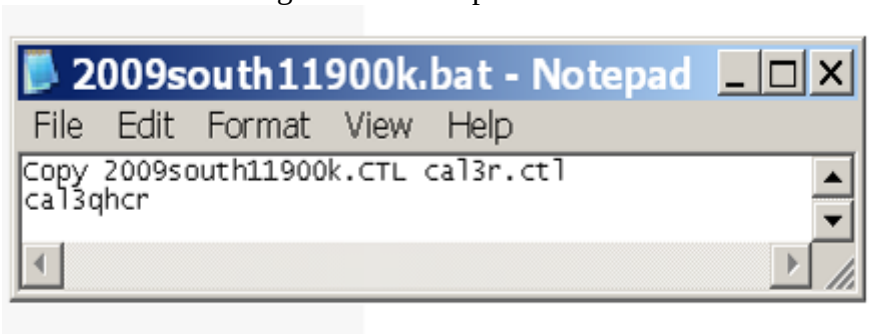
The first step is to select a name for the model run. For the example above, the name of the example scenario run is "2009south11900k". The simplest method for creating the control file is to copy the existing file with a new name. This is done by preparing a batch file (.bat) that is a DOS file batch command. To prepare the file, the user has to right click on the file to open it for editing. (Note that opening or double clicking on the file will cause the program to run. If this happens, simply delete the files the program creates and start again.) Once the file is open, the user types in the filename of the run after the word "Copy". Figure 28 shows an example of how a batch file is created.

Figure 27. Example Scenario East-West Roadway and Receptors Placements for CAL3QHCR



Source: CAPCOA, 2009

Figure 28. Example Batch File



Source: CAPCOA, 2009

Table 13. Other Recommended Parameters for Input into CAL3QHCR

Parameter	Default	
Calculation averaging time (min)	60	
Surface roughness (cm, from 3 to 400). For mixed uses and others not listed here, the modeler should make a reasonable assumption.	single family	108
	offices	170
	apartments	370
Settling velocity (cm/s)	0	
Deposition velocity (cm/s)	0	
Site setting (U=urban, R=rural)	U	
Form of traffic volume, emission rate data (1=one hour's data, 2=one week of hourly data)	2	
Pollutant (P for PM to give output in $\mu g/m^3$)	P	
Hourly ambient background concentration ($\mu g/m^3$)	0	
Roadway height indicator (AG=at grade, FL=elevated and filled, BR=bridge, DP=depressed)	AG	
Roadway height (ft, 0 if AG, relative height if FL, BR, or DP)	0	

Preparing Control File:

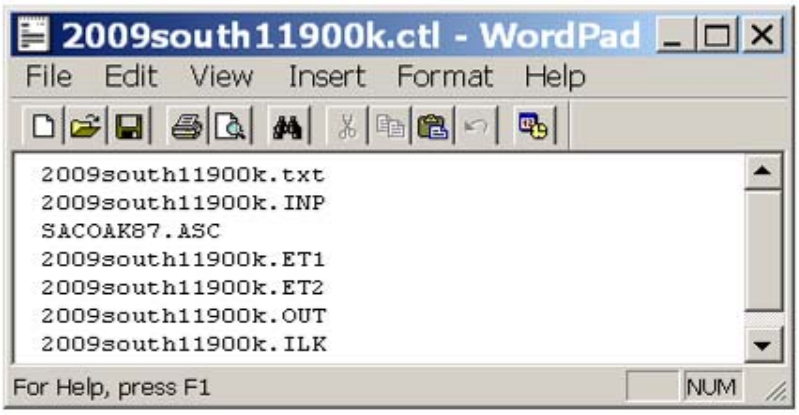
CAL3QHCR looks to the control file to find the file names that are read into the program and outputted by the program. The control file identifies all of the files that the CAL3QHCR will need to complete the run. The user will type the filename of the run in front of each file extension, except the .ASC file (meteorological file), where the user will type in the meteorological data file name. The control file should also be given the same filename with the ctl extension. Figure 29 presents example control file.

The meteorological file can be downloaded from the District web site at http://hank.baaqmd.gov/tec/data/. The user should select a meteorological station that is closest to their proposed project. Once the file is downloaded, the user should change the extension on the file to ".met".

Preparing Input File:

The input file contains the scenario parameters including the emissions and traffic volumes on roadways. The variables to be included in the file have been discussed above. To develop the file, it is recommended that the user edit an existing file (i.e., example file) such as the file provided with the model download, or by editing over a file that was previously used for another project. The user should remember to rename the file prior to editing. An example of the input file is presented in Figure 30 along with detailed explanations of the inputs.

Figure 29. Example Control File



Source: CAPCOA, 2009

Executing the Model Run:

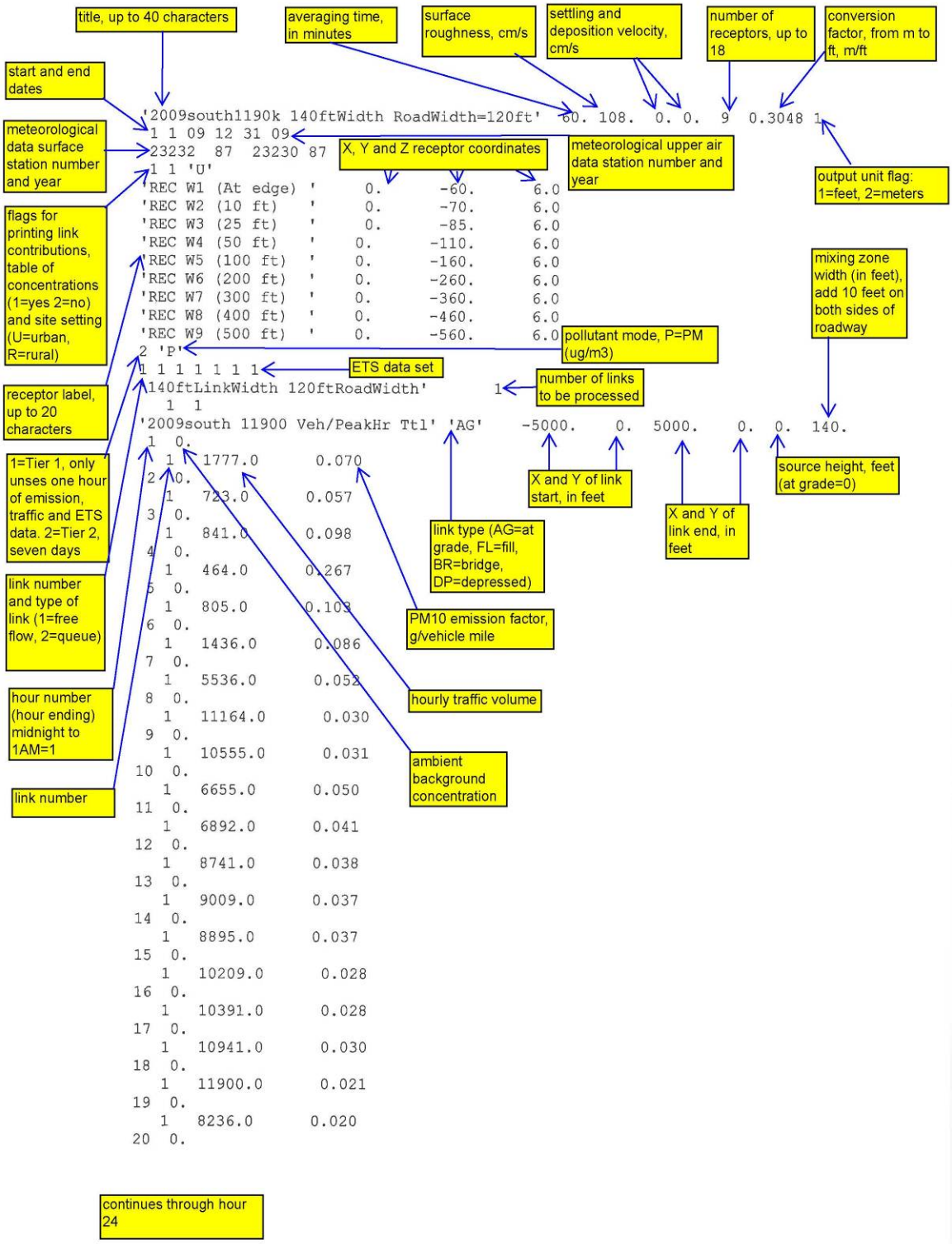
To run the file, the user will double click on the batch file (.bat). The model will produce a series of files with extensions .ET1, .ET2, .ILK, .OUT, .txt, and .ctl. The user should review the file with the extension ".txt" to ensure that no errors were encountered during the run.

The output file (.OUT) will show, among other information, the highest annual average concentrations. Figure 31 presents an example of the relevant output data from the model run.

This example estimates the annual average concentration of PM for a particular roadway at specified receptor locations. However, to translate the concentration to represent a 70-year average concentration, the user must take into account the changes in travel demand over the next 70 years. Discussion is provided in Section 6.0 on modifying the annual average concentration predicted from the model to a 70-year average concentration in which cancer risk can be predicted for comparison to the CEQA thresholds. The user should review the output files and ensure that air concentrations were predicted for each receptor. In cases where the values are zero, the user may consider rerunning the model, but increasing the emissions by a standard factor (i.e., multiplying the emissions by 1000 times). The user then divides the modeled air concentration by the same factor that was used to increase the emissions to yield the actual predicted concentration at each receptor.

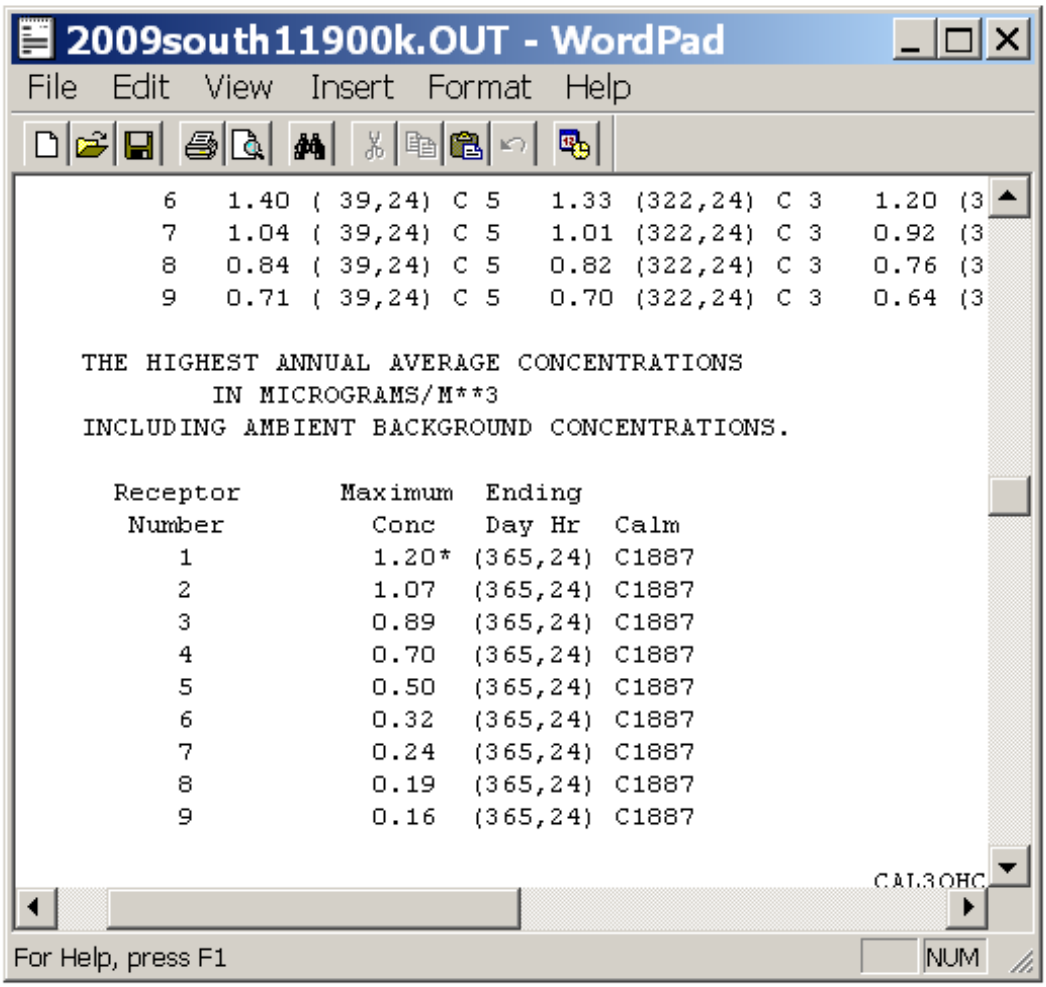
In addition, this example provides a general overview of modeling the most common roadway scenarios; however, the model is also designed to model the effects at traffic intersections, traffic signaling, and traffic queuing. These features are site-specific and the user's manual for the model should be consulted.

Figure 30. Example Input File



Source: CAPCOA, 2009

Figure 31. Example Output File



4.3.3.3 Roadway Modeling using ISC or AERMOD

Roadway impacts can also be modeled using ISC or AERMOD. The advantage of using these models over CAL3QHCR is that most projects including impacts from numerous stationary sources as well as roadways. The CAL3QHCR model is limited to only roadway modeling while ISC and AERMOD can model the impacts from both roadways and stationary sources. For example, a commercial development may have toxic emissions from truck transportation, gasoline dispensing facility, dry cleaners, and standby diesel generators. The user can choose to model these additional sources using ISC or AERMOD and then superimpose the concentrations with those predicted by CAL3QHCR. The simpler option is to model the sources and roadways together using either ISC or AERMOD; results of roadway modeling using ISC and AERMOD are consistent with those from using CAL3QHCR. Procedures for using ISCST3 and AERMOD to model emissions from roadways are discussed below.

The data that are required to model roadway emissions using ISC and AERMOD are similar to those required for using CAL3QHCR. They include the following:

- **Meteorological data** – preprocessed meteorological files for ISC are available though the District web site at http://hank.baaqmd.gov/tec/data/.
- **Traffic data and vehicle emissions** – The same data as discussed above for the CAL3QCHR model are used.
- **Roadway configuration** – The entire width of the roadway including the shoulder is the lateral dimension of the area source. Receptors should be located the same as with the CAL3QCHR model. The initial vertical dimension is the height of the vehicle (i.e., passenger car or truck) to account for the turbulent mixing that is created from vehicle traffic.
- **Terrain data** – For ISC, elevation data must be entered manually. AERMAP is used to generate the elevations and hill slopes for receptors and sources for input to the AERMOD model. Digital Elevation Model (DEM) files for use in AERMAP are available from a variety of sources.

The ISC and AERMOD model emissions from four basic types of sources: point, area, and volume. Emissions from idling vehicles located at a loading dock can be modeled as point sources. Area sources have been used in the past to model emissions from parking lots. The District recommends modeling emissions from travelling vehicles as area sources.

The parameters required to model area sources include:

- **Source ID**: An identification name for the source being defined, up to 8 characters in length.
- **X Coordinate**: The x (east-west) coordinate for the vertex (corner) of the area source that occurs in the southwest quadrant of the source. Units are in meters.
- **Y Coordinate**: The y (north-south) coordinate for the vertex (corner) of the area source that occurs in the southwest quadrant of the source. Units are in meters.
- **Base Elevation** [m]: The source base elevation. The model only uses the source base elevation if elevated terrain is being used. The default unit is meters.
- **Release Height above Ground** [m]: The release height above ground in meters. The release height of the passenger vehicle and/or truck should be used. The District recommends using a height of 10 feet for trucks and height of 1.5 feet for passenger cars.
- **Emission Rate** [g/(s-m^2)]: Enter the emission rate of the pollutant. The emission rate for area sources is input as an emission rate per unit area. The same emission rate is used for both concentration and deposition calculations.
- **Defining Area**: In ISC, the shape of the area source must be a rectangle or square. The maximum length/width aspect ratio for area sources is 10 to 1. If this is exceeded, then the area should be divided to achieve a 10 to 1 aspect ratio (or less) for all sub-areas. The lateral dimension is the entire width of the roadway including all lanes of traffic and the shoulders. If the road does not have a shoulder, then it is recommended that an additional 10 feet be added to the edge of the nearest travel lane to the receptor to account for the wake of moving vehicles. The length of the roadway to be modeled should be at a minimum of one kilometer. The District cautions users to not model roadways beyond five kilometers in length unless the side of the proposed project nearest to the roadway exceeds five kilometers.

A receptor grid similar to CAL3QHCR modeling should be used of at least one kilometer by one kilometer with receptors spaced every 50 to 100 meters. For each receptor and each specified

source group, the output file will contain the highest predicted annual average concentrations for the specified averaging time. Multiple files can be created for multiple source groups (which can be single sources or multiple sources depending upon those specified by the user) and for each averaging time modeled. The user can specify specific plotfiles to be generated as *.XOQ file that can be read through third party packages such as the Hot Spots Analysis and Reporting Program (HARP). They also can be used by graphics programs incorporated into the model interface programs or software such as SURFER to generate isopleths of concentration for a visual display of the results.

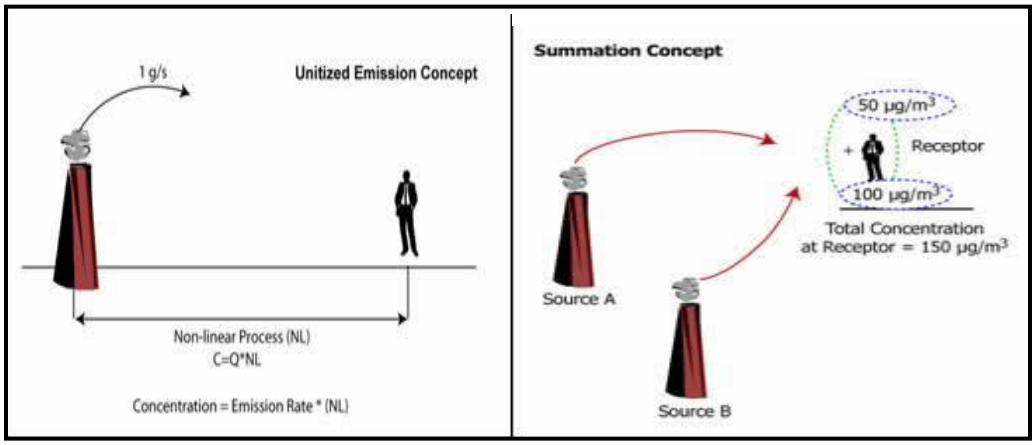
4.3.3.4 Multi-Pollutants Concentrations

Many industrial sources emit multiple pollutants. Models are not equipped to automatically perform modeling of different pollutants that may share the same emission source, but have pollutant-specific emission rates or pollutant-specific variations in emission rates (emissions change per year). One approach to address this issue is to model each scenario in separate model runs for each specific pollutant type and/or year of meteorological data. This requires extensive modeling times and organizational effort to track the results of each separate run.

A simpler solution is to apply unitized, or normalized, emission rates in which the results from the model can be scaled by the actual chemical-specific emissions rate. Then individual pollutant concentrations may be summed. For determining the multi-year averages for estimating cancer risk, the procedure becomes more complex. Discussions on how to perform each of these methods is provided below.

Most air dispersion models produce a Gaussian (bell-shaped) dispersion pattern. The model incorporates the hourly meteorological conditions, terrain elevations, and site characteristics to estimate the downwind concentration. Although the dispersion is non-linear, predicted concentrations scale linearly with emissions. This relationship allows the user to input a unit concentration of one gram/sec to be emitted at the source that can then be multiplied by the actual emission factors for each chemical to predict the downwind concentration of that pollutant at that specific receptor location. Figure 32 helps visualize this concept, by describing an emission rate of 1 g/s (left).

Figure 32. Unitized Emission Rate (left) and Summation (right) Concepts



The Unitized Emission Rate Concept only applies to single sources. For assessments with multiple sources the user can model each source independently by using a unitized emission rate of one gram per sec. For area sources, the unitized emission rate is one gram per second per square meter (1 g/sec/m^2). The concentration at the receptor can then be multiplied by the actual chemical emission rate, and the final result from all the sources will be summed. This is called the Summation Concept, where the concentration and deposition fluxes at a receptor are the linear addition of the resulting values from each source. Figure 27 (right) depicts the Summation concept. The user can use a post-processor such as CARB's HARP program (http://www.arb.ca.gov/toxics/harp/harp.htm) to automatically process model results that have been predicted using a unitized emission rate.

The user should be aware that separate dispersion runs should be performed for estimating acute hazard index, chronic hazard index, cancer risk, and PM2.5 concentrations.

4.4 Tier 3 Model Refinements

The models described above can be further refined to increase the accuracy of the predicted downwind concentrations. The refinements are site-specific and should be determined in conjunction with the lead agency to ensure the changes are appropriate and accurate. The following section provides some available refinements to improve the accuracy of the models.

4.4.1 Variable or Seasonal Emissions

The ISCST3 and AERMOD models both contain support for variable emission rates. This allows for modeling of source emissions that may fluctuate over time since some sources may emit only during certain periods of time. Industrial processes often fluctuate depending on supply and demand requirements. This affects some sectors seasonally, particularly facilities involved in food processing. For example, soup production makes use of agricultural produce which is at its highest in the late summer. Production schedules for soup production typically ramp up resulting in different emissions during the late summer and early fall than at mid to late winter.

Emissions can be varied within the ISCS and AERMOD models by applying scaling factors to different time periods. These emission differences can be accounted for by the application of variable emission factors, with control over the following time periods:

- By Season and hour-of-day
- By Season, hour-of-day, and day-of-week
- By Season, hour, week

For example, for a source that is non-continuous, a factor of 0 is entered for the periods when the source is not operating or is inactive. Model inputs for variable emissions rates can include the following time periods:

- Seasonally

- Monthly
- Hourly
- By Season and hour-of-day
- By Season, hour-of-day, and day-of-week
- By Season, hour, and week

4.4.2 Receptors Located Above Ground Level

In numerous new development projects in the Bay Area, residential units are situated above ground floor commercial/retail areas. The user should work closely with the lead agency to determine the most realistic and long term scenario in which residents would be exposed to toxic air contaminants. If it is determined that residents in their homes will be exposed for the longest duration (up to 12 hours per day) and at the highest concentrations, then receptor heights should be representative of each floor in which residents are living. For example, if a standby generator is located across the street from a four story apartment building with commercial/retail space on the ground floor. The release height of the stack from the generator is approximately 25 feet above ground level. In this case, it may be more conservative and realistic to model concentrations to the second story apartments rather than ground level receptors where the residents would spend significantly less time. In the freeway screening tables, the District has provided estimated cancer risk, $PM_{2.5}$ concentrations, and hazards for second story residential occupancy (20 feet) with commercial uses assumed on the first floor.

4.4.3 On-Site Meteorology

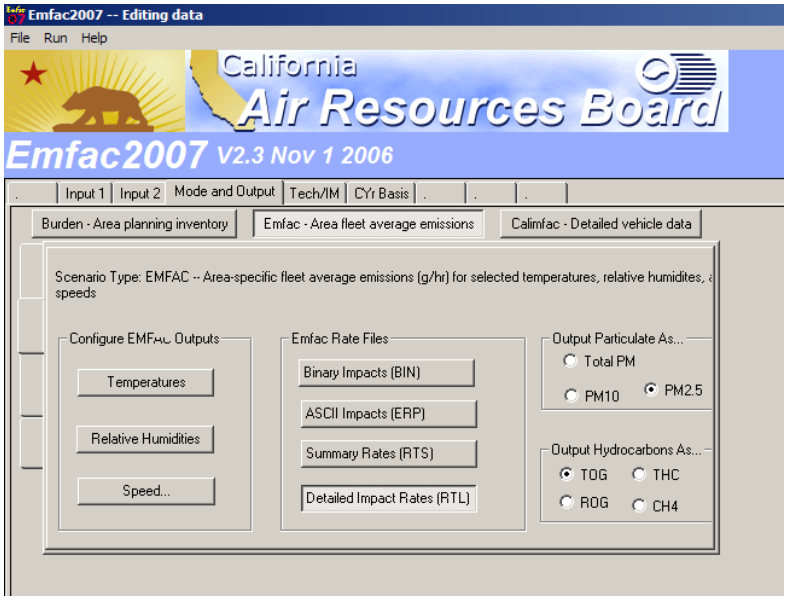
The District receives and collects meteorological data from over 30 stations in the Bay Area. Not every proposed project is in close proximity to one of these stations and a project sponsor may choose to collect their own meteorological data for one year prior to development of the site. There are numerous siting requirements that have to be met in selecting an appropriate location for a meteorological tower. As a general rule, meteorological sensors should be sited at a distance beyond the influence of obstructions, such as buildings and trees. The measurements should also be representative of the project area and be located in a secure and accessible area so that the operator can make any necessary repairs. EPA's Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV, Meteorological Measurements, version 2.0 (Final) (dated January 20, 2008) is a complete reference guide for siting, construction, and collecting meteorological data that adheres District's modeling and accuracy criteria. Approval for the placement of meteorological tower should be obtained from the District prior to any site preparation activities or installation of any equipment.

4.4.4 Constant Vehicle Speed on Local Roadways

In the roadway modeling, the District recommends using the full range of variable vehicle speeds in the EMFAC model to predict roadway emissions. This is a conservative method of accounting for variable vehicle speeds experienced on many of the major highways in the Bay Area. However on local surface streets, a more constant vehicle speeds may be experienced. In this case, surveyed vehicle speeds using automatic counters over a defined study period (over

one week) may result in a more representative speed that can be used in EMFAC. The user can input a specific speed, temperature, and relative humidity under "Mode and Output" in the EMFAC model. Instead of selecting Burden – Area Planning category, the user will select the second option entitled Emfac – Area Fleet Average Emissions. Figure 33 presents a screen shot of the Emfac Area Fleet screen. The District does not recommend setting a single speed for highway travel. The Emfac output was used to estimate annual emissions for speeds of 0 to 35 mph on surface streets.

Figure 33. Example of Emfac-Area Fleet Average Emissions Screen



5.0 CUMULATIVE ANALYSIS

The District is recommending that users examine toxic and $PM_{2.5}$ sources that are located within 1,000 feet of a proposed project site for comparisons to cumulative thresholds of significance. The sources may include, but are not limited to, highways and high volume roadways, truck distribution centers, ports, rail yards, refineries, airports, chrome plating facilities, crematoriums, dry cleaners using perchloroethylene, airports, standby and prime generators, and gasoline dispensing facilities. The user should include all past, present, and foreseeable future sources within a 1,000 foot radius (or beyond where appropriate) from the fenceline of the sources, or from the location of a receptor, plus the contribution from the project. To gather this information, the District recommends:

- Conducting a site walk of the area to determine the locations of significant sources that are not permitted by the District,
- Use District's county-specific kml file created for Google Earth™ that contains information of most permitted sources near the proposed project area
- Contact county-specific congestion management agency to identify local surface streets within the 1,000 foot radius that have over 10,000 vehicles per day

The project sponsor initially evaluates the cumulative impacts by utilizing the screening tables and kml files provided by the District. The cumulative impacts are the summation of the cancer risks, hazards, and $PM_{2.5}$ concentrations from all significant sources identified within 1,000 foot radius of the project. For new sources, the project sponsor should first identify the location of the maximum exposed receptor from the single source screening analysis. In the cumulative analysis, the user evaluates the risks and hazards from all sources within 1,000 foot radius of the new source to the maximally exposed receptor that was identified through the single source analysis. The risks, hazards, and $PM_{2.5}$ concentrations at the maximally exposed receptor locations are then compared against the thresholds of significance. For new receptors, the cumulative analysis evaluates the risks and hazards from all sources within 1,000 foot radius of the receptor.

In some cases, proposed projects may be substantially large where both new receptors and new sources will be added to a community in phases. Sufficient number of new receptors may generate air pollution impacts from their added vehicle trips and support services such as bus and truck deliveries. The District is recommending that new receptors not be evaluated as a new source unless the project sponsor anticipates an additional 10,000 vehicles per day on local streets that are attributable to the new residential development. If the development is anticipated to have more than 10,000 additional vehicles per day on the roads, the District recommends evaluating the sum of the existing traffic with the additional new traffic volume for comparison to the screening tables. If the user conducts a refined modeling analysis, the roadway impacts based on the combined traffic volumes (existing and new traffic) should be compared to the single source thresholds. For the cumulative analysis, the District recommends including all sources within 1000 feet of the roadway be evaluated to estimate the impact to the maximally exposed receptor (i.e., in most cases, this will be the new residential development).

6.0 ESTIMATING HEALTH RISK AND HAZARD

Generally, a health risk assessment for CEQA purposes must include all sources of emissions that will emanate from a project. This includes existing and proposed plant-wide emissions. This includes all sources of potential emissions whether or not they are subject to the District permitting requirements. Additionally, all sources that emit for which OEHHA has identified as having toxicity values must be included in the health risk assessment.

It is not permissible to omit permitted sources under CEQA, even if these sources will be evaluated during the permit process. The permitting process does not evaluate the cumulative risk associated with the entire plant, only the individual permit unit. A challenge to the completeness of the risk assessments can be made if these sources are not included in the analysis.

It is also not permissible to omit pollutants in the plant risk assessment, assuming that these emissions will be evaluated separately. Pollutants that have OEHHA approved toxicity values must be included in the chronic and acute hazard estimates. Again, a challenge to the completeness of the risk assessments can be made if these substances are omitted.

Health risks and hazards shall be assessed by following the procedures described in OEHHA's Health Risk Assessment Guidelines for the Air Toxics Hot Spots Program (August 2003), and any State risk assessment and risk management policies and guidelines, such as CAPCOA's Guidance Document for Health Risk Assessments for Proposed Land Use Projects (July 2009 - http://www.capcoa.org/rokdownloads/HRA/CAPCOA_HRA_LU_Guidelines_8-6-09.pdf). The OEHHA Health Risk Assessment Guidelines contain several sections which identify (a) the overall methodology, (b) the exposure assessment assumptions and procedures, and (c) the health effects data (cancer potency factors, chronic reference exposure levels, and acute reference exposure levels).

A summary of OEHHA's Health Risk Assessment Guidelines and an index of the relevant documents are located at: http://www.oehha.ca.gov/air/hot_spots/index.html

OEHHA's risk assessment methodology (August 2003) is located at:
http://www.oehha.ca.gov/air/risk_assess/index.html

The exposure assessment and stochastic technical support document (September 2000) is located at: http://www.oehha.ca.gov/air/exposure_assess/index.html

The Technical Support Document for Cancer Potency Factors: Methodologies for Derivation, Listing of Available Values, and Adjustments to Allow for Early Life Stage Exposures (May 2009) is located at: http://www.oehha.ca.gov/air/hot_spots/tsd052909.html

The Technical Support Document for the Derivation of Noncancer Reference Exposure Levels (RELs) (June 2008) is located at: http://www.oehha.ca.gov/air/hot_spots/rels_dec2008.html

OEHHA is currently working on revising the risk assessment methodology, as well as the exposure assessment and stochastic technical support documents (TSDs). Upon adoption, these revisions will be incorporated into the CEQA guidelines.

6.1 Exposures

Most of the toxicants assessed are volatile organic compounds that remain as gases when emitted into the air. These chemicals are not subject to appreciable deposition to soil, surface waters, or plants. Therefore, human exposure does not occur to any appreciable extent via ingestion or dermal exposure. Significant exposure to these volatile organic toxicants emitted into the air only occurs through the inhalation pathway. If the emissions consist of only substances that enter the body through the inhalation pathway, the risk assessment methodologies cited under the Air Toxics "Hot Spots" Emissions Inventory and Risk Assessment Program can be used.

However, a small subset of compounds, semi-volatile organic and metal toxicants, are emitted partially or totally as particles subject to deposition. Ingestion and dermal pathways as well as the inhalation pathway must be evaluated for these chemicals for all potential receptor populations. An exception to this is diesel particulate, which is modeled only through the inhalation pathway. A software program, the Hot Spots Analysis and Reporting Program (HARP), is the recommended model for calculating and presenting HRA results. The latest

version of HARP can be downloaded at http://www.arb.ca.gov/toxics/harp/harp.htm. The intent in developing the HARP software is to provide consistent risk assessment procedures. In addition, HARP is designed to assess potential health impacts posed by substances that must be analyzed by a multipathway (e.g., inhalation and non-inhalation) approach.

The District recognizes that the assumptions used in the risk methodology may be overly conservative especially in cases where residents are assumed to spend 24 hours every day for 70 years in outside activity near their homes. The user can deviate from the prescribed inputs in this section if they can provide scientific documentation regarding actual receptor behaviors and activity patterns. For example, the user may consider reducing the exposure duration from 70 years to a shorter time period if the housing is temporary (i.e., shelters, hostel, temporary housing). User may also consider reduced exposures by accounting for the time residents spend indoors. It is recommended that prior to making any adjustments to the exposure duration that the user first analyzes the project's risk and hazards using the standard assumptions. Only in cases where the project exceeds the threshold should additional modifications be considered. The user should keep in mind that the activity patterns of the most vulnerable populations (i.e., infants and seniors) may prove to be the most conservative receptor.

6.2 Cancer Risk

Cancer risk assessment as currently practiced involves estimating exposure to carcinogenic chemicals and multiplying the dose times the cancer potency factor. The toxicity values that are used must be those that the California Office of Environmental Health Hazard Assessment (OEHHA) has identified. These toxicity values can be found at (http://www.arb.ca.gov/toxics/healthval/healthval.htm). If a substance is emitted and toxicity values have not been identified by OEHHA, other sources of data can be applied.

In accordance with OEHHA's revised health risk assessment guidelines (specifically, OEHHA's Technical Support Document (TSD) for Cancer Potency Factors, May 2009), calculation of cancer risk estimates should also incorporate age sensitivity factors (ASFs). The revised TSD for Cancer Potency Factors provides updated calculation procedures used to consider the increased susceptibility of infants and children to carcinogens, as compared to adults. The updated calculation procedure includes the use of age-specific weighting factors in calculating cancer risks from exposures of infants, children and adolescents, to reflect their anticipated special sensitivity to carcinogens. OEHHA recommends weighting cancer risk by a factor of 10 for exposures that occur from the third trimester of pregnancy to 2 years of age, and by a factor of 3 for exposures that occur from 2 years through 15 years of age. These weighting factors should be applied to all carcinogens. For estimating cancer risk for residential receptors, the incorporation of the ASFs results in a cancer risk adjustment factor (CRAF) of 1.7. For estimating cancer risk for student receptors, a CRAF of 3 should be applied. For estimating cancer risk for worker receptors, a CRAF of 1 should be applied.

The procedures for estimating the cancer risk is as follows:

- **Step 1.** Model the emissions to determine both the annual average ground-level concentrations and the maximum one hour concentration (or other period depending on the acutely toxic substance).

- **Step 2.** Create a separate plot file for the annual average and one hour maximum ground level concentrations produced from the air dispersion model.

- **Step 3.** Open the plot file in any spreadsheet application and ensure that the data are parsed into individual cells.

- **Step 4.** Prior to estimating the cancer risk, the first step is to estimate the dose by applying the following formula to each ground-level concentration:

$$\text{Dose} = (C_{air} * \text{DBR} * \text{EF} * \text{ED} * \text{CF}) / \text{AT}$$

  where:

  Dose = dose through inhalation (mg/kg-day)
  C_{air} = air concentration ($\mu g/m^3$) from air dispersion model
  DBR = daily breathing rate (302 L\kg body weight-day for adult and 581 L/kg-day for child)
  EF = exposure frequency (350 days/year)
  ED = exposure duration (70 years)
  CF = conversion factor (10^{-6} ([mg/µg] * [m^3/L])
  AT = averaging time (25,550 days or 70 years)

- **Step 5.** To estimate the cancer risk, the dose is multiplied by the cancer potency factor and the CRAF:

$$\text{Cancer Risk} = (\text{Dose} * \text{CRAF} * \text{Cancer Potency Factor})$$

  where:

  Cancer Risk = risk (potential chances per million)
  Dose = dose through inhalation (mg/kg-day)
  CRAF = 1.7 (residential receptors with constant concentrations over 70 years)
  Cancer Potency Factor = toxicity factor ($mg/kg\text{-}day^{-1}$)

Cancer risk adjustment factors should be used to calculate cancer risk estimates for all applicable exposure pathways and potential receptor populations. Please note that these ASFs represent default values. In cases where there are adequate data for specific carcinogen potency by age, OEHHA will recommend chemical-specific adjustments to cancer risk estimates. In addition, OEHHA is currently revising the TSD for Exposure Assessment. When the revised TSD for Exposure Assessment is finalized and adopted, the Guidelines will be revised accordingly.

The potential cancer risk shall be calculated using standard risk assessment methodology. For residents, they include the assumptions that potential exposures occur 24 hours per day, 350 days per year for a 70-year lifetime.

The methods presented above are applicable to most scenarios except in the case of estimating cancer risks from roadway impacts specifically from tailpipe and evaporative losses from non-diesel vehicles due to the mixture of individual compounds that make up TOG. For cancer risks from diesel particulate matter, cancer potency values are available and the methodology provided above should be used. It should be noted that the age sensitivity values were incorporated into the emissions estimates for roadway in Section 4.3.3.2, so CRAF should not be included in the risk calculations due to TOG and diesel PM emissions.

The District presented an approach in Section 4.3.3.2 for estimating the 70-year average concentrations at downwind receptor location. To estimate the cancer risk from TOG, the user must first speciate the different compounds that make up the toxic portions of TOG. A weighted toxicity value is then developed that incorporates the individual toxicity of each compound that make up TOG. The District uses the following breakdown in Tables 14 and 15 of the toxic portion of TOG for tailpipe and evaporative losses.

Table 14. Toxic Speciation of TOG due to Tailpipe Emissions

Toxic Compounds	**EMFAC Gasoline TOG Speciation (% TOG)**	**Unit Factor**	**(HARP) Residential Cancer Risk Factors** $(ug/m^3)^{-1}$	**Unit Cancer Risk Weighted Factor** $(ug/m^3)^{-1}$	**Chronic Noncancer Reference Dose** (ug/m^3)	**Unit Chronic Noncancer Risk Weighted Factor** (ug/m^3)	**Acute Noncancer Reference Dose** (ug/m^3)	**Unit ACUTE Noncancer Risk Weighted Factor** (ug/m^3)
Acetaldehyde	0.28%	0.0028	0.0000027	7.537E-09	140	0.39	470	1.31
Acrolein	0.13%	0.0013	0	0	0.35	0.00046	2.5	0.0033
Benzene	2.47%	0.0247	0.000029	7.169E-07	60	1.48	1300	32.14
1,3-Butadiene	0.55%	0.0055	0.000174	9.487E-07	20	0.11	0	0
Ethylbenzene	1.05%	0.0105	2.52E-06	2.643E-08	2000	20.97	0	0
Formaldehyde	1.58%	0.0158	6.08E-06	9.602E-08	9	0.14	55	0.87
Hexane	1.60%	0.0160	0	0	7000	111.92	0	0
Methanol	0.12%	0.0012	0	0	4000	4.89	28000	34.22
Methyl Ethyl Ketone	0.02%	0.0002	0	0	0	0	13000	2.37
Naphthalene	0.05%	0.0005	0.000035	1.641E-08	9	0.0042	0	0
Propylene	3.06%	0.0306	0	0	3000	91.86	0	0
Styrene	0.12%	0.0012	0	0	900	1.11	21000	25.79
Toluene	5.76%	0.0576	0	0	300	17.27	37000	2129.65
Xylenes	4.80%	0.0480	0	0	700	33.61	22000	1056.22
Toxicity Weighted Factor				**1.81E-06**		**283.77**		**3282.58**

Table 15. Toxic Speciation of TOG due to Evaporative Losses

Toxic Compounds	EMFAC Gasoline TOG Speciation (% TOG)	Unit Factor	(HARP) Residential Cancer Risk Factors ($ug/m^3)^{-1}$	Unit Cancer Risk Weighted Factor ($ug/m^3)^{-1}$	Chronic Noncancer Reference Dose (ug/m^3)	Unit Chronic Noncancer Risk Weighted Factor (ug/m^3)	Acute Noncancer Reference Dose (ug/m^3)	Unit ACUTE Noncancer Risk Weighted Factor (ug/m^3)
Benzene	0.36%	3.60E-03	2.90E-05	1.04E-07	6.00E+01	2.16E-01	1.30E+03	4.68E+00
Ethylbenzene	0.12%	1.18E-03	2.52E-06	2.97E-09	2000	2.36E+00	0	0
Hexane	1.54%	1.54E-02	0	0	7000	1.08E+02	0	0
Toluene	1.70%	1.70E-02	0	0	300	5.11E+00	3.70E+04	6.30E+02
Xylenes	0.58%	5.78E-03	0	0	700	4.05E+00	2.20E+04	1.27E+02
Toxicity Weighted Factor				**1.07E-07**		**120**		**762**

The weighted toxicity values are then developed for each emission source by multiplying the TOG speciated percentage of each individual compound by its corresponding toxicity value. The summation of all of the individual weighted toxicity values is then cumulative weighted toxicity that should be applied in the risk and hazard calculations.

6.3 Chronic Noncancer Hazard

The potential for chronic non-cancer hazards is evaluated by comparing the long-term exposure level to a chronic Reference Exposure Level (REL). A REL is a concentration level at or below which no adverse health effects are anticipated. RELs are designed to protect sensitive individuals within the population. Noncancer chronic hazard are calculated by dividing the annual average concentration by the REL (Reference Exposure Level) for that substance. The equation for estimating the hazard quotient is:

$$\text{Hazard Quotient} = C_i/REL_i$$

Where:
C_i = Concentration in the air of substance i (annual average concentration in $\mu g/m^3$)
REL_i = Chronic noncancer Reference Exposure Level for substance i ($\mu g/m^3$)

The hazard index (HI) is the sum of the individual HQs for TACs identified as affecting the same target organ or organ systems. HQs for different organ systems are not added, for example, do not sum respiratory irritation HQs with cardiovascular effects. The following equation is used to calculate the Hazard Index for the eye irritation endpoint:

$$\text{Hazard Index } (HI_{eye}) = HQ_{\text{substance 1(eye)}} + HQ_{\text{substance 2(eye)}}$$

In accordance with OEHHA's risk assessment guidelines, chronic non-cancer hazards should be assessed for inhalation and non-inhalation (e.g., ingestion and dermal contact) chronic exposures.

6.4 Acute Noncancer Hazard

The potential for acute non-cancer hazards is evaluated by comparing the maximum short-term exposure level to an acute Reference Exposure Level (REL). A REL is a concentration level at or below which no adverse health effects are anticipated. RELs are designed to protect sensitive individuals within the population. The calculation of acute noncancer impacts is similar to the procedure for chronic noncancer impacts. The equation is as follows:

$$\text{Acute HQ} = \text{Maximum Hourly Air Concentration } (\mu g/m^3) \,/\, \text{Acute REL } (\mu g/m^3)$$

In most cases for a single substance, the acute Hazard Quotient is the highest one hour air concentration divided by the acute REL for that substance. There are a few substances that have acute RELs for exposure periods other than 1 hour. In those cases, the maximum air concentration for the appropriate exposure period (e.g., 8 hours) is divided by the acute REL. As with the chronic noncancer calculation, for multiple substances that impact the same organ system, the individual substance HQs are summed to determine the HI. In accordance with OEHHA's risk assessment guidelines, acute non-cancer hazards should only be assessed for the inhalation exposure pathway. No exposure period adjustments are necessary for acute health impact calculations.

REGULATION 7
ODOROUS SUBSTANCES

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REGULATION 7
ODOROUS SUBSTANCES

7-100 GENERAL

7-101 Description: This Regulation places general limitations on odorous substances and specific emission limitations on certain odorous compounds. A person must meet all limitations of this Regulation, but meeting such limitations shall not exempt such person from any other requirements of the District, state or federal law. See also Rule 1, Sulfur Dioxide and Rule 2, Hydrogen Sulfide, of Regulation 9, Inorganic Gaseous Pollutants.

7-102 Citizen Complaints: The limitations of this Regulation shall not be applicable until the APCO receives odor complaints from ten or more complainants within a 90-day period, alleging that a person has caused odors perceived at or beyond the property line of such person and deemed to be objectionable by the complainants in the normal course of their work, travel or residence. When the limits of this regulation become effective as a result of citizen complaints described above, the limits shall remain effective until such time as no citizen complaints have been received by the APCO for 1 year. The limits of this Regulation shall become applicable again when the APCO receives odor complaints from five or more complainants within a 90-day period. (Amended May 21, 1980)

7-110 Exemptions: The following buildings, materials and operations are exempted from this regulation:

110.1 Single family dwellings.

110.2 Restaurants and other establishments for the purpose of preparing food for human consumption employing less than 5 persons.

110.3 Materials odorized for safety purposes.

110.4 Materials possessing strong odors for reasons of public health and welfare, and where no suitable substitute is available and where best modern practices are employed.

110.5 Agricultural operations as described in the California Health and Safety Code, Section 41705.

7-200 DEFINITIONS

7-201 Odor Free Air: Air which as been passed through a drying agent followed by two successive beds of activated carbon.

7-202 Kraft Pulp Mill: Any combination of industrial operations which converts wood to pulp, and which uses in the pulping process an alkaline sulfide cooking liquor containing sodium hydroxide and sodium sulfide.

TABLE I
DILUTION RATES

Elevation of Emission Point above Grade in Meters (Feet)	Dilution Rate (Volumes of odor-free air per volume of source sample)
Less than 9 (30)	1,000
9 to 18 (30 to 60)	3,000
18 to 30 (60 to 100)	9,000
30 to 55 (100 to 180)	30,000
greater than 55 (180)	50,000

7-300 STANDARDS

7-301 General Limit on Odorous Substances: A person shall not discharge any odorous substance which remains odorous after dilution with odor-free air as specified in Table I. Samples shall be collected and analyzed as prescribed in Section 7-400.

7-302 Limit on Odorous Substances at or Beyond Property Line: A person shall not discharge any odorous substance which causes the ambient air at or beyond the property line of such person to be odorous and to remain odorous after dilution with four parts of odor-free air.

7-303 Limit on Odorous Compounds: A person shall not discharge concentrations of odorous compounds in excess of those specified in Table II, except that this Section shall not apply to kraft mills.

TABLE II
MAXIMUM ALLOWABLE EMISSION CONCENTRATIONS IN PPM

Compound or Family of Compounds	Type A Emission Point	Type B Emission Point
Dimethylsulfide $(CH_3)_2S$	0.1	0.05
Ammonia NH_3	5000	2500
Mercaptans calculated as Methylmercaptan CH_3SH	0.2	0.1
Phenolic compounds calculated as phenol C_6H_5OH	5.0	2.5
Trimethylamine $(CH_3)_3N$	0.02	0.02

7-400 ADMINISTRATIVE REQUIREMENTS

7-401 Collection of Samples: Samples shall be taken and transported in a manner which minimizes alteration of the samples either by contamination or loss of odorous material.

7-402 Analysis of Samples: All samples shall be evaluated as soon after collection as possible in accordance with the procedures set forth in Sections 7-403, 7-404 and 7-405.

7-403 Evaluation Apparatus: The evaluation apparatus consists of a dynamic olfactometer (variable dilution device) which accepts a field sample, dilutes it with odor-free air and conducts it to an inhalation mask at a flow rate of approximately 14 liters/minute (0.5 cfm).

7-404 Evaluation Procedure: Three subjects, selected by the APCO, are seated out-of-sight of the evaluation apparatus and fitted with the inhalation mask. The subjects shall be selected in accordance with procedures approved by the APCO and which are designed to eliminate prospective subjects who have olfactory sensitivity deemed by the APCO to be unduly sensitive or unsensitive at the time of the test. A signal lamp and a signal switch are in front of each subject. The subjects are given 20 presentations, each of 5 seconds duration and 10 seconds apart, for appraisal. Half the presentations (10) are diluted field sample, and half (10) consists only of odor-free air. The presentations of sample and odor-free air are given in random order. At the time each presentation is made, each subject's response is solicited by lighting the subject's signal lamp. If the subject can detect any odor, he responds by pressing his signal switch. The operator records each subject's affirmative or negative response. If the presentation of a sample elicits an affirmative response in less than 5 seconds, odor-free air is substituted for the remainder of the 5 second presentation period. During the 10 second relaxation period between presentations, odor-free air is supplied to the mask.

7-405 Evaluation Analysis: For the purpose of this Regulation, a diluted sample shall be deemed odorous if during evaluation as prescribed in Section 7-404 at least two of the subjects gave negative responses to at least 8 of the 10 odor-free or "blank"

presentations and affirmative responses to at least 8 of the 10 sample presentations. Samples deemed to be odorous in accordance with the evaluation analysis described in this Section shall be deemed to be a violation of the limits established in Sections 7-301 and 7-302.

7-600 MANUAL OF PROCEDURES

7-601 **Collection of Samples:** Samples of odorous compounds specified in Section 7-303, Table II, shall be collected as prescribed in the Manual of Procedures, Volume IV, ST-1, ST-8, ST-11, ST-16, ST-22. (Amended March 17, 1982)

7-602 **Sampling Equipment and Techniques for Collection:** Sampling equipment and techniques for collection purposes in Section 7-401 are prescribed in the Manual of Procedures, Volume IV. (Amended March 17, 1982)

Toxic Air Contaminant Control Program

ANNUAL REPORT
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Bay Area Air Quality Management District
939 Ellis Street
San Francisco, CA 94109

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Bay Area Air Quality Management District
Toxic Air Contaminants
2003 Annual Report

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APPENDIX A

TOXIC AIR CONTAMINANTS

APPENDIX A-1

CALIFORNIA ARB
TOXIC AIR CONTAMINANT
IDENTIFICATION LIST

TOXIC AIR CONTAMINANTS

The substances listed are designated as toxic air contaminants by the California State Air Resources Board under the California Code of Regulations Section 93001.

Toxic Air Contaminant
Acetaldehyde
Acetamide
Acetonitrile
Acetophenone
2-Acetylaminofluorene
Acrolein
Acrylamide
Acrylic acid
Acrylonitrile
Allyl chloride
4-Aminobiphenyl
Aniline
o-Anisidine
Asbestos
Benzene (including benzene from gasoline)
Benzidine
Benzotrichloride
Benzyl chloride
Biphenyl
Bis(2-ethylhexyl)phthalate (DEHP)
Bis(chloromethyl)ether
Bromoform
1,3-Butadiene
Calcium cyanamide
Caprolactam
Captan
Carbaryl
Carbon disulfide
Carbon tetrachloride
Carbonyl sulfide
Catechol
Chloramben
Chlordane
Chlorinated dioxins and dibenzofurans
Chlorine
Chloroacetic acid
2-Chloroacetophenone
Chlorobenzene
Chlorobenzilate
Chloroform
Chloromethyl methyl ether
Chloroprene
Chromium VI
Cresols/Cresylic acid (isomers and mixtures)
o-Cresol
m-Cresol
p-Cresol

Toxic Air Contaminant
Cumene
Diazomethane
1,2-Dibromo-3-chloropropane
Dibutyl phthalate
1,4-Dichlorobenzene(p)
3,3'-Dichlorobenzidine
Dichlorodiphenyldichloroethylene (DDE)
Dichloroethyl ether (Bis(2-chloroethyl)ether)
2,4-Dichlorophenoxyacetic acid, (2,4-D) salts and esters
1,3-Dichloropropene
Dichlorvos
Diethanolamine
Diethyl sulfate
N,N-Dimethylaniline
3,3'-Dimethoxybenzidine
Dimethyl aminoazobenzene
3,3'-Dimethylbenzidine
Dimethyl carbamoyl chloride
Dimethyl formamide
1,1-Dimethylhydrazine
Dimethyl phthalate
Dimethyl sulfate
4,6-Dinitro-o-cresol, and salts
2,4-Dinitrophenol
2,4-Dinitrotoluene
1,4-Dioxane (1,4-Diethyleneoxide)
1,2-Diphenylhydrazine
Epichlorohydrin (1-Chloro-2,3-epoxypropane)
1,2-Epoxybutane
Ethyl acrylate
Ethyl benzene
Ethyl carbamate (Urethane)
Ethyl chloride (Chloroethane)
Ethylene dibromide (Dibromoethane)
Ethylene dichloride (1,2-Dichloroethane)
Ethylene glycol
Ethyleneimine (Aziridine)
Ethylene oxide
Ethylene thiourea
Ethylidene dichloride (1,1-Dichloroethane)
Formaldehyde
Heptachlor
Hexachlorobenzene
Hexachlorobutadiene
Hexachlorocyclopentadiene
Hexachloroethane

TOXIC AIR CONTAMINANTS

Toxic Air Contaminant
Hexamethylene-1,6-diisocyanate
Hexamethylphosphoramide
Hexane
Hydrazine
Hydrochloric acid
Hydrogen fluoride (Hydrofluoric acid)
Hydroquinone
Isophorone
Lindane (all isomers)
Maleic anhydride
Methanol
Methoxychlor
Methyl bromide (Bromomethane)
Methyl chloride (Chloromethane)
Methyl chloroform (1,1,1-Trichloroethane)
Methyl ethyl ketone (2-Butanone)
Methyl hydrazine
Methyl iodide (Iodomethane)
Methyl isobutyl ketone (Hexone)
Methyl isocyanate
Methyl methacrylate
Methyl tert-butyl ether (MTBE)
4,4-Methylene bis(2-chloroaniline)
Methylene chloride (Dichloromethane)
Methylene diphenyl diisocyanate (MDI)
4,4-Methylenedianiline
Naphthalene
Nitrobenzene
4-Nitrobiphenyl
4-Nitrophenol
2-Nitropropane
N-Nitroso-N-methylurea
N-Nitrosodimethylamine
N-Nitrosomorpholine
Parathion
Particulate matter - diesel IC engine exhaust
Pentachloronitrobenzene (Quintobenzene)
Pentachlorophenol
Phenol
p-Phenylenediamine
Phosgene
Phosphine
Phosphorus
Phthalic anhydride
Polychlorinated biphenyls (Aroclors)
1,3-Propane sultone
beta-Propiolactone
Propionaldehyde
Propoxur (Baygon)
Propylene dichloride (1,2-Dichloropropane)
Propylene oxide
1,2-Propylenimine (2-Methylaziridine)
Quinoline
Quinone
Styrene
Styrene oxide
2,3,7,8-Tetrachlorodibenzo-p-dioxin
1,1,2,2-Tetrachloroethane
Tetrachloroethylene (Perchloroethylene)
Titanium tetrachloride
Toluene
2,4-Toluenediamine
2,4-Toluene diisocyanate
o-Toluidine
Toxaphene (chlorinated camphene)
1,2,4-Trichlorobenzene
1,1,2-Trichloroethane
Trichloroethylene
2,4,5-Trichlorophenol
2,4,6-Trichlorophenol
Triethylamine
Trifluralin
2,2,4-Trimethylpentane
Vinyl acetate
Vinyl bromide
Vinyl chloride
Vinylidene chloride (1,1-Dichloroethylene)
Xylenes (isomers and mixture)
o-Xylenes
m-Xylenes
p-Xylenes
Antimony compounds
Arsenic compounds (inorganic including arsine)
Beryllium compounds
Cadmium compounds
Chromium compounds
Cobalt compounds
Coke oven emissions
Cyanide compounds[1]
Glycol ethers[2]
Lead compounds
Manganese compounds
Mercury compounds
Fine mineral fibers[3]
Nickel compounds
Polycyclic Organic Matter[4]
Radionuclides (including radon)[5]
Selenium compounds

APPENDIX A-1 NOTES

This List of Substances was established by Titles 17 and 26 of the California Code of Regulations Section 93001.

GENERAL NOTE: For all substances listed which contain the word "compounds" and for glycol ethers, the following applies: Unless otherwise specified, these listings are defined as including any unique chemical substance that contains the named chemical (i.e., antimony, arsenic, etc.) as part of that chemical's infrastructure.

1 **X'CN where X=H' or any other group where a formal dissociation may occur. For example KCN or $Ca(CN)_2$**

2 **includes mono- and di-ethers of ethylene glycol, diethylene glycol, and triethylene glycol ($R(OCH_2CH_2)_n$-OR' where**

n = 1,2 or 3
R = alkyl or aryl groups
R' = R, H, or groups which, when removed, yield glycol ethers with the structure $R(OCH_2CH)_n$-OH. Polymers are excluded from the glycol category.

3 **includes mineral fiber emissions from facilities manufacturing or processing glass, rock, or slag fibers (or other mineral derived fibers) of average diameter 1 micrometer or less.**

4 **includes organic compounds with more than one benzene ring, and which have a boiling point greater than or equal to 100^oC.**

5 **a type of atom which spontaneously undergoes radioactive decay.**

APPENDIX A-2

"HOT SPOTS" PROGRAM

LIST OF SUBSTANCES

The California State ARB "Hot Spots" Emission Inventory Guidelines contain instructions for the preparation of toxic air contaminant emission inventories. Appendix A of those guidelines establishes a list of the substances which must be included in the inventories. The following is a list of those substances.

Substances For Which Emissions Must Be Quantified

Chemical Abstract Number(CAS)	Add Date[a]	Substance Name
75-07-0		Acetaldehyde
60-35-5		Acetamide
75-05-8	06/91	Acetonitrile
98-86-2	06/91	Acetophenone
53-96-3		2-Acetylaminofluorene [PAH-Derivative, POM]
107-02-8		Acrolein
79-06-1		Acrylamide
79-10-7	06/91	Acrylic acid
107-13-1		Acrylonitrile
107-05-1		Allyl chloride
7429-90-5	06/91	Aluminum
1344-28-1	06/91	Aluminum oxide (fibrous forms)
117-79-3		2-Aminoanthraquinone [PAH-Derivative, POM]
92-67-1		4-Aminobiphenyl [POM]
61-82-5		Amitrole
7664-41-7		Ammonia
6484-52-2	06/91	Ammonium nitrate
7783-20-2	06/91	Ammonium sulfate
62-53-3	09/90	Aniline
90-04-0		o-Anisidine
-		Anthracene [PAH, POM], (see PAH)
7440-36-0	06/91	Antimony
*	06/91	Antimony compounds **
		including but not limited to:
1327-33-9	09/90	Antimony trioxide
7440-38-2		Arsenic
*	06/91	Arsenic compounds (other than inorganic) **
*		Arsenic compounds (inorganic) **
		including but not limited to:
7784-42-1		Arsine
1332-21-4		Asbestos (see mineral fibers)
7440-39-3	06/91	Barium
*	06/91	Barium compounds **
-		Benz[a]anthracene [PAH, POM], (see PAH)
71-43-2		Benzene
92-87-5		Benzidine (and its salts) [POM]
*		Benzidine-based dyes [POM]
		including but not limited to:
1937-37-7		Direct Black 38 [PAH-Derivative, POM]
2602-46-2		Direct Blue 6 [PAH-Derivative, POM]
16071-86-6	09/89	Direct Brown 95 (technical grade) [POM]
-		Benzo[a]pyrene [PAH, POM], (see PAH)
-		Benzo[b]fluoranthene [PAH, POM], (see PAH)
271-89-6	06/91	Benzofuran
98-07-7		Benzoic trichloride {Benzotrichloride}
-		Benzo[j]fluoranthene [PAH, POM], (see PAH)
-		Benzo[k]fluoranthene [PAH, POM], (see PAH)
98-88-4	06/91	Benzoyl chloride
94-36-0	06/91	Benzoyl peroxide
100-44-7		Benzyl chloride
7440-41-7		Beryllium

Substances For Which Emissions Must Be Quantified

Chemical Abstract Number(CAS)	Add Date[a]	Substance Name
*	09/89	Beryllium compounds **
92-52-4	06/91	Biphenyl [POM]
111-44-4	09/89	Bis(2-chloroethyl)ether {DCEE}
542-88-1		Bis(chloromethyl)ether
103-23-1	06/91	Bis(2-ethylhexyl) adipate
7726-95-6		Bromine
*		Bromine compounds (inorganic) **
		including but not limited to:
7758-01-2		Potassium bromate
75-25-2	06/91	Bromoform
106-99-0		1,3-Butadiene
141-32-2	06/91	Butyl acrylate
71-36-3	06/91	n-Butyl alcohol
78-92-2	06/91	sec-Butyl alcohol
75-65-0	06/91	tert-Butyl alcohol
85-68-7	06/91	Butyl benzyl phthalate
7440-43-9		Cadmium
*		Cadmium compounds **
156-62-7	06/91	Calcium cyanamide
105-60-2	06/91	Caprolactam
2425-06-1	09/89	Captafol
133-06-2	09/90	Captan
63-25-2	06/91	Carbaryl [PAH-Derivative, POM]
*		Carbon black extracts
75-15-0	09/89	Carbon disulfide
56-23-5		Carbon tetrachloride
463-58-1	06/91	Carbonyl sulfide
*		Carrageenan (degraded)
120-80-9	06/91	Catechol
133-90-4	06/91	Chloramben
57-74-9	09/89	Chlordane
108171-26-2	09/89	Chlorinated paraffins (average chain length, C12; approximately 60% chlorine by weight)
7782-50-5		Chlorine
10049-04-4	06/91	Chlorine dioxide
79-11-8	06/91	Chloroacetic acid
532-27-4	06/91	2-Chloroacetophenone
106-47-8	07/96	p-Chloroaniline
*	06/91	Chlorobenzenes
		including but not limited to:
108-90-7		Chlorobenzene
25321-22-6	06/91	Dichlorobenzenes (mixed isomers)
		including:
95-50-1	06/91	1,2-Dichlorobenzene
541-73-1	06/91	1,3-Dichlorobenzene
106-46-7		p-Dichlorobenzene {1,4-Dichlorobenzene}
120-82-1	06/91	1,2,4-Trichlorobenzene
510-15-6	09/90	Chlorobenzilate {Ethyl-4,4'-dichlorobenzilate} [POM]
67-66-3		Chloroform
107-30-2		Chloromethyl methyl ether (technical grade)
*		Chlorophenols
		including but not limited to:
120-83-2	06/91	2-4-Dichlorophenol
87-86-5	09/90	Pentachlorophenol
58-90-2	07/96	2,3,4,6-Tetrachlorophenol
95-95-4	06/91	2,4,5-Trichlorophenol
88-06-2		2,4,6-Trichlorophenol

Substances For Which Emissions Must Be Quantified

Chemical Abstract Number(CAS)	Add Date[a]	Substance Name
95-83-0		4-Chloro-o-phenylenediamine
76-06-2		Chloropicrin
126-99-8		Chloroprene
95-69-2		p-Chloro-o-toluidine
7440-47-3	06/91	Chromium
*	06/91	Chromium compounds (other than hexavalent) **
18540-29-9		Chromium, hexavalent (and compounds) **
		including but not limited to:
10294-40-3	06/91	Barium chromate
13765-19-0	06/91	Calcium chromate
1333-82-0	06/91	Chromium trioxide
7758-97-6	06/91	Lead chromate
10588-01-9	06/91	Sodium dichromate
7789-06-2	06/91	Strontium chromate
-		Chrysene [PAH, POM], (see PAH)
7440-48-4	06/91	Cobalt
*	06/91	Cobalt compounds **
*		Coke oven emissions
7440-50-8		Copper
*	09/89	Copper compounds **
*		Creosotes
120-71-8		p-Cresidine
1319-77-3		Cresols (mixtures of) {Cresylic acid}
		including:
108-39-4	06/91	m-Cresol
95-48-7	06/91	o-Cresol
106-44-5	06/91	p-Cresol
4170-30-3	07/96	Crotonaldehyde
98-82-8	06/91	Cumene
80-15-9	06/91	Cumene hydroperoxide
135-20-6		Cupferron
*	06/91	Cyanide compounds **
		including but not limited to:
74-90-8		Hydrocyanic acid
110-82-7	06/91	Cyclohexane
108-93-0	07/96	Cyclohexanol
66-81-9		Cycloheximide
1163-19-5	06/91	Decabromodiphenyl oxide [POM]
*		Dialkylnitrosamines
		including but not limited to:
924-16-3		N-Nitrosodi-n-butylamine
1116-54-7		N-Nitrosodiethanolamine
55-18-5		N-Nitrosodiethylamine
62-75-9		N-Nitrosodimethylamine
621-64-7		N-Nitrosodi-n-propylamine
10595-95-6		N-Nitrosomethylethylamine
615-05-4		2,4-Diaminoanisole
*	09/90	Diaminotoluenes (mixed isomers)
		including but not limited to:
95-80-7		2,4-Diaminotoluene {2,4-Toluenediamine}
334-88-3	06/91	Diazomethane
226-36-8		Dibenz[a,h]acridine [POM]
224-42-0		Dibenz[a,j]acridine [POM]
-		Dibenz[a,h]anthracene [PAH, POM], (see PAH)
194-59-2		7H-Dibenzo[c,g]carbazole [POM]
132-64-9	06/91	Dibenzofuran [POM]

Substances For Which Emissions Must Be Quantified

Chemical Abstract Number(CAS)	Add Date[a]	Substance Name
-		Dibenzofurans (chlorinated) (see Polychlorinated dibenzofurans) [POM]
-		Dibenzo[a,e]pyrene [PAH, POM], (see PAH)
-		Dibenzo[a,h]pyrene [PAH, POM], (see PAH)
-		Dibenzo[a,i]pyrene [PAH, POM], (see PAH)
-		Dibenzo[a,l]pyrene [PAH, POM], (see PAH)
96-12-8		1,2-Dibromo-3-chloropropane {DBCP}
96-13-9	07/96	2,3-Dibromo-1-propanol
84-74-2	06/91	Dibutyl phthalate
-		p-Dichlorobenzene {1,4-Dichlorobenzene} (see Chlorobenzenes)
91-94-1		3,3'-Dichlorobenzidine [POM]
72-55-9	09/89	Dichlorodiphenyldichloroethylene [DDE] [POM]
75-34-3	09/90	1,1-Dichloroethane {Ethylidene dichloride}
94-75-7	06/91	2,4-Dichlorophenoxyacetic acid {2,4-D} salts and esters
78-87-5	09/90	1,2-Dichloropropane {Propylene dichloride}
542-75-6		1,3-Dichloropropene
62-73-7	09/89	Dichlorovos {DDVP}
115-32-2	06/91	Dicofol [POM]
*	09/90	Diesel engine exhaust
*	06/91	Diesel fuel (marine)
111-42-2	06/91	Diethanolamine
117-81-7		Di(2-ethylhexyl) phthalate {DEHP}
64-67-5		Diethyl sulfate
119-90-4		3,3'-Dimethoxybenzidine [POM]
60-11-7		p-Dimethylaminoazobenzene {Methyl yellow} [POM]
121-69-7	06/91	N,N-Dimethylaniline
57-97-6	09/90	7,12-Dimethylbenz[a]anthracene [PAH]-Derivative, POM
119-93-7		3,3'-Dimethylbenzidine {o-Tolidine} [POM]
79-44-7		Dimethyl carbamoyl chloride
68-12-2	09/90	Dimethyl formamide
57-14-7		1,1-Dimethylhydrazine
131-11-3	06/91	Dimethyl phthalate
77-78-1		Dimethyl sulfate
534-52-1	06/91	4,6-Dinitro-o-cresol and salts
51-28-5	06/91	2,4-Dinitrophenol
42397-64-8	06/91	1,6-Dinitropyrene [PAH-Derivative, POM]
42397-65-9	06/91	1,8-Dinitropyrene [PAH-Derivative, POM]
25321-14-6	06/91	Dinitrotoluenes (mixed isomers) including but not limited to:
121-14-2	09/89	2,4-Dinitrotoluene
606-20-2	06/91	2,6-Dinitrotoluene
123-91-1		1,4-Dioxane
-		Dioxins (Chlorinated dibenzodioxins) (see Polychlorinated dibenzo-p-dioxins) [POM]
630-93-3		Diphenylhydantoin [POM]
122-66-7		1,2-Diphenylhydrazine {hydrazobenzene} [POM]
*		Environmental tobacco smoke
106-89-8		Epichlorohydrin
106-88-7	06/91	1,2-Epoxybutane
*	09/89	Epoxy resins
140-88-5		Ethyl acrylate
100-41-4	06/91	Ethyl benzene
75-00-3		Ethyl chloride {Chloroethane}
-		Ethyl-4,4'-dichlorobenzilate (see Chlorobenzilate)
74-85-1	06/91	Ethylene

Substances For Which Emissions Must Be Quantified

Chemical Abstract Number(CAS)	Add Date[a]	Substance Name
106-93-4		Ethylene dibromide {1,2-Dibromoethane}
107-06-2		Ethylene dichloride {1,2-Dichloroethane}
107-21-1	06/91	Ethylene glycol
151-56-4	06/91	Ethyleneimine {Aziridine}
75-21-8		Ethylene oxide
96-45-7		Ethylene thiourea
*	09/89	Fluorides and compounds
		including but not limited to:
7664-39-3		Hydrogen fluoride
*		Fluorocarbons (brominated)
*		Fluorocarbons (chlorinated)
		including but not limited to:
76-13-1		Chlorinated fluorocarbon {CFC 113}
75-45-6	07/96	Chlorodifluoromethane {HCFC 22} {Freon 22}
75-43-4	07/96	Dichlorofluoromethane {CFC 21} {Freon 21}
75-69-4	07/96	Trichlorofluoromethane {CFC 11} {Freon 11}
50-00-0		Formaldehyde
110-00-9	07/96	Furan
*	09/90	Gasoline engine exhaust
		including but not limited to:
*	06/91	Gasoline engine exhaust (condensates and extracts)
*		Gasoline vapors
111-30-8		Glutaraldehyde
*		Glycol ethers and their acetates
		including but not limited to:
111-46-6	09/90	Diethylene glycol
111-96-6	09/90	Diethylene glycol dimethyl ether
112-34-5	09/90	Diethylene glycol monobutyl ether
111-90-0	09/90	Diethylene glycol monoethyl ether
111-77-3	09/90	Diethylene glycol monomethyl ether
25265-71-8	09/90	Dipropylene glycol
34590-94-8	09/90	Dipropylene glycol monomethyl ether
629-14-1	09/90	Ethylene glycol diethyl ether
110-71-4	09/90	Ethylene glycol dimethyl ether
111-76-2	09/90	Ethylene glycol monobutyl ether
110-80-5	09/89	Ethylene glycol monoethyl ether
111-15-9	09/90	Ethylene glycol monoethyl ether acetate
109-86-4	09/89	Ethylene glycol monomethyl ether
110-49-6	09/90	Ethylene glycol monomethyl ether acetate
2807-30-9	09/90	Ethylene glycol monopropyl ether
107-98-2	09/90	Propylene glycol monomethyl ether
108-65-6	09/90	Propylene glycol monomethyl ether acetate
112-49-2	09/90	Triethylene glycol dimethyl ether
76-44-8	09/89	Heptachlor
118-74-1		Hexachlorobenzene
87-68-3	06/91	Hexachlorobutadiene
*		Hexachlorocyclohexanes
		including but not limited to:
58-89-9	09/90	Lindane
77-47-4		Hexachlorocyclopentadiene
67-72-1	09/90	Hexachloroethane
680-31-9		Hexamethylphosphoramide
110-54-3	06/91	Hexane
302-01-2		Hydrazine
7647-01-0		Hydrochloric acid
-		Hydrocyanic acid (see Cyanide compounds **)
7783-06-4		Hydrogen sulfide

Substances For Which Emissions Must Be Quantified

Chemical Abstract Number(CAS)	Add Date[a]	Substance Name
123-31-9	06/91	Hydroquinone
-		Indeno[1,2,3,-cd]pyrene [PAH, POM] (see PAH)
13463-40-6	07/96	Iron pentacarbonyl
*		Isocyanates
		including but not limited to:
822-06-0	06/91	Hexamethylene-1,6-diisocyanate
101-68-8	06/91	Methylene diphenyl diisocyanate {MDI} [POM
624-83-9		Methyl isocyanate
-		Toluene-2,4- diisocyanate (see Toluene diisocyanates)
-		Toluene-2,6-diisocyanate (see Toluene diisocyanates)
78-59-1	06/91	Isophorone
78-79-5	07/96	Isoprene (except from vegetative sources)
67-63-0	06/91	Isopropyl alcohol
80-05-7	06/91	4,4'-Isopropylidenediphenol [POM]
7439-92-1		Lead
*		Lead compounds (inorganic) **
		including but not limited to:
7446-27-7		Lead phosphate
*	06/91	Lead compounds (other than inorganic) **
		including but not limited to:
301-04-2		Lead acetate
1335-32-6	09/90	Lead subacetate
108-31-6		Maleic anhydride
7439-96-5		Manganese
*	09/89	Manganese compounds **
7439-97-6		Mercury
*	09/89	Mercury compounds **
		including but not limited to:
7487-94-7		Mercuric chloride
593-74-8		Methyl mercury {Dimethylmercury}
67-56-1		Methanol
72-43-5	06/91	Methoxychlor [POM]
75-55-8		2-Methylaziridine {1,2-Propyleneimine}
74-83-9		Methyl bromide {Bromomethane}
74-87-3	06/91	Methyl chloride {Chloromethane}
71-55-6		Methyl chloroform {1,1,1-Trichloroethane}
56-49-5	09/90	3-Methylcholanthrene [PAH-Derivative, POM]
3697-24-3		5-Methylchrysene [PAH-Derivative, POM]
101-14-4		4,4'-Methylene bis(2-chloroaniline) {MOCA} [POM]
75-09-2		Methylene chloride {Dichloromethane}
101-77-9		4,4'-Methylenedianiline (and its dichloride) [POM]
78-93-3	06/91	Methyl ethyl ketone {2-Butanone}
60-34-4	06/91	Methyl hydrazine
74-88-4		Methyl iodide {Iodomethane}
108-10-1	06/91	Methyl isobutyl ketone {Hexone}
75-86-5	07/96	2-Methyllactonitrile {Acetone cyanohydrin}
80-62-6		Methyl methacrylate
109-06-8	07/96	2-Methylpyridine
1634-04-4	06/91	Methyl tert-butyl ether
90-94-8		Michler's ketone [POM]
*	06/91	Mineral fibers (fine, manmade)

Substances For Which Emissions Must Be Quantified

Chemical Abstract Number(CAS)	Add Date[a]	Substance Name
		(fine mineral fibers which are manmade and are airborne particles of a respirable size greater than 5 microns in length, less than or equal to 3.5 microns in diameter, with a length to diameter ratio of 3:1)
		including but not limited to:
*	09/89	Ceramic fibers
*	09/89	Glasswool fibers
*	09/89	Rockwool fibers
*	09/89	Slagwool fibers
*		Mineral fibers (other than manmade)
		including but not limited to :
1332-21-4		Asbestos
12510-42-8	06/91	Erionite
*		Talc containing asbestiform fibers
1313-27-5	06/91	Molybdenum trioxide
-		Napthalene [PAH, POM] (see PAH)
7440-02-0		Nickel
*		Nickel compounds **
		including but not limited to:
373-02-4	06/91	Nickel acetate
3333-67-3	06/91	Nickel carbonate
13463-39-3		Nickel carbonyl
12054-48-7	06/91	Nickel hydroxide
1271-28-9	06/91	Nickelocene
1313-99-1	06/91	Nickel oxide
12035-72-2		Nickel subsulfide
*	09/89	Nickel refinery dust from the pyrometallurgical process
7697-37-2	06/91	Nitric acid
139-13-9		Nitrilotriacetic acid
98-95-3		Nitrobenzene
92-93-3	09/89	4-Nitrobiphenyl [POM]
7496-02-8	06/91	6-Nitrochrysene [PAH-Derivative, POM]
607-57-8	06/91	2-Nitrofluorene [PAH-Derivative, POM]
302-70-5		Nitrogen mustard N-oxide
100-02-7	06/91	4-Nitrophenol
79-46-9		2-Nitropropane
5522-43-0	06/91	1-Nitropyrene [PAH-Derivative, POM]
156-10-5		p-Nitrosodiphenylamine [POM]
59-89-2		N-Nitrosomorpholine
684-93-5		N-Nitroso-N-methylurea
100-75-4		N-Nitrosopiperidine
930-55-2		N-Nitrosopyrrolidine
*		PAHs[b] (Polycyclic Aromatic Hydrocarbons) [POM]
		including but not limited to: (see NOTES)
83-32-9	07/96	Acenaphthene
208-96-8	07/96	Acenaphthylene
120-12-7	06/91	Anthracene
56-55-3		Benz[a]anthracene
205-99-2		Benzo[b]fluoranthene
205-82-3		Benzo[j]fluoranthene
207-08-9		Benzo[k]fluoranthene
50-32-8		Benzo[a]pyrene
192-97-2	07/96	Benzo[e]pyrene
191-24-2	07/96	Benzo[g,h,i]pyrene
218-01-9	09/90	Chrysene
53-70-3		Dibenz[a,h]anthracene
192-65-4		Dibenzo[a,e]pyrene

Substances For Which Emissions Must Be Quantified

Chemical Abstract Number(CAS)	Add Date[a]	Substance Name
189-64-0		Dibenzo[a,h]pyrene
189-55-9		Dibenzo[a,i]pyrene
191-30-0		Dibenzo[a,l]pyrene
206-44-0	07/96	Fluoranthene
86-73-7	07/96	Fluorene
193-39-5		Indeno[1,2,3,-cd]pyrene
91-57-6	07/96	2-Methyl naphthalene
91-20-3		Naphtalene
198-55-0	07/96	Perylene
85-01-8	07/96	Phenanthrene
129-00-0	07/96	Pyrene
*	06/91	PAH-Derivatives[c] (Polycyclic Aromatic Hydrocarbon derivatives) [POM] (including but not limited to those substances listed in Appendix A-2 with the bracketed designation [PAH-Derivative, POM] (see NOTES)
56-38-2	06/91	Parathion
1336-36-3		PCBs (Polychlorinated biphenyls) [POM]
82-68-8	06/91	Pentachloronitrobenzene {Quintobenzene}
79-21-0	06/91	Peracetic acid
127-18-4		Perchloroethylene {Tetrachloroethene}
108-95-2		Phenol
106-50-3	06/91	p-Phenylenediamine
90-43-7	06/91	2-Phenylphenol [POM]
75-44-5		Phosgene
7723-14-0		Phosphorus
*	09/89	Phosphorus compounds:
7803-51-2		Phospine
7664-38-2	09/89	Phosphoric acid
10025-87-3	09/89	Phosphorus oxychloride
10026-13-8	09/89	Phosphorus pentachloride
1314-56-3	09/89	Phosphorus pentoxide
7719-12-2	09/89	Phosphorus trichloride
126-73-8	09/89	Tributyl phosphate
78-40-0	09/89	Triethyl phosphine
512-56-1	09/89	Trimethyl phosphate
78-30-8	09/89	Triorthocresyl phosphate [POM]
115-86-6	09/89	Triphenyl phosphate [POM]
101-02-0	09/89	Triphenyl phosphite [POM]
85-44-9	09/89	Phthalic anhydride
*		Polychlorinated dibenzo-p-dioxins {PCDDs} [POM] including but not limited to:
1746-01-6		2,3,7,8-Tetrachlorodibenzo-p-dioxin {TCDD} [POM]
40321-76-4		1,2,3,7,8-Pentachlorodibenzo-p-dioxin [POM]
39227-28-6		1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin [POM]
57653-85-7		1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin [POM]
19408-74-3		1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin [POM]
35822-46-9		1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin [POM]
3268-87-9	07/96	1,2,3,4,5,6,7,8-Octachlorodibenzo-p-dioxin [POM]
41903-57-5	07/96	Total Tetrachlorodibenzo-p-dioxin [POM]
36088-22-9	07/96	Total Pentachlorodibenzo-p-dioxin [POM]
34465-46-8	07/96	Total Hexachlorodibenzo-p-dioxin [POM]
37871-00-4	07/96	Total Heptachlorodibenzo-p-dioxin [POM]
*		Polychlorinated dibenzofurans {PCDFs} [POM] including but not limited to:

Substances For Which Emissions Must Be Quantified

Chemical Abstract Number(CAS)	Add Date[a]	Substance Name
51207-31-9		2,3,7,8-Tetrachlorodibenzofuran [POM]
57117-41-6		1,2,3,7,8-Pentachlorodibenzofuran [POM]
57117-31-4		2,3,4,7,8-Pentachlorodibenzofuran [POM]
70648-26-9		1,2,3,4,7,8-Hexachlorodibenzofuran [POM]
57117-44-9		1,2,3,6,7,8-Hexachlorodibenzofuran [POM]
72918-21-9		1,2,3,7,8,9-Hexachlorodibenzofuran [POM]
60851-34-5		2,3,4,6,7,8-Hexachlorodibenzofuran [POM]
67562-39-4		1,2,3,4,6,7,8-Heptachlorodibenzofuran [POM]
55673-89-7		1,2,3,4,7,8,9-Heptachlorodibenzofuran [POM]
39001-02-0	07/96	1,2,3,4,5,6,7,8-Octachlorodibenzofuran [POM]
55722-27-5	07/96	Total Tetrachlorodibenzofuran [POM]
30402-15-4	07/96	Total Pentachlorodibenzofuran [POM]
55684-94-1	07/96	Total Hexachlorodibenzofuran [POM]
38998-75-3	07/96	Total Heptachlorodibenzofuran [POM]
*	09/89	POM[d] (Polycyclic Organic Matter) (including but not limited to those substances listed in Appendix A-2 with the bracketed designation of [POM], [PAH, POM], or [PAH-Derivative, POM] (see NOTES)
1120-71-4		1,3-Propane sultone
57-57-8		beta-Propiolactone
123-38-6	06/91	Propionaldehyde
114-26-1	06/91	Propoxur {Baygon}
115-07-1		Propylene
-		1,2-Propyleneimine (see 2-Methylaziridine)
75-56-9		Propylene oxide
110-86-1	06/91	Pyridine
91-22-5	06/91	Quinoline
106-51-4	06/91	Quinone
*		Radionuclides including but not limited to:
24267-56-9	09/89	Iodine-131
*	09/89	Radon and its decay products
50-55-5		Reserpine [POM]
*	06/91	Residual (heavy) fuel oils
7782-49-2		Selenium
*		Selenium compounds ** including but not limited to:
7446-34-6	09/90	Selenium sulfide
*		Silica, crystalline
7440-22-4	06/91	Silver
*	06/91	Silver compounds **
1310-73-2		Sodium hydroxide
100-42-5		Styrene
96-09-3		Styrene oxide
7664-93-9	06/91	Sulfuric acid
100-21-0	06/91	Terephthalic acid
79-34-5	09/90	1,1,2,2-Tetrachloroethane
7440-28-0	06/91	Thallium
*	06/91	Thallium compounds **
62-55-5		Thioacetamide
62-56-6		Thiourea
7550-45-0	06/91	Titanium tetrachloride
108-88-3		Toluene
-		2,4-Toluenediamine (see 2,4-Diaminotoluene)
*	06/91	Toluene diisocyanates including but not limited to:
584-84-9		Toluene-2,4-diisocyanate

Substances For Which Emissions Must Be Quantified

Chemical Abstract Number(CAS)	Add Date[a]	Substance Name
91-08-7		Toluene-2,6-diisocyanate
95-53-4		o-Toluidine
8001-35-2		Toxaphene {Polychlorinated camphenes}
-		1,1,1-Trichloroethane (see Methyl chloroform)
79-00-5	06/91	1,1,2-Trichloroethane {Vinyl trichloride}
79-01-6		Trichloroethylene
-		2,4,6-Trichlorophenol (see Chlorophenols)
96-18-4	07/96	1,2,3-Trichloropropane
121-44-8	06/91	Triethylamine
1582-09-8	06/91	Trifluralin
95-63-6	06/91	1,2,4-Trimethylbenzene
540-84-1	06/91	2,2,4-Trimethylpentane
51-79-6		Urethane {Ethyl carbamate}
*	06/91	Vanadium (fume or dust)
108-05-4	06/91	Vinyl acetate
593-60-2		Vinyl bromide
75-01-4		Vinyl chloride
100-40-3	07/96	4-Vinylcyclohexene
75-02-5	07/96	Vinyl fluoride
75-35-4		Vinylidene chloride
*	09/89	Wood preservatives (containing arsenic and chromate)
*		Xylenes (mixed xylenes), including:
108-38-3	06/91	m-Xylene
95-47-6	06/91	o-Xylene
106-42-3	06/91	p-Xylene
7440-66-6		Zinc
*	09/89	Zinc compounds **
		including but not limited to:
1314-13-2		Zinc oxide

APPENDIX A-2 NOTES:

***** **single CAS number not applicable**

****** **metal compounds are to be reported as the metal atom equivalent in the compound, unless specific compounds are listed.**

[a] **All listed substances except those with a (6/91) add date are required to be addressed in risk assessments prepared under the third phase of the program (i.e., those facilities that were required to submit an emission inventory plan or update plan to the District by August 1, 1991). The original list was approved by the ARB Board in July 1988.**

[b] **PAH: (Polycyclic Aromatic Hydrocarbon) - An organic compound consisting of a fused ring structure containing at least two (2) benzene rings and which may also contain additional fused rings not restricted exclusively to hexagonal rings. The structure does not include any heteroatoms or substituent groups. The structure includes only carbon and hydrogen. PAHs are a subgroup of POM and have a boiling point of greater than or equal to 100^{O}C.**

[c] **PAH-Derivative: (Polycyclic Aromatic Hydrocarbon Derivative) - An organic compound consisting of a fused ring structure containing at least two (2) benzene rings, and which may also contain additional fused rings not restricted exclusively to hexagonal rings. The fused ring structure does not contain heteroatoms. The structure does contain one or more substituent groups. PAH-Derivatives are a subgroup of POM and have a boiling point of greater than or equal to 100^{O}C.**

[d] **POM: (Polycyclic Organic Matter) - Includes organic compounds with more than one benzene ring, and which have a boiling point of greater than or equal to 100^{O}C.**

{ } **This designation indicates a synonym for the substance listed.**

This 2003 Annual Report Appendix A-2 contains all changes and updates included in the current "Inventory Guidelines" adopted by ARB in July 1996, and posted on ARB's web site.

APPENDIX B
EMISSIONS INVENTORY

Emissions Inventory

The data in the inventories presented in these appendices represent the most accurate information available to the District on emissions of Toxic Air Contaminants (TAC) from stationary sources during a twelve-month period which coincides approximately with the calendar year 2003.

As part of the annual permit renewal process, facilities supply annual information to the District on material throughput and/or usage for permitted sources at their sites. This information is entered into the District data base where it is used in the estimates of emissions. The emissions values that are published in the inventory are calculated values; they are generally the product of annual throughputs and emission factors that have been developed for individual sources or types of equipment. These emission factors are one element in the District data bank; some emission factors have been developed through source testing, either by the District or by a facility, some are derived from the pertinent literature, and some are obtained from EPA documents. The published emissions also include any reductions due to abatement devices/equipment

Facilities whose emissions are below the thresholds established for each TAC are not listed in the inventory. The emissions from these facilities are however included in the pollutant totals presented in Appendix B-2. The TAC thresholds are based on relative toxicity. These thresholds reflect the emission level that is estimated to result in a de minimus level of health risk based on a set of very conservative risk assessment assumptions. For carcinogens, the threshold reporting levels have been set at the emission level that corresponds to a cancer risk of 1 in-one-million; non-carcinogen trigger levels represent the amount estimated to result in a hazard index of one.

APPENDIX B-1

EMISSION INVENTORY

BY FACILITY AND CITY

BAY AREA AIR QUALITY MANAGEMENT DISTRICT
TOXIC AIR CONTAMINANTS
2003 ANNUAL REPORT

COUNTY: ALAMEDA
CITY: Alameda

Company Name	Pollutant	Estimated Emissions (lbs/yr)
Alameda Hospital (P# 15063) 2070 Clinton Avenue Alameda, CA 94501	Ethylene oxide	13.6
Anthony Cleaners (P# 1003) 1417 Webster Street Alameda, CA 94501	Perchloroethylene	384
Brite 1 Hr Cleaners (P# 956) 1607 Park Street Alameda, CA 94501	Perchloroethylene	5670
Dee Bee's Elegant Cleaners (P# 5076) 1208 Lincoln Alameda, CA 94501	Perchloroethylene	472
Direct Funeral Services (P# 9712) 2900 Main St, Suite 1161 Alameda, CA 94501	Chromium (hexavalent)	.0025
Executive One Hour Martinizing (P# 8562) 2210I Southshore Dr Alameda, CA 94501	Perchloroethylene	2160
Garden Cleaners (P# 11636) 1529 Webster Street Alameda, CA 94501	Perchloroethylene	351
J D Harpe Furniture Finishers (P# 9858) 1910 Clement Avenue Alameda, CA 94501	Methylene chloride	1820
Marina Village Cleaners (P# 5649) 817 Marina Village Pkwy Alameda, CA 94501	Perchloroethylene	1080
Northern Calif Power Agency (P# 1500) 2900 Main St, Site 1 or 2 Alameda, CA 94501	Formaldehyde	35

COUNTY: ALAMEDA
CITY: Alameda

Revelation Cleaners (P# 5247) 2309 Encinal Avenue Alameda, CA 94501	Perchloroethylene	796

BAY AREA AIR QUALITY MANAGEMENT DISTRICT
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COUNTY: ALAMEDA
CITY: Albany

Company Name	Pollutant	Estimated Emissions (lbs/yr)
Norge Cleaners & Laundry (P# 1390) 398 San Pablo Ave Albany, CA 94706	Perchloroethylene	782
One Hour Albany Cleaners (P# 2138) 1187 Solano Avenue Albany, CA 94706	Perchloroethylene	1100
Royal Cleaners (P# 4302) 814 San Pablo Ave Albany, CA 94706	Perchloroethylene	2640
Solano Cleaning Center (P# 7814) 1219 Solano Avenue Albany, CA 94706	Perchloroethylene	372

BAY AREA AIR QUALITY MANAGEMENT DISTRICT
TOXIC AIR CONTAMINANTS
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COUNTY: ALAMEDA
CITY: Berkeley

Company Name	Pollutant	Estimated Emissions (lbs/yr)
Berkland Dry Cleaners (P# 13013) 2979 Sacramento St Berkeley, CA 94702	Perchloroethylene	1190
C & C Drycleaner (P# 10887) 2942 College Avenue Berkeley, CA 94705	Perchloroethylene	1220
Cal Cleaners & Laundry (P# 2359) 2531 Telegraph Ave Berkeley, CA 94704	Perchloroethylene	270
City of Berkeley/Engr Div/Public Works (P# 3590) Cesar Chavez Prk Berkeley, CA 94704	Vinyl chloride	3.8
Electro-Coatings of California Inc (P# 4449) 893 Carleton Street Berkeley, CA 94710	Chromium (hexavalent)	.0027
Euwell & Sons Cleaners (P# 4460) 1806 Alcatraz Avenue Berkeley, CA 94703	Perchloroethylene	698
Merit Cleaners (P# 2534) 1779 Solano Avenue Berkeley, CA 94707	Perchloroethylene	405
New Economy Laundry (P# 7241) 3200 Sacramento St Berkeley, CA 94702	Perchloroethylene	135
PE Berkeley, Inc (P# 11326) Univ of Calif, Berkeley Campus Berkeley, CA 94720	Benzene	86.6
	Formaldehyde	1330
Pacific Steel Casting Co-Plant #1 (P# 187) 1328 2nd Street Berkeley, CA 94710	Manganese	112
	Nickel pollutant	9.05
Pacific Steel Casting Co-Plant #2 (P# 703) 1420 2nd Street Berkeley, CA 94710	Benzene	401.0
	Formaldehyde	415
	Manganese	210
	Nickel pollutant	17.00
Pacific Steel Casting Co-Plant #3 (P# 1603) 1415 2nd Street Berkeley, CA 94710	Nickel pollutant	3.60

BAY AREA AIR QUALITY MANAGEMENT DISTRICT
TOXIC AIR CONTAMINANTS
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COUNTY: ALAMEDA
CITY: Berkeley

Company Name	Pollutant	Estimated Emissions (lbs/yr)
Premier Cleaners (P# 4548) 2552 Martin Luthr Kng Wy Berkeley, CA 94704	Perchloroethylene	668
Tower Cleaners (P# 1310) 1110 University Ave Berkeley, CA 94702	Perchloroethylene	405
Virginia Cleaners (P# 4537) 1650 Shattuck Berkeley, CA 94709	Perchloroethylene	3410
Western Roto Engravers, Inc (P# 4538) 1225 6th Street Berkeley, CA 94710	Chromium (hexavalent)	.0020

BAY AREA AIR QUALITY MANAGEMENT DISTRICT
TOXIC AIR CONTAMINANTS
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COUNTY: ALAMEDA
CITY: Castro Valley

Company Name	Pollutant	Estimated Emissions (lbs/yr)
Dryclean Club of America (P# 7242) 2960 Castro Valley Blvd Castro Valley, CA 94546	Perchloroethylene	499
Jess C Spencer Mortuaries Inc (P# 5148) 21228 Redwood Road Castro Valley, CA 94546	Chromium (hexavalent)	.0064
Manor Cleaners (P# 5051) 20857 Redwood Road Castro Valley, CA 94546	Perchloroethylene	405
Marshall Steel Cleaners (P# 4365) 20457 Redwood Road Castro Valley, CA 94546	Perchloroethylene	432
R&J Quick Clean Center (P# 387) 2522 Castro Valley Blvd Castro Valley, CA 94546	Perchloroethylene	1350
Valley Cleaners of Castro Valley (P# 10702) 2676 Castro Valley Blvd Castro Valley, CA 94546	Perchloroethylene	1240

COUNTY: ALAMEDA
CITY: Dublin

Company Name	Pollutant	Estimated Emissions (lbs/yr)
Dold's Workshop (P# 7926) 7106 Village Pkwy Dublin, CA 94568	Methylene chloride	5660
Dryclean 1 Hour (P# 4204) 7257 Regional St Dublin, CA 94568	Perchloroethylene	850
Glory's Dry Cleaning (P# 15162) 7988 Amador Valley Blvd Dublin, CA 94568	Perchloroethylene	546
Harvey's Cleaners & Laundry (P# 11515) 6797 Dublin Road Dublin, CA 94568	Perchloroethylene	774
One Low Price Cleaners (P# 12598) 6622 Dublin Blvd Dublin, CA 94568	Perchloroethylene	749
Park Ave Cleaners (P# 5827) 7102B Dublin Blvd Dublin, CA 94568	Perchloroethylene	708

BAY AREA AIR QUALITY MANAGEMENT DISTRICT
TOXIC AIR CONTAMINANTS
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COUNTY: ALAMEDA
CITY: Emeryville

Company Name	Pollutant	Estimated Emissions (lbs/yr)
Level 3 Communications Inc (P# 12946) 5000 Hollis Street Emeryville, CA 94608	Formaldehyde	37
Sentinel Cremation Societies Inc (P# 4735) 4080 Horton Street Emeryville, CA 94608	Arsenic (all)	.098
	Chromium (hexavalent)	.0455

COUNTY: ALAMEDA
CITY: Fremont

Company Name	Pollutant	Estimated Emissions (lbs/yr)
Alameda County Water District (P# 8017) 42436 Mission Blvd Fremont, CA 94539		
	Benzene	10.7
	Formaldehyde	67
America Cleaners (P# 4774) 1548 Washington Blvd Fremont, CA 94539		
	Perchloroethylene	337
Ardenwood Cleaners (P# 4339) 4946 Paseo Padre Pkwy Fremont, CA 94555		
	Perchloroethylene	340
Bo-Mar Cleaners (P# 15030) 34460 Fremont Blvd, #A Fremont, CA 94536		
	Perchloroethylene	279
Borden Packaging & Industrial Products (P# 151) 41100 Boyce Road Fremont, CA 94538		
	Formaldehyde	282
Cedar Lawn Memorial Park & Mortuary (P# 4122) 48800 Warm Spring Blvd Fremont, CA 94539		
	Chromium (hexavalent)	.0015
Crist Oil Company (P# 738) 37105 Mission Blvd Fremont, CA 94538		
	Benzene	8.8
Dumbarton Quarry Associates (P# 589) 9600 Quarry Road Fremont, CA 94537		
	Benzene	452.0
	Formaldehyde	1360
Elegant Cleaners (P# 10480) 47950 Warmsprings Blvd Fremont, CA 94539		
	Perchloroethylene	371
Fremont French Cleaners (P# 12515) 4949 Stevenson Blvd Fremont, CA 94538		
	Perchloroethylene	202
Irvington Memorial Cemetery (P# 4134) 41001 Chapel Way Fremont, CA 94538		
	Arsenic (all)	.092
	Chlorinated dioxins & furans	.000007
	Chromium (hexavalent)	.0430
Meadow Cleaners (P# 4474) 41200C Blacow Road Fremont, CA 94538		
	Perchloroethylene	391

COUNTY: ALAMEDA
CITY: Fremont

Company Name	Pollutant	Estimated Emissions (lbs/yr)
Mission Valley Holiday Cleaners (P# 9034) 40093 Mission Blvd Fremont, CA 94539	Perchloroethylene	290
New United Motor Manufacturing, Inc (P# 1438) 45500 Fremont Blvd Fremont, CA 94538	Benzene	11.5
	Butyl cellosolve	125000
	Glycol ether - other/not spec	15800
Oakland Air Route Traffic Control Center (P# 10235) 5125 Central Avenue Fremont, CA 94536	Formaldehyde	37
Pacific Cleaners and Wireless (P# 15471) 40919 Fremont Blvd, #12 Fremont, CA 94538	Perchloroethylene	246
Pegasus Cleaners (P# 4305) 34257 Fremont Blvd Fremont, CA 94555	Perchloroethylene	277
Quality Cleaner (P# 13427) 3607 Thornton Ave Fremont, CA 94536	Perchloroethylene	809
Savings One Hour Cleaners (P# 11874) 39480 Fremont Blvd Fremont, CA 94538	Perchloroethylene	1010
Smart Cleaners (P# 3900) 41083 Fremont Blvd Fremont, CA 94538	Perchloroethylene	715
Stars Cleaners (P# 4425) 46670 Mohave Blvd Fremont, CA 94539	Perchloroethylene	472
State Cleaners Inc (P# 11063) 4565 Eggers Drive Fremont, CA 94536	Perchloroethylene	592
Super Cleaners (P# 4663) 4150 Walnut Avenue Fremont, CA 94538	Perchloroethylene	1150
Township Cleaners (P# 5633) 43464 Ellsworth St Fremont, CA 94539	Perchloroethylene	890

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COUNTY: ALAMEDA
CITY: Fremont

Company Name	Pollutant	Estimated Emissions (lbs/yr)
Tri-Cities Recycling (P# 2246) 7010 Auto Mall Pkwy Fremont, CA 94538		
	Benzene	205.0
	Ethylene dichloride	55.6
	Methylene chloride	1670
	Perchloroethylene	848
	Trichloroethylene	508
	Vinyl chloride	632.0
United Dry Cleaner (P# 3526) 35754 Fremont Blvd Fremont, CA 94536		
	Perchloroethylene	304
Walnut Cleaners (P# 4342) 3367 Walnut Avenue Fremont, CA 94538		
	Perchloroethylene	546

COUNTY: ALAMEDA
CITY: Hayward

Company Name	Pollutant	Estimated Emissions (lbs/yr)
ASAP Drycleaning and Restoration (P# 13317) 26953 Mission Blvd, #K Hayward, CA 94544	Perchloroethylene	540
Alpine Cleaners (P# 9139) 22286 Foothill Blvd Hayward, CA 94541	Perchloroethylene	830
Art Cleaners (P# 2519) 27312 Hesperian Blvd Hayward, CA 94545	Perchloroethylene	261
Bay Area Crematory (P# 3576) 1051 Harder Road Hayward, CA 94542	Chromium (hexavalent)	.0017
Bay Cities Auto Auction (P# 15414) 29900 Auction Way Hayward, CA 94544	Benzene	20.0
	Formaldehyde	125
Chapel of the Chimes Memorial Park (P# 8399) 32992 Mission Blvd Hayward, CA 94544	Chromium (hexavalent)	.0067
Custom Commercial Dry Cleaners (P# 12249) 3201 Investment Blvd, Suite A Hayward, CA 94545	Perchloroethylene	2100
Deep Cleaner (P# 11412) 350 W Tennyson Road Hayward, CA 94544	Perchloroethylene	594
Dry Cleaner (P# 7525) 3300 E Castro Valley Blvd, Suite F Hayward, CA 94552	Perchloroethylene	378
DuPont Electronic Technologies (P# 15492) 2520 Barrington Ct Hayward, CA 94545	Perchloroethylene	55
Dynasty Cleaners (P# 10563) 1147 B Street Hayward, CA 94541	Perchloroethylene	499
Hayward Waste Water Treatment Plant (P# 1009) 3700 Enterprise Ave Hayward, CA 94545	Benzene	17.1
	Chloroform	370
	Methylene chloride	504
	Perchloroethylene	212

COUNTY: ALAMEDA
CITY: Hayward

Company Name	Pollutant	Estimated Emissions (lbs/yr)
High Lustre Metal Finishing (P# 7111) 2466 American Ave, Unit C Hayward, CA 94545	Chromium (hexavalent)	.0035
Highland Cleaners (P# 6120) 26775 Hayward Blvd, #F Hayward, CA 94542	Perchloroethylene	1250
Jack's Cleaners & Shirt Laundry (P# 11984) 1214 W Winton Street Hayward, CA 94544	Perchloroethylene	540
Jackson Cleaners (P# 10927) 203 Jackson Street Hayward, CA 94544	Perchloroethylene	634
Lucky Cleaners (P# 4261) 2061 B Street Hayward, CA 94541	Perchloroethylene	2080
Owens Brockway Glass Container, Inc (P# 11362) 22302 Hathaway Ave Hayward, CA 94541	Lead (all) pollutant	187
Rainbow Cleaners (P# 4309) 427 Industrial Pkwy Hayward, CA 94544	Perchloroethylene	595
Rohm and Haas Co,Polymers & Resin Business (P# 200) 25500 Whitesell St Hayward, CA 94545	Acrylonitrile	38.10
SF Tube, Inc (P# 14664) 23099 Connecticut St Hayward, CA 94545	Trichloroethylene	1340
Selix Formalwear (P# 5045) 22423 Foothill Blvd Hayward, CA 94541	Perchloroethylene	4170
Silktech Cleaners (P# 9954) 853 Sycamore Avenue Hayward, CA 94544	Perchloroethylene	675
Sunny J Cleaners (P# 8612) 1104 W Tennyson Rd, Suite C Hayward, CA 94544	Perchloroethylene	135
Sunshine Center Cleaners (P# 8205) 22530 2nd Street Hayward, CA 94541	Perchloroethylene	530

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COUNTY: ALAMEDA
CITY: Hayward

Company Name	Pollutant	Estimated Emissions (lbs/yr)
Teikuro America Company, Ltd (P# 1794) 31499 Hayman Street Hayward, CA 94544		
	Chromium (hexavalent)	.1170
Town & Country Cleaners (P# 4238) 456 W Harder Road Hayward, CA 94544		
	Perchloroethylene	1030
Trajen Inc (P# 12493) 19990 Skywest Blvd Hayward, CA 94541		
	Benzene	27.0

COUNTY: ALAMEDA
CITY: Livermore

Company Name	Pollutant	Estimated Emissions (lbs/yr)
Biofuel Systems (P# 8329) 30 Greenville Road Livermore, CA 94550		
	Arsenic (all)	.032
	Benzene	24.8
	Beryllium (all) pollutant	.019
	Cadmium	.080
	Chromium (hexavalent)	.0016
	Nickel pollutant	1.29
City of Livermore Sewage Treatment Plant (P# 3169) 101 W Jack London Blvd Livermore, CA 94550		
	Chloroform	70
DOE-KAO Sandia National Laboratories (P# 290) 7011 East Avenue Livermore, CA 94550		
	Butadiene, 1,3-	5.5
	Chloroform	50
	Methylene chloride	282
	Perchloroethylene	183
East Avenue Cleaners (P# 9976) 4074 East Avenue Livermore, CA 94550		
	Perchloroethylene	310
J Cleaners (P# 10371) 2093 Railroad Avenue Livermore, CA 94550		
	Perchloroethylene	310
Lawrence Livermore National Laboratory (P# 255) 7000 East Avenue Livermore, CA 94550		
	Benzene	14.6
	Formaldehyde	76
	Trichloroethylene	367
Mike's Cleaners (P# 4725) 1516 1st Street Livermore, CA 94550		
	Perchloroethylene	202
Pacific Avenue Cleaners (P# 7272) 3018 Pacific Avenue Livermore, CA 94550		
	Perchloroethylene	176
Purity Cleaners & Laundry Inc (P# 4716) 183 N Livermore Livermore, CA 94550		
	Perchloroethylene	1670
Republic Services Vasco Road, LLC (P# 5095) 4001 N Vasco Road Livermore, CA 94550		
	Benzene	272.0
	Ethylene dichloride	75.2
	Methylene chloride	2220
	Perchloroethylene	1130
	Trichloroethylene	679
	Vinyl chloride	845.0

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COUNTY: ALAMEDA
CITY: Livermore

Company Name	Pollutant	Estimated Emissions (lbs/yr)
Roselawn Cemetery (P# 3314) 1240 N Livermore Ave Livermore, CA 94550		
	Arsenic (all)	.026
	Chlorinated dioxins & furans	.000002
	Chromium (hexavalent)	.0123
Sierra Products Inc (P# 9314) 1113 Greenville Road Livermore, CA 94550		
	Methylene chloride	1020
Special Cleaner (P# 10586) 851 E Stanley Blvd Livermore, CA 94550		
	Perchloroethylene	184
Waste Management of Alameda County (P# 2066) 10840 Altamont Pass Rd Livermore, CA 94551		
	Acrylonitrile	66.30
	Benzene	430.0
	Dichlorobenzene	404
	Ethylene dibromide	46.8
	Ethylene dichloride	24.7
	Formaldehyde	239
	Methylene chloride	530
	Perchloroethylene	993
	Tetrachloroethane, 1,1,2,2-	42.0
	Trichloroethylene	459
	Vinyl chloride	172.0

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COUNTY: ALAMEDA
CITY: Newark

Company Name	Pollutant	Estimated Emissions (lbs/yr)
Complete Dry Cleaners (P# 14831) 5532 Thornton Ave Newark, CA 94560	Perchloroethylene	142
FMC Corporation (P# 71) 8787 Enterprise Dr Newark, CA 94560	Ethylene dibromide	18.6
J C Cleaners (P# 6971) 39253 Cedar Blvd Newark, CA 94560	Perchloroethylene	283
Royal Cleaners (P# 9224) 5865 Jarvis Avenue Newark, CA 94560	Perchloroethylene	472
Sparkle One Hour Cleaners (P# 13140) 35284 Newark Blvd Newark, CA 94560	Perchloroethylene	546
Villa One Hr Cleaners (P# 12021) 36601 Newark Blvd, #70 Newark, CA 94560	Perchloroethylene	534

COUNTY: ALAMEDA
CITY: Oakland

Company Name	Pollutant	Estimated Emissions (lbs/yr)
Aman Environmental Construction, Inc (P# 13032) 8300 Baldwin Street Oakland, CA 94621	Formaldehyde	41
American Brass & Iron Foundry (P# 62) 7825 San Leandro St Oakland, CA 94621	Arsenic (all)	3.060
	Beryllium (all) pollutant	.137
	Cadmium	.812
	Chlorinated dioxins & furans	.000289
	Chromium (hexavalent)	.0759
	Manganese	119
	Nickel pollutant	2.74
B & T One Hour Cleaners (P# 3069) 190 14th Street Oakland, CA 94612	Perchloroethylene	1230
Bay 1 Hour Cleaners (P# 7281) 4140 Redwood Road Oakland, CA 94619	Perchloroethylene	135
Bellevue Cleaners (P# 4522) 4155 Piedmont Ave Oakland, CA 94611	Perchloroethylene	513
California Readymix Inc (P# 14927) 220 Burma Rd, Berth 7 Oakland, CA 94607	Benzene	77.9
	Formaldehyde	487
Chapel of the Chimes (P# 3786) 4499 Piedmont Ave Oakland, CA 94611	Chromium (hexavalent)	.0070
Chevron, Oakland Airport-North (P# 519) N Earhardt Drive Oakland, CA 94614	Benzene	50.4
Childrens Hospital, Oakland (P# 1785) 747 52nd Street Oakland, CA 94609	Formaldehyde	37
Classic Touch Fashion Cleaners (P# 8108) 3518 Fruitvale Blvd Oakland, CA 94602	Perchloroethylene	472
Cleveland Steel Container (P# 15023) 3100 E 10th Street Oakland, CA 94601	Butyl cellosolve	5390

COUNTY: ALAMEDA
CITY: Oakland

Company Name	Pollutant	Estimated Emissions (lbs/yr)
Diamond Cleaners (P# 4627) 6816 Bancroft Ave Oakland, CA 94605	Perchloroethylene	607
Dollar Cleaners (P# 3963) 4868 Telegraph Ave Oakland, CA 94609	Perchloroethylene	270
Duke Energy Oakland LLC (P# 11887) 50 Martin Luthr Kng, Jr Way Oakland, CA 94607	Benzene	12.6
	Formaldehyde	59
Earl's Unique Cleaner (P# 11307) 4115 Telegraph Ave Oakland, CA 94609	Perchloroethylene	526
East Bay Municipal Utility District (P# 591) 2020 Wake Avenue Oakland, CA 94607	Acetaldehyde	179
	Acrolein	110.0
	Ammonia (NH3) pollutant	72400
	Benzene	401.0
	Chloroform	1690
	Dichlorobenzene	268
	Formaldehyde	2380
	Methylene chloride	1560
	Perchloroethylene	1690
	Trichloroethylene	295
Esposito Plating & Polishing Corp (P# 2955) 2904 Chapman Street Oakland, CA 94601	Chromium (hexavalent)	.0015
Evergreen Cemetery (P# 6390) 6450 Camden Street Oakland, CA 94605	Arsenic (all)	.056
	Chlorinated dioxins & furans	.000003
	Chromium (hexavalent)	.0261
Fleischmann's Vinegar Company, Inc (P# 15064) 921 98th Avenue Oakland, CA 94603	Acetaldehyde	115
Fountain Cleaner (P# 9662) 7110 International Blvd Oakland, CA 94621	Perchloroethylene	1250
Golden Empire Properties c/o Cambria Environmental (P# 12241) 3055 35th Street Oakland, CA 94619	Benzene	24.3

COUNTY: ALAMEDA
CITY: Oakland

Company Name	Pollutant	Estimated Emissions (lbs/yr)
Hard Chrome Engineering Company (P# 4004) 750 107th Avenue Oakland, CA 94603	Chromium (hexavalent)	.0278
Highland General Hospital (P# 3885) 1411 E 31st Street Oakland, CA 94602	Benzene	12.1
	Formaldehyde	79
Holiday Cleaners (P# 5075) 1431 Leimert Blvd Oakland, CA 94602	Perchloroethylene	263
Ideal Cleaners (P# 378) 322 14th Street Oakland, CA 94612	Perchloroethylene	400
Le Magic Cleaners (P# 10397) 1706 Franklin Street Oakland, CA 94612	Perchloroethylene	600
Lockwood Cleaners (P# 3012) 6160 International Blvd Oakland, CA 94621	Perchloroethylene	514
Mark Borsuk Esq (P# 13071) 1432 Harrison Street Oakland, CA 94612	Benzene	15.0
Mary's Cleaners (P# 5957) 3425 Lakeshore Ave Oakland, CA 94610	Perchloroethylene	526
May Cleaners (P# 15214) 1924 Park Boulevard Oakland, CA 94606	Perchloroethylene	290
Montclair Cleaners (P# 3955) 6122 La Salle Ave Oakland, CA 94611	Perchloroethylene	612
Mountain View Cemetery Association (P# 3809) 5000 Piedmont Ave Oakland, CA 94611	Chromium (hexavalent)	.0018
Norge Village (P# 258) 3908 Grand Avenue Oakland, CA 94610	Perchloroethylene	321

COUNTY: ALAMEDA
CITY: Oakland

Company Name	Pollutant	Estimated Emissions (lbs/yr)
One Hour Martinizing (P# 10598) 3250 Grand Avenue Oakland, CA 94610	Perchloroethylene	1740
Owens-Brockway Glass Container Inc (P# 30) 3600 Alameda Avenue Oakland, CA 94601	Cadmium	11.100
	Chromium (hexavalent)	.0122
	Lead (all) pollutant	178
	Nickel pollutant	2.57
	Selenium	418.0
Pacific Bell (P# 13494) 1587 Franklin Street Oakland, CA 94612	Formaldehyde	36
Perkins Cleaners (P# 6383) 447 Perkins Street Oakland, CA 94610	Perchloroethylene	731
Pride Cleaners (P# 4364) 3401 Grand Avenue Oakland, CA 94610	Perchloroethylene	884
Professional Cleaners (P# 10747) 2809 MacArthur Blvd Oakland, CA 94602	Perchloroethylene	1070
Red Hanger Kleaners Inc (P# 4379) 6239 College Avenue Oakland, CA 94618	Perchloroethylene	1700
Rockridge Royal Cleaners (P# 2028) 5455 College Avenue Oakland, CA 94618	Perchloroethylene	486
Rolls-Royce Engine Services - Oakland, Inc (P# 615) 7200 Earhart Road Oakland, CA 94621	Trichloroethylene	798
Santana's Furniture Refinish (P# 10599) 4356 Coliseum Way Oakland, CA 94601	Methylene chloride	3450
Shattuck One Hour Cleaners (P# 4334) 6103 Shattuck Ave Oakland, CA 94609	Perchloroethylene	567
Sherman's Cleaners (P# 2768) 3249 Lakeshore Dr Oakland, CA 94610	Perchloroethylene	1030

COUNTY: ALAMEDA
CITY: Oakland

Company Name	Pollutant	Estimated Emissions (lbs/yr)
Sparkle Cleaners (P# 6284) 7000 Bancroft Ave Oakland, CA 94605	Perchloroethylene	641
Style Cleaners (P# 4366) 5912 San Pablo Oakland, CA 94608	Perchloroethylene	1010
Sunny Piedmont Cleaners (P# 5546) 4364 Piedmont Ave Oakland, CA 94611	Perchloroethylene	963
Thrifty 1hr Cleaners (P# 7908) 3920 MacArthur Blvd Oakland, CA 94619	Perchloroethylene	233
Trans Bay Container Terminal (P# 12387) 2500 7th Street Oakland, CA 94607	Benzene Formaldehyde	7.8 49
Vale Cleaners (P# 7899) 1917 Fruitvale Ave Oakland, CA 94601	Perchloroethylene	182
WFG-Fuller Funerals Inc (P# 10794) 4647 International Blvd Oakland, CA 94601	Chromium (hexavalent)	.0043
Wing Lee Cleaners (P# 9198) 5861 San Pablo Ave Oakland, CA 94608	Perchloroethylene	406
Young's One Hour Martinizing (P# 5364) 600 Grand Ave, Suite 100 Oakland, CA 94610	Perchloroethylene	352
Youngs Cleaners (P# 4911) 10700 McArthur Blvd, Suite 20D Oakland, CA 94605	Perchloroethylene	384

COUNTY: ALAMEDA
CITY: Pleasanton

Company Name	Pollutant	Estimated Emissions (lbs/yr)
Applied Biosystems (P# 14604) 6055 Sunol Boulevard Pleasanton, CA 94566		
	Benzene	10.5
	Formaldehyde	62
	Methylene chloride	268
Arrow Cleaners (P# 6132) 6700 Santa Rita Rd, Suite G Pleasanton, CA 94566		
	Perchloroethylene	405
Bernal Cleaners (P# 5315) 6654 Koll Center Pkwy Pleasanton, CA 94566		
	Perchloroethylene	336
City Dryclean (P# 15423) 4855 Hopyard Road, #5 Pleasanton, CA 94566		
	Perchloroethylene	1010
Dublin San Ramon Services District - Wastewater TP (P# 1371) 7399 Johnson Drive Pleasanton, CA 94588		
	Benzene	12.3
	Chloroform	199
	Methylene chloride	284
	Perchloroethylene	433
	Trichloroethylene	180
Family Cleaners (P# 9648) 618A Main Street Pleasanton, CA 94566		
	Perchloroethylene	418
Holiday Cleaners of America (P# 7842) 3170 Santa Rita Road, #4 Pleasanton, CA 94588		
	Perchloroethylene	567
Oak Hills Cleaners (P# 4468) 5410 Sunol Boulevard Pleasanton, CA 94566		
	Perchloroethylene	742
Pacific Bell Corporation (P# 13922) 5850 Las Positas Blvd Pleasanton, CA 94588		
	Benzene	6.9
	Formaldehyde	43
Pleasanton Garbage Service, Inc (P# 2451) 2512 Vineyard Avenue Pleasanton, CA 94566		
	Benzene	18.6
	Vinyl chloride	12.5
Plesanton Lucky Cleaners (P# 11942) 6051 W Las Positas Blvd Pleasanton, CA 94566		
	Perchloroethylene	215

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COUNTY: ALAMEDA
CITY: Pleasanton

Company Name	Pollutant	Estimated Emissions (lbs/yr)
VIP Cleaners (P# 4063) 1809 Santa Rita Road Pleasanton, CA 94566	Perchloroethylene	654
Vintage Hills Cleaners (P# 10655) 3550 Bernal Avenue, #160 Pleasanton, CA 94566	Perchloroethylene	675

COUNTY: ALAMEDA
CITY: San Leandro

Company Name	Pollutant	Estimated Emissions (lbs/yr)
Bal Cleaners (P# 4677) 1430 148th Avenue San Leandro, CA 94578	Perchloroethylene	499
Bancroft Cleaners (P# 7854) 625 Bancroft Avenue San Leandro, CA 94577	Perchloroethylene	877
Cherry City Cleaners (P# 11337) 1620 Washington Avenue San Leandro, CA 94577	Perchloroethylene	907
Davis Cleaners (P# 9017) 1290 Davis Street San Leandro, CA 94577	Perchloroethylene	587
Dryclean USA (P# 3967) 1322 Washington Street San Leandro, CA 94577	Perchloroethylene	1240
Dynasty Cleaners (P# 5042) 295 MacArthur Boulevard San Leandro, CA 94577	Perchloroethylene	863
Fairmont Cleaners (P# 10005) 1354 Fairmont Drive San Leandro, CA 94578	Perchloroethylene	704
Fantastic Cleaners (P# 6450) 15225 Washington Avenue San Leandro, CA 94579	Perchloroethylene	795
Fashion Cleaners (P# 12620) 566 Dutton Avenue San Leandro, CA 94577	Perchloroethylene	135
Foamex, L P (P# 11693) 2451 Polvorosa Street San Leandro, CA 94577	Toluene diisocyanate (TDI)	198.0
Gene's Cleaners (P# 4614) 1077 MacArthur Boulevard San Leandro, CA 94577	Perchloroethylene	708
JBR, Inc (P# 4050) 1933 Davis St, Suite 180 San Leandro, CA 94577	Formaldehyde	58

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COUNTY: ALAMEDA
CITY: San Leandro

Company Name	Pollutant	Estimated Emissions (lbs/yr)
Maxwell House, Div of Kraft Foods (P# 167) 100 Halcyon Drive San Leandro, CA 94578	Acrolein	5.1
	Formaldehyde	86
Melody Cleaners (P# 4018) 15025 Farnsworth Street San Leandro, CA 94577	Perchloroethylene	204
Quick Kleeners (P# 898) 122 Pelton Center San Leandro, CA 94577	Perchloroethylene	459
Russell Heath Cleaners (P# 11780) 1056 E 14th Street San Leandro, CA 94577	Perchloroethylene	1130
San Leandro Surgery Center (P# 11058) 15035 E 14th Street San Leandro, CA 94578	Ethylene oxide	10.8
San Leandro Water Pollution Control Plant (P# 2340) 3000 Davis Street San Leandro, CA 94577	Chloroform	147
	Perchloroethylene	273
Sunshine Cleaners (P# 11275) 223 E 14th Street San Leandro, CA 94577	Perchloroethylene	1560
Waste Management Inc (P# 12728) 2615 Davis Street San Leandro, CA 94577	Acrylonitrile	104.00
	Benzene	46.2
	Ethylene dichloride	12.5
	Methylene chloride	376
	Perchloroethylene	192
	Tetrachloroethane, 1,1,2,2-	57.6
	Trichloroethylene	115
	Vinyl chloride	142.0
Windmill Cleaners (P# 15573) 16310 E 14th Street San Leandro, CA 94578	Perchloroethylene	517
Wyman-Gordon Company - San Leandro Operations (P# 194) 414 Hester Street San Leandro, CA 94577	Nickel pollutant	62.00

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COUNTY: ALAMEDA
CITY: San Lorenzo

Company Name	Pollutant	Estimated Emissions (lbs/yr)
Dollar Cleaners (P# 2291) 15576 Hesperian Blvd San Lorenzo, CA 94580	Perchloroethylene	1810
East Bay Dischargers Authority (P# 13187) 2600 Grant Avenue San Lorenzo, CA 94580	Benzene	7.3
	Formaldehyde	46
Hesperian Cleaners (P# 4456) 15848 Hesperian Blvd San Lorenzo, CA 94580	Perchloroethylene	202
Kwik Milady Cleaners (P# 2490) 664 Brockman Road San Lorenzo, CA 94580	Perchloroethylene	1200
Lorenzo Cleaners (P# 4697) 18200 Hesperian Blvd San Lorenzo, CA 94580	Perchloroethylene	607
Oro Loma Sanitary District (P# 1067) 2600 Grant Avenue San Lorenzo, CA 94580	Benzene	50.9
	Chloroform	443
	Formaldehyde	261
	Methylene chloride	519
	Perchloroethylene	628
Simpson Cleaners (P# 4236) 15863 Channel Street San Lorenzo, CA 94580	Perchloroethylene	324
Tesoro c/o RDM Environmental (P# 15137) 44 Lewelling Boulevard San Lorenzo, CA 94580	Benzene	97.6

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COUNTY: ALAMEDA
CITY: Union City

Company Name	Pollutant	Estimated Emissions (lbs/yr)
Blommer Chocolate Company, Inc (P# 8206) 1515 Pacific Street Union City, CA 94587	Formaldehyde	289
Rose Cleaners (P# 7430) 33366 Alvarado Niles Rd Union City, CA 94587	Perchloroethylene	755
Save-On 1hr Cleaners (P# 14610) 34375 Alvarado Niles Rd Union City, CA 94587	Perchloroethylene	782
Turk Island Solid Waste Disposal Site (P# 3256) Union City Boulevard Union City, CA 94587	Benzene	24.2
	Methylene chloride	197
	Perchloroethylene	100
	Vinyl chloride	74.7
Union Sanitary District (P# 1209) 5072 Benson Road Union City, CA 94587	Ammonia (NH3) pollutant	24500
	Benzene	113.0
	Chloroform	405
	Formaldehyde	40
	Methylene chloride	821
	Perchloroethylene	469
	Trichloroethylene	117
United States Pipe & Foundry Company, Inc (P# 83) 1295 Whipple Road Union City, CA 94587	Chlorinated dioxins & furans	.000144

COUNTY: CONTRA COSTA
CITY: Antioch

Company Name	Pollutant	Estimated Emissions (lbs/yr)
Delta Diablo Sanitation District (P# 1258) 2500 Pittsburg & Antioch Hwy Antioch, CA 94509		
	Benzene	12.8
	Chloroform	202
	Formaldehyde	112
	Methylene chloride	658
	Perchloroethylene	354
Delta Fair Cleaners (P# 10031) 2362 Buchanan Road Antioch, CA 94509		
	Perchloroethylene	324
GWF Power Systems,LP (Site 3) (P# 3245) 1900 Wilbur Avenue Antioch, CA 94509		
	Ammonia (NH3) pollutant	88100
	Arsenic (all)	.037
	Benzene	14.4
	Chlorinated dioxins & furans	.000004
	Chromium (hexavalent)	.3570
	Hydrogen Chloride (HCl)	3650
	Nickel pollutant	7.04
	Polychlorinated biphenyl (PCB)	.121
GWF Power Systems,LP (Site 4) (P# 3981) 3400 Wilbur Avenue Antioch, CA 94509		
	Ammonia (NH3) pollutant	24700
	Arsenic (all)	.034
	Benzene	13.4
	Chlorinated dioxins & furans	.000004
	Chromium (hexavalent)	.3340
	Hydrogen Chloride (HCl)	3410
	Nickel pollutant	6.58
	Polychlorinated biphenyl (PCB)	.113
Harbinger Independent Power Fund II (P# 15393) 1779 Wilbur Avenue Antioch, CA 94509		
	Benzene	130.0
	Formaldehyde	27500
Hillcrest Cleaners (P# 5975) 4361 Hillcrest Ave Antioch, CA 94509		
	Perchloroethylene	136
Mirant Delta, LLC (P# 18) 3201 Wilbur Avenue Antioch, CA 94509		
	Benzene	36.1
	Formaldehyde	1750
Oak View Memorial Park (P# 2320) 2500 E 18th Street Antioch, CA 94509		
	Arsenic (all)	.025
	Chlorinated dioxins & furans	.000002
	Chromium (hexavalent)	.0115

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COUNTY: CONTRA COSTA
CITY: Antioch

Company Name	Pollutant	Estimated Emissions (lbs/yr)
Silgan Containers Mfg Corp (P# 14327) 2200 Wilbur Avenue Antioch, CA 94509		
	Butyl cellosolve	42300
TRC (P# 12967) James Donlon Blvd Antioch, CA 94509		
	Benzene	28.2
	Perchloroethylene	66
	Vinyl chloride	76.5

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COUNTY: CONTRA COSTA
CITY: Bethel Island

Company Name	Pollutant	Estimated Emissions (lbs/yr)
Robert A Cohan (P# 11983) Bethel Island, Contra Costa County Bethel Island, CA 94511	Benzene	158.0
Tri-Valley Oil & Gas Co (P# 11961) Bethel Island Bethel Island, CA 94511	Benzene	32.0

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COUNTY: CONTRA COSTA
CITY: Brentwood

Company Name	Pollutant	Estimated Emissions (lbs/yr)
Bay Area/Diablo Petroleum (P# 750) 8285 Brentwood Blvd Brentwood, CA 94513	Benzene	19.5

COUNTY: CONTRA COSTA
CITY: Concord

Company Name	Pollutant	Estimated Emissions (lbs/yr)
Andy's T-Shirts (P# 8401) 1960 Arnold Ind Pl Concord, CA 94520	Methylene chloride	492
Bel Air Cleaners (P# 11572) 4478 Treat Boulevard Concord, CA 94521	Perchloroethylene	567
Best Cleaners (P# 4955) 3456 Clayton Road Concord, CA 94519	Perchloroethylene	729
ChevronTexaco Business and Real Estate Services (P# 1605) 2003 Diamond Blvd Concord, CA 94520	Benzene	296.0
	Formaldehyde	2740
Dana Cleaners (P# 7535) 32 Dana Plaza Concord, CA 94520	Perchloroethylene	202
Fashion Cleaners (P# 12820) 5400Y Ygnacio Valley Rd Concord, CA 94521	Perchloroethylene	364
Market Place Cleaners (P# 11317) 4305 Clayton Road, #C Concord, CA 94521	Perchloroethylene	250
Marshall Steel Drycleaners (P# 10469) 5280 Clayton Road Concord, CA 94521	Perchloroethylene	162
Monument Cleaners (P# 7662) 2250 Monument Blvd Concord, CA 94520	Perchloroethylene	371
Norge Village Cleaner (P# 11373) 4701 Clayton Road, #D Concord, CA 94521	Perchloroethylene	1190
One Hour Cleaners (P# 11177) 1823 Willow Pass Rd Concord, CA 94520	Perchloroethylene	1170
Pacific Gas & Electric Co (P# 541) 4690 Evora Road Concord, CA 94520	Formaldehyde	6006

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COUNTY: CONTRA COSTA
CITY: Concord

Company Name	Pollutant	Estimated Emissions (lbs/yr)
Park Place Discount Cleaners (P# 7129) 1735 Willow Pass Rd Concord, CA 94520	Perchloroethylene	1520
Peshon's Cleaning Specialist (P# 9163) 1381 Franquette, Unit C 1 Concord, CA 94520	Perchloroethylene	283
Royale Cleaners (P# 4436) 4583 Clayton Road Concord, CA 94521	Perchloroethylene	418
SFPP, L P (P# 4022) 1550 Solano Way Concord, CA 94520	Benzene	35.6
Systron Donner Inertial Division (P# 6093) 2700 Systron Drive Concord, CA 94518	Dichlorobenzene	5100
	Perchloroethylene	7390

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COUNTY: CONTRA COSTA
CITY: Crockett

Company Name	Pollutant	Estimated Emissions (lbs/yr)
C & H Sugar Company, Inc (P# 11911) 830 Loring Avenue Crockett, CA 94525		
	Chloroform	78
Crockett Cogeneration, A Cal Ltd Partnership (P# 8664) 550 Loring Avenue Crockett, CA 94525		
	Ammonia (NH3) pollutant	348000
	Benzene	35.8
	Formaldehyde	3720
ST Shore Terminals LLC (P# 581) 90 San Pablo Avenue Crockett, CA 94525		
	Benzene	38.7

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COUNTY: CONTRA COSTA
CITY: Danville

Company Name	Pollutant	Estimated Emissions (lbs/yr)
B-Line Cleaners (P# 8685) 120 Hartz Avenue Danville, CA 94526	Perchloroethylene	759
Sparklizing Cleaners (P# 7448) 514 San Ramon Blvd Danville, CA 94526	Perchloroethylene	958

COUNTY: CONTRA COSTA
CITY: El Cerrito

Company Name	Pollutant	Estimated Emissions (lbs/yr)
Busy Bee Cleaners (P# 8118) 11896 San Pablo Avenue El Cerrito, CA 94530	Perchloroethylene	771
Del Norte Cleaners (P# 1091) 11299 San Pablo Avenue El Cerrito, CA 94530	Perchloroethylene	308
M & P One Hour Cleaner (P# 4604) 10579 San Pablo Avenue El Cerrito, CA 94530	Perchloroethylene	702
O K Cleaners (P# 10588) 6109 Potrero Avenue El Cerrito, CA 94530	Perchloroethylene	135
Sunset View Cemetery Association (P# 7394) 101 Colusa Avenue El Cerrito, CA 94530	Chromium (hexavalent)	.0039
Sunshine Cleaners & Coin Laundry (P# 2178) 10750 San Pablo Avenue El Cerrito, CA 94530	Perchloroethylene	236

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COUNTY: CONTRA COSTA
CITY: El Sobrante

Company Name	Pollutant	Estimated Emissions (lbs/yr)
East Bay Municipal Utility District (P# 11189) 5211 La Honda Road El Sobrante, CA 94803	Benzene	11.3
	Formaldehyde	102
El Sobrante Cleaners (P# 3971) 3650 San Pablo Dam Road El Sobrante, CA 94803	Perchloroethylene	755
Kleen N Brite Cleaners (P# 15310) 3800 San Pablo Dam Rd, Ste D El Sobrante, CA 94803	Perchloroethylene	702
Martindale Cleaners (P# 15239) 3819 San Pablo Dam Road El Sobrante, CA 94803	Perchloroethylene	675
Sunny Cleaners (P# 9380) 4801 Valleyview Road El Sobrante, CA 94803	Perchloroethylene	546

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COUNTY: CONTRA COSTA
CITY: Hercules

Company Name	Pollutant	Estimated Emissions (lbs/yr)
Creekside Cleaners (P# 8320) 1511G Sycamore Ave Hercules, CA 94547	Perchloroethylene	1600
Park Lake Cleaners (P# 7259) 1572C Sycamore Ave Hercules, CA 94547	Perchloroethylene	175
Willow Cleaners (P# 8011) 844 Willow Avenue Hercules, CA 94547	Perchloroethylene	602

COUNTY: CONTRA COSTA
CITY: Lafayette

Company Name	Pollutant	Estimated Emissions (lbs/yr)
Hamlin Cleaners (P# 12133) 3516 Golden Gate Way Lafayette, CA 94549	Perchloroethylene	432
Oakmont Memorial Park (P# 2634) 2099 Reliez Valley Rd Lafayette, CA 94549	Chromium (hexavalent)	.0031
One Hour Cleaners (P# 10608) 3580 Mt Diablo Blvd Lafayette, CA 94549	Perchloroethylene	378
Penguin Cleaners (P# 4969) 3322A Mt Diablo Blvd Lafayette, CA 94549	Perchloroethylene	297
Queen Cleaners (P# 325) 3506 E Mt Diablo Blvd Lafayette, CA 94549	Perchloroethylene	202
Sterling Cleaners (P# 7469) 3425 Mount Diablo Blvd Lafayette, CA 94549	Perchloroethylene	384

COUNTY: CONTRA COSTA
CITY: Martinez

Company Name	Pollutant	Estimated Emissions (lbs/yr)
Acme Fill Corporation (P# 1464) 950 Waterbird Way Martinez, CA 94553		
	Benzene	214.0
	Ethylene dichloride	57.7
	Methylene chloride	1730
	Perchloroethylene	880
	Trichloroethylene	527
	Vinyl chloride	655.0
American Cleaners (P# 11993) 1160A Arnold Drive Martinez, CA 94553		
	Perchloroethylene	331
Central Contra Costa Sanitary District (P# 907) 5019 Imhoff Pl Martinez, CA 94553		
	Ammonia (NH3) pollutant	43000
	Benzene	79.4
	Chloroform	550
	Chromium (hexavalent)	.0095
	Formaldehyde	3430
	Methylene chloride	2200
	Perchloroethylene	1170
Chevron Products Co (P# 91) 611 Solano Way Martinez, CA 94553		
	Benzene	46.6
Equilon Enterprises LLC (P# 11956) 1801 Marina Vista Martinez, CA 94553		
	Benzene	82.3
Martinez Cogen Limited Partnership (P# 1820) 550 Solano Wy, Avon Refinery Martinez, CA 94553		
	Benzene	146.0
	Formaldehyde	269
Mt View Sanitary District (P# 4408) End of Arthur Road Martinez, CA 94553		
	Benzene	7.6
	Chloroform	79
	Perchloroethylene	74
Shell Martinez Refinery (P# 11) 3485 Pacheco Blvd Martinez, CA 94553		
	Acetaldehyde	577
	Arsenic (all)	1.480
	Benzene	1430.0
	Butadiene, 1,3-	12.8
	Butyl alcohol, tert-	691
	Cadmium	.423
	Chromium (hexavalent)	1.5600
	Formaldehyde	19300
	Nickel pollutant	3.76
	PAH's (benzo[a]pyrene equiv)	74.200
	Perchloroethylene	55

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COUNTY: CONTRA COSTA
CITY: Martinez

Company Name	Pollutant	Estimated Emissions (lbs/yr)
Shore Terminals - Martinez (P# 7034) 2801 Waterfront Road Martinez, CA 94553		
	Benzene	76.8
Sunrise Cleaners (P# 5400) 518 Center Street Martinez, CA 94553		
	Perchloroethylene	688
Tesoro Refining and Marketing Company (P# 14628) 150 Solano Wy, Avon Refinery Martinez, CA 94553		
	Acetaldehyde	154
	Arsenic (all)	.441
	Benzene	2580.0
	Butadiene, 1,3-	71.7
	Cadmium	.140
	Chromium (hexavalent)	.3010
	Formaldehyde	9600
	Nickel pollutant	15.40
	PAH's (benzo[a]pyrene equiv)	80.100
	Perchloroethylene	899

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COUNTY: CONTRA COSTA
CITY: Moraga

Company Name	Pollutant	Estimated Emissions (lbs/yr)
Clean Cleaners of Moraga (P# 3750) 1425 Moraga Way Moraga, CA 94556	Perchloroethylene	1160
Lamorinda Cleaners (P# 6256) 629 Moraga Road Moraga, CA 94556	Perchloroethylene	526
Rheem Center Martinizing (P# 5004) 492 Center Street Moraga, CA 94556	Perchloroethylene	492
Rheem Valley Cleaners (P# 4424) 568 Center Street Moraga, CA 94556	Perchloroethylene	472

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COUNTY: CONTRA COSTA
CITY: Oakley

Company Name	Pollutant	Estimated Emissions (lbs/yr)
Custom Cleaners (P# 5866) 2575 Main Street Oakley, CA 94561	Perchloroethylene	540
Cypress Cleaners (P# 5113) 2027 Main Street Oakley, CA 94561	Perchloroethylene	418
Ironhouse Sanitary District (P# 1463) Highway 4 Oakley, CA 94561	Chloroform	122
Oakley 1 Hour Dry Cleaners (P# 4298) 3647 Main Street Oakley, CA 94561	Perchloroethylene	540
Tonka Energy Inc (P# 11241) Cypress Ave & Knightsen Oakley, CA 94561	Benzene	10.7
	Formaldehyde	97

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COUNTY: CONTRA COSTA
CITY: Orinda

Company Name	Pollutant	Estimated Emissions (lbs/yr)
Clean Cleaners of Orinda (P# 12492) 17 Orinda Way Orinda, CA 94563	Perchloroethylene	1240
Orinda Cleaners (P# 4530) 37 Moraga Way Orinda, CA 94563	Perchloroethylene	809

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COUNTY: CONTRA COSTA
CITY: Pinole

Company Name	Pollutant	Estimated Emissions (lbs/yr)
Pinole-Hercules Wastewater Treatment Plant (P# 1194) 11 Tennent Avenue Pinole, CA 94564		
	Benzene	12.3
	Chloroform	124
	Methylene chloride	295
	Perchloroethylene	115
Snow White Cleaners (P# 5126) 610J San Pablo Ave Pinole, CA 94564		
	Perchloroethylene	422
Sun's Cleaners (P# 11926) 1576 Fitzgerald Wy Pinole, CA 94564		
	Perchloroethylene	190

COUNTY: CONTRA COSTA
CITY: Pittsburg

Company Name	Pollutant	Estimated Emissions (lbs/yr)
Allied Waste Industries (Keller Canyon Landfill) (P# 4618) 901 Bailey Road Pittsburg, CA 94565		
	Benzene	96.7
	Ethylene dichloride	26.3
	Methylene chloride	787
	Perchloroethylene	401
	Trichloroethylene	240
	Vinyl chloride	299.0
Calpine Pittsburg LLC (P# 11928) Loveridge Road Pittsburg, CA 94565		
	Ammonia (NH3) pollutant	43000
	Benzene	139.0
	Formaldehyde	225
Criterion Catalysts Company LP (P# 227) 2840 Willow Pass Road Pittsburg, CA 94565		
	Ammonia (NH3) pollutant	32000
	Chromium (hexavalent)	.1900
	Nickel pollutant	111.00
Delta Energy Center (P# 12095) Arcy Lane Pittsburg, CA 94565		
	Ammonia (NH3) pollutant	50900
	Benzene	415.0
	Formaldehyde	1050
Dow Chemical Company (P# 31) Loveridge Road Pittsburg, CA 94565		
	Benzene	12.8
	Butadiene, 1,3-	14.9
	Cadmium	.052
	Carbon tetrachloride	2010.0
	Chlorine pollutant	1910
	Chromium (hexavalent)	.0130
	Hydrochloric acid mist polluta	4520
	Nickel pollutant	1.15
	Perchloroethylene	204
	Polychlorinated biphenyl (PCB)	.034
Faultless Cleaners (P# 4249) 427 E 10th Pittsburg, CA 94565		
	Perchloroethylene	702
GWF Power Systems,LP (Site 1) (P# 3243) 895 E 3rd Street Pittsburg, CA 94565		
	Ammonia (NH3) pollutant	25000
	Arsenic (all)	.036
	Benzene	14.0
	Chlorinated dioxins & furans	.000004
	Chromium (hexavalent)	.3470
	Hydrogen Chloride (HCl)	3540
	Nickel pollutant	6.83
	Polychlorinated biphenyl (PCB)	.118

COUNTY: CONTRA COSTA
CITY: Pittsburg

Company Name	Pollutant	Estimated Emissions (lbs/yr)
GWF Power Systems,LP (Site 2) (P# 3244) 1600 Loveridge Road Pittsburg, CA 94565		
	Ammonia (NH3) pollutant	26400
	Arsenic (all)	.037
	Benzene	14.4
	Chlorinated dioxins & furans	.000004
	Chromium (hexavalent)	.3570
	Hydrogen Chloride (HCl)	3650
	Nickel pollutant	7.03
	Polychlorinated biphenyl (PCB)	.121
GWF Power Systems,LP (Site 5) (P# 3246) 555 Nichols Road Pittsburg, CA 94565		
	Ammonia (NH3) pollutant	25000
	Arsenic (all)	.035
	Benzene	13.8
	Chlorinated dioxins & furans	.000004
	Chromium (hexavalent)	.3400
	Hydrogen Chloride (HCl)	3470
	Nickel pollutant	6.70
	Polychlorinated biphenyl (PCB)	.115
Great American Drycleaning Est (P# 5471) 1353 Buchanan Road Pittsburg, CA 94565		
	Perchloroethylene	702
Koch Carbon, LLC (P# 10684) 700 E 3rd Street Pittsburg, CA 94565		
	Nickel pollutant	.79
Los Medanos Energy Center (P# 11866) 750 E 3rd Street Pittsburg, CA 94565		
	Ammonia (NH3) pollutant	75700
	Benzene	7.7
	Formaldehyde	1610
Mirant Delta, LLC (P# 12) 696 W 10th Street Pittsburg, CA 94565		
	Benzene	84.5
Polychemie, Inc (P# 10183) 501 Nichols Road Pittsburg, CA 94565		
	Formaldehyde	255
Roll Technology West (P# 7546) 900 Loveridge Road Pittsburg, CA 94565		
	Chromium (hexavalent)	.0433
Skill Clean (P# 12242) 198 Harbor Court Pittsburg, CA 94565		
	Perchloroethylene	135

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COUNTY: CONTRA COSTA
CITY: Pittsburg

Company Name	Pollutant	Estimated Emissions (lbs/yr)
Stripping Workshop (P# 13190) 564 W 10th Street C Pittsburg, CA 94565		
	Methylene chloride	7280
USS-POSCO Industries (P# 2371) 900 Loveridge Road Pittsburg, CA 94565		
	Benzene	8.3
	Chromium (hexavalent)	.6520
	Hydrochloric acid mist polluta	8200
Venoco, Inc (P# 813) Nichols Road Pittsburg, CA 94565		
	Benzene	22.6
	Formaldehyde	204

COUNTY: CONTRA COSTA
CITY: Pleasant Hill

Company Name	Pollutant	Estimated Emissions (lbs/yr)
Hosanna Cleaners (P# 12952) 1946 Contra Costa Blvd Pleasant Hill, CA 94523	Perchloroethylene	202
Norge Village Cleaners (P# 5541) 220 Golf Club Road Pleasant Hill, CA 94523	Perchloroethylene	331
One Hour Cleaners (P# 10626) 508B Contra Costa Blvd Pleasant Hill, CA 94523	Perchloroethylene	946
Sisters Cleaners (P# 4457) 2215 Morello Avenue Pleasant Hill, CA 94523	Perchloroethylene	270
Vogue Cleaners (P# 11287) 100 Longbrook Way, #6 Pleasant Hill, CA 94523	Perchloroethylene	2360

COUNTY: CONTRA COSTA
CITY: Richmond

Company Name	Pollutant	Estimated Emissions (lbs/yr)
BP West Coast Products, LLC (P# 13637) 1306 Canal Street Richmond, CA 94804	Benzene	108.0
Bio Rad Laboratories (P# 10218) 3300 Regatta Blvd Richmond, CA 94804	Methylene chloride	586
Bio-Rad Laboratories (P# 5462) 3110 Regatta Blvd Richmond, CA 94804	Formaldehyde	199
Bob's Washette Cleaners (P# 4494) 777 23rd Street Richmond, CA 94804	Perchloroethylene	378
Chevron Products Company (P# 10) 841 Chevron Way Richmond, CA 94802	Acetaldehyde	227
	Ammonia (NH3) pollutant	65400
	Arsenic (all)	1.320
	Benzene	7770.0
	Butadiene, 1,3-	205.0
	Cadmium	.274
	Chromium (hexavalent)	.8640
	Ethylene dibromide	271.0
	Formaldehyde	480
	Manganese	104
	Nickel pollutant	4.17
	PAH's (benzo[a]pyrene equiv)	224.000
	Perchloroethylene	252
	Toluene	46700
Chevron Research and Technology Co (P# 423) 100 Chevron Way Richmond, CA 94802	Benzene	33.1
City of Richmond Water Pollution Control District (P# 2482) 601 Canal Boulevard Richmond, CA 94804	Chloroform	255
	Methylene chloride	437
	Perchloroethylene	49
ConocoPhillips (P# 15693) 1300 Canal Boulevard Richmond, CA 94804	Benzene	128.0
Electro Forming Company (P# 5665) 130 Nevin Avenue Richmond, CA 94801	Chromium (hexavalent)	.0193
Hilltop Cleaners (P# 9211) 2936 Hilltop Mall Rd Richmond, CA 94806	Perchloroethylene	549

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COUNTY: CONTRA COSTA
CITY: Richmond

Company Name	Pollutant	Estimated Emissions (lbs/yr)
IMTT Richmond CA (P# 10649) 100 Cutting Boulevard Richmond, CA 94804	Benzene	13.9
Levin Richmond Terminal Corporation (P# 935) 402 Wright Avenue Richmond, CA 94804	Benzene	11.2
Los Angeles Chemical (P# 1064) 860 Wharf Street Richmond, CA 94804	Perchloroethylene	225
Norge Village Cleaners (P# 4698) 872 23rd Street Richmond, CA 94804	Perchloroethylene	231
Pacific Hard Chrome (P# 3696) 1305 So 51st Street Richmond, CA 94804	Chromium (hexavalent)	.0516
Point Richmond Quarry Inc (P# 9241) 1135 Canal Avenue Richmond, CA 94804	Arsenic (all)	.029
	Benzene	33.3
	Beryllium (all) pollutant	.017
	Cadmium	.073
	Chromium (hexavalent)	.0015
	Formaldehyde	209
	Nickel pollutant	1.17
Radiant Color (P# 99) 2800 Radiant Avenue Richmond, CA 94801	Formaldehyde	142
Red Hanger Kleaners (P# 8312) 319 37th Street Richmond, CA 94805	Perchloroethylene	731
Rolling Hills Memorial Park (P# 7564) 4100 Hilltop Drive Richmond, CA 94803	Chlorinated dioxins & furans	.000002
	Chromium (hexavalent)	.0105
Shore Terminal LLC (P# 745) 488 Wright Avenue Richmond, CA 94804	Benzene	48.6
West Contra Costa County Landfill (P# 1840) Foot of Parr Blvd Richmond, CA 94801	Benzene	220.0
	Vinyl chloride	114.0

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COUNTY: CONTRA COSTA
CITY: Richmond

Company Name	Pollutant	Estimated Emissions (lbs/yr)
West County Wastewater District (P# 1271) 2377 Garden Tract Rd Richmond, CA 94801		
	Benzene	16.7
	Chloroform	510
	Methylene chloride	1230
	Perchloroethylene	72

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COUNTY: CONTRA COSTA
CITY: Rodeo

Company Name	Pollutant	Estimated Emissions (lbs/yr)
Classic Cleaners (P# 14013) 679 Parker Avenue Rodeo, CA 94572	Perchloroethylene	553
ConocoPhillips - San Francisco Refinery (P# 16) 1380 San Pablo Ave Rodeo, CA 94572	Acetaldehyde	92
	Ammonia (NH3) pollutant	113000
	Arsenic (all)	1.670
	Benzene	7060.0
	Cadmium	8.370
	Chromium (hexavalent)	1.6700
	Formaldehyde	33300
	Mercury (all) pollutant	83.7
	Methyl alcohol	175000
	Nickel pollutant	.84
	PAH's (benzo[a]pyrene equiv)	43.800
Tosco Refining Company (P# 22) 2101 Franklin Canyon Rd Rodeo, CA 94572	Chromium (hexavalent)	.4220
	Hydrochloric acid mist polluta	2500
	Hydrogen Chloride (HCl)	116000
	Mercury (all) pollutant	194.0
	Nickel pollutant	9.47

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COUNTY: CONTRA COSTA
CITY: San Pablo

Company Name	Pollutant	Estimated Emissions (lbs/yr)
El Portal One Hour Cleaners And Laundry (P# 2141) 2655 Church Lane San Pablo, CA 94806	Perchloroethylene	1050
Five Star Cleaners (P# 4790) 2145 Rumrill Boulevard San Pablo, CA 94806	Perchloroethylene	4400
Star One Cleaners (P# 12206) 16374 San Pablo Ave San Pablo, CA 94806	Perchloroethylene	358
Steven's Cleaners (P# 6929) 2071 23rd Street San Pablo, CA 94806	Perchloroethylene	68

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COUNTY: CONTRA COSTA
CITY: San Ramon

Company Name	Pollutant	Estimated Emissions (lbs/yr)
Country Club Cleaners (P# 5530) 500 Bollinger Wy, Ste A4 San Ramon, CA 94583	Perchloroethylene	2010
Imperial Cleaners (P# 6014) 2101 Camino Ramon, Ste 108 San Ramon, CA 94583	Perchloroethylene	310
Vonnies One Hour Cleaners (P# 9075) 2217J San Ramon Valley Blvd San Ramon, CA 94583	Perchloroethylene	1210

COUNTY: CONTRA COSTA
CITY: Walnut Creek

Company Name	Pollutant	Estimated Emissions (lbs/yr)
American Cleaners (P# 2847) 2400 Olympic Boulevard, #8 Walnut Creek, CA 94595	Perchloroethylene	310
Americlean (P# 3391) 1545 Palos Verdes Mall Walnut Creek, CA 94596	Perchloroethylene	514
Classic Cleaning of Walnut Creek (P# 10016) 1350 Mt Diablo Boulevard Walnut Creek, CA 94596	Perchloroethylene	405
East Bay Municipal Utility Dist (P# 13716) 2055 Danville Boulevard Walnut Creek, CA 94595	Formaldehyde	35
Herald's Cleaners, Inc (P# 14452) 1525 Cypress Street Walnut Creek, CA 94596	Perchloroethylene	364
Hosanna Cleaners (P# 9254) 1280C Newell Avenue Walnut Creek, CA 94596	Perchloroethylene	391
Hull's Walnut Creek Chapel (P# 11155) 1139 Saranap Avenue Walnut Creek, CA 94595	Chromium (hexavalent)	.0054
Major Town Cleaners (P# 9219) 2918 N Main Street Walnut Creek, CA 94596	Perchloroethylene	675
Marshall Steel Cleaners (P# 4972) 1297 Parkside Drive Walnut Creek, CA 94596	Perchloroethylene	809
St Paul Cleaners (P# 4422) 1381 E Newell Avenue Walnut Creek, CA 94596	Perchloroethylene	917

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COUNTY: MARIN
CITY: Corte Madera

Company Name	Pollutant	Estimated Emissions (lbs/yr)
Corte Madera Cleaners (P# 4322) 143 Corte Madera Twn Ctr Corte Madera, CA 94925	Perchloroethylene	641
L M One Hour Cleaners (P# 13640) 124 Corte Madera Avenue Corte Madera, CA 94925	Perchloroethylene	432
Paradise Cleaners (P# 12195) 5633 Paradise Drive Corte Madera, CA 94925	Perchloroethylene	202

COUNTY: MARIN
CITY: Fairfax

Company Name	Pollutant	Estimated Emissions (lbs/yr)
Fairfax French Laundry & Cleaners (P# 4271) 101 Bolinas Road Fairfax, CA 94930	Perchloroethylene	556
Picaroto Cleaners (P# 5018) 709 Center Boulevard Fairfax, CA 94930	Perchloroethylene	189
Top Hat Cleaners (P# 6187) 1601 Sir Francis Park Fairfax, CA 94930	Perchloroethylene	155

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COUNTY: MARIN
CITY: Larkspur

Company Name	Pollutant	Estimated Emissions (lbs/yr)
Larkspur Cleaners (P# 2835) 590 Magnolia Street Larkspur, CA 94939	Perchloroethylene	650
Maxwell The Cleaner (P# 6106) 1401 Larkspur Landing Circl Larkspur, CA 94939	Perchloroethylene	1800

COUNTY: MARIN
CITY: Mill Valley

Company Name	Pollutant	Estimated Emissions (lbs/yr)
European Tailoring & Cleaners (P# 7063) 237 Shoreline Highway Mill Valley, CA 94941		
	Perchloroethylene	252
Hollywood Forever, Inc (P# 6325) 301 Tennessee Valley Rd Mill Valley, CA 94941		
	Chlorinated dioxins & furans	.000001
	Chromium (hexavalent)	.0073
Quality Cleaners (P# 4399) 450 Miller Avenue Mill Valley, CA 94941		
	Perchloroethylene	1130
Sewerage Agency of South Marin (P# 1345) 450 Sycamore Avenue Mill Valley, CA 94941		
	Benzene	115.0
	Chloroform	136
	Perchloroethylene	125
Shoreline Cleaners (P# 1780) 203 Flamingo Road Mill Valley, CA 94941		
	Perchloroethylene	944
Think Clean Cleaners (P# 10974) 389 Miller Avenue Mill Valley, CA 94941		
	Perchloroethylene	331
Vogue Cleaners, Inc (P# 297) 77 Miller Avenue Mill Valley, CA 94941		
	Perchloroethylene	715
York Cleaners (P# 12592) 31 Miller Avenue Mill Valley, CA 94941		
	Perchloroethylene	135

COUNTY: MARIN
CITY: Novato

Company Name	Pollutant	Estimated Emissions (lbs/yr)
Clean Look Cleaners (P# 13192) 390 Bell Marin Keys Blvd Novato, CA 94949	Perchloroethylene	2430
Fairfax French Cleaners (P# 10674) 173 San Marin Dr Novato, CA 94945	Perchloroethylene	1100
Frank's Dry Cleaners (P# 8978) 526 Alameda Del Prdo Novato, CA 94947	Perchloroethylene	506
L & M One Hour Cleaners (P# 1816) 2017 Novato Blvd Novato, CA 94947	Perchloroethylene	688
North Bay Cleaners (P# 13699) 1559 So Novato Blvd Novato, CA 94947	Perchloroethylene	526
Novato Sanitary District (P# 1275) 500 Davidson Street Novato, CA 94947	Benzene	15.4
	Chloroform	187
	Methylene chloride	401
	Perchloroethylene	157
Orchid French Cleaners (P# 2067) 1531 So Novato Blvd Novato, CA 94947	Perchloroethylene	378
Pacheco Plaza One Hour Cleaners (P# 1436) 446 Ignacio Blvd Novato, CA 94947	Perchloroethylene	809
Prosperity Deluxe Cleaners (P# 15066) 1110 Grant Avenue Novato, CA 94945	Perchloroethylene	135
Redwood Landfill Inc (P# 1179) 8950 Redwood Hwy Novato, CA 94948	Acrylonitrile	.74
	Arsenic (all)	.125
	Benzene	212.0
	Chloroform	735
	Chromium (hexavalent)	.1220
	Dichlorobenzene	914
	Ethylene dichloride	58.2
	Hydrogen Chloride (HCl)	3960
	Methylene chloride	1700
	Perchloroethylene	868
	Trichloroethylene	520
	Vinyl chloride	699.0

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COUNTY: MARIN
CITY: Novato

Company Name	Pollutant	Estimated Emissions (lbs/yr)
Song's Dry Cleaners (P# 14897) 936 7th Ave, Suite P Novato, CA 94947	Perchloroethylene	690
Valley Memorial Park (P# 4209) 650 Bugeia Lane Novato, CA 94945	Chromium (hexavalent)	.0055
Wardrobe Cleaners (P# 1729) 961 Front Street Novato, CA 94945	Perchloroethylene	541

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COUNTY: MARIN
CITY: San Anselmo

Company Name	Pollutant	Estimated Emissions (lbs/yr)
Custom Cleaners (P# 10853) 805 Sir Francis Drak Blvd San Anselmo, CA 94960	Perchloroethylene	472
M&R Cleaners (P# 7710) 90 Greenfield Avenue San Anselmo, CA 94960	Perchloroethylene	1120
Red Hill Holiday Cleaners (P# 10479) 912 Sir Francis Drak Blvd San Anselmo, CA 94960	Perchloroethylene	337
Spotless Cleaners (P# 7036) 32 Redhill Avenue San Anselmo, CA 94960	Perchloroethylene	985

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COUNTY: MARIN
CITY: San Quentin

Company Name	Pollutant	Estimated Emissions (lbs/yr)
San Quentin State Prison (P# 4094) CA State Prison San Quentin, CA 94964	Perchloroethylene	256

COUNTY: MARIN
CITY: San Rafael

Company Name	Pollutant	Estimated Emissions (lbs/yr)
Alex's Drycleaning Valet (P# 12189) 628 Lindaro Street San Rafael, CA 94901	Perchloroethylene	1080
Central Marin Sanitation Agency (P# 653) Andersen Drive, East end San Rafael, CA 94901	Benzene	16.1
	Chloroform	461
	Dichlorobenzene	116
	Methylene chloride	504
	Perchloroethylene	136
Kerns and Walker Cleaners (P# 4301) 412 Las Gallinas San Rafael, CA 94903	Perchloroethylene	809
Las Gallinas Valley Sanitary District (P# 1597) 300 Smith Ranch Road San Rafael, CA 94903	Benzene	10.6
	Chloroform	117
	Methylene chloride	276
	Perchloroethylene	108
Loch Lomond Cleaners (P# 1439) 267 Loch-Lomond Drive San Rafael, CA 94901	Perchloroethylene	142
Magnificent Cleaners (P# 9698) 977 Grand Avenue San Rafael, CA 94901	Perchloroethylene	243
Marin Cleaners (P# 12237) 700 A Street San Rafael, CA 94901	Perchloroethylene	2490
Marin Square Cleaners (P# 9687) 55C Bellam Boulevard San Rafael, CA 94901	Perchloroethylene	381
Maxwell The Cleaners Inc (P# 11083) 1101 3rd Street San Rafael, CA 94901	Perchloroethylene	1560
Mount Tamalpais Cemetery and Mortuary (P# 7831) 2500 5th Avenue San Rafael, CA 94901	Chromium (hexavalent)	.0034
Northgate Cleaners (P# 5114) 270 Northgate One San Rafael, CA 94903	Perchloroethylene	486

COUNTY: MARIN
CITY: San Rafael

Company Name	Pollutant	Estimated Emissions (lbs/yr)
One Hour Superfine Cleaners (P# 8131) 510 3rd Street San Rafael, CA 94901	Perchloroethylene	904
Orchid Cleaners (P# 8132) 120 Bellam Boulevard San Rafael, CA 94901	Perchloroethylene	270
Prosperity Cleaners (P# 13430) 187 Marinwood Avenue San Rafael, CA 94903	Perchloroethylene	326
Terra Linda Cleaners, Inc (P# 13237) 669 Del Ganado Road San Rafael, CA 94903	Perchloroethylene	850

COUNTY: MARIN
CITY: Sausalito

Company Name	Pollutant	Estimated Emissions (lbs/yr)
Apollo Cleaners (P# 11023) 160 Donahue St, Marin City Sausalito, CA 94965	Perchloroethylene	384
Sunshine Cleaners (P# 12038) 2631 Bridgeway Sausalito, CA 94965	Perchloroethylene	152

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COUNTY: NAPA
CITY: American Canyon

Company Name	Pollutant	Estimated Emissions (lbs/yr)
Gas Recovery Systems, Inc (P# 11671) Landfill American Canyon, CA 94558		
	Acrylonitrile	35.60
	Benzene	22.5
	Formaldehyde	386
	PAH's (benzo[a]pyrene equiv)	.138
	Vinyl chloride	10.1

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COUNTY: NAPA
CITY: Calistoga

Company Name	Pollutant	Estimated Emissions (lbs/yr)
City of Calistoga (P# 3471) Dunaweal Lane Calistoga, CA 94515		
	Chloroform	97
Clover Flat Landfill Inc (P# 11247) 4380 Silverado Trail Calistoga, CA 94515		
	Benzene	75.3
	Ethylene dichloride	19.1
	Methylene chloride	573
	Perchloroethylene	292
	Trichloroethylene	175
	Vinyl chloride	217.0

COUNTY: NAPA
CITY: Napa

Company Name	Pollutant	Estimated Emissions (lbs/yr)
Ace Cleaners (P# 11932) 1808 Soscol Ave Napa, CA 94558	Perchloroethylene	863
Bel-Aire Cleaners (P# 5102) 3678 Bel Aire Plaza Napa, CA 94558	Perchloroethylene	1010
Bridgeford Flying Services (P# 11900) 2030 Airport Rd Napa, CA 94558	Benzene	13.7
Brown Valley Cleaners (P# 6254) 3259 Brownsvalley Rd Napa, CA 94558	Perchloroethylene	836
Chardonnay Cleaners (P# 5107) 1520 Trancas St Napa, CA 94558	Perchloroethylene	971
Dow Cleaners (P# 8741) 1634 Clay Street Napa, CA 94559	Perchloroethylene	1280
Green's Cleaners (P# 12008) 860B Kaiser Road Napa, CA 94558	Perchloroethylene	2400
Napa Sanitation District - Soscol (P# 7101) Soscol Ferry Rd Napa, CA 94558	Chloroform	181
	Perchloroethylene	399
Napa State Hospital (P# 1634) 2100 Napa Vallejo Hwy Napa, CA 94558	Benzene	10.6
	Formaldehyde	2110
Napa Valley Petroleum Inc (P# 11978) 257 So Kelly Rd Napa, CA 94558	Benzene	7.7
Napa-Vallejo Waste Management Authority (P# 9183) End Eucalyptus Rd Napa, CA 94558	Benzene	81.6
	Ethylene dichloride	22.2
	Methylene chloride	664
	Perchloroethylene	338
	Trichloroethylene	202
	Vinyl chloride	252.0

COUNTY: NAPA
CITY: Napa

Company Name	Pollutant	Estimated Emissions (lbs/yr)
Renaissance Mark, Inc (P# 15537) 601 Airpark Road Napa, CA 94558	Glycol ether - other/not spec	4160
Richard Pierce Funeral Service (P# 12560) 1660 Silverado Trail Napa, CA 94559	Chromium (hexavalent)	.0031
Shelton Cleaners (P# 4042) 1417 2nd Street Napa, CA 94558	Perchloroethylene	378
Treadway & Wigger Funeral Chapel (P# 10778) 623 Coombs Street Napa, CA 94559	Chromium (hexavalent)	.0024
Tulocay Cemetery Association (P# 5433) 411 Coombsville Rd Napa, CA 94558	Chlorinated dioxins & furans Chromium (hexavalent)	.000001 .0082
USA Gasoline Corporation (P# 13875) 3001 Jefferson St Napa, CA 94558	Benzene	16.8

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COUNTY: NAPA
CITY: Saint Helena

Company Name	Pollutant	Estimated Emissions (lbs/yr)
Klass Cleaners (P# 4598) 1141 Main Street Saint Helena, CA 94574	Perchloroethylene	675

COUNTY: SAN FRANCISCO
CITY: San Francisco

Company Name	Pollutant	Estimated Emissions (lbs/yr)
1010 Full Service Dry Cleaner (P# 9202) 1010 Clement Street San Francisco, CA 94118	Perchloroethylene	690
19th Avenue Cleaner (P# 2669) 4099 19th Avenue San Francisco, CA 94132	Perchloroethylene	333
20th Avenue Cleaner (P# 462) 1845 Irving Street San Francisco, CA 94122	Perchloroethylene	388
ARCO c/o URS Corporation (P# 10510) 1200 Geneva Avenue San Francisco, CA 94112	Benzene	9.7
Annabelle's French Cleaner (P# 495) 363 W Portal Avenue San Francisco, CA 94127	Perchloroethylene	546
Arlene's Cleaners (P# 7360) 2017 Chestnut Street San Francisco, CA 94123	Perchloroethylene	675
Astro Cleaners (P# 13041) 730 Bush Street San Francisco, CA 94108	Perchloroethylene	764
Bank of America (P# 429) 1455 Market St, M/C CA5 701 10 07 San Francisco, CA 94103	Arsenic (all) Beryllium (all) pollutant Cadmium Chromium (hexavalent) Nickel pollutant	.057 .033 .141 .0029 2.28
Bay Breeze Cleaners (P# 12672) 1018 Hyde Street San Francisco, CA 94109	Perchloroethylene	1150
Bell Cleaners (P# 1147) 4726 3rd Street San Francisco, CA 94124	Perchloroethylene	1070
Blue Bird Cleaners (P# 1869) 1341 Clement Street San Francisco, CA 94118	Perchloroethylene	324
Buchanan Cleaners (P# 4284) 2137 Buchanan Street San Francisco, CA 94115	Perchloroethylene	809

COUNTY: SAN FRANCISCO
CITY: San Francisco

Company Name	Pollutant	Estimated Emissions (lbs/yr)
Buchanan Cleaners (P# 6437) 3717 Buchanan Street San Francisco, CA 94123	Perchloroethylene	1540
Budget Cleaners (P# 1795) 536 Divisadero Street San Francisco, CA 94117	Perchloroethylene	405
Burns Cleaners (P# 10675) 809 Ulloa Street San Francisco, CA 94127	Perchloroethylene	773
California Oak Cleaners (P# 11743) 4723 Geary Boulevard San Francisco, CA 94118	Perchloroethylene	1960
Cameo Cleaners (P# 15213) 2920 Diamond Street San Francisco, CA 94131	Perchloroethylene	1300
Campton Place Hotel (P# 8032) 340 Stockton Street San Francisco, CA 94108	Perchloroethylene	1210
Chestnut Street Cleaners (P# 2942) 1327 Chestnut Street San Francisco, CA 94123	Perchloroethylene	661
Clean N' Save (P# 5203) 647 Bosworth Street San Francisco, CA 94131	Perchloroethylene	1440
Clean Wash Center (P# 10008) 4690 Mission Street San Francisco, CA 94112	Perchloroethylene	432
Clift Hotel (P# 4928) 495 Geary Street San Francisco, CA 94102	Perchloroethylene	307
Cole Cleaners (P# 6209) 947 Cole Street San Francisco, CA 94117	Perchloroethylene	514
Comet Cleaners (P# 3480) 930 Columbus Avenue San Francisco, CA 94133	Perchloroethylene	1050
Cortland 1 Hr Cleaners (P# 5448) 331 Cortland Avenue San Francisco, CA 94110	Perchloroethylene	432

COUNTY: SAN FRANCISCO
CITY: San Francisco

Company Name	Pollutant	Estimated Emissions (lbs/yr)
County Line Cleaners (P# 12906) 5960 Mission Street San Francisco, CA 94122	Perchloroethylene	742
Davis Cleaners (P# 5607) 635 Davis Street San Francisco, CA 94111	Perchloroethylene	432
Dri Clean Expert (P# 11030) 998 Oak Street San Francisco, CA 94117	Perchloroethylene	271
Dri Clean Express (P# 13476) 1973 Ocean Avenue San Francisco, CA 94127	Perchloroethylene	534
Esrik Cleaners (P# 4199) 2429 California Street San Francisco, CA 94115	Perchloroethylene	1050
European Cleaners (P# 5463) 1426K Fillmore Street San Francisco, CA 94115	Perchloroethylene	459
Excellent Cleaners (P# 11232) 725 Larkin Street San Francisco, CA 94109	Perchloroethylene	920
Express Cleaner (P# 11656) 1817 Market Street San Francisco, CA 94103	Perchloroethylene	762
Fabricare Cleaners (P# 7219) 2345 Mission Street San Francisco, CA 94110	Perchloroethylene	944
Fabricare Dry Cleaners (P# 8689) 976 Geneva Avenue San Francisco, CA 94112	Perchloroethylene	513
Fairmont Hotel (P# 4525) 950 Mason Street San Francisco, CA 94108	Perchloroethylene	809
Fairway Cleaners (P# 4699) 1798 McAllister San Francisco, CA 94115	Perchloroethylene	198
Family Cleaners (P# 986) 823 Divisadero Street San Francisco, CA 94117	Perchloroethylene	351

COUNTY: SAN FRANCISCO
CITY: San Francisco

Company Name	Pollutant	Estimated Emissions (lbs/yr)
Fay Cleaners (P# 6451) 1434 Noriega Street San Francisco, CA 94122	Perchloroethylene	944
Fine Arts Cleaners (P# 8792) 2379 Chestnut Street San Francisco, CA 94123	Perchloroethylene	169
Fortune Cleaners (P# 10885) 2751 21st Street San Francisco, CA 94110	Perchloroethylene	677
Four Mile Cleaners (P# 1592) 2200 Lane Street San Francisco, CA 94124	Perchloroethylene	809
Francisco Bay Cleaners & Laundry (P# 4899) 369 Bay Street San Francisco, CA 94133	Perchloroethylene	1210
Glen Park Cleaners (P# 1356) 701 Chenery Street San Francisco, CA 94131	Perchloroethylene	702
Golden State Cleaners (P# 4200) 3287 Army Street San Francisco, CA 94110	Perchloroethylene	540
Grant Cleaners (P# 12556) 1327 Grant Avenue San Francisco, CA 94133	Perchloroethylene	580
Hilton Hotel (P# 2344) 333 O'Farrell Street San Francisco, CA 94102	Perchloroethylene	148
Kent Cleaners (P# 12833) 601 3rd Avenue San Francisco, CA 94118	Perchloroethylene	715
Lakeside French Cleaners (P# 4609) 2660 Ocean Avenue San Francisco, CA 94132	Perchloroethylene	1120
Lee Loy Cleaners (P# 4625) 4144 18th Street San Francisco, CA 94114	Perchloroethylene	297
Leland Cleaners (P# 3520) 151 Leland Avenue San Francisco, CA 94134	Perchloroethylene	2020

COUNTY: SAN FRANCISCO
CITY: San Francisco

Company Name	Pollutant	Estimated Emissions (lbs/yr)
Locust Cleaners (P# 867) 3587 Sacramento Street San Francisco, CA 94118	Perchloroethylene	474
Lombard Dry Cleaners (P# 1693) 1701 Lombard Street San Francisco, CA 94123	Perchloroethylene	1110
Lucky Cleaners (P# 8661) 4401 California Street San Francisco, CA 94118	Perchloroethylene	405
Mack's Valet Cleaners (P# 8260) 766 Post Street San Francisco, CA 94109	Perchloroethylene	472
Martini Cleaners (P# 4296) 401 Divisadero Street San Francisco, CA 94117	Perchloroethylene	809
Marvel Cleaners (P# 11284) 1501 California Street San Francisco, CA 94109	Perchloroethylene	189
Michael's Cleaners (P# 12703) 2235 Polk Street San Francisco, CA 94109	Perchloroethylene	1010
Miracle Cleaners (P# 4423) 1708 Ocean Avenue San Francisco, CA 94112	Perchloroethylene	1420
Miraloma Cleaners (P# 6956) 667 Portola Drive San Francisco, CA 94127	Perchloroethylene	1050
Mirant Potrero, LLC (P# 26) 1201 Illinois Street San Francisco, CA 94107	Benzene Formaldehyde	35.1 116
Monaco Film Labs &Video Services (P# 3370) 234 9th Street San Francisco, CA 94103	Perchloroethylene	2900
National Park Service (P# 12596) Alcatraz Island San Francisco, CA 94123	Benzene Formaldehyde	19.4 122

COUNTY: SAN FRANCISCO
CITY: San Francisco

Company Name	Pollutant	Estimated Emissions (lbs/yr)
New Golden Hanger Cleaners (P# 12912) 1611 Lombard Street San Francisco, CA 94123	Perchloroethylene	1090
New Union Quality Cleaners (P# 15051) 2070 Mission Street San Francisco, CA 94110	Perchloroethylene	998
Norman Cleaners (P# 4223) 2255 Chestnut Street San Francisco, CA 94123	Perchloroethylene	364
Ocean Beach 1 Hour Dry Cleaners (P# 4323) 716 La Playa San Francisco, CA 94121	Perchloroethylene	472
Olson's Cleaners #2 (P# 12961) 3140 Vicente Street San Francisco, CA 94116	Perchloroethylene	1350
One Hour Cleaners (P# 4248) 2233 Market Street San Francisco, CA 94114	Perchloroethylene	1170
One Hour Cleaners (P# 12642) 757 Lombard Street San Francisco, CA 94133	Perchloroethylene	202
One Hour Martinizing (P# 10473) 4130 3rd Street San Francisco, CA 94124	Perchloroethylene	270
One Hour Martinizing (P# 13652) 1665 Bryant Street San Francisco, CA 94103	Perchloroethylene	338
PG & E Co, Hunters Point Power Plant (P# 24) 1000 Evans Avenue San Francisco, CA 94124	Benzene	16.0
	Formaldehyde	499
Perfect Cleaners (P# 7987) 1909 Fillmore Street San Francisco, CA 94115	Perchloroethylene	459
Pinecrest Cleaners (P# 800) 1176 Pine Street San Francisco, CA 94109	Perchloroethylene	988

COUNTY: SAN FRANCISCO
CITY: San Francisco

Company Name	Pollutant	Estimated Emissions (lbs/yr)
Portal Cleaners (P# 4925) 181 W Portal San Francisco, CA 94127	Perchloroethylene	998
Proclean One (P# 6512) 1116 Taraval Street San Francisco, CA 94116	Perchloroethylene	513
Progress Cleaners (P# 11439) 1555 Fillmore Street San Francisco, CA 94115	Perchloroethylene	432
Prosperity Cleaners (P# 4668) 912 Cole Street San Francisco, CA 94117	Perchloroethylene	234
Rainbow Cleaners (P# 15344) 3001B Geary Boulevard San Francisco, CA 94118	Perchloroethylene	1520
Ridgewood/California Power Partners LP (P# 14680) 1525 Post Street San Francisco, CA 94109	Benzene	9.8
	Formaldehyde	89
Royal Cleaners (P# 12840) 1461 Church Street San Francisco, CA 94131	Perchloroethylene	621
Russ Cleaners (P# 7596) 1515 Waller Street San Francisco, CA 94117	Perchloroethylene	540
SF State University, Main Campus (P# 9618) 1600 Holloway Avenue San Francisco, CA 94132	Benzene	74.2
	Formaldehyde	666
SFSU Housing Facilities (Cogeneration Plant) (P# 1004) 1600 Holloway Avenue San Francisco, CA 94132	Benzene	15.6
	Formaldehyde	143
Sagan Cleaners (P# 5847) 989 Post Street San Francisco, CA 94109	Perchloroethylene	3390
San Francisco Cleaners (P# 9088) 2123 Polk Street San Francisco, CA 94109	Perchloroethylene	135

COUNTY: SAN FRANCISCO
CITY: San Francisco

Company Name	Pollutant	Estimated Emissions (lbs/yr)
San Francisco International Airport (P# 1784)		
SF Int'l Airport		
San Francisco, CA 94128		
	Benzene	27.0
	Formaldehyde	162
San Francisco Petroleum Co (P# 915)		
2121 3rd Street		
San Francisco, CA 94107		
	Benzene	13.0
San Francisco South East Treatment Plant (P# 568)		
1700 Jerrold Avenue		
San Francisco, CA 94124		
	Benzene	53.5
	Chloroform	398
	PAH's (benzo[a]pyrene equiv)	.797
	Perchloroethylene	770
	Trichloroethylene	106
San Francisco Thermal, L P (P# 8988)		
465 Stevenson Street		
San Francisco, CA 94103		
	Formaldehyde	124
San Francisco, City & County, PUC (P# 4116)		
3500 Great Highway		
San Francisco, CA 94132		
	Benzene	14.5
	Chloroform	107
	Perchloroethylene	206
Sandy's Cleaners (P# 14255)		
364 W Portal Avenue		
San Francisco, CA 94127		
	Perchloroethylene	627
Schlage Lock Company (P# 2632)		
2401 Bayshore Boulevard		
San Francisco, CA 94134		
	Perchloroethylene	330
	Trichloroethylene	102
Scott Cleaners (P# 10710)		
3226 Scott Street		
San Francisco, CA 94123		
	Perchloroethylene	256
Silk Tech Cleaners (P# 11880)		
2221 Polk Street		
San Francisco, CA 94109		
	Perchloroethylene	337
Snow White Cleaners (P# 7369)		
2650 Clement Street		
San Francisco, CA 94122		
	Perchloroethylene	688
Sohn's French Cleaner (P# 4055)		
1933 Post Street		
San Francisco, CA 94115		
	Perchloroethylene	342

COUNTY: SAN FRANCISCO
CITY: San Francisco

Company Name	Pollutant	Estimated Emissions (lbs/yr)
Specialty Crushing Inc (P# 10384) Port of SF, Lot Seawall 352 San Francisco, CA 94111		
	Benzene	21.6
	Cadmium	.047
	Formaldehyde	136
	Nickel pollutant	.76
Sundown Cleaners (P# 4672) 1952 Irving Street San Francisco, CA 94122		
	Perchloroethylene	229
Sunshine Cleaners (P# 4665) 1500 9th Avenue San Francisco, CA 94122		
	Perchloroethylene	580
Sunshine Cleaners (P# 10436) 1735 Fulton Street San Francisco, CA 94117		
	Perchloroethylene	526
Superior Furniture Stripping & Refinishing (P# 13056) 1212 Underwood Avenue San Francisco, CA 94124		
	Methylene chloride	480
The Ritz Carlton San Francisco (P# 12799) 600 Stockton Street San Francisco, CA 94108		
	Perchloroethylene	614
Toni Cleaners (P# 4409) 270 Noe Street San Francisco, CA 94114		
	Perchloroethylene	317
Town Cleaners (P# 9701) 2840 California Street San Francisco, CA 94115		
	Perchloroethylene	231
UCSF/Parnassus (P# 2478) 3rd Avenue & Parnassus San Francisco, CA 94122		
	Arsenic (all)	.077
	Benzene	47.3
	Beryllium (all) pollutant	.045
	Cadmium	.192
	Chromium (hexavalent)	.0040
	Formaldehyde	9560
	Nickel pollutant	3.10
Union French Cleaners (P# 12929) 1718 Union Street San Francisco, CA 94123		
	Perchloroethylene	742
Unique Laundry & Cleaners (P# 12604) 820 Post Street San Francisco, CA 94109		
	Perchloroethylene	1470

COUNTY: SAN FRANCISCO
CITY: San Francisco

Company Name	Pollutant	Estimated Emissions (lbs/yr)
United States Mint (P# 5474) 155 Hermann Street San Francisco, CA 94102	Chromium (hexavalent)	.2030
Vel Cleaners (P# 13644) 485 O'Farrell Street San Francisco, CA 94102	Perchloroethylene	378
Vermont Cleaners (P# 5220) 600 Vermont Street San Francisco, CA 94107	Perchloroethylene	541
Veteran's DeLuxe Cleaners (P# 2075) 2053 Divisadero Street San Francisco, CA 94115	Perchloroethylene	2260
Veterans Administration Medical Center (P# 459) 4150 Clement Street San Francisco, CA 94121	Chlorinated dioxins & furans	.000008
Walnut Cleaners (P# 1168) 2266 Chestnut Street San Francisco, CA 94123	Perchloroethylene	499
West Portal Clean Center (P# 4664) 161 W Portal Avenue San Francisco, CA 94127	Perchloroethylene	243
Zephyr Cleaners (P# 11238) 4001 Balboa Street San Francisco, CA 94121	Perchloroethylene	1090

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COUNTY: SAN MATEO
CITY: Atherton

Company Name	Pollutant	Estimated Emissions (lbs/yr)
Poly Clean Center (P# 298) 3275 El Camino Atherton, CA 94027	Perchloroethylene	1540

COUNTY: SAN MATEO
CITY: Belmont

Company Name	Pollutant	Estimated Emissions (lbs/yr)
Belmont Village Cleaners (P# 461) 1932 Ralston Avenue Belmont, CA 94002	Perchloroethylene	729
Carlmont Village Cleaners (P# 4114) 1011 Alameda Belmont, CA 94002	Perchloroethylene	88
Dryclean City (P# 7807) 2040 Ralston Ave, Suite A Belmont, CA 94002	Perchloroethylene	398
Holiday Cleaners Belmont (P# 15155) 880 Ralston Avenue Belmont, CA 94002	Perchloroethylene	405
Moquin Press Inc (P# 12166) 555 Harbor Boulevard Belmont, CA 94002	Dioxane, 1,4-	87
One Hour Martinizing (P# 9864) 1412 El Camino Real Belmont, CA 94002	Perchloroethylene	742
Richard's Dry Cleaners (P# 3985) 940 Old County Road Belmont, CA 94002	Perchloroethylene	931

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COUNTY: SAN MATEO
CITY: Brisbane

Company Name	Pollutant	Estimated Emissions (lbs/yr)
Fong Brothers Printing Inc (P# 3734) 320 Valley Drive Brisbane, CA 94005	Methylene chloride	1700
SFPP, LP (P# 4021) 950 Tunnel Avenue Brisbane, CA 94005	Benzene	34.1
Sunquest Properties Inc (P# 5691) Brisbane Landfll Brisbane, CA 94005	Vinyl chloride	8.3

COUNTY: SAN MATEO
CITY: Burlingame

Company Name	Pollutant	Estimated Emissions (lbs/yr)
Bay Area Business Cards, Inc (P# 7949) 1745 Adrian Road Burlingame, CA 94010	Methylene chloride	192
Broadway Fashion Cleaners (P# 7897) 1175 Chula Vista Burlingame, CA 94010	Perchloroethylene	675
Burlingame One Hour Cleaners (P# 5283) 507 California Drive Burlingame, CA 94010	Perchloroethylene	472
City of Burlingame, Waste Water Treatment Plant (P# 1351) 1103 Airport Boulevard Burlingame, CA 94010	Benzene	52.3
	Chloroform	128
	Methylene chloride	402
	Perchloroethylene	481
	Trichloroethylene	357
	Vinyl chloride	71.4
Coen Company, Inc (P# 4008) 1510 Rollins Road Burlingame, CA 94010	Trichloroethylene	113
Coit Drapery & Carpet Cleaners, Inc (P# 1148) 897 Hinckley Road Burlingame, CA 94010	Perchloroethylene	4740
Holiday Cleaners (P# 5415) 1883 El Camino Real Burlingame, CA 94010	Perchloroethylene	344
Lux Cleaners (P# 12143) 1560 Trousdale Drive Burlingame, CA 94010	Perchloroethylene	405
Peninsula French Laundry, Inc (P# 5295) 1251 California Drive Burlingame, CA 94010	Perchloroethylene	270
Primrose Cleaners (P# 8628) 339 Primrose Road Burlingame, CA 94010	Perchloroethylene	393
Royal Airline Linen of San Francisco (P# 12243) 1688 Gilbreth Road Burlingame, CA 94010	Perchloroethylene	2280
West Coast Valet Service, Inc (P# 8116) 855 Malcolm Road Burlingame, CA 94010	Perchloroethylene	1790

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COUNTY: SAN MATEO
CITY: Colma

Company Name	Pollutant	Estimated Emissions (lbs/yr)
Cypress Amloc Land Co , Inc (P# 1364) 1 Sand Hill Road Colma, CA 94014		
	Benzene	80.5
	Ethylene dichloride	21.9
	Methylene chloride	655
	Perchloroethylene	334
	Trichloroethylene	200
	Vinyl chloride	249.0
Cypress Lawn Cemetery Association (P# 2932) El Camino Real Colma, CA 94014		
	Chromium (hexavalent)	.0050
Woodlawn Cemetery (P# 8020) 1000 El Camino Real Colma, CA 94014		
	Arsenic (all)	.058
	Chlorinated dioxins & furans	.000005
	Chromium (hexavalent)	.0272

COUNTY: SAN MATEO
CITY: Daly City

Company Name	Pollutant	Estimated Emissions (lbs/yr)
Crocker Cleaners (P# 12285) 6215 Mission Street Daly City, CA 94014	Perchloroethylene	3630
Hilltop Cleaners (P# 4235) 6379 Mission Street Daly City, CA 94014	Perchloroethylene	2270
Jofran Cleaners (P# 7540) 950 King Plaza, Suite 110 Daly City, CA 94015	Perchloroethylene	924
National Cleaners (P# 11422) 7375 Mission Street Daly City, CA 94014	Perchloroethylene	715
North San Mateo County Sanitation Dist (P# 1507) 153 Lake Merced Blvd Daly City, CA 94015	Benzene	97.7
	Chloroform	74
Skyline Cleaning Center (P# 10169) 45 Skyline Plaza Daly City, CA 94015	Perchloroethylene	202
Southgate Cleaners (P# 4596) 183 Southgate Avenue Daly City, CA 94015	Perchloroethylene	1030
Tidy Cleaners (P# 5936) 51 St Francis Square Daly City, CA 94015	Perchloroethylene	148
Twin Cleaners (P# 4333) 6772 Mission Street Daly City, CA 94014	Perchloroethylene	175
Westlake French Cleaners (P# 301) 330 So Mayfair Avenue Daly City, CA 94015	Perchloroethylene	714

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COUNTY: SAN MATEO
CITY: East Palo Alto

Company Name	Pollutant	Estimated Emissions (lbs/yr)
Romic Environmental Technologies Corporation (P# 468) 2081 Bay Road East Palo Alto, CA 94303	Perchloroethylene	110

COUNTY: SAN MATEO
CITY: Foster City

Company Name	Pollutant	Estimated Emissions (lbs/yr)
De Luxe Cleaners (P# 3351) 1058 Shell Boulevard Foster City, CA 94404	Perchloroethylene	553
Edgewater Cleaners (P# 3066) 901B Edgewater Boulevard Foster City, CA 94404	Perchloroethylene	958
Kent Cleaners (P# 7273) 999 Edgewater Boulevard Foster City, CA 94404	Perchloroethylene	1900

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COUNTY: SAN MATEO
CITY: Half Moon Bay

Company Name	Pollutant	Estimated Emissions (lbs/yr)
Alves Petroleum Inc (P# 761) San Mateo Road Half Moon Bay, CA 94019		
	Benzene	7.2
Browning-Ferris Industries of CA, Inc (P# 2266) 12310 San Mateo Road Half Moon Bay, CA 94019		
	Benzene	693.0
	Methylene chloride	2510
	Perchloroethylene	1000
	Trichloroethylene	673
	Vinyl chloride	304.0
Crown Cleaners (P# 1140) 210 San Mateo Rd, Suite 109 Half Moon Bay, CA 94019		
	Perchloroethylene	1140
Half Moon Bay Cleaners (P# 12295) 160B San Mateo Road Half Moon Bay, CA 94019		
	Perchloroethylene	1350

COUNTY: SAN MATEO
CITY: Menlo Park

Company Name	Pollutant	Estimated Emissions (lbs/yr)
City of Menlo Park (P# 3499) Marsh Road Menlo Park, CA 94025		
	Benzene	96.4
	Ethylene dichloride	26.2
	Methylene chloride	785
	Perchloroethylene	400
	Trichloroethylene	239
	Vinyl chloride	298.0
Gas Recovery Systems, Inc (P# 11668) Marsh Road Menlo Park, CA 94025		
	Vinyl chloride	16.2
Hoot N' Toot Cleaners (P# 1838) 875 Santa Cruz Avenue Menlo Park, CA 94025		
	Perchloroethylene	149
IPT SRI Cogeneration Inc (P# 3011) 333 Ravenswood Drive Menlo Park, CA 94025		
	Benzene	20.6
	Formaldehyde	4300
Lux Dry Cleaners (P# 10017) 1135 Chestnut Street Menlo Park, CA 94025		
	Perchloroethylene	304
Sharon Height Drycleaning Center (P# 4306) 325 Sharon Park Drive Menlo Park, CA 94025		
	Perchloroethylene	2270
Stanford Linear Accelerator (P# 556) 2575 Sand Hill Road Menlo Park, CA 94025		
	Perchloroethylene	4920
Wo Sing Cleaners (P# 4325) 570 Derry Lane Menlo Park, CA 94025		
	Perchloroethylene	440

COUNTY: SAN MATEO
CITY: Millbrae

Company Name	Pollutant	Estimated Emissions (lbs/yr)
City of Millbrae Wastewater Treatment Plant (P# 4106) 400 E Millbrae Ave Millbrae, CA 94030		
	Chloroform	55
	Perchloroethylene	90
Jiffy Cleaners (P# 1199) 512 Magnolia Avenue Millbrae, CA 94030		
	Perchloroethylene	337
Lomita Cleaners (P# 307) 1651 El Camino Real Millbrae, CA 94030		
	Perchloroethylene	405
Mills 1 Hour Cleaners (P# 6399) 336 Broadway Millbrae, CA 94030		
	Perchloroethylene	755
Peninsula Cleaners (P# 1130) 285 Broadway Millbrae, CA 94030		
	Perchloroethylene	1210
Tommy's Cleaners (P# 9459) 1340 El Camino Real Millbrae, CA 94030		
	Perchloroethylene	1010
US Airways (P# 13177) SF Int'l Airport Millbrae, CA 94030		
	Benzene	19.1
	Formaldehyde	109

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COUNTY: SAN MATEO
CITY: Pacifica

Company Name	Pollutant	Estimated Emissions (lbs/yr)
City of Pacifica Calera Creek Water Recycling (P# 12182) 700 Coast Highway Pacifica, CA 94044		
	Benzene	219.0
	Methylene chloride	626
Cleaning by Albert (P# 7501) 452 Manor Plaza Pacifica, CA 94044		
	Perchloroethylene	337

COUNTY: SAN MATEO
CITY: Redwood City

Company Name	Pollutant	Estimated Emissions (lbs/yr)
Beach Cleaners (P# 11854) 500 Howland Street Redwood City, CA 94063	Perchloroethylene	270
Broadway Cleaners (P# 289) 1681 Main Street Redwood City, CA 94063	Perchloroethylene	931
Fashion Cleaners & Shirt Laundry (P# 9765) 336 Woodside Plaza Redwood City, CA 94061	Perchloroethylene	607
Helens Cleaners (P# 4989) 1594 Woodside Road Redwood City, CA 94061	Perchloroethylene	580
Marsh Manor Cleaners (P# 14626) 3760 Florence Road Redwood City, CA 94063	Perchloroethylene	727
Metal Fusion Inc (P# 5082) 425 Hurlingame Redwood City, CA 94063	Nickel pollutant	3.51
Quong Lee Laundry (P# 14613) 1681 Broadway Redwood City, CA 94063	Perchloroethylene	2050
Roy's Cleaners (P# 345) 1100 El Camino Real Redwood City, CA 94063	Perchloroethylene	1280
Royal Cleaners (P# 15234) 902 Whipple Avenue Redwood City, CA 94063	Perchloroethylene	675
South Bayside System Authority (P# 1534) Radio Road, End of Redwood City, CA 94065	Benzene	78.5
	Chloroform	1220
	Methylene chloride	3810
	Perchloroethylene	1240
	Trichloroethylene	227
Woodside Cleaners & Alterations (P# 13392) 317 Woodside Road Redwood City, CA 94061	Perchloroethylene	546

COUNTY: SAN MATEO
CITY: San Bruno

Company Name	Pollutant	Estimated Emissions (lbs/yr)
Buck & Change Cleaners (P# 7132) 675 San Mateo Avenue San Bruno, CA 94066	Perchloroethylene	63
Crest Cleaners, Inc (P# 5104) 118 Skycrest Center San Bruno, CA 94066	Perchloroethylene	405
Holiday Cleaners (P# 7808) 4 Bayhill Shopping Ctr San Bruno, CA 94066	Perchloroethylene	661
Leader Cleaners (P# 7444) 1310H El Camino Real San Bruno, CA 94066	Perchloroethylene	398
Mills Park Cleaners (P# 3589) 709 Camino Plaza San Bruno, CA 94066	Perchloroethylene	405
One Hour Drycleaning (P# 8418) 100 El Camino Real San Bruno, CA 94066	Perchloroethylene	809

COUNTY: SAN MATEO
CITY: San Carlos

Company Name	Pollutant	Estimated Emissions (lbs/yr)
ABC Cleaners (P# 9791) 445 Old County Road San Carlos, CA 94070	Perchloroethylene	459
BFI Waste Systems of North America, Inc (P# 11530) 225 Shoreway Road San Carlos, CA 94070	Dioxane, 1,4-	71
Blu-White Cleaners (P# 7274) 1161 Brittan Avenue San Carlos, CA 94070	Perchloroethylene	2150
Industrial Plating Co (P# 3873) 803 American Street San Carlos, CA 94070	Chromium (hexavalent)	.0019
Jin's Cleaners (P# 6964) 765 Laurel Street San Carlos, CA 94070	Perchloroethylene	411
L-3 Communication, Electron Devices Division (P# 3691) 960 Industrial Road San Carlos, CA 94070	Hexamethylene-1,6-diisocyanate	2.5
San Carlos Dry Cleaners (P# 11099) 81 El Camino Real San Carlos, CA 94070	Perchloroethylene	169
Vogue Cleaners (P# 3127) 1249 San Carlos Avenue San Carlos, CA 94070	Perchloroethylene	1230
White Oak Cleaners (P# 5319) 1200 Belmont Avenue San Carlos, CA 94070	Perchloroethylene	202

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COUNTY: SAN MATEO
CITY: San Francisco

Company Name	Pollutant	Estimated Emissions (lbs/yr)
United Airlines, SF Maintenance Center (P# 51) SF Int'l Airport San Francisco, CA 94128		
	Benzene	44.0
	Chromium (hexavalent)	.0108
	Formaldehyde	9180
United Airlines SFOPV (P# 12197) SFOPV, Bldg #642, Rd #9 San Francisco, CA 94128		
	Benzene	138.0
	Cadmium	.059
	Formaldehyde	864
	Nickel pollutant	.96

COUNTY: SAN MATEO
CITY: San Mateo

Company Name	Pollutant	Estimated Emissions (lbs/yr)
ARCO Station No 515 c/o URS (P# 9853) 300 So Delaware San Mateo, CA 94401	Benzene	16.6
Blue Bird Cleaners (P# 4956) 60 W 42nd Avenue San Mateo, CA 94403	Perchloroethylene	809
Borel Cleaners (P# 13596) 67 Bovet Road San Mateo, CA 94402	Perchloroethylene	1350
Carl's Fine Dry Cleaning (P# 324) 801 So B Street San Mateo, CA 94401	Perchloroethylene	1300
Cleaning by Eddie (P# 4806) 1114 So El Camino Real San Mateo, CA 94402	Perchloroethylene	607
Cray Cleaners (P# 11484) 33 W 37th Avenue San Mateo, CA 94403	Perchloroethylene	675
Crystal Cleaning Center (P# 318) 110 Crystal Springs, Shopping Center San Mateo, CA 94402	Perchloroethylene	675
Dura Finish of San Mateo (P# 2723) 726 So Amphlett Blvd San Mateo, CA 94402	Methylene chloride	4830
Express Drapery Cleaners (P# 12096) 263 N Amphlett Blvd San Mateo, CA 94401	Perchloroethylene	874
Hills Cleaners (P# 7509) 746 Polhemus Road San Mateo, CA 94402	Perchloroethylene	589
Holiday Cleaners (P# 4967) 3166 Campus Drive San Mateo, CA 94403	Perchloroethylene	472
Holiday Cleaners (P# 14896) 1946 So El Camino Real San Mateo, CA 94403	Perchloroethylene	789
J & C One Hour Cleaners (P# 10173) 111 W 25th Avenue San Mateo, CA 94403	Perchloroethylene	135

COUNTY: SAN MATEO
CITY: San Mateo

Company Name	Pollutant	Estimated Emissions (lbs/yr)
Major Cleaners (P# 11945) 144 W 25th Avenue San Mateo, CA 94403	Perchloroethylene	162
New A-1 Cleaners (P# 14330) 17 E 4th Avenue San Mateo, CA 94401	Perchloroethylene	1060
Park's Wardrobe Cleaners (P# 362) 335 E 4th Street San Mateo, CA 94401	Perchloroethylene	405
Polhemus Cleaners and Laundry (P# 13153) 774 Polhemus Road San Mateo, CA 94402	Perchloroethylene	513
San Mateo Water Quality Control Plant (P# 861) 2050 Detroit Drive San Mateo, CA 94404	Benzene	12.5
	Chloroform	174
	Formaldehyde	68
	Methylene chloride	814
	Perchloroethylene	673
	Trichloroethylene	339
Skylawn Memorial Park (P# 1299) 10600 Skyline Blvd San Mateo, CA 94402	Chromium (hexavalent)	.0027
Sunrise Cleaners (P# 5293) 235 Baldwin Avenue San Mateo, CA 94401	Perchloroethylene	405
Top Hat Cleaners (P# 4353) 368 N Ellsworth Ave San Mateo, CA 94401	Perchloroethylene	580
Town & Country Cleaners (P# 311) 1234 W Hillsdale Blvd San Mateo, CA 94403	Perchloroethylene	877
Wickland Oil Company (P# 12401) 706 E 4th Street San Mateo, CA 94401	Benzene	7.0

COUNTY: SAN MATEO
CITY: South San Francisco

Company Name	Pollutant	Estimated Emissions (lbs/yr)
Carriage Cleaners (P# 12597) 1121 El Camino Real South San Francisco, CA 94080	Perchloroethylene	378
Central Cleaners (P# 14612) 386 Grand Avenue South San Francisco, CA 94080	Perchloroethylene	594
Chestnut Cleaners (P# 12519) 26 Chestnut Avenue South San Francisco, CA 94080	Perchloroethylene	236
Cycle Shack Inc (P# 11496) 1104 San Mateo Avenue South San Francisco, CA 94080	Chromium (hexavalent)	.0182
Genentech, Inc (P# 1257) 460 Point San Bruno Boulevard South San Francisco, CA 94080	Benzene Formaldehyde	8.3 56
Holiday Cleaners (P# 11414) 675 El Camino Real South San Francisco, CA 94080	Perchloroethylene	169
Inter-City Cleaners (P# 1703) 438 So Airport Boulevard South San Francisco, CA 94080	Perchloroethylene	4250
Kaiser Foundation Hospital (P# 4047) 1200 El Camino Real South San Francisco, CA 94080	Benzene Formaldehyde	9.0 56
My Cleaners (P# 8575) 1053F El Camino South San Francisco, CA 94080	Perchloroethylene	236
One Hour Dry Cleaning (P# 4636) 110 Hazelwood South San Francisco, CA 94080	Perchloroethylene	880
Peninou French Laundry (P# 3399) 101 So Maple South San Francisco, CA 94080	Perchloroethylene	1350
Royal Laundry (P# 11257) 1120 San Mateo Avenue South San Francisco, CA 94080	Perchloroethylene	3280

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COUNTY: SAN MATEO
CITY: South San Francisco

Company Name	Pollutant	Estimated Emissions (lbs/yr)
Shell Oil Co, Distribution Plant (P# 80)		
135 N Access Road		
South San Francisco, CA 94080		
	Benzene	36.4
South San Francisco-San Bruno Water Quality Plant (P# 5876)		
195 Belle Air Road		
South San Francisco, CA 94080		
	Benzene	36.4
	Chloroform	292
	Dichlorobenzene	328
	Perchloroethylene	255
	Trichloroethylene	146
Wardrobe Cleaners (P# 3841)		
471 Grand Avenue		
South San Francisco, CA 94080		
	Perchloroethylene	419
Wright Cleaners (P# 4316)		
316 Grand Avenue		
South San Francisco, CA 94080		
	Perchloroethylene	688

COUNTY: SANTA CLARA
CITY: Campbell

Company Name	Pollutant	Estimated Emissions (lbs/yr)
Benson's Cleaners (P# 3334) 467 E Campbell Campbell, CA 95008	Perchloroethylene	277
Brink's Cleaners (P# 5939) 1775B Winchester Blvd Campbell, CA 95008	Perchloroethylene	256
Campbell Plaza Cleaners (P# 11736) 2345 So Winchstr Blvd #D Campbell, CA 95008	Perchloroethylene	1260
Express Cleaners (P# 10047) 1663 So Bascom Ave Campbell, CA 95008	Perchloroethylene	688
Pacific Aerospace Services (P# 2746) 354 McGlincey Lane Campbell, CA 95008	Trichloroethylene	2010
Riverside Cleaners (P# 14909) 691 W Hamilton Ave Campbell, CA 95008	Perchloroethylene	250
Roc's Cleaners (P# 4268) 800 W Hamilton Campbell, CA 95008	Perchloroethylene	650
Young's Cleaners (P# 4313) 2050 So Bascom Ave Campbell, CA 95008	Perchloroethylene	560

COUNTY: SANTA CLARA
CITY: Cupertino

Company Name	Pollutant	Estimated Emissions (lbs/yr)
Cupertino Village Cleaners (P# 15319) 10989 N Wolfe Road Cupertino, CA 95014	Perchloroethylene	492
Dryclean Pro (P# 3049) 20379 Stevens Creek Blvd Cupertino, CA 95014	Perchloroethylene	607
Hanson Permanente Cement (P# 17) 24001 Stevens Creek Blvd Cupertino, CA 95014	Acetaldehyde	4130
	Arsenic (all)	.460
	Benzene	11800.0
	Beryllium (all) pollutant	.077
	Butadiene, 1,3-	60.0
	Cadmium	.304
	Chlorinated dioxins & furans	.000046
	Chromium (hexavalent)	.0461
	Formaldehyde	2120
	Hydrogen Chloride (HCl)	2500
	Mercury (all) pollutant	164.0
	Nickel pollutant	5.60
	PAH's (benzo[a]pyrene equiv)	.184
	Polychlorinated biphenyl (PCB)	2.020
Holiday Cleaners of America (P# 7530) 19720 Stevens Creek Blvd Cupertino, CA 95014	Perchloroethylene	812
McClellan Square Cleaners (P# 5264) 10477 De Anza Blvd Cupertino, CA 95014	Perchloroethylene	69
One Hour Martinizing by Lee (P# 1010) 10045 E Estates Drive Cupertino, CA 95014	Perchloroethylene	262
SMI Holdings, LLC c/o Levine Fricke (P# 593) 19000 Homestead Road Cupertino, CA 95014	Trichloroethylene	620
Scotty's Cleaners (P# 4954) 10620 So DeAnza Blvd Cupertino, CA 95014	Perchloroethylene	432
Stevens Creek Quarry Inc (P# 10394) 12100 Stevens Canyon Rd Cupertino, CA 95014	Benzene	18.6
	Formaldehyde	117

COUNTY: SANTA CLARA
CITY: Gilroy

Company Name	Pollutant	Estimated Emissions (lbs/yr)
Brenda's Classic Cleaners (P# 12012) 1280 1st St, Unit D Gilroy, CA 95020	Perchloroethylene	1380
Gavilan Hills Crematory (P# 1426) 910 1st Street Gilroy, CA 95020	Chromium (hexavalent)	.0022
Calpine Gilroy Cogen,LP & Gilroy Energy Center LLC (P# 11180) 1400 Pacheco Pass Hwy Gilroy, CA 95020	Benzene	20.5
	Formaldehyde	210
Master Cleaners (P# 5724) 340E 10th Street, #B Gilroy, CA 95020	Perchloroethylene	297
Norcal Waste Systems Pacheco Pass Landfill, Inc (P# 13566) Bloomfield Rd & Highway 152 Gilroy, CA 95021	Vinyl chloride	9.3
Toro Petroleum Corp (P# 756) 6470 Monterey Road Gilroy, CA 95020	Benzene	17.5
Z-Best Composting Facility (P# 11531) 980 State Highway 25 Gilroy, CA 95020	Benzene	22.7
	Cadmium	.049
	Nickel pollutant	.79

COUNTY: SANTA CLARA
CITY: Los Altos

Company Name	Pollutant	Estimated Emissions (lbs/yr)
Los Altos Laundry & Cleaners (P# 5046) 392 1st Street Los Altos, CA 94022	Perchloroethylene	615
Millers Drycleaning Service (P# 12968) 1554 Miramonte Los Altos, CA 94022	Perchloroethylene	541
Skyline Cleaners (P# 4405) 4600 El Camino Real Los Altos, CA 94022	Perchloroethylene	499

COUNTY: SANTA CLARA
CITY: Los Gatos

Company Name	Pollutant	Estimated Emissions (lbs/yr)
(Vasona Station) Orchid Cleaners (P# 10298) 14107Q Winchester Blvd Los Gatos, CA 95030	Perchloroethylene	540
Dryclean City (P# 4203) 653 N Santa Cruz Ave Los Gatos, CA 95030	Perchloroethylene	474
EZ Cleaner & Shoe Repair (P# 10379) 540 N Santa Cruz Ave, #I Los Gatos, CA 95030	Perchloroethylene	135
El Gato Cleaners (P# 15439) 15720 Los Gatos Blvd Los Gatos, CA 95030	Perchloroethylene	135
Fashion Cleaners (P# 12977) 461 N Santa Cruz Ave Los Gatos, CA 95030	Perchloroethylene	641
Ford Cleaners (P# 8804) 33 N Santa Cruz Ave Los Gatos, CA 95030	Perchloroethylene	675
Gatito Cleaners (P# 6081) 312 N Santa Cruz Ave Los Gatos, CA 95030	Perchloroethylene	549
Orchid Cleaners (P# 4913) 15310 Los Gatos Blvd Los Gatos, CA 95030	Perchloroethylene	395
Rinconada Cleaners & Laundry (P# 4620) 1488 Pollard Road Los Gatos, CA 95030	Perchloroethylene	809
Tip Top Cleaners (P# 8997) 216 N Santa Cruz Ave Los Gatos, CA 95030	Perchloroethylene	216

COUNTY: SANTA CLARA
CITY: Milpitas

Company Name	Pollutant	Estimated Emissions (lbs/yr)
BFI - The Recyclery (P# 5472) 1601 Dixon Landing Rd Milpitas, CA 95035		
	Arsenic (all)	.054
	Benzene	63.2
	Beryllium (all) pollutant	.032
	Cadmium	.136
	Chromium (hexavalent)	.0028
	Nickel pollutant	2.20
Contempo Design West, Inc (P# 7133) 212 Railroad Avenue Milpitas, CA 95035		
	Methylene chloride	805
Dryclean USA (P# 3511) 473 Jacklin Road Milpitas, CA 95035		
	Perchloroethylene	769
Dynamic Details, Inc (P# 8297) 1831 Tarob Court Milpitas, CA 95035		
	Ammonia (NH3) pollutant	19700
Ford Cleaners (P# 8296) 1822 Milmont Drive Milpitas, CA 95035		
	Perchloroethylene	135
GW Properties LLC (P# 15571) 601 Vista Way Milpitas, CA 95035		
	Perchloroethylene	111
	Trichloroethylene	111
International Disposal Corporation of Calif (P# 9013) 1601 W Dixon Landing Rd Milpitas, CA 95035		
	Benzene	447.0
	Ethylene dichloride	119.0
	Methylene chloride	3560
	Perchloroethylene	1820
	Trichloroethylene	1090
	Vinyl chloride	1350.0
J C Cleaners (P# 5771) 76 So Park Victoria Dr Milpitas, CA 95035		
	Perchloroethylene	159
KLA Tencor (P# 13399) 1 Technology Drive Milpitas, CA 95035		
	Benzene	24.1
	Formaldehyde	151
Landmark Label (P# 8940) 1664 Watson Court Milpitas, CA 95035		
	Perchloroethylene	68

COUNTY: SANTA CLARA
CITY: Milpitas

Company Name	Pollutant	Estimated Emissions (lbs/yr)
Michaels Cleaners (P# 13604) 1309 Jacklin Road Milpitas, CA 95035	Perchloroethylene	675
Parktown One Hour Martinizing (P# 5195) 1350 So Park Victoria Dr Milpitas, CA 95035	Perchloroethylene	384
Pro-Tech Cleaners (P# 2890) 110 Dixon Road Milpitas, CA 95035	Perchloroethylene	607
Raisch Products (P# 11740) 2122 Old Calaveras Rd Milpitas, CA 95035	Benzene	13.2
	Formaldehyde	83

COUNTY: SANTA CLARA
CITY: Morgan Hill

Company Name	Pollutant	Estimated Emissions (lbs/yr)
A French Cleaners (P# 12678) 602 Tennant Station Wy Morgan Hill, CA 95037	Perchloroethylene	2700
Advance Dry Cleaners (P# 4670) 259 W Main Avenue Morgan Hill, CA 95037	Perchloroethylene	202
Andpak EMA Inc (P# 12093) 400 Jarvis Drive Morgan Hill, CA 95037	Methylene chloride	585
Creekside Plaza Cleaners (P# 7309) 16145B Monterey Road Morgan Hill, CA 95037	Perchloroethylene	1280
Dryclean A+ (P# 12813) 211 W Main Avenue Morgan Hill, CA 95037	Perchloroethylene	405
King's Cleaners (P# 12109) 17020 Condit Road Morgan Hill, CA 95037	Perchloroethylene	607
Kirby Canyon Landfill (P# 1812) 910 Coyote Creek Glf Dr Morgan Hill, CA 95037	Benzene	78.3
	Ethylene dichloride	21.3
	Methylene chloride	637
	Perchloroethylene	324
	Trichloroethylene	194
	Vinyl chloride	242.0
Morgan Hill Discount Cleaners (P# 13083) 16990 Monterey Road, #130 Morgan Hill, CA 95037	Perchloroethylene	1110
Plaza Cleaners (P# 9274) 16965 So Monterey, Ste 118 Morgan Hill, CA 95037	Perchloroethylene	932
Rainbow Cleaners (P# 7895) 218 Tennant Station Morgan Hill, CA 95037	Perchloroethylene	375
Vineyard Cleaners (P# 12747) 259 Vineyard Town Ctr Morgan Hill, CA 95037	Perchloroethylene	175

COUNTY: SANTA CLARA
CITY: Mountain View

Company Name	Pollutant	Estimated Emissions (lbs/yr)
California Cleaners (P# 5790) 2425 California Street Mountain View, CA 94040	Perchloroethylene	607
Camaro Cleaners (P# 15656) 660B San Antonio Road Mountain View, CA 94040	Perchloroethylene	405
City of Mountain View (Shoreline) (P# 2740) 2600 Shoreline Boulevard Mountain View, CA 94043	Benzene	245.0
	Ethylene dichloride	66.7
	Methylene chloride	2000
	Perchloroethylene	1020
	Trichloroethylene	609
	Vinyl chloride	757.0
Courtesy Cleaners (P# 1016) 835 Leong Drive Mountain View, CA 94043	Perchloroethylene	1880
El Camino Hospital (P# 4272) 2500 Grant Road Mountain View, CA 94040	Benzene	8.8
	Formaldehyde	70
El Moderne Cleaners (P# 12538) 820 E El Camino Real Mountain View, CA 94040	Perchloroethylene	176
Grant Cleaners (P# 10511) 1040 Grant Road, #175 Mountain View, CA 94040	Perchloroethylene	310
Holiday Cleaners (P# 8488) 1350 Grant Road, #9 Mountain View, CA 94040	Perchloroethylene	1690
Intel Corporation c/o Weiss Associates (P# 12209) 365 E Middlefield Road Mountain View, CA 94043	Vinyl chloride	18.0
One Hour Cleaners (P# 9118) 580 N Rengstorff Avenue Mountain View, CA 94040	Perchloroethylene	490
Schlumberger Technology Corp (P# 5859) 441 N Whisman Road Mountain View, CA 94043	Trichloroethylene	1960

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COUNTY: SANTA CLARA
CITY: Mountain View

Company Name	Pollutant	Estimated Emissions (lbs/yr)
Shoreline Amphitheatre (P# 2561) One Amphitheatre Parkway Mountain View, CA 94043	Benzene	7.1
	Vinyl chloride	21.8
Sparkle Dry Cleaners (P# 992) 2565 W Middlefield Road Mountain View, CA 94040	Perchloroethylene	162
Sun Beam Cleaners (P# 4292) 128 N Rengstorff Avenue Mountain View, CA 94043	Perchloroethylene	432
Super Fluff Cleaners & Laundry (P# 5090) 803 W El Camino Real Mountain View, CA 94040	Perchloroethylene	202
Vogue Cleaners (P# 9485) 595 Escuela Avenue Mountain View, CA 94040	Perchloroethylene	513

COUNTY: SANTA CLARA
CITY: Palo Alto

Company Name	Pollutant	Estimated Emissions (lbs/yr)
AJ's Quick Clean Center (P# 353) 3175 Middlefield Road Palo Alto, CA 94306	Perchloroethylene	931
Alta Mesa Improvement Company (P# 11268) 695 Arastradero Road Palo Alto, CA 94306	Chromium (hexavalent)	.0017
California Avenue Norge Village Cleaners (P# 5030) 240 California Avenue Palo Alto, CA 94306	Perchloroethylene	924
Cardinal Cogen Inc (P# 15128) Campus & Jordan Way Palo Alto, CA 94305	Benzene	162.0
	Formaldehyde	1090
Cavallino Rampante Ltd (P# 2951) 1880 W Bayshore Road Palo Alto, CA 94303	Butyl alcohol, tert-	5
Charleston Cleaners (P# 6449) 3900 Middlefield Road Palo Alto, CA 94303	Perchloroethylene	607
City of Palo Alto Landfill (P# 2721) Byxbee Park Palo Alto, CA 94301	Benzene	88.4
	Ethylene dichloride	24.0
	Methylene chloride	719
	Perchloroethylene	366
	Trichloroethylene	219
	Vinyl chloride	273.0
Emerson Cleaners (P# 9916) 935 Emerson Street Palo Alto, CA 94301	Perchloroethylene	300
Holiday Cleaners (P# 9348) 595 Bryant Street Palo Alto, CA 94301	Perchloroethylene	809
Palo Alto One Hour Martinizing (P# 673) 3886 El Camino Real Palo Alto, CA 94306	Perchloroethylene	135

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COUNTY: SANTA CLARA
CITY: Palo Alto

Company Name	Pollutant	Estimated Emissions (lbs/yr)
Palo Alto Regional Water Quality Control Plant (P# 617) 2501 Embarcadero Way Palo Alto, CA 94303		
	Chloroform	522
	Chromium (hexavalent)	.0586
	Dichlorobenzene	87
	Methylene chloride	1570
	Perchloroethylene	174
	Trichloroethylene	609
Roy-Aero Enterprise LLC (P# 4421) 1901 Embarcadero Rd, Suite 101 Palo Alto, CA 94303		
	Benzene	7.1
Stanford Cleaners (P# 12932) 2875 El Camino Real Palo Alto, CA 94306		
	Perchloroethylene	434
Stanford University (P# 639) ESF-480 Oak Road Palo Alto, CA 94305		
	Benzene	14.2
	Formaldehyde	89
Town & Country Cleaners (P# 4652) 855 El Camino Real Palo Alto, CA 94301		
	Perchloroethylene	749

COUNTY: SANTA CLARA
CITY: San Jose

Company Name	Pollutant	Estimated Emissions (lbs/yr)
American Cleaner (P# 13439) 4750 Almaden Expy, Suite G San Jose, CA 95118		
	Perchloroethylene	297
Applied Anodize Inc (P# 6919) 622 Charcot Ave, Unit D San Jose, CA 95131		
	Chromium (hexavalent)	.0100
Art Cleaners (P# 10873) 400 E Santa Clara St San Jose, CA 95113		
	Perchloroethylene	204
Azevedo Quarry (P# 1262) 55 Hillsdale Avenue San Jose, CA 95111		
	Arsenic (all)	.052
	Benzene	59.8
	Beryllium (all) pollutant	.031
	Cadmium	.130
	Chromium (hexavalent)	.0027
	Formaldehyde	374
	Nickel pollutant	2.11
Bascom Best Cleaners (P# 8644) 3970 So Bascom Ave San Jose, CA 95124		
	Perchloroethylene	146
Bay Drycleaners (P# 13117) 1574 Branham Lane San Jose, CA 95118		
	Perchloroethylene	1590
Benjamin's Cleaners (P# 9863) 2997 Union Avenue San Jose, CA 95124		
	Perchloroethylene	1210
Benson Cleaners (P# 4037) 5965 Almaden Expwy San Jose, CA 95120		
	Perchloroethylene	607
Bonded Cleaners (P# 5124) 1242 So Bascom Ave San Jose, CA 95128		
	Perchloroethylene	1820
Bonded Cleaners (P# 11523) 873 Blossom Hill Rd San Jose, CA 95123		
	Perchloroethylene	1690
Bret Harte Cleaners (P# 4521) 6934 Almaden Expwy San Jose, CA 95120		
	Perchloroethylene	580

COUNTY: SANTA CLARA
CITY: San Jose

Company Name	Pollutant	Estimated Emissions (lbs/yr)
Budget Cleaners (P# 5032) 1160 Blossom Hill San Jose, CA 95118	Perchloroethylene	796
Camaro Cleaners (P# 13799) 1705 Branham Ln, #B 5 San Jose, CA 95198	Perchloroethylene	1590
Camaro Cleaners (P# 13800) 1072 So De Anza Road San Jose, CA 95129	Perchloroethylene	755
Cambrian Plaza Dry Cleaners (P# 372) 14414 Union Avenue San Jose, CA 95124	Perchloroethylene	2590
Camden Cleaners (P# 4639) 5731 Camden Avenue San Jose, CA 95124	Perchloroethylene	135
Chevron Products Company (P# 49) 1020 Berryessa Street San Jose, CA 95133	Benzene	195.0
City Cleaners (P# 5116) 102 Race Street San Jose, CA 95126	Perchloroethylene	1310
City of Paris Cleaners (P# 11791) 1739 W San Carlos St San Jose, CA 95128	Perchloroethylene	1070
City of San Jose (Singleton Road Landfill) (P# 4175) 885 Singleton Road San Jose, CA 95111	Benzene Perchloroethylene Vinyl chloride	19.3 80 59.5
Cleaner Cleaners, The (P# 7135) 5373 Camden Avenue San Jose, CA 95124	Perchloroethylene	405
Cleaning & Alteration Shop (P# 8443) 1709 Tully Road San Jose, CA 95122	Perchloroethylene	256
Cleaning & Alteration Shop (P# 11642) 571 W Alma Street San Jose, CA 95103	Perchloroethylene	1080

COUNTY: SANTA CLARA
CITY: San Jose

Company Name	Pollutant	Estimated Emissions (lbs/yr)
Cleaning & Alteration Shop (P# 14699) 1634 E Capitol Expwy San Jose, CA 95121	Perchloroethylene	809
County of Santa Clara (P# 1982) Hellyer Park San Jose, CA 95111	Benzene	17.4
	Perchloroethylene	72
	Vinyl chloride	53.6
Courtside Cleaners (P# 4671) 478 Blossom Hill Rd San Jose, CA 95123	Perchloroethylene	472
Crown Cleaners (P# 4382) 229 E Jackson Street San Jose, CA 95112	Perchloroethylene	138
Crystal Clear Cleaners (P# 11881) 3035 McKee Road San Jose, CA 95127	Perchloroethylene	277
Custom Cleaners (P# 3454) 1890 Curtner Avenue San Jose, CA 95124	Perchloroethylene	560
Custom Cleaners #2 (P# 4779) 4440 Pearl Avenue San Jose, CA 95136	Perchloroethylene	202
Diamond Cleaners (P# 4234) 398 W San Carlos San Jose, CA 95110	Perchloroethylene	526
Dry Clean America (P# 6199) 5885 Santa Teresa Blvd, Suite #105 San Jose, CA 95123	Perchloroethylene	776
Dryclean Plus (P# 8107) 4644B Meridian Ave San Jose, CA 95124	Perchloroethylene	235
Dryclean USA (P# 5742) 5540 Monterey Road San Jose, CA 95138	Perchloroethylene	455
Econo Cleaners (P# 11056) 2590 Bascom Ave, Suite B San Jose, CA 95124	Perchloroethylene	729

COUNTY: SANTA CLARA
CITY: San Jose

Company Name	Pollutant	Estimated Emissions (lbs/yr)
Equilon Enterprises LLC-San Jose Terminal (P# 64) 2165 O'Toole Avenue San Jose, CA 95131	Benzene	35.1
Equiva Services LLC c/o Toxichem (P# 13770) 1025 Winchester Blvd San Jose, CA 95117	Benzene	7.0
F & F Steel & Stairway Inc (P# 5149) 1775 Monterey Rd, Bldg #46A San Jose, CA 95112	Dioxane, 1,4-	57
Fairmont Hotel, San Jose (P# 8556) 170 So Market Street San Jose, CA 95113	Benzene	35.2
	Formaldehyde	221
	Perchloroethylene	1080
Fashion Express Cleaners (P# 6007) 1375 So Bascom Ave San Jose, CA 95128	Perchloroethylene	1270
Gas Recovery Systems, Inc (P# 11669) 15999 Guadalupe Mines Rd San Jose, CA 95120	Vinyl chloride	16.2
Gas Recovery Systems, Inc (P# 11670) 1804 Dixon Landing Rd San Jose, CA 95134	Benzene	12.2
	Perchloroethylene	51
	Vinyl chloride	37.6
Golden Cleaners (P# 13902) 2114 Senter Road #13 San Jose, CA 95112	Perchloroethylene	877
Guadalupe Rubbish Disposal (P# 3294) 15999 Guadalupe Mines Rd San Jose, CA 95120	Benzene	157.0
	Ethylene dichloride	40.7
	Methylene chloride	1220
	Perchloroethylene	621
	Trichloroethylene	372
	Vinyl chloride	462.0
Hacienda Gardens Cleaners (P# 4808) 3023 Meridian Avenue San Jose, CA 95124	Perchloroethylene	136
Har's One Hour Martinizing (P# 5011) 994 Saratoga Avenue San Jose, CA 95129	Perchloroethylene	1090

COUNTY: SANTA CLARA
CITY: San Jose

Company Name	Pollutant	Estimated Emissions (lbs/yr)
Hitachi Global Storage Technologies Inc (P# 85) 5600 Cottle Road San Jose, CA 95193		
	Arsenic (all)	.025
	Cadmium	.063
	Nickel pollutant	1.02
Holiday Cleaners (P# 4350) 1693 Branham Lane San Jose, CA 95118		
	Perchloroethylene	189
Holiday Cleaners (P# 4943) 5309 Prospect Road San Jose, CA 95129		
	Perchloroethylene	250
Insituform Technologies Inc (P# 12388) 3000 Zanker Road San Jose, CA 95134		
	Arsenic (all)	.037
	Beryllium (all) pollutant	.022
	Cadmium	.092
	Chromium (hexavalent)	.0019
	Nickel pollutant	1.48
International Power Technology (SJ State) (P# 7265) San Carlos Boulevard San Jose, CA 95150		
	Benzene	18.9
	Formaldehyde	246
Joseph's Cleaners (P# 5896) 2544 Berryessa Road San Jose, CA 95132		
	Perchloroethylene	290
Kelly & Louise Cleaners (P# 9112) 555 E Santa Clara St San Jose, CA 95112		
	Perchloroethylene	256
Kiely Park Dry Cleaner (P# 4715) 445 So Kiely Blvd San Jose, CA 95117		
	Perchloroethylene	648
Lien Dry Cleaning (P# 10217) 2354 Senter Road San Jose, CA 95112		
	Perchloroethylene	514
Lincoln Avenue Cleaners (P# 4532) 990 Coe Avenue San Jose, CA 95125		
	Perchloroethylene	944
Los Gatos Memorial Park (P# 12958) 2255 Los Gatos Almadn Rd San Jose, CA 95124		
	Chromium (hexavalent)	.0053

COUNTY: SANTA CLARA
CITY: San Jose

Company Name	Pollutant	Estimated Emissions (lbs/yr)
Mark Cleaners (P# 7018) 5353 Almaden Expwy, #44 San Jose, CA 95118	Perchloroethylene	816
Merit Cleaners (P# 13438) 1190 Hillsdal Av #160 San Jose, CA 95118	Perchloroethylene	607
Micrel Semiconductor Inc (P# 10751) 1849 Fortune Drive San Jose, CA 95131	Benzene	7.0
	Formaldehyde	44
Monterey Collision Frame & Body Inc (P# 9912) 2871 Monterey Road San Jose, CA 95111	Butyl alcohol, tert-	2
Moon's Best Cleaners (P# 5381) 1124 Branham Lane San Jose, CA 95118	Perchloroethylene	1010
Moorpark Cleaners (P# 12601) 5162 Moorpark Avenue San Jose, CA 95129	Perchloroethylene	324
My Cleaners (P# 10618) 1078 Leigh Avenue San Jose, CA 95126	Perchloroethylene	594
O L S Energy-Agnews (P# 6044) 3530 Zanker Road San Jose, CA 95134	Formaldehyde	517
Oak Hill Memorial Park & Mortuary (P# 4205) 300 Curtner Avenue San Jose, CA 95125	Arsenic (all)	.044
	Chlorinated dioxins & furans	.000004
	Chromium (hexavalent)	.0204
One Hour Blossom Hill Cleaners (P# 13394) 445 Blossom Hill Rd San Jose, CA 95123	Perchloroethylene	485
One Hour Cleaners (P# 4297) 6477 Almaden Expwy San Jose, CA 95120	Perchloroethylene	1350
One Hour Cleaners (P# 9064) 2343 McKee Road San Jose, CA 95116	Perchloroethylene	742

COUNTY: SANTA CLARA
CITY: San Jose

Company Name	Pollutant	Estimated Emissions (lbs/yr)
Orchard Cleaners (P# 10484) 6162 Bollinger Rd, D 11 San Jose, CA 95129	Perchloroethylene	243
Pacific Bell Corp (P# 13066) 2211 Junction Avenue San Jose, CA 95131	Benzene	104.0
	Formaldehyde	651
Pacific Gas and Electric Company (P# 3102) 6402 Santa Teresa San Jose, CA 95119	Benzene	8.0
Park Cleaners (P# 5341) 5837 E Camden Avenue San Jose, CA 95124	Perchloroethylene	472
Patrician Cleaners (P# 4372) 2306D Almaden Road San Jose, CA 95125	Perchloroethylene	492
Philips Semiconductors (P# 1338) 1109 McKay Drive San Jose, CA 95131	Formaldehyde	40
Poly Cleaners (P# 4830) 3471 McKee Road San Jose, CA 95127	Perchloroethylene	189
Premier Cleaners (P# 11506) 1127 So De Anza Road San Jose, CA 95129	Perchloroethylene	459
Queen Cleaners (P# 4951) 2511 So King Road San Jose, CA 95122	Perchloroethylene	68
Quimby Cleaners (P# 4520) 2809 So White Road San Jose, CA 95148	Perchloroethylene	675
Reed & Graham, Inc (P# 107) 690 Sunol Street San Jose, CA 95126	Benzene	8.7
	Formaldehyde	55
Rex Cleaners (P# 4259) 60 Race Street San Jose, CA 95126	Perchloroethylene	724

COUNTY: SANTA CLARA
CITY: San Jose

Company Name	Pollutant	Estimated Emissions (lbs/yr)
Ritz Cleaners (P# 4299) 526 So Bascom Avenue San Jose, CA 95128	Perchloroethylene	694
Royal Cleaners (P# 9487) 1192 N Capitol Ave San Jose, CA 95132	Perchloroethylene	202
SFPP, LP (P# 4020) 2150 Kruse Drive San Jose, CA 95131	Benzene	228.0
Safe Cleaners (P# 15146) 1814A Hillsdale Ave San Jose, CA 95124	Perchloroethylene	1160
San Jose International Airport (P# 13367) 2075 Airport Blvd San Jose, CA 95112	Formaldehyde	34
SJCC FBO Services,LLC (P# 4593) 1250 Aviation Avenue San Jose, CA 95110	Benzene	10.0
San Jose/Santa Clara Water Pollution Control (P# 778) 700 Los Esteros Road San Jose, CA 95134	Ammonia (NH3) pollutant	735000
	Arsenic (all)	.042
	Benzene	340.0
	Beryllium (all) pollutant	.024
	Cadmium	.104
	Chloroform	2090
	Chromium (hexavalent)	.0022
	Formaldehyde	6490
	Hydrogen Sulfide (H2S)	11300
	Methylene chloride	7680
	Nickel pollutant	1.69
	Perchloroethylene	2710
	Trichloroethylene	334
Sands Cleaners (P# 10253) 375 Saratoga Ave, F & G San Jose, CA 95129	Perchloroethylene	1770
Sang's Cleaners (P# 2399) 1303 So Winchester Blvd, Suite 3 San Jose, CA 95128	Perchloroethylene	391
Santa Clara Valley Health & Hospital System (P# 475) 751 So Bascom Avenue San Jose, CA 95128	Formaldehyde	49

COUNTY: SANTA CLARA
CITY: San Jose

Company Name	Pollutant	Estimated Emissions (lbs/yr)
Saving Cleaners (P# 7997) 1641 McKee Road San Jose, CA 95116	Perchloroethylene	742
Sparkle Clean Cleaners (P# 4340) 3128 Williams Road San Jose, CA 95117	Perchloroethylene	688
Sparkle Clean Cleaners (P# 4433) 4102 Monterey Highway San Jose, CA 95111	Perchloroethylene	459
Sparkle Dry Cleaners (P# 12325) 2854 Alum Rock Ave San Jose, CA 95127	Perchloroethylene	229
Speedy Cleaners (P# 15347) 1080 Saratoga Ave, #13 San Jose, CA 95129	Perchloroethylene	661
Star Cleaners (P# 1079) 2910 Almaden Expwy San Jose, CA 95125	Perchloroethylene	660
Swan Cleaners (P# 4692) 840 N Winchester Blvd San Jose, CA 95128	Perchloroethylene	629
Swift Cleaner & Draperies (P# 4953) 1409 Bird Avenue San Jose, CA 95125	Perchloroethylene	310
Swift Cleaners (P# 886) 1628 So De Anza Road San Jose, CA 95129	Perchloroethylene	1080
Swiss Cleaners (P# 4393) 14540 Camden Avenue San Jose, CA 95124	Perchloroethylene	855
Technibuilders Iron (P# 10004) 1049 Felipe Avenue San Jose, CA 95122	Dioxane, 1,4-	55
United Airlines San Jose Airport Terminal (P# 13375) Airport Terminal San Jose, CA 95110	Benzene Formaldehyde	18.9 118

COUNTY: SANTA CLARA
CITY: San Jose

Company Name	Pollutant	Estimated Emissions (lbs/yr)
United Technologies Corporation (P# 710) 600 Metcalf Road San Jose, CA 95138		
	Arsenic (all)	.129
	Beryllium (all) pollutant	.041
	Cadmium	1.500
	Chromium (hexavalent)	.0234
	Hydrogen Chloride (HCl)	4490
	Nickel pollutant	2.69
Univar USA Inc (P# 618) 2256 Junction Avenue San Jose, CA 95131		
	Methylene chloride	1930
VIP Cleaners (P# 4410) 305 N Capitol Avenue San Jose, CA 95133		
	Perchloroethylene	698
Verio Hosting Exchange (P# 12859) 2334 Lundy Place San Jose, CA 95131		
	Formaldehyde	35
Vogue Enterprises Cleaners (P# 11017) 5723 Cottle Road San Jose, CA 95123		
	Perchloroethylene	231
Winchester Cleaners (P# 15085) 1308 So Winchester Blvd, Ste C San Jose, CA 95128		
	Perchloroethylene	1070
Worldcom (P# 12969) 55 So Market Street San Jose, CA 95113		
	Benzene	9.2
	Formaldehyde	58
Zanker Road Resource Management,Ltd (P# 3312) 705 Los Esteros Road San Jose, CA 95134		
	Benzene	160.0
	Cadmium	.054
	Ethylene dichloride	36.8
	Formaldehyde	154
	Methylene chloride	1100
	Nickel pollutant	.87
	Perchloroethylene	560
	Trichloroethylene	336
	Vinyl chloride	417.0

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COUNTY: SANTA CLARA
CITY: San Martin

Company Name	Pollutant	Estimated Emissions (lbs/yr)
2 Genes Aviation Inc (P# 12472) 13025 Murphy Avenue San Martin, CA 95046	Benzene	25.8

COUNTY: SANTA CLARA
CITY: Santa Clara

Company Name	Pollutant	Estimated Emissions (lbs/yr)
Beam on Technology (P# 11533) 2272 Calle del Mundo Santa Clara, CA 95054	Methylene chloride	579
Bellomy Cleaners (P# 8439) 1975 Bellomy Street Santa Clara, CA 95050	Perchloroethylene	1190
Bourns Inc (P# 9208) 1500 Space Park Drive Santa Clara, CA 95054	Trichloroethylene	166
California Paperboard Corporation (P# 9010) 525 Mathew Street Santa Clara, CA 95052	Acetaldehyde	2070
Catalytica Energy Systems Inc (P# 11840) 2339 Gianera Street Santa Clara, CA 95054	Formaldehyde	655
City of Santa Clara (P# 1771) Gianera Street Santa Clara, CA 95050	Formaldehyde	321
City of Santa Clara (P# 3464) 5401 Lafayette Santa Clara, CA 95050	Benzene	106.0
	Ethylene dichloride	28.8
	Methylene chloride	863
	Perchloroethylene	440
	Trichloroethylene	263
	Vinyl chloride	327.0
City of Santa Clara, Silicon Valley Power (P# 621) 560 Robert Avenue Santa Clara, CA 95050	Benzene	37.3
	Formaldehyde	7870
Crystal Cleaners (P# 12600) 28 Washington Street Santa Clara, CA 95050	Perchloroethylene	459
Dry Clean 4 U (P# 10256) 3787 Stevens Creek Blvd, #101 Santa Clara, CA 95051	Perchloroethylene	274
Fairway Cleaners (P# 10783) 4685 Lafayette Street Santa Clara, CA 95054	Perchloroethylene	297

COUNTY: SANTA CLARA
CITY: Santa Clara

Company Name	Pollutant	Estimated Emissions (lbs/yr)
Homestead Cleaners (P# 11325) 3587 Homestead Road Santa Clara, CA 95051	Perchloroethylene	513
JDS Uniphase Corporation (P# 13148) 3530 Bassett Street Santa Clara, CA 95054	Chloroform	225
Jefferson Smurfit Corporation (P# 732) 2600 De La Cruz Blvd Santa Clara, CA 95050	Acetaldehyde	757
	Formaldehyde	438
Killarney Cleaners (P# 299) 3550 Homestead Road Santa Clara, CA 95051	Perchloroethylene	811
Memorex Drive LLC (P# 10299) 1200 Memorex Drive Santa Clara, CA 95050	Perchloroethylene	44
Nelson's Cleaners (P# 15189) 53 Washington Street Santa Clara, CA 95050	Perchloroethylene	675
One Hour Mart Cleaners (P# 15190) 2334 El Camino Real Santa Clara, CA 95051	Perchloroethylene	487
Owens Corning (P# 41) 960 Central Expressway Santa Clara, CA 95050	Ammonia (NH3) pollutant	321000
	Formaldehyde	19500
Pacific Recovery Corporation (P# 1583) 5401 Lafayette Street Santa Clara, CA 95050	Benzene	36.6
	Formaldehyde	301
	Vinyl chloride	10.1
Perfect Cleaners (P# 11319) 1520 Kiely Boulevard Santa Clara, CA 95051	Perchloroethylene	365
Pycon, Inc (P# 7941) 3301 Leonard Court Santa Clara, CA 95054	Ammonia (NH3) pollutant	45000
San Felipe Cleaner (P# 13560) 3569 Benton Street Santa Clara, CA 95051	Perchloroethylene	1440

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COUNTY: SANTA CLARA
CITY: Santa Clara

Company Name	Pollutant	Estimated Emissions (lbs/yr)
Tiffany Cleaners (P# 15032) 3004 El Camino Real Santa Clara, CA 95051	Perchloroethylene	1490

COUNTY: SANTA CLARA
CITY: Saratoga

Company Name	Pollutant	Estimated Emissions (lbs/yr)
Argonaut Oaks Cleaners (P# 9780) 12912 Saratoga Sunnyvl Rd Saratoga, CA 95070	Perchloroethylene	499
Cleaners Connection (P# 10060) 12300 Saratoga Sunnyvl Rd Saratoga, CA 95070	Perchloroethylene	1290
Hillview Cleaner (P# 13840) 14440 Big Basin Way Saratoga, CA 95070	Perchloroethylene	459
Kerful Cleaners (P# 10765) 20472 Saratoga Los Gts Rd Saratoga, CA 95070	Perchloroethylene	310
Quito Park Dry Cleaners (P# 1518) 18808 Cox Avenue Saratoga, CA 95070	Perchloroethylene	607
Saratoga Drycleaners (P# 5087) 14495 Big Basin Saratoga, CA 95070	Perchloroethylene	513

COUNTY: SANTA CLARA
CITY: Sunnyvale

Company Name	Pollutant	Estimated Emissions (lbs/yr)
Angela's Drycleaning (P# 4543) 110 E Fremont Avenue Sunnyvale, CA 94087	Perchloroethylene	359
Betty Brite Cleaners (P# 12564) 631 Grape Avenue Sunnyvale, CA 94087	Perchloroethylene	424
Camaro Cleaners (P# 13798) 505 So Pastoria Ave, #22 Sunnyvale, CA 94086	Perchloroethylene	2700
Carriage Cleaners (P# 993) 115 E Fremont Avenue Sunnyvale, CA 94087	Perchloroethylene	654
Central Cleaners (P# 5741) 415 N Mary Avenue Sunnyvale, CA 94086	Perchloroethylene	146
City of Sunnyvale Solid Waste Program (P# 2253) Borregas St & Caribbean St Sunnyvale, CA 94088	Benzene	48.6
	Ethylene dichloride	13.2
	Methylene chloride	395
	Perchloroethylene	201
	Trichloroethylene	121
	Vinyl chloride	150.0
City of Sunnyvale Water Pollution Control (P# 733) 1440 Borregas Avenue Sunnyvale, CA 94089	Benzene	16.5
	Chloroform	270
	Methylene chloride	518
	Perchloroethylene	110
	Trichloroethylene	121
De Anza Square Cleaners, Inc (P# 999) 1358 So Mary Avenue Sunnyvale, CA 94087	Perchloroethylene	540
Delight Cleaners (P# 5052) 1281 W El Camino Real Sunnyvale, CA 94087	Perchloroethylene	499
Dryclean ABC (P# 6098) 641 Bernardo Avenue Sunnyvale, CA 94087	Perchloroethylene	675
Dryclean Best (P# 11601) 605 E El Camino Real Sunnyvale, CA 94087	Perchloroethylene	492

COUNTY: SANTA CLARA
CITY: Sunnyvale

Company Name	Pollutant	Estimated Emissions (lbs/yr)
Everybody's Cleaners (P# 7864) 903A E Duane Avenue Sunnyvale, CA 94086	Perchloroethylene	432
Excel Cleaners (P# 13582) 1082 E El Camino Real, #1 Sunnyvale, CA 94087	Perchloroethylene	1110
Exxon c/o ETIC (P# 6988) 1005 El Camino Real Sunnyvale, CA 94086	Benzene	10.1
Lockheed Martin Corporation (P# 55) 1111 Lockheed Martin Wy Sunnyvale, CA 94089	Chromium (hexavalent)	.5510
	Formaldehyde	86
	Methylene chloride	246
	Perchloroethylene	91
Mark Cleaners (P# 6445) 755 So Wolfe Road Sunnyvale, CA 94086	Perchloroethylene	492
Meigs Quick Clean (P# 2081) 1191 W El Camino Real Sunnyvale, CA 94087	Perchloroethylene	148
Nino's Cleaners (P# 9403) 826 E Fremont Ave, #A Sunnyvale, CA 94087	Perchloroethylene	229
One Day Cleaners (P# 4540) 417 E El Camino Real Sunnyvale, CA 94087	Perchloroethylene	735
Proper Wood Finishing (P# 11182) 1058 W Evelyn Avenue Sunnyvale, CA 94086	Methylene chloride	499
Royal Dry Cleaning (P# 11728) 1151 Lawrence Expwy Sunnyvale, CA 94086	Perchloroethylene	553
Saigon's Cleaners (P# 12791) 1034 E El Camno Rl Sunnyvale, CA 94087	Perchloroethylene	391
Sequoia Cleaners (P# 7450) 526 So Murphy Avenue Sunnyvale, CA 94087	Perchloroethylene	556

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COUNTY: SANTA CLARA
CITY: Sunnyvale

Company Name	Pollutant	Estimated Emissions (lbs/yr)
Spansion LLC (P# 592) 915 De Guigne Drive Sunnyvale, CA 94086		
	Benzene	32.9
	Formaldehyde	295

COUNTY: SOLANO
CITY: Benicia

Company Name	Pollutant	Estimated Emissions (lbs/yr)
City of Benicia (P# 1791) 614 5th Street Benicia, CA 94510		
	Ammonia (NH3) pollutant	38500
	Benzene	23.1
	Perchloroethylene	116
Onyx Industrial Services (P# 12802) 4501 California Ct Benicia, CA 94510		
	Benzene	9.5
Perfection Cleaners (P# 1180) 886 So Hampton Road Benicia, CA 94510		
	Perchloroethylene	649
Valero Benicia Asphalt Plant (P# 13193) 3001 Park Road Benicia, CA 94510		
	Benzene	13.3
	PAH's (benzo[a]pyrene equiv)	.166
Valero Refining Company (P# 12611) 3410 E 2nd Street Benicia, CA 94510		
	Benzene	92.8
Valero Refining Company - California (P# 12626) 3400 E 2nd Street Benicia, CA 94510		
	Acetaldehyde	342
	Ammonia (NH3) pollutant	356000
	Arsenic (all)	.253
	Benzene	1530.0
	Butadiene, 1,3-	74.5
	Cadmium	23.200
	Chromium (hexavalent)	.3830
	Formaldehyde	8610
	Hydrogen Sulfide (H2S)	23500
	Manganese	289
	Nickel pollutant	439.00
	PAH's (benzo[a]pyrene equiv)	34.400

COUNTY: SOLANO
CITY: Fairfield

Company Name	Pollutant	Estimated Emissions (lbs/yr)
Anheuser-Busch, Inc (P# 606) 3101 Busch Drive Fairfield, CA 94533	Formaldehyde	87
Ball Metal Beverage Container Corp (P# 148) 2400 Huntington Drive Fairfield, CA 94533	Butyl cellosolve	61600
	Cellosolve	91900
Fairfield Cleaners (P# 2660) 625 Jackson Street Fairfield, CA 94533	Perchloroethylene	823
Fairfield-Suisun Sewer District (P# 1404) 1010 Chadbourne Road Fairfield, CA 94534	Ammonia (NH3) pollutant	26800
	Benzene	32.9
	Chloroform	360
	Methylene chloride	238
Fairmont Memorial Park (P# 5791) 1901 Union Avenue Fairfield, CA 94533	Chlorinated dioxins & furans	.000001
	Chromium (hexavalent)	.0071
Han's Cleaners (P# 12054) 3336 N Texas Street, #F Fairfield, CA 94533	Perchloroethylene	270
Lucky's Cleaners (P# 7931) 1972 N Texas Street Fairfield, CA 94533	Perchloroethylene	755
Orchid Cleaners L L C (P# 10911) 1791 N Texas Street Fairfield, CA 94533	Perchloroethylene	1390
Pacific Bell (P# 7519) 2525 N Watney Way Fairfield, CA 94533	Benzene	13.1
	Formaldehyde	82
Rexam Beverage Can Company (P# 1665) So Pacific, Industrial Park Fairfield, CA 94533	Butyl cellosolve	7310

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COUNTY: SOLANO
CITY: Suisun City

Company Name	Pollutant	Estimated Emissions (lbs/yr)
Park Place Cleaners (P# 7716) 258E Sunset Boulevard Suisun City, CA 94585		
	Perchloroethylene	944
Potrero Hills Landfill, Inc (P# 2039) 3675 Potrero Hills Lane Suisun City, CA 94585		
	Benzene	114.0
	Ethylene dichloride	28.5
	Methylene chloride	853
	Perchloroethylene	434
	Trichloroethylene	260
	Vinyl chloride	323.0

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COUNTY: SOLANO
CITY: Travis AFB

Company Name	Pollutant	Estimated Emissions (lbs/yr)
Travis AFB (P# 770) 60th Air Base Gr, 60th AMW Travis AFB, CA 94535		
	Benzene	22.0
	Formaldehyde	51

COUNTY: SOLANO
CITY: Vallejo

Company Name	Pollutant	Estimated Emissions (lbs/yr)
Ace Cleaners (P# 7770) 1601 Marine World Pkwy, #345 Vallejo, CA 94589	Perchloroethylene	1010
Magic Cleaner (P# 5750) 3325 Sonoma Blvd, #70 Vallejo, CA 94590	Perchloroethylene	422
Redwood Cleaners (P# 5072) 784 Admiral Callaghn Ln Vallejo, CA 94591	Perchloroethylene	1010
Sparkle Cleaners (P# 8824) 627 Broadway Vallejo, CA 94590	Perchloroethylene	135
Star Cleaners (P# 7172) 4300 Sonoma Blvd, Ste #824 Vallejo, CA 94589	Perchloroethylene	135
Twin Chapels Mortuary (P# 12163) 1100 Tennessee St Vallejo, CA 94590	Chromium (hexavalent)	.0057
Vallejo Corners Cleaners (P# 13801) 950 Admiral Callaghn Ln Vallejo, CA 94591	Perchloroethylene	136
Vallejo Sanitation & Flood Control District (P# 3319) 450 Ryder Street Vallejo, CA 94590	Chloroform	335
	Methylene chloride	403
	Perchloroethylene	138
Your Cleaners (P# 10453) 609 Tennessee Street Vallejo, CA 94590	Perchloroethylene	890

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COUNTY: SONOMA
CITY: Cotati

Company Name	Pollutant	Estimated Emissions (lbs/yr)
Stony Point Rock Quarry, Inc (P# 1541) 7171 Stony Point Rd Cotati, CA 94928		
	Arsenic (all)	.046
	Benzene	52.7
	Beryllium (all) pollutant	.027
	Cadmium	.115
	Chromium (hexavalent)	.0024
	Formaldehyde	330
	Nickel pollutant	1.86
Tip Top Cleaners (P# 3094) 33 Henry Street Cotati, CA 94931		
	Perchloroethylene	567

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COUNTY: SONOMA
CITY: Eldridge

Company Name	Pollutant	Estimated Emissions (lbs/yr)
Sonoma Developemental Center (P# 1941) 15000 Arnold Drive Eldridge, CA 95431	Formaldehyde	274

COUNTY: SONOMA
CITY: Petaluma

Company Name	Pollutant	Estimated Emissions (lbs/yr)
Carpenter Parmatech (P# 11948) 2221 Pine View Way Petaluma, CA 94954		
	Hexane	81000
Cisco Systems (P# 14235) 1435 N McDowell Blvd Petaluma, CA 94954		
	Arsenic (all)	.174
	Beryllium (all) pollutant	.102
	Cadmium	.435
	Chromium (hexavalent)	.0090
	Nickel pollutant	7.04
Fairfax French Cleaners (P# 5188) 915 Lakeville Highway Petaluma, CA 94952		
	Perchloroethylene	702
Koller's Town & Country Cleaners (P# 8463) 1010 Petaluma Blvd, North Petaluma, CA 94952		
	Perchloroethylene	594
Parent-Sorensen Mortuary (P# 11971) 850 Keokuk Street Petaluma, CA 94952		
	Chromium (hexavalent)	.0039
Petaluma French Cleaners (P# 10749) 2000 Lakeville Hwy Petaluma, CA 94975		
	Perchloroethylene	2840
Petaluma Quick Cleaners (P# 4253) 214 Western Avenue Petaluma, CA 94952		
	Perchloroethylene	487
Plaza Cleaners (P# 12516) 121 N McDowell Blvd Petaluma, CA 94952		
	Perchloroethylene	432
Redwood Cleaners (P# 4708) 211 Western Avenue Petaluma, CA 94952		
	Perchloroethylene	1230
Sonoma County Department of Public Works (P# 2254) 500 Mecham Road Petaluma, CA 94952		
	Benzene	259.0
	Ethylene dichloride	70.4
	Methylene chloride	2110
	Perchloroethylene	1070
	Trichloroethylene	643
	Vinyl chloride	800.0

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COUNTY: SONOMA
CITY: Rohnert Park

Company Name	Pollutant	Estimated Emissions (lbs/yr)
Ace Cleaners (P# 11946) 6404 Commerce Boulevard Rohnert Park, CA 94928	Perchloroethylene	708
Dr Dryclean Inc (P# 7225) 1451 Southwest Blvd, #121 Rohnert Park, CA 94928	Perchloroethylene	917
Express Cleaners (P# 13164) 1460 E Cotati Avenue Rohnert Park, CA 94928	Perchloroethylene	135
Major Cleaners (P# 13225) 60 Raleys Town Center Rohnert Park, CA 94928	Perchloroethylene	1890
West & Associates Environmental Engineers Inc (P# 14926) 5600 State Farm Drive Rohnert Park, CA 94928	Benzene	474.0

COUNTY: SONOMA
CITY: Santa Rosa

Company Name	Pollutant	Estimated Emissions (lbs/yr)
ABC Cleaners (P# 4121) 711 Stoney Point Road Santa Rosa, CA 95401	Perchloroethylene	347
Best Cleaners (P# 11820) 1007 W College Ave, #B Santa Rosa, CA 95401	Perchloroethylene	135
Boomer's Fabricare Ctr Inc (P# 5395) 1321 Guernville Road Santa Rosa, CA 95403	Perchloroethylene	689
Chapel of the Chimes (P# 7658) 2607 Santa Rosa Avenue Santa Rosa, CA 95407	Arsenic (all)	.033
	Chlorinated dioxins & furans	.000003
	Chromium (hexavalent)	.0153
City of Santa Rosa Wastewater Treatment (P# 1403) 4300 Llano Road Santa Rosa, CA 95407	Benzene	115.0
	Chloroform	707
	Formaldehyde	48
	Methylene chloride	786
	Perchloroethylene	550
Cleaners 2000 (P# 10767) 721 Hahman Drive Santa Rosa, CA 95405	Perchloroethylene	1010
Coit Services of North Bay Inc (P# 12145) 5277 Aero Drive Santa Rosa, CA 95403	Perchloroethylene	364
Daniels Chapel of the Roses (P# 11953) 1225 Sonoma Avenue Santa Rosa, CA 95405	Chromium (hexavalent)	.0050
Empire Cleaners (P# 12782) 526 Sonoma Avenue Santa Rosa, CA 95401	Perchloroethylene	411
Exxon Company USA (P# 12435) 1101 Yulupa Avenue Santa Rosa, CA 95404	Benzene	24.1
Family Cleaners (P# 12882) 500 Mission Blvd, Suite D Santa Rosa, CA 95409	Perchloroethylene	358

COUNTY: SONOMA
CITY: Santa Rosa

Company Name	Pollutant	Estimated Emissions (lbs/yr)
King Cleaners (P# 11478) 5875 Sonoma Highway Santa Rosa, CA 95401	Perchloroethylene	337
Lakeside Cleaners (P# 12861) 4211 Montgomery Santa Rosa, CA 95405	Perchloroethylene	499
One Stop Cleaners (P# 4439) 1557 Farmers Lane Santa Rosa, CA 95405	Perchloroethylene	324
Pacific Gas and Electric Company (P# 3033) 3965 Occidental Road Santa Rosa, CA 95401	Benzene	8.2
Redwood Coast Petroleum (P# 869) 455 Yolanda Avenue Santa Rosa, CA 95404	Benzene	40.5
Redwood Oil Company (P# 13043) 455 Yolanda Avenue Santa Rosa, CA 95402	Benzene	33.0
Rincon Valley Cleaners (P# 5970) 534 Montecito Center Santa Rosa, CA 95409	Perchloroethylene	131
Royal Petroleum Company (P# 10986) 365 Todd Road Santa Rosa, CA 95407	Benzene	13.1
Santa Rosa Cleaners (P# 14800) 1415 Fulton Rd, Suite 201 Santa Rosa, CA 95401	Perchloroethylene	135
St Francis Cleaners (P# 906) 112 Calistoga Road Santa Rosa, CA 95405	Perchloroethylene	985
Stony Point Cleaners (P# 4905) 469 Stony Point Road Santa Rosa, CA 95401	Perchloroethylene	432
Thompson Cleaners (P# 7411) 4040 Montgomery Drive Santa Rosa, CA 95405	Perchloroethylene	971
Union Pacific Railroad Company (P# 11648) 99 Frances Street Santa Rosa, CA 95401	Trichloroethylene	142

COUNTY: SONOMA
CITY: Sebastopol

Company Name	Pollutant	Estimated Emissions (lbs/yr)
Dave's Pit Stop #2 (P# 12949) 7200 Healdsburg Avenue Sebastopol, CA 95472	Benzene	17.2
La Blue Fiesta Cleaners (P# 4266) 580 Gravenstein Hwy, North Sebastopol, CA 95472	Perchloroethylene	487
Pleasant Hill Cemetery (P# 4863) 1700 Pleasant Hill Rd Sebastopol, CA 95472	Chlorinated dioxins & furans	.000002
	Chromium (hexavalent)	.0095
Superior Cleaners (P# 8534) 732 Gravenstein Hwy, North Sebastopol, CA 95472	Perchloroethylene	809

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COUNTY: SONOMA
CITY: Sonoma

Company Name	Pollutant	Estimated Emissions (lbs/yr)
Crown Cleaners (P# 8874) 568 Broadway Sonoma, CA 95476	Perchloroethylene	216
Off Broadway Cleaners Inc (P# 4403) 19485 Sonoma Hwy, #A Sonoma, CA 95476	Perchloroethylene	1130
Sonoma County Water Agency (P# 1228) 22675 8th St, East Sonoma, CA 95476	Benzene	136.0
	Chloroform	160
	Methylene chloride	380
	Perchloroethylene	148
Sonoma Rock Company (P# 1867) 26650 Arnold Drive Sonoma, CA 95476	Benzene	18.8
	Formaldehyde	118

COUNTY: SONOMA
CITY: Windsor

Company Name	Pollutant	Estimated Emissions (lbs/yr)
Lakewood Cleaners (P# 11664) 8778 Lakewood Drive Windsor, CA 95492	Perchloroethylene	243
Palms Dry Cleaners (P# 7857) 8499 Old Redwood, #106 Windsor, CA 95492	Perchloroethylene	944
Standard Structures Inc (P# 4982) 920 Shiloh Road Windsor, CA 95492	Formaldehyde	691
Windsor Cleaners (P# 8531) 9082 Brooks Road Windsor, CA 95492	Perchloroethylene	1100

APPENDIX B-2

EMISSION INVENTORY
BY POLLUTANT

BAY AREA AIR QUALITY MANAGEMENT DISTRICT
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POLLUTANT	P#	PLANT NAME	ESTIMATED EMISSIONS (LBS/YR)	
ACETALDEHYDE	(>72 lbs/yr)			
	17	Hanson Permanente Cement, Cupertino	4100	
	9010	California Paperboard Corporation, Santa Clara	2100	
	732	Jefferson Smurfit Corporation, Santa Clara	760	
	11	Shell Martinez Refinery, Martinez	580	
	12626	Valero Refining Company - California, Benicia	340	
	10	Chevron Products Company, Richmond	230	
	591	East Bay Municipal Utility District, Oakland	180	
	14628	Tesoro Refining and Marketing Company, Martinez	150	
	15064	Fleischmann's Vinegar Company, Inc, Oakland	120	
	16	ConocoPhillips - San Francisco Refinery, Rodeo	92	
	81	plants reported	8800	(total)
ACROLEIN	(>3.9 lbs/yr)			
	591	East Bay Municipal Utility District, Oakland	110.0	
	167	Maxwell House, Div of Kraft Foods, San Leandro	5.1	
	4	plants reported	110.0	(total)
ACRYLIC ACID	(>190 lbs/yr)			
		emission from each plant is below reporting level	---	
	1	plant reported	45	(total)
ACRYLONITRILE	(>.67 lbs/yr)			
	12728	Waste Management Inc, San Leandro	100.00	
	2066	Waste Management of Alameda County, Livermore	66.00	
	200	Rohm and Haas Co,Polymers & Resin Busine, Hayward	38.00	
	11671	Gas Recovery Systems, Inc, American Canyon	36.00	
	1179	Redwood Landfill Inc, Novato	.74	
	5	plants reported	250.00	(total)
ALLYL CHLORIDE	(>193 lbs/yr)			
		emission from each plant is below reporting level	---	
	2	plants reported	54	(total)
AMMONIA (NH3)	POLLUTANT (>19300 lbs/yr)			
	778	San Jose/Santa Clara Water Pollution Con, San Jose	730000	
	12626	Valero Refining Company - California, Benicia	360000	
	8664	Crockett Cogeneration, A Cal Ltd Partner, Crockett	350000	
	41	Owens Corning, Santa Clara	320000	
	16	ConocoPhillips - San Francisco Refinery, Rodeo	110000	
	3245	GWF Power Systems,LP (Site 3), Antioch	88000	
	11866	Los Medanos Energy Center, Pittsburg	76000	
	591	East Bay Municipal Utility District, Oakland	72000	
	10	Chevron Products Company, Richmond	65000	
	12095	Delta Energy Center, Pittsburg	51000	
	7941	Pycon, Inc, Santa Clara	45000	
	907	Central Contra Costa Sanitary District, Martinez	43000	
	11928	Calpine Pittsburg LLC, Pittsburg	43000	
	1791	City of Benicia, Benicia	38000	
	227	Criterion Catalysts Company LP, Pittsburg	32000	
	1404	Fairfield-Suisun Sewer District, Fairfield	27000	
	3244	GWF Power Systems,LP (Site 2), Pittsburg	26000	
	3243	GWF Power Systems,LP (Site 1), Pittsburg	25000	
	3246	GWF Power Systems,LP (Site 5), Pittsburg	25000	
	3981	GWF Power Systems,LP (Site 4), Antioch	25000	
	1209	Union Sanitary District, Union City	25000	
	8297	Dynamic Details, Inc, Milpitas	20000	
	69	plants reported	2700000	(total)

POLLUTANT	P#	PLANT NAME	ESTIMATED EMISSIONS (LBS/YR)	
ARSENIC (ALL)	(>.024 lbs/yr)			
	62	American Brass & Iron Foundry, Oakland	3.100	
	16	ConocoPhillips - San Francisco Refinery, Rodeo	1.700	
	11	Shell Martinez Refinery, Martinez	1.500	
	10	Chevron Products Company, Richmond	1.300	
	17	Hanson Permanente Cement, Cupertino	.460	
	14628	Tesoro Refining and Marketing Company, Martinez	.440	
	12626	Valero Refining Company - California, Benicia	.250	
	14235	Cisco Systems, Petaluma	.170	
	710	United Technologies Corporation, San Jose	.130	
	1179	Redwood Landfill Inc, Novato	.130	
	4735	Sentinel Cremation Societies Inc, Emeryville	.098	
	4134	Irvington Memorial Cemetery, Fremont	.092	
	2478	UCSF/Parnassus, San Francisco	.077	
	8020	Woodlawn Cemetery, Colma	.058	
	429	Bank of America, San Francisco	.056	
	6390	Evergreen Cemetery, Oakland	.056	
	5472	BFI - The Recyclery, Milpitas	.054	
	1262	Azevedo Quarry, San Jose	.052	
	1541	Stony Point Rock Quarry, Inc, Cotati	.046	
	4205	Oak Hill Memorial Park & Mortuary, San Jose	.044	
	778	San Jose/Santa Clara Water Pollution Con, San Jose	.042	
	12388	Insituform Technologies Inc, San Jose	.037	
	3245	GWF Power Systems,LP (Site 3), Antioch	.037	
	3244	GWF Power Systems,LP (Site 2), Pittsburg	.037	
	3243	GWF Power Systems,LP (Site 1), Pittsburg	.036	
	3246	GWF Power Systems,LP (Site 5), Pittsburg	.035	
	3981	GWF Power Systems,LP (Site 4), Antioch	.034	
	7658	Chapel of the Chimes, Santa Rosa	.033	
	8329	Biofuel Systems, Livermore	.032	
	9241	Point Richmond Quarry Inc, Richmond	.029	
	3314	Roselawn Cemetery, Livermore	.026	
	85	Hitachi Global Storage Technologies Inc, San Jose	.025	
	2320	Oak View Memorial Park, Antioch	.025	
	625	plants reported	11.000	(total)
BENZENE	(>6.7 lbs/yr)			
	17	Hanson Permanente Cement, Cupertino	12000.0	
	10	Chevron Products Company, Richmond	7800.0	
	16	ConocoPhillips - San Francisco Refinery, Rodeo	7100.0	
	14628	Tesoro Refining and Marketing Company, Martinez	2600.0	
	12626	Valero Refining Company - California, Benicia	1500.0	
	11	Shell Martinez Refinery, Martinez	1400.0	
	2266	Browning-Ferris Industries of CA, Inc, Half Moon Bay	690.0	
	14926	West & Associates Environmental Engineer, Rohnert Park	470.0	
	589	Dumbarton Quarry Associates, Fremont	450.0	
	9013	International Disposal Corporation of Ca, Milpitas	450.0	
	2066	Waste Management of Alameda County, Livermore	430.0	
	12095	Delta Energy Center, Pittsburg	420.0	
	591	East Bay Municipal Utility District, Oakland	400.0	
	703	Pacific Steel Casting Co-Plant #2, Berkeley	400.0	
	778	San Jose/Santa Clara Water Pollution Con, San Jose	340.0	
	1605	ChevronTexaco Business and Real Estate S, Concord	300.0	
	5095	Republic Services Vasco Road, LLC, Livermore	270.0	
	2254	Sonoma County Department of Public Works, Petaluma	260.0	
	2740	City of Mountain View (Shoreline), Mountain View	250.0	
	4020	SFPP, LP, San Jose	230.0	
	1840	West Contra Costa County Landfill, Richmond	220.0	
	12182	City of Pacifica Calera Creek Water Recy, Pacifica	220.0	
	1464	Acme Fill Corporation, Martinez	210.0	
	1179	Redwood Landfill Inc, Novato	210.0	
	2246	Tri-Cities Recycling, Fremont	210.0	
	49	Chevron Products Company, San Jose	200.0	
	15128	Cardinal Cogen Inc, Palo Alto	160.0	
	3312	Zanker Road Resource Management,Ltd, San Jose	160.0	
	11983	Robert A Cohan, Bethel Island	160.0	

POLLUTANT	P#	PLANT NAME	ESTIMATED EMISSIONS (LBS/YR)
BENZENE (>6.7 lbs/yr) (cont)			
	1820	Martinez Cogen Limited Partnership, Martinez	150.0
	11928	Calpine Pittsburg LLC, Pittsburg	140.0
	12197	United Airlines SFOPV, San Francisco	140.0
	1228	Sonoma County Water Agency, Sonoma	140.0
	15393	Harbinger Independent Power Fund II, Antioch	130.0
	15693	ConocoPhillips, Richmond	130.0
	1403	City of Santa Rosa Wastewater Treatment, Santa Rosa	120.0
	1345	Sewerage Agency of South Marin, Mill Valley	120.0
	2039	Potrero Hills Landfill, Inc, Suisun City	110.0
	1209	Union Sanitary District, Union City	110.0
	13637	BP West Coast Products, LLC, Richmond	110.0
	3464	City of Santa Clara, Santa Clara	110.0
	13066	Pacific Bell Corp, San Jose	100.0
	1507	North San Mateo County Sanitation Dist, Daly City	98.0
	15137	Tesoro c/o RDM Environmental, San Lorenzo	98.0
	4618	Allied Waste Industries (Keller Canyon L, Pittsburg	97.0
	3499	City of Menlo Park, Menlo Park	96.0
	12611	Valero Refining Company, Benicia	93.0
	2721	City of Palo Alto Landfill, Palo Alto	88.0
	11326	PE Berkeley, Inc, Berkeley	87.0
	12	Mirant Delta, LLC, Pittsburg	85.0
	11956	Equilon Enterprises LLC, Martinez	82.0
	9183	Napa-Vallejo Waste Management Authority, Napa	82.0
	1364	Cypress Amloc Land Co , Inc, Colma	81.0
	907	Central Contra Costa Sanitary District, Martinez	79.0
	1534	South Bayside System Authority, Redwood City	78.0
	1812	Kirby Canyon Landfill, Morgan Hill	78.0
	14927	California Readymix Inc, Oakland	78.0
	7034	Shore Terminals - Martinez, Martinez	77.0
	11247	Clover Flat Landfill Inc, Calistoga	75.0
	9618	SF State University, Main Campus, San Francisco	74.0
	5472	BFI - The Recyclery, Milpitas	63.0
	1262	Azevedo Quarry, San Jose	60.0
	568	San Francisco South East Treatment Plant, San Francisco	54.0
	1541	Stony Point Rock Quarry, Inc, Cotati	53.0
	1351	City of Burlingame, Waste Water Treatmen, Burlingame	52.0
	1067	Oro Loma Sanitary District, San Lorenzo	51.0
	519	Chevron, Oakland Airport-North, Oakland	50.0
	745	Shore Terminal LLC, Richmond	49.0
	2253	City of Sunnyvale Solid Waste Program, Sunnyvale	49.0
	2478	UCSF/Parnassus, San Francisco	47.0
	91	Chevron Products Co, Martinez	47.0
	12728	Waste Management Inc, San Leandro	46.0
	51	United Airlines, SF Maintenance Center, San Francisco	44.0
	869	Redwood Coast Petroleum, Santa Rosa	41.0
	581	ST Shore Terminals LLC, Crockett	39.0
	621	City of Santa Clara, Silicon Valley Powe, Santa Clara	37.0
	1583	Pacific Recovery Corporation, Santa Clara	37.0
	5876	South San Francisco-San Bruno Water Qual, South San Francis	36.0
	80	Shell Oil Co, Distribution Plant, South San Francisco	36.0
	18	Mirant Delta, LLC, Antioch	36.0
	8664	Crockett Cogeneration, A Cal Ltd Partner, Crockett	36.0
	4022	SFPP, L P, Concord	36.0
	8556	Fairmont Hotel, San Jose, San Jose	35.0
	26	Mirant Potrero, LLC, San Francisco	35.0
	64	Equilon Enterprises LLC-San Jose Termina, San Jose	35.0
	4021	SFPP, LP, Brisbane	34.0
	9241	Point Richmond Quarry Inc, Richmond	33.0
	423	Chevron Research and Technology Co, Richmond	33.0
	13043	Redwood Oil Company, Santa Rosa	33.0
	1404	Fairfield-Suisun Sewer District, Fairfield	33.0
	592	Spansion LLC, Sunnyvale	33.0
	11961	Tri-Valley Oil & Gas Co, Bethel Island	32.0
	12967	TRC, Antioch	28.0
	1784	San Francisco International Airport, San Francisco	27.0
	12493	Trajen Inc, Hayward	27.0

POLLUTANT	P#	PLANT NAME	ESTIMATED EMISSIONS (LBS/YR)
BENZENE (>6.7 lbs/yr) (cont)			
	12472	2 Genes Aviation Inc, San Martin	26.0
	8329	Biofuel Systems, Livermore	25.0
	12241	Golden Empire Properties c/o Cambria Env, Oakland	24.0
	3256	Turk Island Solid Waste Disposal Site, Union City	24.0
	13399	KLA Tencor, Milpitas	24.0
	12435	Exxon Company USA, Santa Rosa	24.0
	1791	City of Benicia, Benicia	23.0
	11531	Z-Best Composting Facility, Gilroy	23.0
	813	Venoco, Inc, Pittsburg	23.0
	11671	Gas Recovery Systems, Inc, American Canyon	22.0
	770	Travis AFB, Travis AFB	22.0
	10384	Specialty Crushing Inc, San Francisco	22.0
	3011	IPT SRI Cogeneration Inc, Menlo Park	21.0
	11180	Calpine Gilroy Cogen,LP & Gilroy Energy, Gilroy	21.0
	15414	Bay Cities Auto Auction, Hayward	20.0
	750	Bay Area/Diablo Petroleum, Brentwood	20.0
	12596	National Park Service, San Francisco	19.0
	4175	City of San Jose (Singleton Road Landfil, San Jose	19.0
	13177	US Airways, Millbrae	19.0
	7265	International Power Technology (SJ State, San Jose	19.0
	13375	United Airlines San Jose Airport Termina, San Jose	19.0
	1867	Sonoma Rock Company, Sonoma	19.0
	10394	Stevens Creek Quarry Inc, Cupertino	19.0
	2451	Pleasanton Garbage Service, Inc, Pleasanton	19.0
	756	Toro Petroleum Corp, Gilroy	18.0
	1982	County of Santa Clara, San Jose	17.0
	12949	Dave's Pit Stop #2, Sebastopol	17.0
	1009	Hayward Waste Water Treatment Plant, Hayward	17.0
	13875	USA Gasoline Corporation, Napa	17.0
	1271	West County Wastewater District, Richmond	17.0
	9853	ARCO Station No 515 c/o URS, San Mateo	17.0
	733	City of Sunnyvale Water Pollution Contro, Sunnyvale	17.0
	653	Central Marin Sanitation Agency, San Rafael	16.0
	24	PG & E Co, Hunters Point Power Plant, San Francisco	16.0
	1004	SFSU Housing Facilities (Cogeneration Pl, San Francisco	16.0
	1275	Novato Sanitary District, Novato	15.0
	13071	Mark Borsuk Esq, Oakland	15.0
	255	Lawrence Livermore National Laboratory, Livermore	15.0
	4116	San Francisco, City & County, PUC, San Francisco	14.0
	3244	GWF Power Systems,LP (Site 2), Pittsburg	14.0
	3245	GWF Power Systems,LP (Site 3), Antioch	14.0
	639	Stanford University, Palo Alto	14.0
	3243	GWF Power Systems,LP (Site 1), Pittsburg	14.0
	10649	IMTT Richmond CA, Richmond	14.0
	3246	GWF Power Systems,LP (Site 5), Pittsburg	14.0
	11900	Bridgeford Flying Services, Napa	14.0
	3981	GWF Power Systems,LP (Site 4), Antioch	13.0
	13193	Valero Benicia Asphalt Plant, Benicia	13.0
	11740	Raisch Products, Milpitas	13.0
	10986	Royal Petroleum Company, Santa Rosa	13.0
	7519	Pacific Bell, Fairfield	13.0
	915	San Francisco Petroleum Co, San Francisco	13.0
	1258	Delta Diablo Sanitation District, Antioch	13.0
	31	Dow Chemical Company, Pittsburg	13.0
	11887	Duke Energy Oakland LLC, Oakland	13.0
	861	San Mateo Water Quality Control Plant, San Mateo	12.0
	1371	Dublin San Ramon Services District - Was, Pleasanton	12.0
	1194	Pinole-Hercules Wastewater Treatment Pla, Pinole	12.0
	11670	Gas Recovery Systems, Inc, San Jose	12.0
	3885	Highland General Hospital, Oakland	12.0
	1438	New United Motor Manufacturing, Inc, Fremont	11.0
	11189	East Bay Municipal Utility District, El Sobrante	11.0
	935	Levin Richmond Terminal Corporation, Richmond	11.0
	11241	Tonka Energy Inc, Oakley	11.0
	8017	Alameda County Water District, Fremont	11.0
	1597	Las Gallinas Valley Sanitary District, San Rafael	11.0

POLLUTANT	P#	PLANT NAME	ESTIMATED EMISSIONS (LBS/YR)	
BENZENE (>6.7 lbs/yr) (cont)				
	1634	Napa State Hospital, Napa	11.0	
	14604	Applied Biosystems, Pleasanton	10.0	
	6988	Exxon c/o ETIC, Sunnyvale	10.0	
	4593	SJCC FBO Services,LLC, San Jose	10.0	
	14680	Ridgewood/California Power Partners LP, San Francisco	9.8	
	10510	ARCO c/o URS Corporation, San Francisco	9.7	
	12802	Onyx Industrial Services, Benicia	9.5	
	12969	Worldcom, San Jose	9.2	
	4047	Kaiser Foundation Hospital, South San Francisco	9.0	
	738	Crist Oil Company, Fremont	8.8	
	4272	El Camino Hospital, Mountain View	8.8	
	107	Reed & Graham, Inc, San Jose	8.7	
	2371	USS-POSCO Industries, Pittsburg	8.3	
	1257	Genentech, Inc, South San Francisco	8.2	
	3033	Pacific Gas and Electric Company, Santa Rosa	8.2	
	3102	Pacific Gas and Electric Company, San Jose	8.0	
	12387	Trans Bay Container Terminal, Oakland	7.8	
	11866	Los Medanos Energy Center, Pittsburg	7.7	
	11978	Napa Valley Petroleum Inc, Napa	7.7	
	4408	Mt View Sanitary District, Martinez	7.6	
	13187	East Bay Dischargers Authority, San Lorenzo	7.3	
	761	Alves Petroleum Inc, Half Moon Bay	7.2	
	541	Pacific Gas & Electric Co, Concord	7.2	
	4421	Roy-Aero Enterprise LLC, Palo Alto	7.1	
	2561	Shoreline Amphitheatre, Mountain View	7.1	
	12401	Wickland Oil Company, San Mateo	7.0	
	13770	Equiva Services LLC c/o Toxichem, San Jose	7.0	
	10751	Micrel Semiconductor Inc, San Jose	7.0	
	13922	Pacific Bell Corporation, Pleasanton	6.9	
	1637	plants reported	46000.0	(total)
BENZYL CHLORIDE (>2320 lbs/yr)				
		emission from each plant is below reporting level	---	
	4	plants reported	840	(total)
BERYLLIUM (ALL) POLLUTANT (>.015 lbs/yr)				
	62	American Brass & Iron Foundry, Oakland	.140	
	14235	Cisco Systems, Petaluma	.100	
	17	Hanson Permanente Cement, Cupertino	.077	
	2478	UCSF/Parnassus, San Francisco	.045	
	710	United Technologies Corporation, San Jose	.041	
	429	Bank of America, San Francisco	.033	
	5472	BFI - The Recyclery, Milpitas	.032	
	1262	Azevedo Quarry, San Jose	.031	
	1541	Stony Point Rock Quarry, Inc, Cotati	.027	
	778	San Jose/Santa Clara Water Pollution Con, San Jose	.024	
	12388	Insituform Technologies Inc, San Jose	.021	
	8329	Biofuel Systems, Livermore	.019	
	9241	Point Richmond Quarry Inc, Richmond	.017	
	625	plants reported	1.200	(total)
BROMINE (>328 lbs/yr)				
		emission from each plant is below reporting level	---	
	1	plant reported	0	(total)

POLLUTANT	P#	PLANT NAME	ESTIMATED EMISSIONS (LBS/YR)	
BUTADIENE, 1,3-	(>1.1 lbs/yr)			
	10	Chevron Products Company, Richmond	200.0	
	12626	Valero Refining Company - California, Benicia	75.0	
	14628	Tesoro Refining and Marketing Company, Martinez	72.0	
	17	Hanson Permanente Cement, Cupertino	60.0	
	31	Dow Chemical Company, Pittsburg	15.0	
	11	Shell Martinez Refinery, Martinez	13.0	
	290	DOE-KAO Sandia National Laboratories, Livermore	5.5	
	8	plants reported	440.0	(total)
BUTYL ALCOHOL, TERT-	(>-8888 lbs/yr)			
	11	Shell Martinez Refinery, Martinez	690	
	2951	Cavallino Rampante Ltd, Palo Alto	5	
	9912	Monterey Collision Frame & Body Inc, San Jose	2	
	3	plants reported	700	(total)
BUTYL CELLOSOLVE	(>3860 lbs/yr)			
	1438	New United Motor Manufacturing, Inc, Fremont	120000	
	148	Ball Metal Beverage Container Corp, Fairfield	62000	
	14327	Silgan Containers Mfg Corp, Antioch	42000	
	1665	Rexam Beverage Can Company, Fairfield	7300	
	15023	Cleveland Steel Container, Oakland	5400	
	389	plants reported	300000	(total)
CADMIUM	(>.046 lbs/yr)			
	12626	Valero Refining Company - California, Benicia	23.000	
	30	Owens-Brockway Glass Container Inc, Oakland	11.000	
	16	ConocoPhillips - San Francisco Refinery, Rodeo	8.400	
	710	United Technologies Corporation, San Jose	1.500	
	62	American Brass & Iron Foundry, Oakland	.810	
	14235	Cisco Systems, Petaluma	.440	
	11	Shell Martinez Refinery, Martinez	.420	
	17	Hanson Permanente Cement, Cupertino	.300	
	10	Chevron Products Company, Richmond	.270	
	2478	UCSF/Parnassus, San Francisco	.190	
	429	Bank of America, San Francisco	.140	
	14628	Tesoro Refining and Marketing Company, Martinez	.140	
	5472	BFI - The Recyclery, Milpitas	.140	
	1262	Azevedo Quarry, San Jose	.130	
	1541	Stony Point Rock Quarry, Inc, Cotati	.110	
	778	San Jose/Santa Clara Water Pollution Con, San Jose	.100	
	12388	Insituform Technologies Inc, San Jose	.092	
	8329	Biofuel Systems, Livermore	.080	
	9241	Point Richmond Quarry Inc, Richmond	.073	
	85	Hitachi Global Storage Technologies Inc, San Jose	.063	
	12197	United Airlines SFOPV, San Francisco	.059	
	3312	Zanker Road Resource Management,Ltd, San Jose	.054	
	31	Dow Chemical Company, Pittsburg	.052	
	11531	Z-Best Composting Facility, Gilroy	.049	
	10384	Specialty Crushing Inc, San Francisco	.047	
	629	plants reported	50.000	(total)
CARBON TETRACHLORIDE	(>4.6 lbs/yr)			
	31	Dow Chemical Company, Pittsburg	2000.0	
	40	plants reported	2000.0	(total)
CELLOSOLVE	(>38600 lbs/yr)			
	148	Ball Metal Beverage Container Corp, Fairfield	92000	
	45	plants reported	96000	(total)

POLLUTANT	P#	PLANT NAME	ESTIMATED EMISSIONS (LBS/YR)	
CELLOSOLVE ACETATE (>12400 lbs/yr)				
		emission from each plant is below reporting level	---	
	30	plants reported	4700	(total)
CHLORINATED DIOXINS & FURANS ((>1.2E-6 lbs/yr)				
	62	American Brass & Iron Foundry, Oakland	.000290	
	83	United States Pipe & Foundry Company, In, Union City	.000140	
	17	Hanson Permanente Cement, Cupertino	.000046	
	459	Veterans Administration Medical Center, San Francisco	.000008	
	4134	Irvington Memorial Cemetery, Fremont	.000007	
	8020	Woodlawn Cemetery, Colma	.000005	
	3245	GWF Power Systems,LP (Site 3), Antioch	.000004	
	3244	GWF Power Systems,LP (Site 2), Pittsburg	.000004	
	3243	GWF Power Systems,LP (Site 1), Pittsburg	.000004	
	3246	GWF Power Systems,LP (Site 5), Pittsburg	.000004	
	3981	GWF Power Systems,LP (Site 4), Antioch	.000004	
	4205	Oak Hill Memorial Park & Mortuary, San Jose	.000003	
	6390	Evergreen Cemetery, Oakland	.000003	
	7658	Chapel of the Chimes, Santa Rosa	.000003	
	3314	Roselawn Cemetery, Livermore	.000002	
	2320	Oak View Memorial Park, Antioch	.000002	
	7564	Rolling Hills Memorial Park, Richmond	.000002	
	4863	Pleasant Hill Cemetery, Sebastopol	.000002	
	5433	Tulocay Cemetery Association, Napa	.000001	
	6325	Hollywood Forever, Inc, Mill Valley	.000001	
	5791	Fairmont Memorial Park, Fairfield	.000001	
	52	plants reported	.000560	(total)
CHLORINE POLLUTANT (>1370 lbs/yr)				
	31	Dow Chemical Company, Pittsburg	1900	
	3	plants reported	1900	(total)
CHLOROBENZENE (>13500 lbs/yr)				
		emission from each plant is below reporting level	---	
	10	plants reported	4700	(total)
CHLOROBENZENE - OTHER/NOT SPEC (>13500 lbs/yr)				
		emission from each plant is below reporting level	---	
	2	plants reported	5100	(total)
CHLOROFORM (>36 lbs/yr)				
	778	San Jose/Santa Clara Water Pollution Con, San Jose	2100	
	591	East Bay Municipal Utility District, Oakland	1700	
	1534	South Bayside System Authority, Redwood City	1200	
	1179	Redwood Landfill Inc, Novato	730	
	1403	City of Santa Rosa Wastewater Treatment, Santa Rosa	710	
	907	Central Contra Costa Sanitary District, Martinez	550	
	617	Palo Alto Regional Water Quality Control, Palo Alto	520	
	1271	West County Wastewater District, Richmond	510	
	653	Central Marin Sanitation Agency, San Rafael	460	
	1067	Oro Loma Sanitary District, San Lorenzo	440	
	1209	Union Sanitary District, Union City	410	
	568	San Francisco South East Treatment Plant, San Francisco	400	
	1009	Hayward Waste Water Treatment Plant, Hayward	370	
	1404	Fairfield-Suisun Sewer District, Fairfield	360	
	3319	Vallejo Sanitation & Flood Control Distr, Vallejo	330	
	5876	South San Francisco-San Bruno Water Qual, South San Francis	290	
	733	City of Sunnyvale Water Pollution Contro, Sunnyvale	270	
	2482	City of Richmond Water Pollution Control, Richmond	260	
	13148	JDS Uniphase Corporation, Santa Clara	230	
	1258	Delta Diablo Sanitation District, Antioch	200	
	1371	Dublin San Ramon Services District - Was, Pleasanton	200	

POLLUTANT	P#	PLANT NAME	ESTIMATED EMISSIONS (LBS/YR)	
CHLOROFORM	(>36 lbs/yr) (cont)			
	1275	Novato Sanitary District, Novato	190	
	7101	Napa Sanitation District - Soscol, Napa	180	
	861	San Mateo Water Quality Control Plant, San Mateo	170	
	1228	Sonoma County Water Agency, Sonoma	160	
	2340	San Leandro Water Pollution Control Plan, San Leandro	150	
	1345	Sewerage Agency of South Marin, Mill Valley	140	
	1351	City of Burlingame, Waste Water Treatmen, Burlingame	130	
	1194	Pinole-Hercules Wastewater Treatment Pla, Pinole	120	
	1463	Ironhouse Sanitary District, Oakley	120	
	1597	Las Gallinas Valley Sanitary District, San Rafael	120	
	4116	San Francisco, City & County, PUC, San Francisco	110	
	3471	City of Calistoga, Calistoga	97	
	4408	Mt View Sanitary District, Martinez	79	
	11911	C & H Sugar Company, Inc, Crockett	78	
	1507	North San Mateo County Sanitation Dist, Daly City	74	
	3169	City of Livermore Sewage Treatment Plant, Livermore	70	
	4106	City of Millbrae Wastewater Treatment Pl, Millbrae	55	
	290	DOE-KAO Sandia National Laboratories, Livermore	50	
	92	plants reported	15000	(total)
CHROMIUM (HEXAVALENT)	(>.0014 lbs/yr)			
	16	ConocoPhillips - San Francisco Refinery, Rodeo	1.7000	
	11	Shell Martinez Refinery, Martinez	1.6000	
	10	Chevron Products Company, Richmond	.8600	
	2371	USS-POSCO Industries, Pittsburg	.6500	
	55	Lockheed Martin Corporation, Sunnyvale	.5500	
	22	Tosco Refining Company, Rodeo	.4200	
	12626	Valero Refining Company - California, Benicia	.3800	
	3245	GWF Power Systems,LP (Site 3), Antioch	.3600	
	3244	GWF Power Systems,LP (Site 2), Pittsburg	.3600	
	3243	GWF Power Systems,LP (Site 1), Pittsburg	.3500	
	3246	GWF Power Systems,LP (Site 5), Pittsburg	.3400	
	3981	GWF Power Systems,LP (Site 4), Antioch	.3300	
	14628	Tesoro Refining and Marketing Company, Martinez	.3000	
	5474	United States Mint, San Francisco	.2000	
	227	Criterion Catalysts Company LP, Pittsburg	.1900	
	1179	Redwood Landfill Inc, Novato	.1200	
	1794	Teikuro America Company, Ltd, Hayward	.1200	
	62	American Brass & Iron Foundry, Oakland	.0760	
	617	Palo Alto Regional Water Quality Control, Palo Alto	.0590	
	3696	Pacific Hard Chrome, Richmond	.0520	
	17	Hanson Permanente Cement, Cupertino	.0460	
	4735	Sentinel Cremation Societies Inc, Emeryville	.0460	
	7546	Roll Technology West, Pittsburg	.0430	
	4134	Irvington Memorial Cemetery, Fremont	.0430	
	4004	Hard Chrome Engineering Company, Oakland	.0280	
	8020	Woodlawn Cemetery, Colma	.0270	
	6390	Evergreen Cemetery, Oakland	.0260	
	710	United Technologies Corporation, San Jose	.0230	
	4205	Oak Hill Memorial Park & Mortuary, San Jose	.0200	
	5665	Electro Forming Company, Richmond	.0190	
	11496	Cycle Shack Inc, South San Francisco	.0180	
	7658	Chapel of the Chimes, Santa Rosa	.0150	
	31	Dow Chemical Company, Pittsburg	.0130	
	3314	Roselawn Cemetery, Livermore	.0120	
	30	Owens-Brockway Glass Container Inc, Oakland	.0120	
	2320	Oak View Memorial Park, Antioch	.0120	
	51	United Airlines, SF Maintenance Center, San Francisco	.0110	
	7564	Rolling Hills Memorial Park, Richmond	.0100	
	6919	Applied Anodize Inc, San Jose	.0100	
	907	Central Contra Costa Sanitary District, Martinez	.0095	
	4863	Pleasant Hill Cemetery, Sebastopol	.0095	
	14235	Cisco Systems, Petaluma	.0090	
	5433	Tulocay Cemetery Association, Napa	.0082	
	6325	Hollywood Forever, Inc, Mill Valley	.0073	

POLLUTANT	P#	PLANT NAME	ESTIMATED EMISSIONS (LBS/YR)	
CHROMIUM (HEXAVALENT)	(>.0014 lbs/yr) (cont)			
	5791	Fairmont Memorial Park, Fairfield	.0071	
	3786	Chapel of the Chimes, Oakland	.0070	
	8399	Chapel of the Chimes Memorial Park, Hayward	.0067	
	5148	Jess C Spencer Mortuaries Inc, Castro Valley	.0064	
	12163	Twin Chapels Mortuary, Vallejo	.0057	
	4209	Valley Memorial Park, Novato	.0055	
	11155	Hull's Walnut Creek Chapel, Walnut Creek	.0054	
	12958	Los Gatos Memorial Park, San Jose	.0053	
	11953	Daniels Chapel of the Roses, Santa Rosa	.0050	
	2932	Cypress Lawn Cemetery Association, Colma	.0050	
	10794	WFG-Fuller Funerals Inc, Oakland	.0043	
	2478	UCSF/Parnassus, San Francisco	.0040	
	11971	Parent-Sorensen Mortuary, Petaluma	.0039	
	7394	Sunset View Cemetery Association, El Cerrito	.0039	
	7111	High Lustre Metal Finishing, Hayward	.0035	
	7831	Mount Tamalpais Cemetery and Mortuary, San Rafael	.0034	
	12560	Richard Pierce Funeral Service, Napa	.0031	
	2634	Oakmont Memorial Park, Lafayette	.0031	
	429	Bank of America, San Francisco	.0029	
	5472	BFI - The Recyclery, Milpitas	.0028	
	1299	Skylawn Memorial Park, San Mateo	.0027	
	4449	Electro-Coatings of California Inc, Berkeley	.0027	
	1262	Azevedo Quarry, San Jose	.0027	
	9712	Direct Funeral Services, Alameda	.0025	
	10778	Treadway & Wigger Funeral Chapel, Napa	.0024	
	1541	Stony Point Rock Quarry, Inc, Cotati	.0024	
	1426	Gavilan Hills Crematory, Gilroy	.0022	
	778	San Jose/Santa Clara Water Pollution Con, San Jose	.0022	
	4538	Western Roto Engravers, Inc, Berkeley	.0020	
	12388	Insituform Technologies Inc, San Jose	.0019	
	3873	Industrial Plating Co, San Carlos	.0019	
	3809	Mountain View Cemetery Association, Oakland	.0018	
	11268	Alta Mesa Improvement Company, Palo Alto	.0017	
	3576	Bay Area Crematory, Hayward	.0017	
	8329	Biofuel Systems, Livermore	.0017	
	4122	Cedar Lawn Memorial Park & Mortuary, Fremont	.0015	
	9241	Point Richmond Quarry Inc, Richmond	.0015	
	2955	Esposito Plating & Polishing Corp, Oakland	.0015	
	649	plants reported	9.6000	(total)
COPPER (ALL) POLLUTANT	(>463 lbs/yr)			
		emission from each plant is below reporting level	---	
	52	plants reported	440	(total)
CRESOL	(>34700 lbs/yr)			
		emission from each plant is below reporting level	---	
	10	plants reported	390	(total)
DI(2-ETHYLHEXYL) PHTHALATE	(>81 lbs/yr)			
		emission from each plant is below reporting level	---	
	1	plant reported	0	(total)
DICHLOROBENZENE	(>68 lbs/yr)			
	6093	Systron Donner Inertial Division, Concord	5100	
	1179	Redwood Landfill Inc, Novato	910	
	2066	Waste Management of Alameda County, Livermore	400	
	5876	South San Francisco-San Bruno Water Qual, South San Francis	330	
	591	East Bay Municipal Utility District, Oakland	270	
	653	Central Marin Sanitation Agency, San Rafael	120	
	617	Palo Alto Regional Water Quality Control, Palo Alto	87	
	37	plants reported	7900	(total)

POLLUTANT	P#	PLANT NAME	ESTIMATED EMISSIONS (LBS/YR)	
DIOXANE, 1,4-	(>25 lbs/yr)			
	12166	Moquin Press Inc, Belmont	87	
	11530	BFI Waste Systems of North America, Inc, San Carlos	71	
	5149	F & F Steel & Stairway Inc, San Jose	57	
	10004	Technibuilders Iron, San Jose	55	
	26	plants reported	400	(total)
EPICHLOROHYDRIN	(>8.3 lbs/yr)			
		emission from each plant is below reporting level	---	
	1	plant reported	.1	(total)
ETHYL ACRYLATE	(>9260 lbs/yr)			
		emission from each plant is below reporting level	---	
	5	plants reported	78	(total)
ETHYL BENZENE	(>190000 lbs/yr)			
		emission from each plant is below reporting level	---	
	225	plants reported	27000	(total)
ETHYL CHLORIDE	(>1.93E6 lbs/yr)			
		emission from each plant is below reporting level	---	
	28	plants reported	1700	(total)
ETHYLENE DIBROMIDE	(>2.7 lbs/yr)			
	10	Chevron Products Company, Richmond	270.0	
	2066	Waste Management of Alameda County, Livermore	47.0	
	71	FMC Corporation, Newark	19.0	
	21	plants reported	340.0	(total)
ETHYLENE DICHLORIDE	(>9.7 lbs/yr)			
	9013	International Disposal Corporation of Ca, Milpitas	120.0	
	5095	Republic Services Vasco Road, LLC, Livermore	75.0	
	2254	Sonoma County Department of Public Works, Petaluma	70.0	
	2740	City of Mountain View (Shoreline), Mountain View	67.0	
	1179	Redwood Landfill Inc, Novato	58.0	
	1464	Acme Fill Corporation, Martinez	58.0	
	2246	Tri-Cities Recycling, Fremont	56.0	
	3294	Guadalupe Rubbish Disposal, San Jose	41.0	
	3312	Zanker Road Resource Management,Ltd, San Jose	37.0	
	3464	City of Santa Clara, Santa Clara	29.0	
	2039	Potrero Hills Landfill, Inc, Suisun City	28.0	
	4618	Allied Waste Industries (Keller Canyon L, Pittsburg	26.0	
	3499	City of Menlo Park, Menlo Park	26.0	
	2066	Waste Management of Alameda County, Livermore	25.0	
	2721	City of Palo Alto Landfill, Palo Alto	24.0	
	9183	Napa-Vallejo Waste Management Authority, Napa	22.0	
	1364	Cypress Amloc Land Co , Inc, Colma	22.0	
	1812	Kirby Canyon Landfill, Morgan Hill	21.0	
	11247	Clover Flat Landfill Inc, Calistoga	19.0	
	2253	City of Sunnyvale Solid Waste Program, Sunnyvale	13.0	
	12728	Waste Management Inc, San Leandro	13.0	
	56	plants reported	910.0	(total)
ETHYLENE OXIDE	(>2.1 lbs/yr)			
	15063	Alameda Hospital, Alameda	14.0	
	11058	San Leandro Surgery Center, San Leandro	11.0	
	39	plants reported	35.0	(total)

POLLUTANT	P#	PLANT NAME	ESTIMATED EMISSIONS (LBS/YR)
FORMALDEHYDE	(>33	lbs/yr)	
	16	ConocoPhillips - San Francisco Refinery, Rodeo	33000
	15393	Harbinger Independent Power Fund II, Antioch	27000
	41	Owens Corning, Santa Clara	20000
	11	Shell Martinez Refinery, Martinez	19000
	14628	Tesoro Refining and Marketing Company, Martinez	9600
	2478	UCSF/Parnassus, San Francisco	9600
	51	United Airlines, SF Maintenance Center, San Francisco	9200
	12626	Valero Refining Company - California, Benicia	8600
	621	City of Santa Clara, Silicon Valley Powe, Santa Clara	7900
	778	San Jose/Santa Clara Water Pollution Con, San Jose	6500
	541	Pacific Gas & Electric Co, Concord	6000
	3011	IPT SRI Cogeneration Inc, Menlo Park	4300
	8664	Crockett Cogeneration, A Cal Ltd Partner, Crockett	3700
	907	Central Contra Costa Sanitary District, Martinez	3400
	1605	ChevronTexaco Business and Real Estate S, Concord	2700
	591	East Bay Municipal Utility District, Oakland	2400
	17	Hanson Permanente Cement, Cupertino	2100
	1634	Napa State Hospital, Napa	2100
	18	Mirant Delta, LLC, Antioch	1800
	11866	Los Medanos Energy Center, Pittsburg	1600
	589	Dumbarton Quarry Associates, Fremont	1400
	11326	PE Berkeley, Inc, Berkeley	1300
	15128	Cardinal Cogen Inc, Palo Alto	1100
	12095	Delta Energy Center, Pittsburg	1000
	12197	United Airlines SFOPV, San Francisco	860
	4982	Standard Structures Inc, Windsor	690
	9618	SF State University, Main Campus, San Francisco	670
	11840	Catalytica Energy Systems Inc, Santa Clara	660
	13066	Pacific Bell Corp, San Jose	650
	6044	O L S Energy-Agnews, San Jose	520
	24	PG & E Co, Hunters Point Power Plant, San Francisco	500
	14927	California Readymix Inc, Oakland	490
	10	Chevron Products Company, Richmond	480
	732	Jefferson Smurfit Corporation, Santa Clara	440
	703	Pacific Steel Casting Co-Plant #2, Berkeley	420
	11671	Gas Recovery Systems, Inc, American Canyon	390
	1262	Azevedo Quarry, San Jose	370
	1541	Stony Point Rock Quarry, Inc, Cotati	330
	1771	City of Santa Clara, Santa Clara	320
	1583	Pacific Recovery Corporation, Santa Clara	300
	592	Spansion LLC, Sunnyvale	300
	8206	Blommer Chocolate Company, Inc, Union City	290
	151	Borden Packaging & Industrial Products, Fremont	280
	1941	Sonoma Developemental Center, Eldridge	270
	1820	Martinez Cogen Limited Partnership, Martinez	270
	1067	Oro Loma Sanitary District, San Lorenzo	260
	10183	Polychemie, Inc, Pittsburg	260
	7265	International Power Technology (SJ State, San Jose	250
	2066	Waste Management of Alameda County, Livermore	240
	11928	Calpine Pittsburg LLC, Pittsburg	230
	8556	Fairmont Hotel, San Jose, San Jose	220
	11180	Calpine Gilroy Cogen,LP & Gilroy Energy, Gilroy	210
	9241	Point Richmond Quarry Inc, Richmond	210
	813	Venoco, Inc, Pittsburg	200
	5462	Bio-Rad Laboratories, Richmond	200
	1784	San Francisco International Airport, San Francisco	160
	3312	Zanker Road Resource Management,Ltd, San Jose	150
	13399	KLA Tencor, Milpitas	150
	1004	SFSU Housing Facilities (Cogeneration Pl, San Francisco	140
	99	Radiant Color, Richmond	140
	10384	Specialty Crushing Inc, San Francisco	140
	15414	Bay Cities Auto Auction, Hayward	130
	8988	San Francisco Thermal, L P, San Francisco	120
	12596	National Park Service, San Francisco	120
	13375	United Airlines San Jose Airport Termina, San Jose	120
	1867	Sonoma Rock Company, Sonoma	120

POLLUTANT	P#	PLANT NAME	ESTIMATED EMISSIONS (LBS/YR)	
FORMALDEHYDE	(>33 lbs/yr) (cont)			
	10394	Stevens Creek Quarry Inc, Cupertino	120	
	26	Mirant Potrero, LLC, San Francisco	120	
	1258	Delta Diablo Sanitation District, Antioch	110	
	13177	US Airways, Millbrae	110	
	11189	East Bay Municipal Utility District, El Sobrante	100	
	11241	Tonka Energy Inc, Oakley	97	
	639	Stanford University, Palo Alto	89	
	14680	Ridgewood/California Power Partners LP, San Francisco	89	
	606	Anheuser-Busch, Inc, Fairfield	87	
	55	Lockheed Martin Corporation, Sunnyvale	86	
	167	Maxwell House, Div of Kraft Foods, San Leandro	86	
	11740	Raisch Products, Milpitas	83	
	7519	Pacific Bell, Fairfield	82	
	3885	Highland General Hospital, Oakland	79	
	255	Lawrence Livermore National Laboratory, Livermore	76	
	4272	El Camino Hospital, Mountain View	70	
	861	San Mateo Water Quality Control Plant, San Mateo	68	
	8017	Alameda County Water District, Fremont	67	
	14604	Applied Biosystems, Pleasanton	62	
	11887	Duke Energy Oakland LLC, Oakland	59	
	4050	JBR, Inc, San Leandro	58	
	12969	Worldcom, San Jose	58	
	4047	Kaiser Foundation Hospital, South San Francisco	56	
	1257	Genentech, Inc, South San Francisco	56	
	107	Reed & Graham, Inc, San Jose	55	
	770	Travis AFB, Travis AFB	51	
	475	Santa Clara Valley Health & Hospital Sys, San Jose	49	
	12387	Trans Bay Container Terminal, Oakland	49	
	1403	City of Santa Rosa Wastewater Treatment, Santa Rosa	48	
	13187	East Bay Dischargers Authority, San Lorenzo	46	
	10751	Micrel Semiconductor Inc, San Jose	44	
	13922	Pacific Bell Corporation, Pleasanton	43	
	13032	Aman Environmental Construction, Inc, Oakland	41	
	1338	Philips Semiconductors, San Jose	40	
	1209	Union Sanitary District, Union City	39	
	1785	Childrens Hospital, Oakland, Oakland	37	
	10235	Oakland Air Route Traffic Control Center, Fremont	37	
	12946	Level 3 Communications Inc, Emeryville	37	
	13494	Pacific Bell, Oakland	36	
	12859	Verio Hosting Exchange, San Jose	35	
	1500	Northern Calif Power Agency, Alameda	35	
	13716	East Bay Municipal Utility Dist, Walnut Creek	35	
	13367	San Jose International Airport, San Jose	34	
	1001	plants reported	200000	(total)
GLYCOL ETHER - OTHER/NOT SPEC	(>3860 lbs/yr)			
	1438	New United Motor Manufacturing, Inc, Fremont	16000	
	15537	Renaissance Mark, Inc, Napa	4200	
	119	plants reported	48000	(total)
HEXACHLOROBENZENE	(>.39 lbs/yr)			
		emission from each plant is below reporting level	---	
	2	plants reported	.04	(total)
HEXAMETHYLENE-1,6-DIISOCYANATE	(>1.9 lbs/yr)			
	3691	L-3 Communication, Electron Devices Divi, San Carlos	2.5	
	1	plant reported	2.5	(total)
HEXANE	(>39000 lbs/yr)			
	11948	Carpenter Parmatech, Petaluma	81000	
	67	plants reported	130000	(total)

POLLUTANT	P#	PLANT NAME	ESTIMATED EMISSIONS (LBS/YR)	
HYDROCHLORIC ACID MIST POLLUTA (>1350 lbs/yr)				
	2371	USS-POSCO Industries, Pittsburg	8200	
	31	Dow Chemical Company, Pittsburg	4500	
	22	Tosco Refining Company, Rodeo	2500	
	72	plants reported	18000	(total)
HYDROGEN CHLORIDE (HCL) (>1350 lbs/yr)				
	22	Tosco Refining Company, Rodeo	120000	
	710	United Technologies Corporation, San Jose	4500	
	1179	Redwood Landfill Inc, Novato	4000	
	3245	GWF Power Systems,LP (Site 3), Antioch	3700	
	3244	GWF Power Systems,LP (Site 2), Pittsburg	3600	
	3243	GWF Power Systems,LP (Site 1), Pittsburg	3500	
	3246	GWF Power Systems,LP (Site 5), Pittsburg	3500	
	3981	GWF Power Systems,LP (Site 4), Antioch	3400	
	17	Hanson Permanente Cement, Cupertino	2500	
	58	plants reported	150000	(total)
HYDROGEN FLUORIDE (HF) (>1140 lbs/yr)				
		emission from each plant is below reporting level	---	
	47	plants reported	1600	(total)
HYDROGEN SULFIDE (H2S) (>8110 lbs/yr)				
	12626	Valero Refining Company - California, Benicia	23000	
	778	San Jose/Santa Clara Water Pollution Con, San Jose	11000	
	59	plants reported	95000	(total)
ISOPHORONE (>390000 lbs/yr)				
		emission from each plant is below reporting level	---	
	3	plants reported	91	(total)
LEAD (ALL) POLLUTANT (>29 lbs/yr)				
	11362	Owens Brockway Glass Container, Inc, Hayward	190	
	30	Owens-Brockway Glass Container Inc, Oakland	180	
	631	plants reported	420	(total)
MANGANESE (>77 lbs/yr)				
	12626	Valero Refining Company - California, Benicia	290	
	703	Pacific Steel Casting Co-Plant #2, Berkeley	210	
	62	American Brass & Iron Foundry, Oakland	120	
	187	Pacific Steel Casting Co-Plant #1, Berkeley	110	
	10	Chevron Products Company, Richmond	100	
	592	plants reported	1100	(total)
MERCURY (ALL) POLLUTANT (>57.9 lbs/yr)				
	22	Tosco Refining Company, Rodeo	190.0	
	17	Hanson Permanente Cement, Cupertino	160.0	
	16	ConocoPhillips - San Francisco Refinery, Rodeo	84.0	
	628	plants reported	520.0	(total)
METHYL ALCOHOL (>120000 lbs/yr)				
	16	ConocoPhillips - San Francisco Refinery, Rodeo	180000	
	291	plants reported	340000	(total)
METHYL BROMIDE (>1160 lbs/yr)				
		emission from each plant is below reporting level	---	
	1	plant reported	9	(total)

POLLUTANT	P#	PLANT NAME	ESTIMATED EMISSIONS (LBS/YR)	
METHYL CELLOSOLVE	(>3860 lbs/yr)			
		emission from each plant is below reporting level	---	
	10	plants reported	2100	(total)
METHYL ETHYL KETONE (MEK)	(>149000 lbs/yr)			
		emission from each plant is below reporting level	---	
	381	plants reported	170000	(total)
METHYL METHACRYLATE	(>189000 lbs/yr)			
		emission from each plant is below reporting level	---	
	2	plants reported	20	(total)
METHYL TERTIARY-BUTYL ETHER	(>580000 lbs/yr)			
		emission from each plant is below reporting level	---	
	109	plants reported	220000	(total)
METHYLENE CHLORIDE	(>190 lbs/yr)			
	778	San Jose/Santa Clara Water Pollution Con, San Jose	7700	
	13190	Stripping Workshop, Pittsburg	7300	
	7926	Dold's Workshop, Dublin	5700	
	2723	Dura Finish of San Mateo, San Mateo	4800	
	1534	South Bayside System Authority, Redwood City	3800	
	9013	International Disposal Corporation of Ca, Milpitas	3600	
	10599	Santana's Furniture Refinish, Oakland	3400	
	2266	Browning-Ferris Industries of CA, Inc, Half Moon Bay	2500	
	5095	Republic Services Vasco Road, LLC, Livermore	2200	
	907	Central Contra Costa Sanitary District, Martinez	2200	
	2254	Sonoma County Department of Public Works, Petaluma	2100	
	2740	City of Mountain View (Shoreline), Mountain View	2000	
	618	Univar USA Inc, San Jose	1900	
	9858	J D Harpe Furniture Finishers, Alameda	1800	
	1464	Acme Fill Corporation, Martinez	1700	
	3734	Fong Brothers Printing Inc, Brisbane	1700	
	1179	Redwood Landfill Inc, Novato	1700	
	2246	Tri-Cities Recycling, Fremont	1700	
	617	Palo Alto Regional Water Quality Control, Palo Alto	1600	
	591	East Bay Municipal Utility District, Oakland	1600	
	1271	West County Wastewater District, Richmond	1200	
	3294	Guadalupe Rubbish Disposal, San Jose	1200	
	3312	Zanker Road Resource Management,Ltd, San Jose	1100	
	9314	Sierra Products Inc, Livermore	1000	
	3464	City of Santa Clara, Santa Clara	860	
	2039	Potrero Hills Landfill, Inc, Suisun City	850	
	1209	Union Sanitary District, Union City	820	
	861	San Mateo Water Quality Control Plant, San Mateo	810	
	7133	Contempo Design West, Inc, Milpitas	810	
	4618	Allied Waste Industries (Keller Canyon L, Pittsburg	790	
	1403	City of Santa Rosa Wastewater Treatment, Santa Rosa	790	
	3499	City of Menlo Park, Menlo Park	780	
	2721	City of Palo Alto Landfill, Palo Alto	720	
	9183	Napa-Vallejo Waste Management Authority, Napa	660	
	1258	Delta Diablo Sanitation District, Antioch	660	
	1364	Cypress Amloc Land Co , Inc, Colma	660	
	1812	Kirby Canyon Landfill, Morgan Hill	640	
	12182	City of Pacifica Calera Creek Water Recy, Pacifica	630	
	10218	Bio Rad Laboratories, Richmond	590	
	12093	Andpak EMA Inc, Morgan Hill	590	
	11533	Beam on Technology, Santa Clara	580	
	11247	Clover Flat Landfill Inc, Calistoga	570	
	2066	Waste Management of Alameda County, Livermore	530	
	1067	Oro Loma Sanitary District, San Lorenzo	520	
	733	City of Sunnyvale Water Pollution Contro, Sunnyvale	520	
	653	Central Marin Sanitation Agency, San Rafael	500	

POLLUTANT	P#	PLANT NAME	ESTIMATED EMISSIONS (LBS/YR)	
METHYLENE CHLORIDE		(>190 lbs/yr) (cont)		
	1009	Hayward Waste Water Treatment Plant, Hayward	500	
	11182	Proper Wood Finishing, Sunnyvale	500	
	8401	Andy's T-Shirts, Concord	490	
	13056	Superior Furniture Stripping & Refinishi, San Francisco	480	
	2482	City of Richmond Water Pollution Control, Richmond	440	
	3319	Vallejo Sanitation & Flood Control Distr, Vallejo	400	
	1351	City of Burlingame, Waste Water Treatmen, Burlingame	400	
	1275	Novato Sanitary District, Novato	400	
	2253	City of Sunnyvale Solid Waste Program, Sunnyvale	400	
	1228	Sonoma County Water Agency, Sonoma	380	
	12728	Waste Management Inc, San Leandro	380	
	1194	Pinole-Hercules Wastewater Treatment Pla, Pinole	290	
	1371	Dublin San Ramon Services District - Was, Pleasanton	280	
	290	DOE-KAO Sandia National Laboratories, Livermore	280	
	1597	Las Gallinas Valley Sanitary District, San Rafael	280	
	14604	Applied Biosystems, Pleasanton	270	
	55	Lockheed Martin Corporation, Sunnyvale	250	
	1404	Fairfield-Suisun Sewer District, Fairfield	240	
	3256	Turk Island Solid Waste Disposal Site, Union City	200	
	7949	Bay Area Business Cards, Inc, Burlingame	190	
	135	plants reported	91000	(total)
NAPHTHALENE		(>270 lbs/yr)		
		emission from each plant is below reporting level	---	
	6	plants reported	170	(total)
NICKEL POLLUTANT		(>.73 lbs/yr)		
	12626	Valero Refining Company - California, Benicia	440.00	
	227	Criterion Catalysts Company LP, Pittsburg	110.00	
	194	Wyman-Gordon Company - San Leandro Opera, San Leandro	62.00	
	703	Pacific Steel Casting Co-Plant #2, Berkeley	17.00	
	14628	Tesoro Refining and Marketing Company, Martinez	15.00	
	22	Tosco Refining Company, Rodeo	9.50	
	187	Pacific Steel Casting Co-Plant #1, Berkeley	9.00	
	3245	GWF Power Systems,LP (Site 3), Antioch	7.00	
	14235	Cisco Systems, Petaluma	7.00	
	3244	GWF Power Systems,LP (Site 2), Pittsburg	7.00	
	3243	GWF Power Systems,LP (Site 1), Pittsburg	6.80	
	3246	GWF Power Systems,LP (Site 5), Pittsburg	6.70	
	3981	GWF Power Systems,LP (Site 4), Antioch	6.60	
	17	Hanson Permanente Cement, Cupertino	5.60	
	10	Chevron Products Company, Richmond	4.20	
	11	Shell Martinez Refinery, Martinez	3.80	
	1603	Pacific Steel Casting Co-Plant #3, Berkeley	3.60	
	5082	Metal Fusion Inc, Redwood City	3.50	
	2478	UCSF/Parnassus, San Francisco	3.10	
	62	American Brass & Iron Foundry, Oakland	2.70	
	710	United Technologies Corporation, San Jose	2.70	
	30	Owens-Brockway Glass Container Inc, Oakland	2.60	
	429	Bank of America, San Francisco	2.30	
	5472	BFI - The Recyclery, Milpitas	2.20	
	1262	Azevedo Quarry, San Jose	2.10	
	1541	Stony Point Rock Quarry, Inc, Cotati	1.90	
	778	San Jose/Santa Clara Water Pollution Con, San Jose	1.70	
	12388	Insituform Technologies Inc, San Jose	1.50	
	8329	Biofuel Systems, Livermore	1.30	
	9241	Point Richmond Quarry Inc, Richmond	1.20	
	31	Dow Chemical Company, Pittsburg	1.20	

POLLUTANT	P#	PLANT NAME	ESTIMATED EMISSIONS (LBS/YR)	
NICKEL POLLUTANT	(>.73 lbs/yr) (cont)			
	85	Hitachi Global Storage Technologies Inc, San Jose	1.00	
	12197	United Airlines SFOPV, San Francisco	.96	
	3312	Zanker Road Resource Management,Ltd, San Jose	.87	
	16	ConocoPhillips - San Francisco Refinery, Rodeo	.84	
	10684	Koch Carbon, LLC, Pittsburg	.79	
	11531	Z-Best Composting Facility, Gilroy	.79	
	10384	Specialty Crushing Inc, San Francisco	.76	
	636	plants reported	790.00	(total)
PAH'S (BENZO[A]PYRENE EQUIV)	(>.043 lbs/yr)			
	10	Chevron Products Company, Richmond	220.000	
	14628	Tesoro Refining and Marketing Company, Martinez	80.000	
	11	Shell Martinez Refinery, Martinez	74.000	
	16	ConocoPhillips - San Francisco Refinery, Rodeo	44.000	
	12626	Valero Refining Company - California, Benicia	34.000	
	568	San Francisco South East Treatment Plant, San Francisco	.800	
	17	Hanson Permanente Cement, Cupertino	.180	
	13193	Valero Benicia Asphalt Plant, Benicia	.170	
	11671	Gas Recovery Systems, Inc, American Canyon	.140	
	54	plants reported	460.000	(total)
PERCHLOROETHYLENE	(>33 lbs/yr)			
	6093	Systron Donner Inertial Division, Concord	7400	
	956	Brite 1 Hr Cleaners, Alameda	5700	
	556	Stanford Linear Accelerator, Menlo Park	4900	
	1148	Coit Drapery & Carpet Cleaners, Inc, Burlingame	4700	
	4790	Five Star Cleaners, San Pablo	4400	
	1703	Inter-City Cleaners, South San Francisco	4200	
	5045	Selix Formalwear, Hayward	4200	
	12285	Crocker Cleaners, Daly City	3600	
	4537	Virginia Cleaners, Berkeley	3400	
	5847	Sagan Cleaners, San Francisco	3400	
	11257	Royal Laundry, South San Francisco	3300	
	3370	Monaco Film Labs &Video Services, San Francisco	2900	
	10749	Petaluma French Cleaners, Petaluma	2800	
	778	San Jose/Santa Clara Water Pollution Con, San Jose	2700	
	12678	A French Cleaners, Morgan Hill	2700	
	13798	Camaro Cleaners, Sunnyvale	2700	
	4302	Royal Cleaners, Albany	2600	
	372	Cambrian Plaza Dry Cleaners, San Jose	2600	
	12237	Marin Cleaners, San Rafael	2500	
	13192	Clean Look Cleaners, Novato	2400	
	12008	Green's Cleaners, Napa	2400	
	11287	Vogue Cleaners, Pleasant Hill	2400	
	12243	Royal Airline Linen of San Francisco, Burlingame	2300	
	4235	Hilltop Cleaners, Daly City	2300	
	4306	Sharon Height Drycleaning Center, Menlo Park	2300	
	2075	Veteran's DeLuxe Cleaners, San Francisco	2300	
	8562	Executive One Hour Martinizing, Alameda	2200	
	7274	Blu-White Cleaners, San Carlos	2100	
	12249	Custom Commercial Dry Cleaners, Hayward	2100	
	4261	Lucky Cleaners, Hayward	2100	
	14613	Quong Lee Laundry, Redwood City	2100	
	3520	Leland Cleaners, San Francisco	2000	
	5530	Country Club Cleaners, San Ramon	2000	
	11743	California Oak Cleaners, San Francisco	2000	
	7273	Kent Cleaners, Foster City	1900	
	13225	Major Cleaners, Rohnert Park	1900	
	1016	Courtesy Cleaners, Mountain View	1900	
	5124	Bonded Cleaners, San Jose	1800	
	9013	International Disposal Corporation of Ca, Milpitas	1800	
	2291	Dollar Cleaners, San Lorenzo	1800	
	6106	Maxwell The Cleaner, Larkspur	1800	
	8116	West Coast Valet Service, Inc, Burlingame	1800	

POLLUTANT	P#	PLANT NAME	ESTIMATED EMISSIONS (LBS/YR)
PERCHLOROETHYLENE	(>33 lbs/yr) (cont)		
	10253	Sands Cleaners, San Jose	1800
	10598	One Hour Martinizing, Oakland	1700
	4379	Red Hanger Kleaners Inc, Oakland	1700
	8488	Holiday Cleaners, Mountain View	1700
	591	East Bay Municipal Utility District, Oakland	1700
	11523	Bonded Cleaners, San Jose	1700
	4716	Purity Cleaners & Laundry Inc, Livermore	1700
	8320	Creekside Cleaners, Hercules	1600
	13117	Bay Drycleaners, San Jose	1600
	13799	Camaro Cleaners, San Jose	1600
	11083	Maxwell The Cleaners Inc, San Rafael	1600
	11275	Sunshine Cleaners, San Leandro	1600
	6437	Buchanan Cleaners, San Francisco	1500
	298	Poly Clean Center, Atherton	1500
	7129	Park Place Discount Cleaners, Concord	1500
	15344	Rainbow Cleaners, San Francisco	1500
	15032	Tiffany Cleaners, Santa Clara	1500
	12604	Unique Laundry & Cleaners, San Francisco	1500
	5203	Clean N' Save, San Francisco	1400
	13560	San Felipe Cleaner, Santa Clara	1400
	4423	Miracle Cleaners, San Francisco	1400
	10911	Orchid Cleaners L L C, Fairfield	1400
	12012	Brenda's Classic Cleaners, Gilroy	1400
	13596	Borel Cleaners, San Mateo	1400
	387	R&J Quick Clean Center, Castro Valley	1300
	3399	Peninou French Laundry, South San Francisco	1300
	4297	One Hour Cleaners, San Jose	1300
	12295	Half Moon Bay Cleaners, Half Moon Bay	1300
	12961	Olson's Cleaners #2, San Francisco	1300
	5116	City Cleaners, San Jose	1300
	324	Carl's Fine Dry Cleaning, San Mateo	1300
	15213	Cameo Cleaners, San Francisco	1300
	10060	Cleaners Connection, Saratoga	1300
	345	Roy's Cleaners, Redwood City	1300
	7309	Creekside Plaza Cleaners, Morgan Hill	1300
	8741	Dow Cleaners, Napa	1300
	6007	Fashion Express Cleaners, San Jose	1300
	11736	Campbell Plaza Cleaners, Campbell	1300
	6120	Highland Cleaners, Hayward	1300
	9662	Fountain Cleaner, Oakland	1300
	3967	Dryclean USA, San Leandro	1200
	1534	South Bayside System Authority, Redwood City	1200
	12492	Clean Cleaners of Orinda, Orinda	1200
	10702	Valley Cleaners of Castro Valley, Castro Valley	1200
	3069	B & T One Hour Cleaners, Oakland	1200
	3127	Vogue Cleaners, San Carlos	1200
	4708	Redwood Cleaners, Petaluma	1200
	10887	C & C Drycleaner, Berkeley	1200
	1130	Peninsula Cleaners, Millbrae	1200
	4899	Francisco Bay Cleaners & Laundry, San Francisco	1200
	8032	Campton Place Hotel, San Francisco	1200
	9863	Benjamin's Cleaners, San Jose	1200
	9075	Vonnies One Hour Cleaners, San Ramon	1200
	2490	Kwik Milady Cleaners, San Lorenzo	1200
	11373	Norge Village Cleaner, Concord	1200
	13013	Berkland Dry Cleaners, Berkeley	1200
	8439	Bellomy Cleaners, Santa Clara	1200
	4248	One Hour Cleaners, San Francisco	1200
	11177	One Hour Cleaners, Concord	1200
	907	Central Contra Costa Sanitary District, Martinez	1200
	3750	Clean Cleaners of Moraga, Moraga	1200
	15146	Safe Cleaners, San Jose	1200
	4663	Super Cleaners, Fremont	1100
	12672	Bay Breeze Cleaners, San Francisco	1100
	1140	Crown Cleaners, Half Moon Bay	1100
	5095	Republic Services Vasco Road, LLC, Livermore	1100

POLLUTANT	P#	PLANT NAME	ESTIMATED EMISSIONS (LBS/YR)
PERCHLOROETHYLENE	(>33 lbs/yr) (cont)		
	4403	Off Broadway Cleaners Inc, Sonoma	1100
	11780	Russell Heath Cleaners, San Leandro	1100
	4399	Quality Cleaners, Mill Valley	1100
	4609	Lakeside French Cleaners, San Francisco	1100
	7710	M&R Cleaners, San Anselmo	1100
	1693	Lombard Dry Cleaners, San Francisco	1100
	13083	Morgan Hill Discount Cleaners, Morgan Hill	1100
	13582	Excel Cleaners, Sunnyvale	1100
	10674	Fairfax French Cleaners, Novato	1100
	2138	One Hour Albany Cleaners, Albany	1100
	8531	Windsor Cleaners, Windsor	1100
	5011	Har's One Hour Martinizing, San Jose	1100
	11238	Zephyr Cleaners, San Francisco	1100
	12912	New Golden Hanger Cleaners, San Francisco	1100
	8556	Fairmont Hotel, San Jose, San Jose	1100
	886	Swift Cleaners, San Jose	1100
	5649	Marina Village Cleaners, Alameda	1100
	11642	Cleaning & Alteration Shop, San Jose	1100
	12189	Alex's Drycleaning Valet, San Rafael	1100
	2254	Sonoma County Department of Public Works, Petaluma	1100
	10747	Professional Cleaners, Oakland	1100
	1147	Bell Cleaners, San Francisco	1100
	11791	City of Paris Cleaners, San Jose	1100
	15085	Winchester Cleaners, San Jose	1100
	14330	New A-1 Cleaners, San Mateo	1100
	2141	El Portal One Hour Cleaners And Laundry, San Pablo	1100
	3480	Comet Cleaners, San Francisco	1100
	4199	Esrik Cleaners, San Francisco	1000
	6956	Miraloma Cleaners, San Francisco	1000
	2768	Sherman's Cleaners, Oakland	1000
	4238	Town & Country Cleaners, Hayward	1000
	4596	Southgate Cleaners, Daly City	1000
	2740	City of Mountain View (Shoreline), Mountain View	1000
	7770	Ace Cleaners, Vallejo	1000
	4366	Style Cleaners, Oakland	1000
	5072	Redwood Cleaners, Vallejo	1000
	5102	Bel-Aire Cleaners, Napa	1000
	5381	Moon's Best Cleaners, San Jose	1000
	9459	Tommy's Cleaners, Millbrae	1000
	11874	Savings One Hour Cleaners, Fremont	1000
	12703	Michael's Cleaners, San Francisco	1000
	15423	City Dryclean, Pleasanton	1000
	10767	Cleaners 2000, Santa Rosa	1000
	2266	Browning-Ferris Industries of CA, Inc, Half Moon Bay	1000
	4925	Portal Cleaners, San Francisco	1000
	15051	New Union Quality Cleaners, San Francisco	1000
	2066	Waste Management of Alameda County, Livermore	990
	800	Pinecrest Cleaners, San Francisco	990
	906	St Francis Cleaners, Santa Rosa	980
	7036	Spotless Cleaners, San Anselmo	980
	5107	Chardonnay Cleaners, Napa	970
	7411	Thompson Cleaners, Santa Rosa	970
	5546	Sunny Piedmont Cleaners, Oakland	960
	3066	Edgewater Cleaners, Foster City	960
	7448	Sparklizing Cleaners, Danville	960
	10626	One Hour Cleaners, Pleasant Hill	950
	1780	Shoreline Cleaners, Mill Valley	940
	4532	Lincoln Avenue Cleaners, San Jose	940
	6451	Fay Cleaners, San Francisco	940
	7219	Fabricare Cleaners, San Francisco	940
	7716	Park Place Cleaners, Suisun City	940
	7857	Palms Dry Cleaners, Windsor	940
	9274	Plaza Cleaners, Morgan Hill	930
	289	Broadway Cleaners, Redwood City	930
	353	AJ's Quick Clean Center, Palo Alto	930
	3985	Richard's Dry Cleaners, Belmont	930

POLLUTANT	P#	PLANT NAME	ESTIMATED EMISSIONS (LBS/YR)
PERCHLOROETHYLENE	(>33 lbs/yr) (cont)		
	5030	California Avenue Norge Village Cleaners, Palo Alto	920
	7540	Jofran Cleaners, Daly City	920
	11232	Excellent Cleaners, San Francisco	920
	4422	St Paul Cleaners, Walnut Creek	920
	7225	Dr Dryclean Inc, Rohnert Park	920
	11337	Cherry City Cleaners, San Leandro	910
	8131	One Hour Superfine Cleaners, San Rafael	900
	14628	Tesoro Refining and Marketing Company, Martinez	900
	5633	Township Cleaners, Fremont	890
	10453	Your Cleaners, Vallejo	890
	4364	Pride Cleaners, Oakland	880
	1464	Acme Fill Corporation, Martinez	880
	4636	One Hour Dry Cleaning, South San Francisco	880
	311	Town & Country Cleaners, San Mateo	880
	7854	Bancroft Cleaners, San Leandro	880
	13902	Golden Cleaners, San Jose	880
	12096	Express Drapery Cleaners, San Mateo	870
	1179	Redwood Landfill Inc, Novato	870
	5042	Dynasty Cleaners, San Leandro	860
	11932	Ace Cleaners, Napa	860
	4393	Swiss Cleaners, San Jose	850
	4204	Dryclean 1 Hour, Dublin	850
	13237	Terra Linda Cleaners, Inc, San Rafael	850
	2246	Tri-Cities Recycling, Fremont	850
	6254	Brown Valley Cleaners, Napa	840
	9139	Alpine Cleaners, Hayward	830
	2660	Fairfield Cleaners, Fairfield	820
	7018	Mark Cleaners, San Jose	820
	7530	Holiday Cleaners of America, Cupertino	810
	299	Killarney Cleaners, Santa Clara	810
	1436	Pacheco Plaza One Hour Cleaners, Novato	810
	1592	Four Mile Cleaners, San Francisco	810
	4284	Buchanan Cleaners, San Francisco	810
	4296	Martini Cleaners, San Francisco	810
	4301	Kerns and Walker Cleaners, San Rafael	810
	4525	Fairmont Hotel, San Francisco	810
	4530	Orinda Cleaners, Orinda	810
	4620	Rinconada Cleaners & Laundry, Los Gatos	810
	4956	Blue Bird Cleaners, San Mateo	810
	4972	Marshall Steel Cleaners, Walnut Creek	810
	8418	One Hour Drycleaning, San Bruno	810
	8534	Superior Cleaners, Sebastopol	810
	9348	Holiday Cleaners, Palo Alto	810
	13427	Quality Cleaner, Fremont	810
	14699	Cleaning & Alteration Shop, San Jose	810
	5032	Budget Cleaners, San Jose	800
	5247	Revelation Cleaners, Alameda	800
	6450	Fantastic Cleaners, San Leandro	790
	14896	Holiday Cleaners, San Mateo	790
	1390	Norge Cleaners & Laundry, Albany	780
	14610	Save-On 1hr Cleaners, Union City	780
	6199	Dry Clean America, San Jose	780
	11515	Harvey's Cleaners & Laundry, Dublin	770
	10675	Burns Cleaners, San Francisco	770
	8118	Busy Bee Cleaners, El Cerrito	770
	568	San Francisco South East Treatment Plant, San Francisco	770
	3511	Dryclean USA, Milpitas	770
	13041	Astro Cleaners, San Francisco	760
	11656	Express Cleaner, San Francisco	760
	8685	B-Line Cleaners, Danville	760
	3971	El Sobrante Cleaners, El Sobrante	760
	6399	Mills 1 Hour Cleaners, Millbrae	760
	7430	Rose Cleaners, Union City	760
	7931	Lucky's Cleaners, Fairfield	760
	13800	Camaro Cleaners, San Jose	760
	4652	Town & Country Cleaners, Palo Alto	750

POLLUTANT	P#	PLANT NAME	ESTIMATED EMISSIONS (LBS/YR)
PERCHLOROETHYLENE	(>33 lbs/yr) (cont)		
	12598	One Low Price Cleaners, Dublin	750
	4468	Oak Hills Cleaners, Pleasanton	740
	7997	Saving Cleaners, San Jose	740
	9064	One Hour Cleaners, San Jose	740
	9864	One Hour Martinizing, Belmont	740
	12906	County Line Cleaners, San Francisco	740
	12929	Union French Cleaners, San Francisco	740
	4540	One Day Cleaners, Sunnyvale	740
	6383	Perkins Cleaners, Oakland	730
	8312	Red Hanger Kleaners, Richmond	730
	461	Belmont Village Cleaners, Belmont	730
	4955	Best Cleaners, Concord	730
	11056	Econo Cleaners, San Jose	730
	14626	Marsh Manor Cleaners, Redwood City	730
	4259	Rex Cleaners, San Jose	720
	297	Vogue Cleaners, Inc, Mill Valley	720
	3900	Smart Cleaners, Fremont	720
	11422	National Cleaners, Daly City	720
	12833	Kent Cleaners, San Francisco	720
	301	Westlake French Cleaners, Daly City	710
	4614	Gene's Cleaners, San Leandro	710
	5827	Park Ave Cleaners, Dublin	710
	11946	Ace Cleaners, Rohnert Park	710
	10005	Fairmont Cleaners, San Leandro	700
	1356	Glen Park Cleaners, San Francisco	700
	4249	Faultless Cleaners, Pittsburg	700
	4604	M & P One Hour Cleaner, El Cerrito	700
	5188	Fairfax French Cleaners, Petaluma	700
	5471	Great American Drycleaning Est, Pittsburg	700
	15310	Kleen N Brite Cleaners, El Sobrante	700
	4460	Euwell & Sons Cleaners, Berkeley	700
	4410	VIP Cleaners, San Jose	700
	4299	Ritz Cleaners, San Jose	690
	9202	1010 Full Service Dry Cleaner, San Francisco	690
	14897	Song's Dry Cleaners, Novato	690
	5395	Boomer's Fabricare Ctr Inc, Santa Rosa	690
	1816	L & M One Hour Cleaners, Novato	690
	4316	Wright Cleaners, South San Francisco	690
	4340	Sparkle Clean Cleaners, San Jose	690
	5400	Sunrise Cleaners, Martinez	690
	7369	Snow White Cleaners, San Francisco	690
	10047	Express Cleaners, Campbell	690
	10885	Fortune Cleaners, San Francisco	680
	318	Crystal Cleaning Center, San Mateo	670
	4520	Quimby Cleaners, San Jose	670
	4598	Klass Cleaners, Saint Helena	670
	6098	Dryclean ABC, Sunnyvale	670
	7360	Arlene's Cleaners, San Francisco	670
	7897	Broadway Fashion Cleaners, Burlingame	670
	8804	Ford Cleaners, Los Gatos	670
	9219	Major Town Cleaners, Walnut Creek	670
	9954	Silktech Cleaners, Hayward	670
	10655	Vintage Hills Cleaners, Pleasanton	670
	11484	Cray Cleaners, San Mateo	670
	13604	Michaels Cleaners, Milpitas	670
	15189	Nelson's Cleaners, Santa Clara	670
	15234	Royal Cleaners, Redwood City	670
	15239	Martindale Cleaners, El Sobrante	670
	861	San Mateo Water Quality Control Plant, San Mateo	670
	4548	Premier Cleaners, Berkeley	670
	2942	Chestnut Street Cleaners, San Francisco	660
	7808	Holiday Cleaners, San Bruno	660
	15347	Speedy Cleaners, San Jose	660
	1079	Star Cleaners, San Jose	660
	993	Carriage Cleaners, Sunnyvale	650
	4063	VIP Cleaners, Pleasanton	650

POLLUTANT	P#	PLANT NAME	ESTIMATED EMISSIONS (LBS/YR)
PERCHLOROETHYLENE	(>33 lbs/yr) (cont)		
	2835	Larkspur Cleaners, Larkspur	650
	4268	Roc's Cleaners, Campbell	650
	1180	Perfection Cleaners, Benicia	650
	4715	Kiely Park Dry Cleaner, San Jose	650
	4322	Corte Madera Cleaners, Corte Madera	640
	6284	Sparkle Cleaners, Oakland	640
	12977	Fashion Cleaners, Los Gatos	640
	10927	Jackson Cleaners, Hayward	630
	4692	Swan Cleaners, San Jose	630
	1067	Oro Loma Sanitary District, San Lorenzo	630
	14255	Sandy's Cleaners, San Francisco	630
	3294	Guadalupe Rubbish Disposal, San Jose	620
	12840	Royal Cleaners, San Francisco	620
	5046	Los Altos Laundry & Cleaners, Los Altos	620
	12799	The Ritz Carlton San Francisco, San Francisco	610
	3955	Montclair Cleaners, Oakland	610
	1518	Quito Park Dry Cleaners, Saratoga	610
	2890	Pro-Tech Cleaners, Milpitas	610
	3049	Dryclean Pro, Cupertino	610
	4037	Benson Cleaners, San Jose	610
	4627	Diamond Cleaners, Oakland	610
	4697	Lorenzo Cleaners, San Lorenzo	610
	4806	Cleaning by Eddie, San Mateo	610
	5790	California Cleaners, Mountain View	610
	6449	Charleston Cleaners, Palo Alto	610
	9765	Fashion Cleaners & Shirt Laundry, Redwood City	610
	12109	King's Cleaners, Morgan Hill	610
	13438	Merit Cleaners, San Jose	610
	8011	Willow Cleaners, Hercules	600
	10397	Le Magic Cleaners, Oakland	600
	4309	Rainbow Cleaners, Hayward	600
	8463	Koller's Town & Country Cleaners, Petaluma	590
	10618	My Cleaners, San Jose	590
	11412	Deep Cleaner, Hayward	590
	14612	Central Cleaners, South San Francisco	590
	11063	State Cleaners Inc, Fremont	590
	7509	Hills Cleaners, San Mateo	590
	9017	Davis Cleaners, San Leandro	590
	4353	Top Hat Cleaners, San Mateo	580
	4521	Bret Harte Cleaners, San Jose	580
	4665	Sunshine Cleaners, San Francisco	580
	4989	Helens Cleaners, Redwood City	580
	12556	Grant Cleaners, San Francisco	580
	3094	Tip Top Cleaners, Cotati	570
	4334	Shattuck One Hour Cleaners, Oakland	570
	7842	Holiday Cleaners of America, Pleasanton	570
	11572	Bel Air Cleaners, Concord	570
	3312	Zanker Road Resource Management,Ltd, San Jose	560
	3454	Custom Cleaners, San Jose	560
	4313	Young's Cleaners, Campbell	560
	4271	Fairfax French Laundry & Cleaners, Fairfax	560
	7450	Sequoia Cleaners, Sunnyvale	560
	3351	De Luxe Cleaners, Foster City	550
	11728	Royal Dry Cleaning, Sunnyvale	550
	14013	Classic Cleaners, Rodeo	550
	1403	City of Santa Rosa Wastewater Treatment, Santa Rosa	550
	6081	Gatito Cleaners, Los Gatos	550
	9211	Hilltop Cleaners, Richmond	550
	4342	Walnut Cleaners, Fremont	550
	9380	Sunny Cleaners, El Sobrante	550
	13140	Sparkle One Hour Cleaners, Newark	550
	13392	Woodside Cleaners & Alterations, Redwood City	550
	15162	Glory's Dry Cleaning, Dublin	550
	495	Annabelle's French Cleaner, San Francisco	550
	1729	Wardrobe Cleaners, Novato	540
	5220	Vermont Cleaners, San Francisco	540

POLLUTANT	P#	PLANT NAME	ESTIMATED EMISSIONS (LBS/YR)
PERCHLOROETHYLENE	(>33 lbs/yr) (cont)		
	12968	Millers Drycleaning Service, Los Altos	540
	999	De Anza Square Cleaners, Inc, Sunnyvale	540
	4200	Golden State Cleaners, San Francisco	540
	4298	Oakley 1 Hour Dry Cleaners, Oakley	540
	5866	Custom Cleaners, Oakley	540
	7596	Russ Cleaners, San Francisco	540
	10298	(Vasona Station) Orchid Cleaners, Los Gatos	540
	11984	Jack's Cleaners & Shirt Laundry, Hayward	540
	13317	ASAP Drycleaning and Restoration, Hayward	540
	12021	Villa One Hr Cleaners, Newark	530
	13476	Dri Clean Express, San Francisco	530
	8205	Sunshine Center Cleaners, Hayward	530
	4234	Diamond Cleaners, San Jose	530
	5957	Mary's Cleaners, Oakland	530
	6256	Lamorinda Cleaners, Moraga	530
	10436	Sunshine Cleaners, San Francisco	530
	11307	Earl's Unique Cleaner, Oakland	530
	13699	North Bay Cleaners, Novato	530
	15573	Windmill Cleaners, San Leandro	520
	3012	Lockwood Cleaners, Oakland	510
	6209	Cole Cleaners, San Francisco	510
	10217	Lien Dry Cleaning, San Jose	510
	3391	Americlean, Walnut Creek	510
	4522	Bellevue Cleaners, Oakland	510
	5087	Saratoga Drycleaners, Saratoga	510
	6512	Proclean One, San Francisco	510
	8689	Fabricare Dry Cleaners, San Francisco	510
	9485	Vogue Cleaners, Mountain View	510
	11325	Homestead Cleaners, Santa Clara	510
	13153	Polhemus Cleaners and Laundry, San Mateo	510
	8978	Frank's Dry Cleaners, Novato	510
	1168	Walnut Cleaners, San Francisco	500
	4405	Skyline Cleaners, Los Altos	500
	4677	Bal Cleaners, San Leandro	500
	5052	Delight Cleaners, Sunnyvale	500
	7242	Dryclean Club of America, Castro Valley	500
	9780	Argonaut Oaks Cleaners, Saratoga	500
	10563	Dynasty Cleaners, Hayward	500
	12861	Lakeside Cleaners, Santa Rosa	500
	4372	Patrician Cleaners, San Jose	490
	5004	Rheem Center Martinizing, Moraga	490
	6445	Mark Cleaners, Sunnyvale	490
	11601	Dryclean Best, Sunnyvale	490
	15319	Cupertino Village Cleaners, Cupertino	490
	9118	One Hour Cleaners, Mountain View	490
	4253	Petaluma Quick Cleaners, Petaluma	490
	4266	La Blue Fiesta Cleaners, Sebastopol	490
	15190	One Hour Mart Cleaners, Santa Clara	490
	2028	Rockridge Royal Cleaners, Oakland	490
	5114	Northgate Cleaners, San Rafael	490
	13394	One Hour Blossom Hill Cleaners, San Jose	480
	1351	City of Burlingame, Waste Water Treatmen, Burlingame	480
	4203	Dryclean City, Los Gatos	470
	867	Locust Cleaners, San Francisco	470
	4323	Ocean Beach 1 Hour Dry Cleaners, San Francisco	470
	4424	Rheem Valley Cleaners, Moraga	470
	4425	Stars Cleaners, Fremont	470
	4671	Courtside Cleaners, San Jose	470
	4967	Holiday Cleaners, San Mateo	470
	5076	Dee Bee's Elegant Cleaners, Alameda	470
	5283	Burlingame One Hour Cleaners, Burlingame	470
	5341	Park Cleaners, San Jose	470
	8108	Classic Touch Fashion Cleaners, Oakland	470
	8260	Mack's Valet Cleaners, San Francisco	470
	9224	Royal Cleaners, Newark	470
	10853	Custom Cleaners, San Anselmo	470

POLLUTANT	P#	PLANT NAME	ESTIMATED EMISSIONS (LBS/YR)
PERCHLOROETHYLENE	(>33 lbs/yr) (cont)		
	1209	Union Sanitary District, Union City	470
	898	Quick Kleeners, San Leandro	460
	4433	Sparkle Clean Cleaners, San Jose	460
	5463	European Cleaners, San Francisco	460
	7987	Perfect Cleaners, San Francisco	460
	9791	ABC Cleaners, San Carlos	460
	11506	Premier Cleaners, San Jose	460
	12600	Crystal Cleaners, Santa Clara	460
	13840	Hillview Cleaner, Saratoga	460
	5742	Dryclean USA, San Jose	460
	4325	Wo Sing Cleaners, Menlo Park	440
	3464	City of Santa Clara, Santa Clara	440
	2039	Potrero Hills Landfill, Inc, Suisun City	430
	12932	Stanford Cleaners, Palo Alto	430
	1371	Dublin San Ramon Services District - Was, Pleasanton	430
	4292	Sun Beam Cleaners, Mountain View	430
	4365	Marshall Steel Cleaners, Castro Valley	430
	4905	Stony Point Cleaners, Santa Rosa	430
	4954	Scotty's Cleaners, Cupertino	430
	5448	Cortland 1 Hr Cleaners, San Francisco	430
	5607	Davis Cleaners, San Francisco	430
	7864	Everybody's Cleaners, Sunnyvale	430
	10008	Clean Wash Center, San Francisco	430
	11439	Progress Cleaners, San Francisco	430
	12133	Hamlin Cleaners, Lafayette	430
	12516	Plaza Cleaners, Petaluma	430
	13640	L M One Hour Cleaners, Corte Madera	430
	12564	Betty Brite Cleaners, Sunnyvale	420
	5126	Snow White Cleaners, Pinole	420
	5750	Magic Cleaner, Vallejo	420
	3841	Wardrobe Cleaners, South San Francisco	420
	4436	Royale Cleaners, Concord	420
	5113	Cypress Cleaners, Oakley	420
	9648	Family Cleaners, Pleasanton	420
	6964	Jin's Cleaners, San Carlos	410
	12782	Empire Cleaners, Santa Rosa	410
	9198	Wing Lee Cleaners, Oakland	410
	307	Lomita Cleaners, Millbrae	400
	362	Park's Wardrobe Cleaners, San Mateo	400
	1310	Tower Cleaners, Berkeley	400
	1795	Budget Cleaners, San Francisco	400
	2534	Merit Cleaners, Berkeley	400
	3589	Mills Park Cleaners, San Bruno	400
	5051	Manor Cleaners, Castro Valley	400
	5104	Crest Cleaners, Inc, San Bruno	400
	5293	Sunrise Cleaners, San Mateo	400
	6132	Arrow Cleaners, Pleasanton	400
	7135	Cleaner Cleaners, The, San Jose	400
	8661	Lucky Cleaners, San Francisco	400
	10016	Classic Cleaning of Walnut Creek, Walnut Creek	400
	12143	Lux Cleaners, Burlingame	400
	12813	Dryclean A+, Morgan Hill	400
	15155	Holiday Cleaners Belmont, Belmont	400
	15656	Camaro Cleaners, Mountain View	400
	4618	Allied Waste Industries (Keller Canyon L, Pittsburg	400
	378	Ideal Cleaners, Oakland	400
	3499	City of Menlo Park, Menlo Park	400
	7101	Napa Sanitation District - Soscol, Napa	400
	7444	Leader Cleaners, San Bruno	400
	7807	Dryclean City, Belmont	400
	4913	Orchid Cleaners, Los Gatos	390
	8628	Primrose Cleaners, Burlingame	390
	2399	Sang's Cleaners, San Jose	390
	4474	Meadow Cleaners, Fremont	390
	9254	Hosanna Cleaners, Walnut Creek	390
	12791	Saigon's Cleaners, Sunnyvale	390

POLLUTANT	P#	PLANT NAME	ESTIMATED EMISSIONS (LBS/YR)
PERCHLOROETHYLENE	(>33 lbs/yr) (cont)		
	462	20th Avenue Cleaner, San Francisco	390
	1003	Anthony Cleaners, Alameda	380
	4911	Youngs Cleaners, Oakland	380
	5195	Parktown One Hour Martinizing, Milpitas	380
	11023	Apollo Cleaners, Sausalito	380
	7469	Sterling Cleaners, Lafayette	380
	9687	Marin Square Cleaners, San Rafael	380
	2067	Orchid French Cleaners, Novato	380
	4042	Shelton Cleaners, Napa	380
	4494	Bob's Washette Cleaners, Richmond	380
	7525	Dry Cleaner, Hayward	380
	10608	One Hour Cleaners, Lafayette	380
	12597	Carriage Cleaners, South San Francisco	380
	13644	Vel Cleaners, San Francisco	380
	7895	Rainbow Cleaners, Morgan Hill	380
	7814	Solano Cleaning Center, Albany	370
	7662	Monument Cleaners, Concord	370
	10480	Elegant Cleaners, Fremont	370
	2721	City of Palo Alto Landfill, Palo Alto	370
	11319	Perfect Cleaners, Santa Clara	370
	12820	Fashion Cleaners, Concord	360
	4223	Norman Cleaners, San Francisco	360
	12145	Coit Services of North Bay Inc, Santa Rosa	360
	14452	Herald's Cleaners, Inc, Walnut Creek	360
	4543	Angela's Drycleaning, Sunnyvale	360
	12206	Star One Cleaners, San Pablo	360
	12882	Family Cleaners, Santa Rosa	360
	1258	Delta Diablo Sanitation District, Antioch	350
	5364	Young's One Hour Martinizing, Oakland	350
	986	Family Cleaners, San Francisco	350
	11636	Garden Cleaners, Alameda	350
	4121	ABC Cleaners, Santa Rosa	350
	5415	Holiday Cleaners, Burlingame	340
	4055	Sohn's French Cleaner, San Francisco	340
	4339	Ardenwood Cleaners, Fremont	340
	13652	One Hour Martinizing, San Francisco	340
	9183	Napa-Vallejo Waste Management Authority, Napa	340
	1199	Jiffy Cleaners, Millbrae	340
	4774	America Cleaners, Fremont	340
	7501	Cleaning by Albert, Pacifica	340
	10479	Red Hill Holiday Cleaners, San Anselmo	340
	11478	King Cleaners, Santa Rosa	340
	11880	Silk Tech Cleaners, San Francisco	340
	5315	Bernal Cleaners, Pleasanton	340
	1364	Cypress Amloc Land Co , Inc, Colma	330
	2669	19th Avenue Cleaner, San Francisco	330
	5541	Norge Village Cleaners, Pleasant Hill	330
	10974	Think Clean Cleaners, Mill Valley	330
	11993	American Cleaners, Martinez	330
	2632	Schlage Lock Company, San Francisco	330
	13430	Prosperity Cleaners, San Rafael	330
	1812	Kirby Canyon Landfill, Morgan Hill	320
	1869	Blue Bird Cleaners, San Francisco	320
	4236	Simpson Cleaners, San Lorenzo	320
	4439	One Stop Cleaners, Santa Rosa	320
	10031	Delta Fair Cleaners, Antioch	320
	12601	Moorpark Cleaners, San Jose	320
	258	Norge Village, Oakland	320
	4409	Toni Cleaners, San Francisco	320
	2847	American Cleaners, Walnut Creek	310
	4953	Swift Cleaner & Draperies, San Jose	310
	6014	Imperial Cleaners, San Ramon	310
	9976	East Avenue Cleaners, Livermore	310
	10371	J Cleaners, Livermore	310
	10511	Grant Cleaners, Mountain View	310
	10765	Kerful Cleaners, Saratoga	310

POLLUTANT	P#	PLANT NAME	ESTIMATED EMISSIONS (LBS/YR)
PERCHLOROETHYLENE	(>33 lbs/yr) (cont)		
	1091	Del Norte Cleaners, El Cerrito	310
	4928	Clift Hotel, San Francisco	310
	3526	United Dry Cleaner, Fremont	300
	10017	Lux Dry Cleaners, Menlo Park	300
	9916	Emerson Cleaners, Palo Alto	300
	4625	Lee Loy Cleaners, San Francisco	300
	4969	Penguin Cleaners, Lafayette	300
	5724	Master Cleaners, Gilroy	300
	10783	Fairway Cleaners, Santa Clara	300
	13439	American Cleaner, San Jose	300
	11247	Clover Flat Landfill Inc, Calistoga	290
	5896	Joseph's Cleaners, San Jose	290
	9034	Mission Valley Holiday Cleaners, Fremont	290
	15214	May Cleaners, Oakland	290
	6971	J C Cleaners, Newark	280
	9163	Peshon's Cleaning Specialist, Concord	280
	15030	Bo-Mar Cleaners, Fremont	280
	3334	Benson's Cleaners, Campbell	280
	4305	Pegasus Cleaners, Fremont	280
	11881	Crystal Clear Cleaners, San Jose	280
	10256	Dry Clean 4 U, Santa Clara	270
	2340	San Leandro Water Pollution Control Plan, San Leandro	270
	11030	Dri Clean Expert, San Francisco	270
	2359	Cal Cleaners & Laundry, Berkeley	270
	3963	Dollar Cleaners, Oakland	270
	4457	Sisters Cleaners, Pleasant Hill	270
	5295	Peninsula French Laundry, Inc, Burlingame	270
	8132	Orchid Cleaners, San Rafael	270
	10473	One Hour Martinizing, San Francisco	270
	11854	Beach Cleaners, Redwood City	270
	12054	Han's Cleaners, Fairfield	270
	5075	Holiday Cleaners, Oakland	260
	1010	One Hour Martinizing by Lee, Cupertino	260
	2519	Art Cleaners, Hayward	260
	4094	San Quentin State Prison, San Quentin	260
	5939	Brink's Cleaners, Campbell	260
	8443	Cleaning & Alteration Shop, San Jose	260
	9112	Kelly & Louise Cleaners, San Jose	260
	10710	Scott Cleaners, San Francisco	260
	5876	South San Francisco-San Bruno Water Qual, South San Francis	260
	10	Chevron Products Company, Richmond	250
	7063	European Tailoring & Cleaners, Mill Valley	250
	11317	Market Place Cleaners, Concord	250
	4943	Holiday Cleaners, San Jose	250
	14909	Riverside Cleaners, Campbell	250
	15471	Pacific Cleaners and Wireless, Fremont	250
	4664	West Portal Clean Center, San Francisco	240
	9698	Magnificent Cleaners, San Rafael	240
	10484	Orchard Cleaners, San Jose	240
	11664	Lakewood Cleaners, Windsor	240
	2178	Sunshine Cleaners & Coin Laundry, El Cerrito	240
	8575	My Cleaners, South San Francisco	240
	12519	Chestnut Cleaners, South San Francisco	240
	8107	Dryclean Plus, San Jose	240
	4668	Prosperity Cleaners, San Francisco	230
	7908	Thrifty 1hr Cleaners, Oakland	230
	4698	Norge Village Cleaners, Richmond	230
	9701	Town Cleaners, San Francisco	230
	11017	Vogue Enterprises Cleaners, San Jose	230
	4672	Sundown Cleaners, San Francisco	230
	9403	Nino's Cleaners, Sunnyvale	230
	12325	Sparkle Dry Cleaners, San Jose	230
	1064	Los Angeles Chemical, Richmond	230
	8997	Tip Top Cleaners, Los Gatos	220
	8874	Crown Cleaners, Sonoma	220
	11942	Plesanton Lucky Cleaners, Pleasanton	220

POLLUTANT	P#	PLANT NAME	ESTIMATED EMISSIONS (LBS/YR)
PERCHLOROETHYLENE	(>33 lbs/yr) (cont)		
	1009	Hayward Waste Water Treatment Plant, Hayward	210
	4116	San Francisco, City & County, PUC, San Francisco	210
	4018	Melody Cleaners, San Leandro	200
	10873	Art Cleaners, San Jose	200
	31	Dow Chemical Company, Pittsburg	200
	325	Queen Cleaners, Lafayette	200
	4456	Hesperian Cleaners, San Lorenzo	200
	4670	Advance Dry Cleaners, Morgan Hill	200
	4725	Mike's Cleaners, Livermore	200
	4779	Custom Cleaners #2, San Jose	200
	5090	Super Fluff Cleaners & Laundry, Mountain View	200
	5319	White Oak Cleaners, San Carlos	200
	7535	Dana Cleaners, Concord	200
	9487	Royal Cleaners, San Jose	200
	10169	Skyline Cleaning Center, Daly City	200
	12195	Paradise Cleaners, Corte Madera	200
	12515	Fremont French Cleaners, Fremont	200
	12642	One Hour Cleaners, San Francisco	200
	12952	Hosanna Cleaners, Pleasant Hill	200
	2253	City of Sunnyvale Solid Waste Program, Sunnyvale	200
	4699	Fairway Cleaners, San Francisco	200
	12728	Waste Management Inc, San Leandro	190
	11926	Sun's Cleaners, Pinole	190
	4350	Holiday Cleaners, San Jose	190
	4830	Poly Cleaners, San Jose	190
	5018	Picaroto Cleaners, Fairfax	190
	11284	Marvel Cleaners, San Francisco	190
	10586	Special Cleaner, Livermore	180
	290	DOE-KAO Sandia National Laboratories, Livermore	180
	7899	Vale Cleaners, Oakland	180
	7272	Pacific Avenue Cleaners, Livermore	180
	12538	El Moderne Cleaners, Mountain View	180
	4333	Twin Cleaners, Daly City	180
	7259	Park Lake Cleaners, Hercules	180
	12747	Vineyard Cleaners, Morgan Hill	180
	617	Palo Alto Regional Water Quality Control, Palo Alto	170
	11099	San Carlos Dry Cleaners, San Carlos	170
	8792	Fine Arts Cleaners, San Francisco	170
	11414	Holiday Cleaners, South San Francisco	170
	992	Sparkle Dry Cleaners, Mountain View	160
	10469	Marshall Steel Drycleaners, Concord	160
	11945	Major Cleaners, San Mateo	160
	5771	J C Cleaners, Milpitas	160
	1275	Novato Sanitary District, Novato	160
	6187	Top Hat Cleaners, Fairfax	160
	12038	Sunshine Cleaners, Sausalito	150
	1838	Hoot N' Toot Cleaners, Menlo Park	150
	2081	Meigs Quick Clean, Sunnyvale	150
	2344	Hilton Hotel, San Francisco	150
	5936	Tidy Cleaners, Daly City	150
	1228	Sonoma County Water Agency, Sonoma	150
	5741	Central Cleaners, Sunnyvale	150
	8644	Bascom Best Cleaners, San Jose	150
	1439	Loch Lomond Cleaners, San Rafael	140
	14831	Complete Dry Cleaners, Newark	140
	4382	Crown Cleaners, San Jose	140
	3319	Vallejo Sanitation & Flood Control Distr, Vallejo	140
	4808	Hacienda Gardens Cleaners, San Jose	140
	13801	Vallejo Corners Cleaners, Vallejo	140
	5975	Hillcrest Cleaners, Antioch	140
	653	Central Marin Sanitation Agency, San Rafael	140
	4639	Camden Cleaners, San Jose	140
	9088	San Francisco Cleaners, San Francisco	140
	673	Palo Alto One Hour Martinizing, Palo Alto	130
	7172	Star Cleaners, Vallejo	130
	7241	New Economy Laundry, Berkeley	130

POLLUTANT	P#	PLANT NAME	ESTIMATED EMISSIONS (LBS/YR)	
PERCHLOROETHYLENE	(>33 lbs/yr) (cont)			
	7281	Bay 1 Hour Cleaners, Oakland	130	
	8296	Ford Cleaners, Milpitas	130	
	8612	Sunny J Cleaners, Hayward	130	
	8824	Sparkle Cleaners, Vallejo	130	
	10173	J & C One Hour Cleaners, San Mateo	130	
	10379	EZ Cleaner & Shoe Repair, Los Gatos	130	
	10588	O K Cleaners, El Cerrito	130	
	11820	Best Cleaners, Santa Rosa	130	
	12242	Skill Clean, Pittsburg	130	
	12592	York Cleaners, Mill Valley	130	
	12620	Fashion Cleaners, San Leandro	130	
	13164	Express Cleaners, Rohnert Park	130	
	14800	Santa Rosa Cleaners, Santa Rosa	130	
	15066	Prosperity Deluxe Cleaners, Novato	130	
	15439	El Gato Cleaners, Los Gatos	130	
	5970	Rincon Valley Cleaners, Santa Rosa	130	
	1345	Sewerage Agency of South Marin, Mill Valley	130	
	1791	City of Benicia, Benicia	120	
	1194	Pinole-Hercules Wastewater Treatment Pla, Pinole	120	
	15571	GW Properties LLC, Milpitas	110	
	733	City of Sunnyvale Water Pollution Contro, Sunnyvale	110	
	468	Romic Environmental Technologies Corpora, East Palo Alto	110	
	1597	Las Gallinas Valley Sanitary District, San Rafael	110	
	3256	Turk Island Solid Waste Disposal Site, Union City	100	
	55	Lockheed Martin Corporation, Sunnyvale	91	
	4106	City of Millbrae Wastewater Treatment Pl, Millbrae	90	
	4114	Carlmont Village Cleaners, Belmont	88	
	4175	City of San Jose (Singleton Road Landfil, San Jose	80	
	4408	Mt View Sanitary District, Martinez	74	
	1271	West County Wastewater District, Richmond	72	
	1982	County of Santa Clara, San Jose	72	
	5264	McClellan Square Cleaners, Cupertino	69	
	8940	Landmark Label, Milpitas	68	
	4951	Queen Cleaners, San Jose	67	
	6929	Steven's Cleaners, San Pablo	67	
	12967	TRC, Antioch	66	
	7132	Buck & Change Cleaners, San Bruno	63	
	15492	DuPont Electronic Technologies, Hayward	55	
	11	Shell Martinez Refinery, Martinez	55	
	11670	Gas Recovery Systems, Inc, San Jose	50	
	2482	City of Richmond Water Pollution Control, Richmond	49	
	10299	Memorex Drive LLC, Santa Clara	44	
	790	plants reported	530000	(total)
PHENOL	(>8690 lbs/yr)			
		emission from each plant is below reporting level	---	
	18	plants reported	14000	(total)
PHOSPHINE	(>1930 lbs/yr)			
		emission from each plant is below reporting level	---	
	1	plant reported	110	(total)
PHTHALIC ANHYDRIDE	(>1.35E6 lbs/yr)			
		emission from each plant is below reporting level	---	
	1	plant reported	15	(total)

POLLUTANT	P#	PLANT NAME	ESTIMATED EMISSIONS (LBS/YR)	
POLYCHLORINATED BIPHENYL (PCB) (>.007 lbs/yr)				
	17	Hanson Permanente Cement, Cupertino	2.000	
	3245	GWF Power Systems,LP (Site 3), Antioch	.120	
	3244	GWF Power Systems,LP (Site 2), Pittsburg	.120	
	3243	GWF Power Systems,LP (Site 1), Pittsburg	.120	
	3246	GWF Power Systems,LP (Site 5), Pittsburg	.120	
	3981	GWF Power Systems,LP (Site 4), Antioch	.110	
	31	Dow Chemical Company, Pittsburg	.034	
	7	plants reported	2.600	(total)
SELENIUM (>96.5 lbs/yr)				
	30	Owens-Brockway Glass Container Inc, Oakland	420.0	
	47	plants reported	600.0	(total)
STYRENE (>135000 lbs/yr)				
		emission from each plant is below reporting level	---	
	68	plants reported	260000	(total)
TETRACHLOROETHANE, 1,1,2,2- (>3.3 lbs/yr)				
	12728	Waste Management Inc, San Leandro	58.0	
	2066	Waste Management of Alameda County, Livermore	42.0	
	3	plants reported	100.0	(total)
TOLUENE (>38600 lbs/yr)				
	10	Chevron Products Company, Richmond	47000	
	788	plants reported	320000	(total)
TOLUENE DIISOCYANATE (TDI) (>18.3 lbs/yr)				
	11693	Foamex, L P, San Leandro	200.0	
	3	plants reported	200.0	(total)
TRICHLOROETHANE, 1,1,1- (W/O DIOXANE) (>61800 lbs/yr)				
		emission from each plant is below reporting level	---	
	72	plants reported	81000	(total)
TRICHLOROETHANE, 1,1,1- (WITH DIOXANE) (>61800 lbs/yr)				
		emission from each plant is below reporting level	---	
	37	plants reported	12000	(total)
TRICHLOROETHANE, 1,1,2- (>12 lbs/yr)				
		emission from each plant is below reporting level	---	
	1	plant reported	2	(total)
TRICHLOROETHYLENE (>97 lbs/yr)				
	2746	Pacific Aerospace Services, Campbell	2000	
	5859	Schlumberger Technology Corp, Mountain View	2000	
	14664	SF Tube, Inc, Hayward	1300	
	9013	International Disposal Corporation of Ca, Milpitas	1100	
	615	Rolls-Royce Engine Services - Oakland, I, Oakland	800	
	5095	Republic Services Vasco Road, LLC, Livermore	680	
	2266	Browning-Ferris Industries of CA, Inc, Half Moon Bay	670	
	2254	Sonoma County Department of Public Works, Petaluma	640	
	593	SMI Holdings, LLC c/o Levine Fricke, Cupertino	620	
	2740	City of Mountain View (Shoreline), Mountain View	610	
	617	Palo Alto Regional Water Quality Control, Palo Alto	610	
	1464	Acme Fill Corporation, Martinez	530	
	1179	Redwood Landfill Inc, Novato	520	
	2246	Tri-Cities Recycling, Fremont	510	

POLLUTANT	P#	PLANT NAME	ESTIMATED EMISSIONS (LBS/YR)	
TRICHLOROETHYLENE	(>97 lbs/yr) (cont)			
	2066	Waste Management of Alameda County, Livermore	460	
	3294	Guadalupe Rubbish Disposal, San Jose	370	
	255	Lawrence Livermore National Laboratory, Livermore	370	
	1351	City of Burlingame, Waste Water Treatmen, Burlingame	360	
	861	San Mateo Water Quality Control Plant, San Mateo	340	
	3312	Zanker Road Resource Management,Ltd, San Jose	340	
	778	San Jose/Santa Clara Water Pollution Con, San Jose	330	
	591	East Bay Municipal Utility District, Oakland	290	
	3464	City of Santa Clara, Santa Clara	260	
	2039	Potrero Hills Landfill, Inc, Suisun City	260	
	4618	Allied Waste Industries (Keller Canyon L, Pittsburg	240	
	3499	City of Menlo Park, Menlo Park	240	
	1534	South Bayside System Authority, Redwood City	230	
	2721	City of Palo Alto Landfill, Palo Alto	220	
	9183	Napa-Vallejo Waste Management Authority, Napa	200	
	1364	Cypress Amloc Land Co , Inc, Colma	200	
	1812	Kirby Canyon Landfill, Morgan Hill	190	
	1371	Dublin San Ramon Services District - Was, Pleasanton	180	
	11247	Clover Flat Landfill Inc, Calistoga	170	
	9208	Bourns Inc, Santa Clara	170	
	5876	South San Francisco-San Bruno Water Qual, South San Francis	150	
	11648	Union Pacific Railroad Company, Santa Rosa	140	
	733	City of Sunnyvale Water Pollution Contro, Sunnyvale	120	
	2253	City of Sunnyvale Solid Waste Program, Sunnyvale	120	
	1209	Union Sanitary District, Union City	120	
	12728	Waste Management Inc, San Leandro	110	
	4008	Coen Company, Inc, Burlingame	110	
	15571	GW Properties LLC, Milpitas	110	
	568	San Francisco South East Treatment Plant, San Francisco	110	
	2632	Schlage Lock Company, San Francisco	100	
	124	plants reported	21000	(total)
TRIETHYLAMINE	(>1400 lbs/yr)			
	emission from each plant is below reporting level		---	
	2	plants reported	290	(total)
VINYL CHLORIDE	(>2.5 lbs/yr)			
	9013	International Disposal Corporation of Ca, Milpitas	1400.0	
	5095	Republic Services Vasco Road, LLC, Livermore	850.0	
	2254	Sonoma County Department of Public Works, Petaluma	800.0	
	2740	City of Mountain View (Shoreline), Mountain View	760.0	
	1179	Redwood Landfill Inc, Novato	700.0	
	1464	Acme Fill Corporation, Martinez	660.0	
	2246	Tri-Cities Recycling, Fremont	630.0	
	3294	Guadalupe Rubbish Disposal, San Jose	460.0	
	3312	Zanker Road Resource Management,Ltd, San Jose	420.0	
	3464	City of Santa Clara, Santa Clara	330.0	
	2039	Potrero Hills Landfill, Inc, Suisun City	320.0	
	2266	Browning-Ferris Industries of CA, Inc, Half Moon Bay	300.0	
	4618	Allied Waste Industries (Keller Canyon L, Pittsburg	300.0	
	3499	City of Menlo Park, Menlo Park	300.0	
	2721	City of Palo Alto Landfill, Palo Alto	270.0	
	9183	Napa-Vallejo Waste Management Authority, Napa	250.0	
	1364	Cypress Amloc Land Co , Inc, Colma	250.0	
	1812	Kirby Canyon Landfill, Morgan Hill	240.0	
	11247	Clover Flat Landfill Inc, Calistoga	220.0	
	2066	Waste Management of Alameda County, Livermore	170.0	
	2253	City of Sunnyvale Solid Waste Program, Sunnyvale	150.0	
	12728	Waste Management Inc, San Leandro	140.0	
	1840	West Contra Costa County Landfill, Richmond	110.0	
	12967	TRC, Antioch	77.0	
	3256	Turk Island Solid Waste Disposal Site, Union City	75.0	

POLLUTANT	P#	PLANT NAME	ESTIMATED EMISSIONS (LBS/YR)	
VINYL CHLORIDE (>2.5 lbs/yr) (cont)				
	1351	City of Burlingame, Waste Water Treatmen, Burlingame	71.0	
	4175	City of San Jose (Singleton Road Landfil, San Jose	60.0	
	1982	County of Santa Clara, San Jose	54.0	
	11670	Gas Recovery Systems, Inc, San Jose	38.0	
	2561	Shoreline Amphitheatre, Mountain View	22.0	
	12209	Intel Corporation c/o Weiss Associates, Mountain View	18.0	
	11669	Gas Recovery Systems, Inc, San Jose	16.0	
	11668	Gas Recovery Systems, Inc, Menlo Park	16.0	
	2451	Pleasanton Garbage Service, Inc, Pleasanton	12.0	
	11671	Gas Recovery Systems, Inc, American Canyon	10.0	
	1583	Pacific Recovery Corporation, Santa Clara	10.0	
	13566	Norcal Waste Systems Pacheco Pass Landfi, Gilroy	9.2	
	5691	Sunquest Properties Inc, Brisbane	8.3	
	3590	City of Berkeley/Engr Div/Public Works, Berkeley	3.8	
	51	plants reported	10000.0	(total)
VINYLIDENE CHLORIDE (>6180 lbs/yr)				
		emission from each plant is below reporting level	---	
	34	plants reported	410	(total)
XYLENE (>57900 lbs/yr)				
		emission from each plant is below reporting level	---	
	962	plants reported	320000	(total)
ZINC POLLUTANT (>6760 lbs/yr)				
		emission from each plant is below reporting level	---	
	50	plants reported	3000	(total)

APPENDIX B-3

EMISSIONS SUMMARY

BY
COUNTY AND
POLLUTANT

BAY AREA AIR QUALITY MANAGEMENT DISTRICT
TOXIC AIR CONTAMINANTS
2003 ANNUAL REPORT

EMISSION SUMMARY BY COUNTY AND POLLUTANT

(lbs/year)

POLLUTANT	ALAMEDA	CONTRA COSTA	MARIN	NAPA	SAN FRANCISCO	SAN MATEO	SANTA CLARA	SOLANO	SONOMA	TOTAL EMISSIONS
Acetaldehyde	384	1050	0.35	1.16	1.91	9.01	6960	342	0.409	8750
Acrolein	115	0.0081	0	0	0.0101	0	0	0	0	115
Acrylic acid	0	0	0	0	0	0	0	45	0	45
Acrylonitrile	209	0	0.74	35.6	0	0	0	0	0	245
Allyl chloride	53.5	0	0	0	0	0	0	0	0	53.5
Ammonia (NH3) pollutant	97000	1.01E+06	0	0	31	23900	1.15E+06	422000	0	2.70E+06
Arsenic (all)	3.6	5.27	0.163	0.0407	0.264	0.13	1.1	0.336	0.372	11.3
Benzene	3140	21900	383	252	560	1630	15100	1900	1230	46100
Benzyl chloride	770	0	0	3.23	0	64.8	0	0	0	838
Beryllium (all) pollutant	0.267	0.133	0.00527	0.00792	0.155	0.0345	0.387	0.038	0.178	1.21
Bromine	0.0183	0	0	0	0	0	0	0	0	0.0183
Butadiene, 1,3-	5.48	304	0.752	0	0	0	60	74.5	0	445
Butyl alcohol, tert-	0	691	0	0	0	0	6.99	0	0	698
Butyl cellosolve	147000	50300	1660	2240	1650	7820	19200	69800	4410	304000
Cadmium	12.6	9.75	0.0269	0.0388	0.687	0.16	2.97	23.3	0.77	50.3
Carbon tetrachloride	8.41	2010	1.39	0.626	0	0.858	5.62	0.432	1.07	2030
Cellosolve	883	519	0	0	123	373	2000	92000	355	96300
Cellosolve acetate	238	119	11.4	0	417	933	2530	302	144	4690
Chlorinated dioxins & furans (Calif TCDD	0.000453	2.62E-05	2.78E-06	2.37E-06	0.000008	5.42E-06	5.04E-05	2.20E-06	5.97E-06	0.000556
Chlorine pollutant	0	1910	0	0	0	0	0.000321	0	1.52	1910
Chlorobenzene	80.1	287	0	0	0	0	4300	0.7	0	4670
Chlorobenzene - other/not spec	5100	0	0	0	0	0	0	0	0	5100
Chloroform	3400	1960	1700	337	524	1960	3140	720	891	14600
Chromium (hexavalent)	0.412	7.58	0.138	0.0144	0.216	0.0696	0.743	0.399	0.0502	9.62
Copper (all) pollutant	23.2	22.1	0.0518	0.0266	0.000493	0.0696	3.95	386	0.0672	436
Cresol	337	14.7	0	0	0	0	14.4	0	23.6	390
Dichlorobenzene	822	5290	1090	51.4	33.8	339	137	75.7	21.3	7860
Dioxane, 1,4-	31.8	47.9	1.22	0	0	163	156	2.33	0	402

BAY AREA AIR QUALITY MANAGEMENT DISTRICT
TOXIC AIR CONTAMINANTS
2003 ANNUAL REPORT

EMISSION SUMMARY BY COUNTY AND POLLUTANT

(lbs/year)

POLLUTANT	ALAMEDA	CONTRA COSTA	MARIN	NAPA	SAN FRANCISCO	SAN MATEO	SANTA CLARA	SOLANO	SONOMA	TOTAL EMISSIONS
Epichlorohydrin	0	0	0	0	0	0	0.0832	0	0	0.0832
Ethyl acrylate	77	0	0	0.0812	0	0.126	0.313	0	0	77.5
Ethyl benzene	2860	12200	722	620	191	3040	5690	682	867	26900
Ethyl chloride	273	176	113	82.1	0	110	722	56.6	133	1660
Ethylene dibromide	65.6	272	0.647	0	0	0	0.0213	0.000791	0.0353	338
Ethylene dichloride	185	97.2	58.2	41.6	0	56.6	370	28.5	71.3	908
Ethylene oxide	27	1.72	1.62	0.142	0.706	1.63	2.22	0.145	0.116	35.3
Formaldehyde	8740	113000	70.6	2590	12900	14100	43500	9050	1570	205000
Glycol ether - other/not spec	24100	5580	790	4160	1330	2820	8040	512	1130	48400
Hexachlorobenzene	0	0.0272	0	0	0	0	0.0157	0	0	0.0429
Hexane	11900	19700	821	595	170	2010	6800	3630	82000	128000
Hydrochloric acid mist pollutant	19.6	16700	0	0	0	343	895	0	0.0406	17900
Hydrogen Chloride (HCl)	1970	134000	4040	260	0	220	7140	65.9	195	148000
Hydrogen Fluoride (HF)	140	204	0.871	572	0	1.97	658	0.604	1.79	1580
Hydrogen Sulfide (H2S)	10600	8530	1690	682	8070	10500	22600	29700	2100	94500
Isophorone	4.04	0	0	0	0	1.5	0	0	85.6	91.1
Lead (all) pollutant	402	3.64	0.127	0.0888	0.965	0.282	10	0.189	0.794	419
Manganese	512	275	0.0147	0.0371	0.88	0.175	21.8	289	0.988	1100
Mercury (all) pollutant	15.6	296	1.28	1.09	0.186	2.87	167	33.1	2.95	520
Methyl alcohol	45000	235000	127	0	1510	3630	32100	18000	399	335000
Methyl bromide	8.98	0	0	0	0	0	0	0	0	8.98
Methyl cellosolve	1640	390	0	0	88.6	0	19.8	0	0	2140
Methyl ethyl ketone (MEK)	53800	17800	1610	1140	9240	12200	46100	19000	7670	168000
Methyl methacrylate	0	3.53	0	0	0	0	16.5	0	0	20.1
Methyl tertiary-butyl ether	1230	178000	28.6	320	528	6800	20800	12200	422	220000
Methylene chloride	21900	16400	3400	1500	707	16800	25600	1560	3300	91200
Naphthalene	0.374	129	0.0245	29.1	0.224	7.81	2.11	0	0	169
Nickel pollutant	105	184	0.263	0.489	10.6	5.74	26.8	441	12.1	787

BAY AREA AIR QUALITY MANAGEMENT DISTRICT
TOXIC AIR CONTAMINANTS
2003 ANNUAL REPORT

EMISSION SUMMARY BY COUNTY AND POLLUTANT

(lbs/year)

POLLUTANT	ALAMEDA	CONTRA COSTA	MARIN	NAPA	SAN FRANCISCO	SAN MATEO	SANTA CLARA	SOLANO	SONOMA	TOTAL EMISSIONS
PAH's (benzo[a]pyrene equiv)	0.000756	422	0.000112	0.138	0.797	0.000217	0.184	34.5	0.000241	457
Perchloroethylene	113000	60300	30600	9520	75900	88400	121000	9280	24300	532000
Phenol	1880	5510	0	0	51.7	13.9	3090	121	3630	14300
Phosphine	110	0	0	0	0	0	0	0	0	110
Phthalic anhydride	14.8	0	0	0	0	0	0	0	0	14.8
Polychlorinated biphenyl (PCB)	0	0.623	0	0	0	0	2.02	0	0	2.64
Selenium	511	0.119	0.0555	0.0434	0.00124	0.113	90.4	0.0403	0.11	602
Styrene	67400	27100	185	11900	7030	24000	75200	37100	9310	259000
Tetrachloroethane, 1,1,2,2-	99.5	0.00328	0	0	0	0	0	0	0	99.5
Toluene	71600	85600	8400	5240	14500	34100	68100	18600	15900	322000
Toluene diisocyanate (TDI)	200	0	0	0	0	0	0.00833	0	0	200
Trichloroethane, 1,1,1- (w/o dioxane)	60200	2020	462	65.2	0	9800	7860	939	111	81500
Trichloroethane, 1,1,1- (with dioxane)	7440	958	866	250	101	1250	926	23.2	265	12100
Trichloroethane, 1,1,2-	1.65	0	0	0	0	0	0	0	0	1.65
Trichloroethylene	5170	1070	701	400	237	2400	9820	402	994	21200
Triethylamine	61.2	0	0	0	0	0	0	0	224	285
Vinyl chloride	1880	1140	699	479	0	946	4210	323	800	10500
Vinylidene chloride	65.6	44.5	27.1	19.7	0	27	176	13.6	33.7	408
Xylene	89900	91600	7260	18700	18000	21400	50900	10200	15000	323000
Zinc pollutant	613	1610	0.405	0.345	0.000329	0.902	6.81	781	0.774	3010

APPENDIX B-4

SUMMARIES OF TOXIC POLLUTANTS

BAY AREA AIR QUALITY MANAGEMENT DISTRICT
TOXIC AIR CONTAMINANTS
2003 ANNUAL REPORT

SUMMARY OF TOXIC POLLUTANTS

SORTED BY POLLUTANT

Pollutant	Trigger Level (lbs/yr)	Total # Plants Emitting	# Plants Above Trigger	Total Emissions (lbs/yr)
Acetaldehyde	72	81	10	8800
Acrolein	3.9	4	2	110
Acrylic acid	190	1	0	45
Acrylonitrile	.67	5	5	250
Allyl chloride	193	2	0	54
Ammonia (NH3) pollutant	19300	69	22	2700000
Arsenic (all)	.024	625	33	11
Benzene	6.7	1637	190	46000
Benzyl chloride	2320	4	0	840
Beryllium (all) pollutant	.015	625	13	1.200
Bromine	328	1	0	0
Butadiene, 1,3-	1.1	8	7	440
Butyl alcohol, tert-	-8888	3	3	700
Butyl cellosolve	3860	389	5	300000
Cadmium	.046	629	25	50
Carbon tetrachloride	4.6	40	1	2000
Cellosolve	38600	45	1	96000
Cellosolve acetate	12400	30	0	4700
Chlorinated dioxins & furans	.0000012	52	21	.0005600
Chlorine pollutant	1370	3	1	1900
Chlorobenzene	13500	10	0	4700
Chlorobenzene - other/not spec	13500	2	0	5100
Chloroform	36	92	39	15000
Chromium (hexavalent)	.0014	649	82	9.6000
Copper (all) pollutant	463	52	0	440
Cresol	34700	10	0	390
Di(2-ethylhexyl) phthalate	81	1	0	0
Dichlorobenzene	68	37	7	7900
Dioxane, 1,4-	25	26	4	400
Epichlorohydrin	8.3	1	0	.1
Ethyl acrylate	9260	5	0	78
Ethyl benzene	190000	225	0	27000
Ethyl chloride	1930000	28	0	1700
Ethylene dibromide	2.7	21	3	340
Ethylene dichloride	9.7	56	21	910
Ethylene oxide	2.1	39	2	35
Formaldehyde	33	1001	109	210000
Glycol ether - other/not spec	3860	119	2	48000
Hexachlorobenzene	.39	2	0	.04
Hexamethylene-1,6-diisocyanate	1.9	1	1	2.5
Hexane	39000	67	1	130000
Hydrochloric acid mist polluta	1350	72	3	18000
Hydrogen Chloride (HCl)	1350	58	9	150000
Hydrogen Fluoride (HF)	1140	47	0	1600
Hydrogen Sulfide (H2S)	8110	59	2	95000
Isophorone	390000	3	0	91
Lead (all) pollutant	29	631	2	420
Manganese	77	592	5	1100
Mercury (all) pollutant	57.9	628	3	520
Methyl alcohol	120000	291	1	340000
Methyl bromide	1160	1	0	9
Methyl cellosolve	3860	10	0	2100
Methyl ethyl ketone (MEK)	149000	381	0	170000
Methyl methacrylate	189000	2	0	20
Methyl tertiary-butyl ether	580000	109	0	220000
Methylene chloride	190	135	66	91000
Naphthalene	270	6	0	170
Nickel pollutant	.73	636	38	790

SUMMARY OF TOXIC POLLUTANTS

SORTED BY POLLUTANT (cont)

Pollutant	Trigger Level (lbs/yr)	Total # Plants Emitting	# Plants Above Trigger	Total Emissions (lbs/yr)
PAH's (benzo[a]pyrene equiv)	.043	54	9	460
Perchloroethylene	33	790	744	530000
Phenol	8690	18	0	14000
Phosphine	1930	1	0	110
Phthalic anhydride	1350000	1	0	15
Polychlorinated biphenyl (PCB)	.007	7	7	2.600
Selenium	96.5	47	1	600
Styrene	135000	68	0	260000
Tetrachloroethane, 1,1,2,2-	3.3	3	2	100
Toluene	38600	788	1	320000
Toluene diisocyanate (TDI)	18.3	3	1	200
Trichloroethane, 1,1,1- (w/o	61800	72	0	81000
Trichloroethane, 1,1,1- (with	61800	37	0	12000
Trichloroethane, 1,1,2-	12	1	0	2
Trichloroethylene	97	124	44	21000
Triethylamine	1400	2	0	290
Vinyl chloride	2.5	51	39	10000
Vinylidene chloride	6180	34	0	410
Xylene	57900	962	0	320000
Zinc pollutant	6760	50	0	3000
78 pollutants				6275910

number of toxic pollutants tracked in BAAQMD: 114
number of toxic pollutants reported in BAAQMD: 78
number of toxic pollutants reported > cutoff: 44

BAY AREA AIR QUALITY MANAGEMENT DISTRICT
TOXIC AIR CONTAMINANTS
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SUMMARY OF TOXIC POLLUTANTS

SORTED BY EMISSIONS

Pollutant	Trigger Level (lbs/yr)	Total # Plants Emitting	# Plants Above Trigger	Total Emissions (lbs/yr)
Ammonia (NH3) pollutant	19300	69	22	2700000
Perchloroethylene	33	790	744	530000
Methyl alcohol	120000	291	1	340000
Xylene	57900	962	0	320000
Toluene	38600	788	1	320000
Butyl cellosolve	3860	389	5	300000
Styrene	135000	68	0	260000
Methyl tertiary-butyl ether	580000	109	0	220000
Formaldehyde	33	1001	109	210000
Methyl ethyl ketone (MEK)	149000	381	0	170000
Hydrogen Chloride (HCl)	1350	58	9	150000
Hexane	39000	67	1	130000
Cellosolve	38600	45	1	96000
Hydrogen Sulfide (H2S)	8110	59	2	95000
Methylene chloride	190	135	66	91000
Trichloroethane, 1,1,1- (w/o	61800	72	0	81000
Glycol ether - other/not spec	3860	119	2	48000
Benzene	6.7	1637	190	46000
Ethyl benzene	190000	225	0	27000
Trichloroethylene	97	124	44	21000
Hydrochloric acid mist polluta	1350	72	3	18000
Chloroform	36	92	39	15000
Phenol	8690	18	0	14000
Trichloroethane, 1,1,1- (with	61800	37	0	12000
Vinyl chloride	2.5	51	39	10000
Acetaldehyde	72	81	10	8800
Dichlorobenzene	68	37	7	7900
Chlorobenzene - other/not spec	13500	2	0	5100
Cellosolve acetate	12400	30	0	4700
Chlorobenzene	13500	10	0	4700
Zinc pollutant	6760	50	0	3000
Methyl cellosolve	3860	10	0	2100
Carbon tetrachloride	4.6	40	1	2000
Chlorine pollutant	1370	3	1	1900
Ethyl chloride	1930000	28	0	1700
Hydrogen Fluoride (HF)	1140	47	0	1600
Manganese	77	592	5	1100
Ethylene dichloride	9.7	56	21	910
Benzyl chloride	2320	4	0	840
Nickel pollutant	.73	636	38	790
Butyl alcohol, tert-	-8888	3	3	700
Selenium	96.5	47	1	600
Mercury (all) pollutant	57.9	628	3	520
PAH's (benzo[a]pyrene equiv)	.043	54	9	460
Butadiene, 1,3-	1.1	8	7	440
Copper (all) pollutant	463	52	0	440
Lead (all) pollutant	29	631	2	420
Vinylidene chloride	6180	34	0	410
Dioxane, 1,4-	25	26	4	400
Cresol	34700	10	0	390
Ethylene dibromide	2.7	21	3	340
Triethylamine	1400	2	0	290
Acrylonitrile	.67	5	5	250
Toluene diisocyanate (TDI)	18.3	3	1	200
Naphthalene	270	6	0	170
Acrolein	3.9	4	2	110
Phosphine	1930	1	0	110
Tetrachloroethane, 1,1,2,2-	3.3	3	2	100

SUMMARY OF TOXIC POLLUTANTS

SORTED BY EMISSIONS (cont)

Pollutant	Trigger Level (lbs/yr)	Total # Plants Emitting	# Plants Above Trigger	Total Emissions (lbs/yr)
Isophorone	390000	3	0	91
Ethyl acrylate	9260	5	0	78
Allyl chloride	193	2	0	54
Cadmium	.046	629	25	50
Acrylic acid	190	1	0	45
Ethylene oxide	2.1	39	2	35
Methyl methacrylate	189000	2	0	20
Phthalic anhydride	1350000	1	0	15
Arsenic (all)	.024	625	33	11
Chromium (hexavalent)	.0014	649	82	9.6000
Methyl bromide	1160	1	0	9
Polychlorinated biphenyl (PCB)	.007	7	7	2.600
Hexamethylene-1,6-diisocyanate	1.9	1	1	2.5
Trichloroethane, 1,1,2-	12	1	0	2
Beryllium (all) pollutant	.015	625	13	1.200
Epichlorohydrin	8.3	1	0	.1
Hexachlorobenzene	.39	2	0	.04
Bromine	328	1	0	0
Chlorinated dioxins & furans (	.0000012	52	21	.0005600
Di(2-ethylhexyl) phthalate	81	1	0	0
78 pollutants				6275910

number of toxic pollutants tracked in BAAQMD: 114
number of toxic pollutants reported in BAAQMD: 78
number of toxic pollutants reported > cutoff: 44

BAY AREA AIR QUALITY MANAGEMENT DISTRICT
TOXIC AIR CONTAMINANTS
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SUMMARY OF TOXIC POLLUTANTS

SORTED BY OCCURRENCES

Pollutant	Trigger Level (lbs/yr)	Total # Plants Emitting	# Plants Above Trigger	Total Emissions (lbs/yr)
Benzene	6.7	1637	190	46000
Formaldehyde	33	1001	109	210000
Xylene	57900	962	0	320000
Perchloroethylene	33	790	744	530000
Toluene	38600	788	1	320000
Chromium (hexavalent)	.0014	649	82	9.6000
Nickel pollutant	.73	636	38	790
Lead (all) pollutant	29	631	2	420
Cadmium	.046	629	25	50
Mercury (all) pollutant	57.9	628	3	520
Arsenic (all)	.024	625	33	11
Beryllium (all) pollutant	.015	625	13	1.200
Manganese	77	592	5	1100
Butyl cellosolve	3860	389	5	300000
Methyl ethyl ketone (MEK)	149000	381	0	170000
Methyl alcohol	120000	291	1	340000
Ethyl benzene	190000	225	0	27000
Methylene chloride	190	135	66	91000
Trichloroethylene	97	124	44	21000
Glycol ether - other/not spec	3860	119	2	48000
Methyl tertiary-butyl ether	580000	109	0	220000
Chloroform	36	92	39	15000
Acetaldehyde	72	81	10	8800
Hydrochloric acid mist polluta	1350	72	3	18000
Trichloroethane, 1,1,1- (w/o	61800	72	0	81000
Ammonia (NH3) pollutant	19300	69	22	2700000
Styrene	135000	68	0	260000
Hexane	39000	67	1	130000
Hydrogen Sulfide (H2S)	8110	59	2	95000
Hydrogen Chloride (HCl)	1350	58	9	150000
Ethylene dichloride	9.7	56	21	910
PAH's (benzo[a]pyrene equiv)	.043	54	9	460
Chlorinated dioxins & furans (	.0000012	52	21	.0005600
Copper (all) pollutant	463	52	0	440
Vinyl chloride	2.5	51	39	10000
Zinc pollutant	6760	50	0	3000
Hydrogen Fluoride (HF)	1140	47	0	1600
Selenium	96.5	47	1	600
Cellosolve	38600	45	1	96000
Carbon tetrachloride	4.6	40	1	2000
Ethylene oxide	2.1	39	2	35
Dichlorobenzene	68	37	7	7900
Trichloroethane, 1,1,1- (with	61800	37	0	12000
Vinylidene chloride	6180	34	0	410
Cellosolve acetate	12400	30	0	4700
Ethyl chloride	1930000	28	0	1700
Dioxane, 1,4-	25	26	4	400
Ethylene dibromide	2.7	21	3	340
Phenol	8690	18	0	14000
Chlorobenzene	13500	10	0	4700
Cresol	34700	10	0	390
Methyl cellosolve	3860	10	0	2100
Butadiene, 1,3-	1.1	8	7	440
Polychlorinated biphenyl (PCB)	.007	7	7	2.600
Naphthalene	270	6	0	170
Acrylonitrile	.67	5	5	250
Ethyl acrylate	9260	5	0	78
Acrolein	3.9	4	2	110

SUMMARY OF TOXIC POLLUTANTS

SORTED BY OCCURRENCES (cont)

Pollutant	Trigger Level (lbs/yr)	Total # Plants Emitting	# Plants Above Trigger	Total Emissions (lbs/yr)
Benzyl chloride	2320	4	0	840
Butyl alcohol, tert-	-8888	3	3	700
Chlorine pollutant	1370	3	1	1900
Isophorone	390000	3	0	91
Tetrachloroethane, 1,1,2,2-	3.3	3	2	100
Toluene diisocyanate (TDI)	18.3	3	1	200
Allyl chloride	193	2	0	54
Chlorobenzene - other/not spec	13500	2	0	5100
Hexachlorobenzene	.39	2	0	.04
Methyl methacrylate	189000	2	0	20
Triethylamine	1400	2	0	290
Acrylic acid	190	1	0	45
Bromine	328	1	0	0
Di(2-ethylhexyl) phthalate	81	1	0	0
Epichlorohydrin	8.3	1	0	.1
Hexamethylene-1,6-diisocyanate	1.9	1	1	2.5
Methyl bromide	1160	1	0	9
Phosphine	1930	1	0	110
Phthalic anhydride	1350000	1	0	15
Trichloroethane, 1,1,2-	12	1	0	2
78 pollutants				6275910

number of toxic pollutants tracked in BAAQMD: 114
number of toxic pollutants reported in BAAQMD: 78
number of toxic pollutants reported > cutoff: 44

BAY AREA AIR QUALITY MANAGEMENT DISTRICT
TOXIC AIR CONTAMINANTS
2003 ANNUAL REPORT

SUMMARY OF TOXIC POLLUTANTS

SORTED BY TRIGGER LEVEL

Pollutant	Trigger Level (lbs/yr)	Total # Plants Emitting	# Plants Above Trigger	Total Emissions (lbs/yr)
Chlorinated dioxins & furans (	.0000012	52	21	.0005600
Chromium (hexavalent)	.0014	649	82	9.6000
Polychlorinated biphenyl (PCB)	.007	7	7	2.600
Beryllium (all) pollutant	.015	625	13	1.200
Arsenic (all)	.024	625	33	11
PAH's (benzo[a]pyrene equiv)	.043	54	9	460
Cadmium	.046	629	25	50
Hexachlorobenzene	.39	2	0	.04
Acrylonitrile	.67	5	5	250
Nickel pollutant	.73	636	38	790
Butadiene, 1,3-	1.1	8	7	440
Hexamethylene-1,6-diisocyanate	1.9	1	1	2.5
Ethylene oxide	2.1	39	2	35
Vinyl chloride	2.5	51	39	10000
Ethylene dibromide	2.7	21	3	340
Tetrachloroethane, 1,1,2,2-	3.3	3	2	100
Acrolein	3.9	4	2	110
Carbon tetrachloride	4.6	40	1	2000
Benzene	6.7	1637	190	46000
Epichlorohydrin	8.3	1	0	.1
Ethylene dichloride	9.7	56	21	910
Trichloroethane, 1,1,2-	12	1	0	2
Toluene diisocyanate (TDI)	18.3	3	1	200
Dioxane, 1,4-	25	26	4	400
Lead (all) pollutant	29	631	2	420
Formaldehyde	33	1001	109	210000
Perchloroethylene	33	790	744	530000
Chloroform	36	92	39	15000
Mercury (all) pollutant	57.9	628	3	520
Dichlorobenzene	68	37	7	7900
Acetaldehyde	72	81	10	8800
Manganese	77	592	5	1100
Di(2-ethylhexyl) phthalate	81	1	0	0
Selenium	96.5	47	1	600
Trichloroethylene	97	124	44	21000
Acrylic acid	190	1	0	45
Methylene chloride	190	135	66	91000
Allyl chloride	193	2	0	54
Naphthalene	270	6	0	170
Bromine	328	1	0	0
Copper (all) pollutant	463	52	0	440
Hydrogen Fluoride (HF)	1140	47	0	1600
Methyl bromide	1160	1	0	9
Hydrochloric acid mist polluta	1350	72	3	18000
Hydrogen Chloride (HCl)	1350	58	9	150000
Chlorine pollutant	1370	3	1	1900
Triethylamine	1400	2	0	290
Phosphine	1930	1	0	110
Benzyl chloride	2320	4	0	840
Butyl cellosolve	3860	389	5	300000
Glycol ether - other/not spec	3860	119	2	48000
Methyl cellosolve	3860	10	0	2100
Vinylidene chloride	6180	34	0	410
Zinc pollutant	6760	50	0	3000
Hydrogen Sulfide (H2S)	8110	59	2	95000
Phenol	8690	18	0	14000
Ethyl acrylate	9260	5	0	78
Cellosolve acetate	12400	30	0	4700

SUMMARY OF TOXIC POLLUTANTS

SORTED BY TRIGGER LEVEL (cont)

Pollutant	Trigger Level (lbs/yr)	Total # Plants Emitting	# Plants Above Trigger	Total Emissions (lbs/yr)
Chlorobenzene	13500	10	0	4700
Chlorobenzene - other/not spec	13500	2	0	5100
Ammonia (NH3) pollutant	19300	69	22	2700000
Cresol	34700	10	0	390
Cellosolve	38600	45	1	96000
Toluene	38600	788	1	320000
Hexane	39000	67	1	130000
Xylene	57900	962	0	320000
Trichloroethane, 1,1,1- (w/o	61800	72	0	81000
Trichloroethane, 1,1,1- (with	61800	37	0	12000
Methyl alcohol	120000	291	1	340000
Styrene	135000	68	0	260000
Methyl ethyl ketone (MEK)	149000	381	0	170000
Methyl methacrylate	189000	2	0	20
Ethyl benzene	190000	225	0	27000
Isophorone	390000	3	0	91
Methyl tertiary-butyl ether	580000	109	0	220000
Phthalic anhydride	1350000	1	0	15
Ethyl chloride	1930000	28	0	1700
Butyl alcohol, tert-	-8888	3	3	700
78 pollutants				6275910

number of toxic pollutants tracked in BAAQMD: 114
number of toxic pollutants reported in BAAQMD: 78
number of toxic pollutants reported > cutoff: 44

BAY AREA AIR QUALITY MANAGEMENT DISTRICT
TOXIC AIR CONTAMINANTS
2003 ANNUAL REPORT

SUMMARY OF TOXIC POLLUTANTS

SORTED BY PLANTS ABOVE TRIGGER

Pollutant	Trigger Level (lbs/yr)	Total # Plants Emitting	# Plants Above Trigger	Total Emissions (lbs/yr)
Perchloroethylene	33	790	744	530000
Benzene	6.7	1637	190	46000
Formaldehyde	33	1001	109	210000
Chromium (hexavalent)	.0014	649	82	9.6000
Methylene chloride	190	135	66	91000
Trichloroethylene	97	124	44	21000
Chloroform	36	92	39	15000
Vinyl chloride	2.5	51	39	10000
Nickel pollutant	.73	636	38	790
Arsenic (all)	.024	625	33	11
Cadmium	.046	629	25	50
Ammonia (NH3) pollutant	19300	69	22	2700000
Chlorinated dioxins & furans (	.0000012	52	21	.0005600
Ethylene dichloride	9.7	56	21	910
Beryllium (all) pollutant	.015	625	13	1.200
Acetaldehyde	72	81	10	8800
Hydrogen Chloride (HCl)	1350	58	9	150000
PAH's (benzo[a]pyrene equiv)	.043	54	9	460
Butadiene, 1,3-	1.1	8	7	440
Dichlorobenzene	68	37	7	7900
Polychlorinated biphenyl (PCB)	.007	7	7	2.600
Acrylonitrile	.67	5	5	250
Butyl cellosolve	3860	389	5	300000
Manganese	77	592	5	1100
Dioxane, 1,4-	25	26	4	400
Butyl alcohol, tert-	-8888	3	3	700
Ethylene dibromide	2.7	21	3	340
Hydrochloric acid mist polluta	1350	72	3	18000
Mercury (all) pollutant	57.9	628	3	520
Acrolein	3.9	4	2	110
Ethylene oxide	2.1	39	2	35
Glycol ether - other/not spec	3860	119	2	48000
Hydrogen Sulfide (H2S)	8110	59	2	95000
Lead (all) pollutant	29	631	2	420
Tetrachloroethane, 1,1,2,2-	3.3	3	2	100
Carbon tetrachloride	4.6	40	1	2000
Cellosolve	38600	45	1	96000
Chlorine pollutant	1370	3	1	1900
Hexamethylene-1,6-diisocyanate	1.9	1	1	2.5
Hexane	39000	67	1	130000
Methyl alcohol	120000	291	1	340000
Selenium	96.5	47	1	600
Toluene	38600	788	1	320000
Toluene diisocyanate (TDI)	18.3	3	1	200
Acrylic acid	190	1	0	45
Allyl chloride	193	2	0	54
Benzyl chloride	2320	4	0	840
Bromine	328	1	0	0
Cellosolve acetate	12400	30	0	4700
Chlorobenzene	13500	10	0	4700
Chlorobenzene - other/not spec	13500	2	0	5100
Copper (all) pollutant	463	52	0	440
Cresol	34700	10	0	390
Di(2-ethylhexyl) phthalate	81	1	0	0
Epichlorohydrin	8.3	1	0	.1
Ethyl acrylate	9260	5	0	78
Ethyl benzene	190000	225	0	27000
Ethyl chloride	1930000	28	0	1700

SUMMARY OF TOXIC POLLUTANTS

SORTED BY PLANTS ABOVE TRIGGER (cont)

Pollutant	Trigger Level (lbs/yr)	Total # Plants Emitting	# Plants Above Trigger	Total Emissions (lbs/yr)
Hexachlorobenzene	.39	2	0	.04
Hydrogen Fluoride (HF)	1140	47	0	1600
Isophorone	390000	3	0	91
Methyl bromide	1160	1	0	9
Methyl cellosolve	3860	10	0	2100
Methyl ethyl ketone (MEK)	149000	381	0	170000
Methyl methacrylate	189000	2	0	20
Methyl tertiary-butyl ether	580000	109	0	220000
Naphthalene	270	6	0	170
Phenol	8690	18	0	14000
Phosphine	1930	1	0	110
Phthalic anhydride	1350000	1	0	15
Styrene	135000	68	0	260000
Trichloroethane, 1,1,1- (w/o	61800	72	0	81000
Trichloroethane, 1,1,1- (with	61800	37	0	12000
Trichloroethane, 1,1,2-	12	1	0	2
Triethylamine	1400	2	0	290
Vinylidene chloride	6180	34	0	410
Xylene	57900	962	0	320000
Zinc pollutant	6760	50	0	3000
78 pollutants				6275910

number of toxic pollutants tracked in BAAQMD: 114
number of toxic pollutants reported in BAAQMD: 78
number of toxic pollutants reported > cutoff: 44

APPENDIX C

AMBIENT AIR MONITORING DATA

APPENDIX C-1

AMBIENT AIR MONITORING
DATA SUMMARY BY STATION

DIRECTORY OF ACTIVE TOXIC AIR CONTAMINANT MONITORING STATIONS

Station	Location	Address
1018	Oakland – Davie Stadium	198 Oak Road
1022	San Leandro	15400 Foothill Boulevard
1023	Livermore	793 Rincon Avenue
1024	Oakland – Filbert Street	2419 Filbert Street
2010	Pittsburg	583 West l0th Street
2014	Martinez	521 Jones Street
2017	Crockett	End of Kendall Avenue
2018	Concord – Treat Blvd.	2975 Treat Boulevard
2019	Richmond	1065 7th Street
2021	Bethel Island	5551 Bethel Island Road
2035	San Pablo – Rumrill Blvd.	1865-D Rumrill Boulevard
3005	San Rafael	534 4th Street
3007	Fort Cronkhite – Sausalito	National Park Service Bldg 1049
4001	Napa	2552 Jefferson Street
5011	San Francisco	10 Arkansas Street
6004	Redwood City	897 Barron Avenue
7030	Sunnyvale	910 Ticonderoga Avenue
7032	San Jose – Jackson Street	158 East Jackson Street, Suite B
8004	Vallejo	304 Tuolumne Street
9004	Santa Rosa	837 5th Street

20 stations total

POLLUTANT KEY

Pollutant	Pollutant Name	Limit of Detection (ppb)	IUPAC Name*
Acetone	Acetone	0.30	2-propanone
BENZ	Benzene	0.10	Benzene
BUT-1,3	1,3-Butadiene	0.15	1,3-butadiene
CCl_4	Carbon tetrachloride	0.01	Tetrachloromethane
$CHCl_3$	Chloroform	0.02	Trichloromethane
DCM	Methylene chloride	0.50	Dichloromethane
EthBenz	Ethylbenzene	0.10	Ethylbenzene
EDB	Ethylene dibromide	0.02	1,2-dibromoethane
EDC	Ethylene dichloride	0.10	1,2-dichloroethane
Freon 11	Trichlorofluoromethane	0.01	Trichlorofluoromethane
Freon 113	1,1,2-trichlorotrifluoroethane	0.01	1,1,2-trichlorotrifluoroethane
MEK	Methyl ethyl ketone	0.20	2-butanone
MTBE	Methyl tertiary-butyl ether	0.30	Methyl tertiary-butyl ether
PERC	Perchloroethylene	0.01	Tetrachloroethene
TCA	Methyl chloroform	0.05	1,1,1-trichloroethane
TCE	Trichloroethylene	0.05	Trichloroethene
TOL	Toluene	0.10	Toluene
VC	Vinyl chloride	0.30	Chloroethene
M/P Xyl	M/P Xylene	0.10	1,3-dimethylbenzene/ 1,4-dimethylbenzene
O Xyl	O-Xylene	0.10	1,2-dimethylbenzene

20 Pollutants Total

***IUPAC – International Union of Pure and Applied Chemistry**

Bay Area Air Quality Management District
Toxic Air Contaminants
2003 Annual Report

Ambient Air Toxics Data - Gases (ppb)
Date Range: Jan 1, 2003 - Dec 31, 2003

Station: Oakland-Davie Stadium
198 Oak Road
Oakland, CA 94610

Station ID: 1018
AIRS ID:
CARB ID:

Date	Acetone	Benz	But-1,3	CCl4	CHCl3	DCM	EDB	EDC	EthBenz	Freon 11	Freon 113	M/P Xyl	MEK	MTBE	O Xyl	Perc	TCA	TCE	Tol	VC
03-Jan-03	2.10	0.50	<0.15	0.12	<0.02	<0.50	<0.02	<0.10	<0.10	0.31	0.08	0.40	0.20	0.30	0.20	0.04	<0.05	<0.05	0.90	<0.30
15-Jan-03	2.10	0.30	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	0.10	0.29	0.07	0.40	0.20	<0.30	0.20	0.04	<0.05	<0.05	0.70	<0.30
27-Jan-03	2.80	0.60	<0.15	0.10	<0.02	<0.50	<0.02	<0.10	0.30	0.27	0.07	1.00	0.20	0.50	0.30	0.07	<0.05	<0.05	1.70	<0.30
08-Feb-03	2.50	0.60	<0.15	0.11	0.03	0.60	<0.02	<0.10	0.10	0.27	0.07	0.50	0.20	<0.30	0.20	0.03	<0.05	<0.05	2.00	<0.30
20-Feb-03	2.20	0.30	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	<0.10	0.26	0.07	0.30	<0.20	<0.30	0.10	0.04	<0.05	<0.05	0.70	<0.30
04-Mar-03	2.30	0.80	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	0.10	0.26	0.07	0.30	0.20	<0.30	0.10	0.03	<0.05	<0.05	0.70	<0.30
16-Mar-03	1.50	0.20	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	<0.10	0.28	0.07	0.20	<0.20	<0.30	0.10	<0.01	<0.05	<0.05	0.40	<0.30
28-Mar-03	1.80	0.20	<0.15	0.12	<0.02	<0.50	<0.02	<0.10	0.10	0.27	0.07	0.10	0.20	<0.30	0.10	<0.01	<0.05	<0.05	0.40	<0.30
# Obs	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8
# <LOD	0	0	8	0	7	7	8	8	3	0	0	0	2	6	0	2	8	8	0	8
Mean*	2.16	0.44	0.08	0.11	0.01	0.29	0.01	0.05	0.11	0.28	0.07	0.40	0.18	0.21	0.16	0.03	0.03	0.03	0.94	0.15
Max	2.80	0.80	<0.15	0.12	0.03	0.60	<0.02	<0.10	0.30	0.31	0.08	1.00	0.20	0.50	0.30	0.07	<0.05	<0.05	2.00	<0.30
Min	1.50	0.20	<0.15	0.10	<0.02	<0.50	<0.02	<0.10	<0.10	0.26	0.07	0.10	<0.20	<0.30	0.10	<0.01	<0.05	<0.05	0.40	<0.30

*Values below the detection limit are set to one-half the detection limit for statistical calculations.

Bay Area Air Quality Management District
Toxic Air Contaminants
2003 Annual Report

Ambient Air Toxics Data - Gases (ppb)
Date Range: Jan 1, 2003 - Dec 31, 2003

Station: San Leandro
15400 Foothill Boulevard
San Leandro, CA 94578

Station ID: 1022
AIRS ID: 060010006
CARB ID: 6000343

Date	Acetone	Benz	But-1,3	CCl4	CHCl3	DCM	EDB	EDC	EthBenz	Freon 11	Freon 113	M/P Xyl	MEK	MTBE	O Xyl	Perc	TCA	TCE	Tol	VC
08-Jan-03	4.20	0.30	<0.15	0.09	<0.02	<0.50	<0.02	<0.10	0.10	0.27	0.08	0.30	0.30	0.40	0.10	0.03	<0.05	<0.05	1.20	<0.30
15-Jan-03	3.70	0.40	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	0.10	0.25	0.07	0.50	0.30	0.30	0.20	0.03	<0.05	<0.05	1.80	<0.30
27-Jan-03	4.50	0.40	<0.15	0.10	<0.02	<0.50	<0.02	<0.10	0.10	0.24	0.08	0.40	0.40	0.40	0.10	0.04	<0.05	<0.05	2.30	<0.30
08-Feb-03	2.20	0.40	<0.15	0.10	<0.02	<0.50	<0.02	<0.10	0.10	0.27	0.07	0.40	0.20	<0.30	0.10	0.02	<0.05	<0.05	1.20	<0.30
20-Feb-03	2.20	0.20	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	<0.10	0.26	0.08	0.20	<0.20	<0.30	<0.10	0.02	<0.05	<0.05	1.20	<0.30
04-Mar-03	2.40	0.30	<0.15	0.11	1.47	<0.50	<0.02	<0.10	0.10	0.26	0.07	0.30	0.20	<0.30	0.10	<0.01	<0.05	<0.05	0.90	<0.30
16-Mar-03	2.30	0.20	<0.15	0.11	0.08	<0.50	<0.02	<0.10	<0.10	0.25	0.06	0.20	0.20	<0.30	0.10	<0.01	<0.05	<0.05	1.20	<0.30
02-Apr-03	2.80	0.20	<0.15	0.11	0.06	<0.50	<0.02	<0.10	<0.10	0.24	0.08	0.10	0.20	<0.30	<0.10	<0.01	<0.05	<0.05	0.40	<0.30
09-Apr-03	7.50	0.30	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	0.10	0.25	0.07	0.40	0.20	<0.30	0.10	0.03	<0.05	<0.05	1.00	<0.30
21-Apr-03	7.30	0.20	<0.15	0.11	0.21	<0.50	<0.02	<0.10	<0.10	0.27	0.07	0.20	0.20	<0.30	<0.10	0.02	<0.05	<0.05	1.50	<0.30
06-May-03	4.30	0.20	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	<0.10	0.27	0.07	0.20	<0.20	<0.30	<0.10	0.02	<0.05	<0.05	0.50	<0.30
15-May-03	3.20	0.20	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	<0.10	0.26	0.07	0.10	0.20	<0.30	<0.10	<0.01	<0.05	<0.05	0.50	<0.30
27-May-03	6.40	0.40	<0.15	0.12	0.05	<0.50	<0.02	<0.10	0.10	0.24	0.08	0.40	0.30	0.40	0.10	0.04	0.05	<0.05	1.00	<0.30
08-Jun-03	3.40	0.10	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	<0.10	0.28	0.07	0.10	0.20	<0.30	<0.10	<0.01	<0.05	<0.05	0.20	<0.30
20-Jun-03	2.30	0.10	<0.15	0.11	0.16	<0.50	<0.02	<0.10	<0.10	0.23	0.08	0.10	0.20	<0.30	<0.10	<0.01	<0.05	<0.05	0.40	<0.30
02-Jul-03	4.60	0.20	<0.15	0.12	0.07	<0.50	<0.02	<0.10	<0.10	0.28	0.06	0.20	0.20	0.30	<0.10	0.02	<0.05	<0.05	0.80	<0.30
14-Jul-03	4.50	0.40	0.17	0.11	0.06	<0.50	<0.02	<0.10	0.10	0.27	0.07	0.40	0.30	0.40	0.20	0.03	0.05	<0.05	1.10	<0.30
26-Jul-03	3.90	0.20	<0.15	0.11	0.04	<0.50	<0.02	<0.10	<0.10	0.29	0.07	0.40	0.30	0.80	0.10	0.03	<0.05	<0.05	0.90	<0.30
07-Aug-03	3.20	0.30	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	<0.10	0.26	0.07	0.20	0.20	<0.30	<0.10	<0.01	<0.05	<0.05	0.60	<0.30
19-Aug-03	1.60	0.20	<0.15	0.11	<0.02	0.70	<0.02	<0.10	<0.10	0.28	0.09	0.10	0.20	<0.30	<0.10	<0.01	<0.05	<0.05	0.50	<0.30
31-Aug-03	3.40	0.30	<0.15	0.10	<0.02	<0.50	<0.02	<0.10	0.10	0.24	0.07	0.40	0.20	0.40	0.10	<0.01	<0.05	<0.05	0.90	<0.30
12-Sep-03	6.20	0.50	<0.15	0.10	0.05	<0.50	<0.02	<0.10	0.20	0.27	0.08	0.70	0.40	1.30	0.20	0.04	<0.05	<0.05	1.20	<0.30
24-Sep-03	1.80	0.10	<0.15	0.12	<0.02	<0.50	<0.02	<0.10	<0.10	0.30	0.08	0.10	0.20	<0.30	<0.10	<0.01	<0.05	<0.05	0.30	<0.30
06-Oct-03	3.30	0.50	<0.15	0.12	0.05	<0.50	<0.02	<0.10	0.20	0.28	0.09	0.60	0.30	0.80	0.20	0.05	0.05	<0.05	1.10	<0.30
18-Oct-03	3.80	0.50	<0.15	0.09	0.04	0.60	<0.02	<0.10	0.20	0.23	0.08	0.60	0.40	1.00	0.20	0.04	<0.05	<0.05	1.10	<0.30
30-Oct-03	3.10	0.20	<0.15	0.10	<0.02	<0.50	<0.02	<0.10	<0.10	0.25	0.07	0.20	0.20	0.30	<0.10	<0.01	<0.05	<0.05	0.80	<0.30

Bay Area Air Quality Management District
Toxic Air Contaminants
2003 Annual Report

Ambient Air Toxics Data - Gases (ppb)
Date Range: Jan 1, 2003 - Dec 31, 2003

Station: San Leandro
15400 Foothill Boulevard
San Leandro, CA 94578

Station ID: 1022
AIRS ID: 060010006
CARB ID: 6000343

Date	Acetone	Benz	But-1,3	CCl4	CHCl3	DCM	EDB	EDC	EthBenz	Freon 11	Freon 113	M/P Xyl	MEK	MTBE	O Xyl	Perc	TCA	TCE	Tol	VC
11-Nov-03	2.80	0.40	0.19	0.11	0.03	<0.50	<0.02	<0.10	0.10	0.26	0.08	0.40	0.20	0.50	0.10	0.03	<0.05	<0.05	0.70	<0.30
23-Nov-03	1.70	0.20	<0.15	0.09	0.03	<0.50	<0.02	<0.10	<0.10	0.27	0.08	0.10	0.20	<0.30	<0.10	0.02	<0.05	<0.05	0.30	<0.30
05-Dec-03	3.10	0.40	0.22	0.09	<0.02	<0.50	<0.02	<0.10	0.10	0.23	0.06	0.60	0.20	<0.30	0.20	0.03	<0.05	<0.05	1.10	<0.30
17-Dec-03	1.50	0.20	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	<0.10	0.24	0.06	0.20	0.20	<0.30	<0.10	<0.01	<0.05	<0.05	0.50	<0.30
29-Dec-03	1.80	0.20	<0.15	0.10	<0.02	<0.50	<0.02	<0.10	<0.10	0.25	0.06	0.20	<0.20	<0.30	<0.10	<0.01	<0.05	<0.05	0.50	<0.30
# Obs	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31
# <LOD	0	0	28	0	17	29	31	31	17	0	0	0	3	18	15	13	28	31	0	31
Mean*	3.52	0.28	0.09	0.11	0.08	0.28	0.01	0.05	0.08	0.26	0.07	0.30	0.23	0.32	0.10	0.02	0.03	0.03	0.89	0.15
Max	7.50	0.50	0.22	0.12	1.47	0.70	<0.02	<0.10	0.20	0.30	0.09	0.70	0.40	1.30	0.20	0.05	0.05	<0.05	2.30	<0.30
Min	1.50	0.10	<0.15	0.09	<0.02	<0.50	<0.02	<0.10	<0.10	0.23	0.06	0.10	<0.20	<0.30	<0.10	<0.01	<0.05	<0.05	0.20	<0.30

*Values below the detection limit are set to one-half the detection limit for statistical calculations.

Bay Area Air Quality Management District
Toxic Air Contaminants
2003 Annual Report

Ambient Air Toxics Data - Gases (ppb)
Date Range: Jan 1, 2003 - Dec 31, 2003

Station: Livermore
793 Rincon Avenue
Livermore, CA 94551

Station ID: 1023
AIRS ID: 060010007
CARB ID: 6000344

Date	Acetone	Benz	But-1,3	CCl4	CHCl3	DCM	EDB	EDC	EthBenz	Freon 11	Freon 113	M/P Xyl	MEK	MTBE	O Xyl	Perc	TCA	TCE	Tol	VC
03-Jan-03	5.10	0.80	0.24	0.11	0.03	<0.50	<0.02	<0.10	0.20	0.28	0.08	0.90	0.30	1.10	0.30	0.03	0.25	<0.05	1.50	<0.30
15-Jan-03	4.90	0.40	0.16	0.11	<0.02	<0.50	<0.02	<0.10	0.10	0.25	0.08	0.40	0.60	0.50	0.10	0.02	0.19	<0.05	0.70	<0.30
27-Jan-03	4.70	0.50	<0.15	0.10	<0.02	<0.50	<0.02	<0.10	0.20	0.26	0.07	0.90	0.50	0.60	0.30	0.04	0.20	<0.05	1.50	<0.30
08-Feb-03	4.60	0.80	<0.15	0.12	0.03	0.60	<0.02	<0.10	0.20	0.29	0.08	1.00	0.90	0.40	0.30	0.03	0.19	<0.05	1.80	<0.30
20-Feb-03	3.90	0.60	<0.15	0.11	0.03	<0.50	<0.02	<0.10	0.20	0.26	0.07	0.80	0.50	0.60	0.30	0.03	0.23	<0.05	1.40	<0.30
04-Mar-03	3.20	0.70	<0.15	0.11	0.03	<0.50	<0.02	<0.10	0.10	0.26	0.07	0.50	0.40	0.30	0.20	0.02	0.23	<0.05	1.00	<0.30
16-Mar-03	2.30	0.20	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	<0.10	0.24	0.08	0.20	0.20	<0.30	0.10	<0.01	0.20	<0.05	0.40	<0.30
28-Mar-03	11.50	0.30	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	<0.10	0.27	0.08	0.30	0.50	0.30	0.10	0.02	0.27	<0.05	0.50	<0.30
09-Apr-03	4.00	0.30	<0.15	0.11	0.03	0.60	<0.02	<0.10	0.10	0.25	0.07	0.50	0.30	0.50	0.20	0.02	0.27	<0.05	0.70	<0.30
21-Apr-03	4.00	0.10	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	<0.10	0.26	0.07	0.10	0.30	<0.30	<0.10	<0.01	0.21	<0.05	0.20	<0.30
03-May-03	2.30	0.20	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	<0.10	0.28	0.08	0.10	0.20	<0.30	<0.10	<0.01	0.24	<0.05	0.30	<0.30
15-May-03	3.10	0.10	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	<0.10	0.26	0.07	<0.10	0.20	<0.30	<0.10	<0.01	0.23	<0.05	0.10	<0.30
27-May-03	7.40	0.40	<0.15	0.11	0.03	<0.50	<0.02	<0.10	0.10	0.27	0.07	0.50	0.50	0.70	0.20	0.03	0.28	<0.05	0.90	<0.30
08-Jun-03	3.20	0.10	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	<0.10	0.26	0.07	0.10	0.20	<0.30	<0.10	<0.01	0.26	<0.05	0.20	<0.30
20-Jun-03	2.30	0.10	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	<0.10	0.23	0.08	<0.10	0.30	<0.30	<0.10	<0.01	0.26	<0.05	0.10	<0.30
02-Jul-03	4.80	0.30	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	0.10	0.24	0.07	0.30	0.30	0.50	0.10	0.02	0.29	<0.05	0.70	<0.30
14-Jul-03	4.80	0.40	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	<0.10	0.27	0.07	0.40	0.40	0.40	0.10	0.02	0.45	<0.05	0.80	<0.30
26-Jul-03	4.10	0.20	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	<0.10	0.26	0.07	0.20	0.30	0.50	<0.10	0.02	0.28	<0.05	0.50	<0.30
07-Aug-03	3.80	0.20	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	<0.10	0.26	0.07	0.10	0.20	<0.30	<0.10	<0.01	0.38	<0.05	0.30	<0.30
19-Aug-03	3.40	0.20	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	<0.10	0.28	0.07	0.20	0.20	<0.30	<0.10	0.02	0.82	<0.05	0.40	<0.30
31-Aug-03	4.20	0.20	<0.15	0.10	<0.02	<0.50	<0.02	<0.10	0.10	0.24	0.07	0.30	0.30	0.30	0.10	<0.01	0.39	<0.05	0.70	<0.30
12-Sep-03	7.60	0.60	<0.15	0.10	0.03	<0.50	<0.02	<0.10	0.20	0.24	0.08	1.00	0.60	1.90	0.30	0.03	0.28	<0.05	1.70	<0.30
24-Sep-03	4.00	0.20	<0.15	0.10	<0.02	<0.50	<0.02	<0.10	<0.10	0.25	0.06	0.20	0.20	<0.30	<0.10	<0.01	0.40	<0.05	0.40	<0.30
06-Oct-03	4.60	0.60	<0.15	0.11	0.04	<0.50	<0.02	<0.10	0.20	0.27	0.09	0.80	0.80	1.40	0.20	0.03	0.24	<0.05	1.40	<0.30
18-Oct-03	11.60	0.60	<0.15	0.09	<0.02	<0.50	<0.02	<0.10	0.30	0.27	0.07	1.20	1.00	1.00	0.40	0.04	1.02	<0.05	2.40	<0.30
30-Oct-03	2.60	0.10	<0.15	0.10	<0.02	<0.50	<0.02	<0.10	<0.10	0.25	0.07	0.10	0.20	<0.30	<0.10	<0.01	0.31	<0.05	0.30	<0.30

Bay Area Air Quality Management District
Toxic Air Contaminants
2003 Annual Report

Ambient Air Toxics Data - Gases (ppb)
Date Range: Jan 1, 2003 - Dec 31, 2003

Station: Livermore
793 Rincon Avenue
Livermore, CA 94551

Station ID: 1023
AIRS ID: 060010007
CARB ID: 6000344

Date	Acetone	Benz	But-1,3	CCl4	CHCl3	DCM	EDB	EDC	EthBenz	Freon 11	Freon 113	M/P Xyl	MEK	MTBE	O Xyl	Perc	TCA	TCE	Tol	VC
23-Nov-03	5.40	0.60	0.26	0.11	0.06	<0.50	<0.02	<0.10	0.20	0.26	0.08	0.70	0.60	0.40	0.20	0.02	0.18	<0.05	1.10	<0.30
05-Dec-03	9.60	0.80	0.29	0.09	<0.02	<0.50	<0.02	<0.10	0.30	0.25	0.06	1.40	0.40	0.30	0.50	0.04	0.36	<0.05	2.60	<0.30
17-Dec-03	6.70	0.70	0.40	0.11	0.03	<0.50	<0.02	<0.10	0.30	0.25	0.08	0.90	0.70	<0.30	0.40	0.03	0.22	<0.05	1.40	<0.30
29-Dec-03	2.60	0.20	0.19	0.10	<0.02	<0.50	<0.02	<0.10	<0.10	0.24	0.06	0.30	0.20	<0.30	0.10	<0.01	0.16	<0.05	0.50	<0.30
# Obs	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31
# <LOD	0	0	24	0	20	29	31	31	14	0	0	2	0	12	10	11	0	31	0	31
Mean*	4.91	0.39	0.12	0.11	0.02	0.27	0.01	0.05	0.12	0.26	0.07	0.50	0.42	0.46	0.17	0.02	0.31	0.03	0.90	0.15
Max	11.60	0.80	0.40	0.12	0.06	0.60	<0.02	<0.10	0.30	0.29	0.09	1.40	1.00	1.90	0.50	0.04	1.02	<0.05	2.60	<0.30
Min	2.30	0.10	<0.15	0.09	<0.02	<0.50	<0.02	<0.10	<0.10	0.23	0.06	<0.10	0.20	<0.30	<0.10	<0.01	0.16	<0.05	0.10	<0.30

*Values below the detection limit are set to one-half the detection limit for statistical calculations.

Bay Area Air Quality Management District
Toxic Air Contaminants
2003 Annual Report

Ambient Air Toxics Data - Gases (ppb)
Date Range: Jan 1, 2003 - Dec 31, 2003

Station: Oakland
2419 Filbert Street
Oakland, CA 94607

Station ID: 1024
AIRS ID: 060010008
CARB ID: 6000345

Date	Acetone	Benz	But-1,3	CCl4	CHCl3	DCM	EDB	EDC	EthBenz	Freon 11	Freon 113	M/P Xyl	MEK	MTBE	O Xyl	Perc	TCA	TCE	Tol	VC
03-Jan-03	13.20	1.20	<0.15	0.11	0.03	0.80	<0.02	<0.10	0.60	0.33	0.14	2.60	0.60	1.20	0.90	0.28	0.05	0.05	4.80	<0.30
15-Jan-03	12.20	0.80	0.17	0.11	<0.02	<0.50	<0.02	<0.10	0.30	0.30	0.10	1.20	0.80	0.80	0.40	0.07	<0.05	<0.05	1.90	<0.30
27-Jan-03	12.90	0.70	<0.15	0.09	0.03	<0.50	<0.02	<0.10	0.40	0.27	0.08	1.40	0.70	0.80	0.50	0.10	<0.05	<0.05	2.70	<0.30
08-Feb-03	16.20	1.80	0.50	0.11	0.07	0.90	<0.02	<0.10	0.60	0.34	0.09	2.60	0.90	1.10	0.90	0.20	0.05	<0.05	4.20	<0.30
20-Feb-03	8.30	0.30	<0.15	0.10	<0.02	<0.50	<0.02	<0.10	0.10	0.24	0.07	0.50	0.40	<0.30	0.20	0.09	<0.05	<0.05	0.80	<0.30
04-Mar-03	12.90	0.50	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	0.20	0.29	0.08	0.80	0.50	0.30	0.30	0.03	<0.05	<0.05	1.20	<0.30
16-Mar-03	11.60	0.40	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	0.10	0.26	0.09	0.40	0.50	0.30	0.10	0.02	<0.05	<0.05	0.60	<0.30
28-Mar-03	16.10	0.30	<0.15	0.11	0.04	<0.50	<0.02	<0.10	0.10	0.26	0.09	0.40	0.60	0.30	0.10	0.02	<0.05	<0.05	0.80	<0.30
09-Apr-03	3.90	0.50	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	0.20	0.26	0.07	0.90	0.30	0.30	0.30	0.06	<0.05	<0.05	1.60	<0.30
21-Apr-03	3.60	0.20	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	<0.10	0.26	0.07	0.30	0.20	<0.30	0.10	<0.01	<0.05	<0.05	0.70	<0.30
03-May-03	3.50	0.30	<0.15	0.10	0.03	<0.50	<0.02	<0.10	<0.10	0.25	0.07	0.30	0.20	<0.30	0.10	0.02	<0.05	<0.05	1.10	<0.30
15-May-03	2.30	0.20	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	<0.10	0.26	0.07	0.30	<0.20	<0.30	0.10	0.02	<0.05	<0.05	0.50	<0.30
27-May-03	5.50	0.50	<0.15	0.11	0.04	<0.50	<0.02	<0.10	0.20	0.31	0.07	0.70	0.40	0.50	0.30	0.05	<0.05	<0.05	1.00	<0.30
08-Jun-03	3.40	0.20	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	<0.10	0.27	0.07	0.20	0.30	<0.30	0.10	<0.01	<0.05	<0.05	0.60	<0.30
20-Jun-03	2.90	0.20	<0.15	0.11	<0.02	0.50	<0.02	<0.10	<0.10	0.25	0.07	0.20	0.30	<0.30	<0.10	0.02	<0.05	<0.05	0.40	<0.30
02-Jul-03	7.00	0.30	<0.15	0.11	0.03	<0.50	<0.02	<0.10	0.10	0.28	0.07	0.40	0.30	<0.30	0.10	0.03	<0.05	0.05	0.70	<0.30
14-Jul-03	8.10	0.30	<0.15	0.11	0.03	<0.50	<0.02	<0.10	0.10	0.46	0.06	0.40	0.60	0.50	0.10	0.03	<0.05	<0.05	0.60	<0.30
26-Jul-03	6.00	0.20	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	<0.10	0.26	0.07	0.20	0.30	0.30	<0.10	0.02	<0.05	<0.05	0.60	<0.30
07-Aug-03	3.70	0.20	<0.15	0.11	<0.02	1.00	<0.02	<0.10	<0.10	0.29	0.06	0.20	0.60	0.40	<0.10	0.02	<0.05	<0.05	0.40	<0.30
19-Aug-03	7.50	0.30	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	<0.10	0.28	0.07	0.20	0.40	<0.30	0.10	<0.01	<0.05	<0.05	0.60	<0.30
31-Aug-03	7.00	0.20	<0.15	0.09	<0.02	<0.50	<0.02	<0.10	<0.10	0.24	0.08	0.30	0.40	0.30	0.10	<0.01	<0.05	<0.05	0.80	<0.30
12-Sep-03	18.50	1.00	<0.15	0.10	0.06	0.70	<0.02	<0.10	0.40	0.40	0.08	1.60	1.10	2.10	0.50	0.10	0.06	<0.05	2.40	<0.30
24-Sep-03	7.20	0.20	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	<0.10	0.29	0.08	0.30	0.50	<0.30	0.10	0.02	<0.05	<0.05	0.30	<0.30
06-Oct-03	15.80	0.60	<0.15	0.09	<0.02	<0.50	<0.02	<0.10	0.20	0.28	0.07	0.80	0.80	0.30	0.30	0.04	<0.05	<0.05	1.40	<0.30
18-Oct-03	14.30	0.50	<0.15	0.10	0.04	<0.50	<0.02	<0.10	0.20	0.26	0.08	0.70	1.00	0.80	0.20	0.03	<0.05	<0.05	1.00	<0.30
30-Oct-03	8.80	0.20	<0.15	0.09	<0.02	<0.50	<0.02	<0.10	0.10	0.23	0.07	0.70	0.40	<0.30	0.20	<0.01	<0.05	<0.05	1.10	<0.30

Bay Area Air Quality Management District
Toxic Air Contaminants
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Ambient Air Toxics Data - Gases (ppb)
Date Range: Jan 1, 2003 - Dec 31, 2003

Station: Oakland
2419 Filbert Street
Oakland, CA 94607

Station ID: 1024
AIRS ID: 060010008
CARB ID: 6000345

Date	Acetone	Benz	But-1,3	CCl4	CHCl3	DCM	EDB	EDC	EthBenz	Freon 11	Freon 113	M/P Xyl	MEK	MTBE	O Xyl	Perc	TCA	TCE	Tol	VC
23-Nov-03	10.70	1.00	0.37	0.11	0.06	<0.50	<0.02	<0.10	0.40	0.29	0.09	2.00	0.60	0.50	0.40	0.04	<0.05	<0.05	2.20	<0.30
05-Dec-03	6.50	0.40	0.22	0.11	0.03	<0.50	<0.02	<0.10	0.10	0.29	0.08	0.50	0.50	0.30	0.10	0.03	<0.05	<0.05	1.00	<0.30
17-Dec-03	14.70	0.80	0.30	0.11	0.04	<0.50	<0.02	<0.10	0.40	0.35	0.08	1.40	0.70	<0.30	0.60	0.04	<0.05	<0.05	1.90	<0.30
29-Dec-03	5.00	0.30	0.18	0.10	<0.02	<0.50	<0.02	<0.10	0.10	0.25	0.06	0.50	0.40	<0.30	0.20	<0.01	<0.05	<0.05	0.80	<0.30
# Obs	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31
# <LOD	0	0	24	0	17	26	31	31	10	0	0	0	1	12	3	6	27	29	0	31
Mean*	9.09	0.50	0.12	0.11	0.02	0.34	0.01	0.05	0.18	0.29	0.08	0.79	0.52	0.46	0.26	0.05	0.03	0.03	1.33	0.15
Max	18.50	1.80	0.50	0.11	0.07	1.00	<0.02	<0.10	0.60	0.46	0.14	2.60	1.10	2.10	0.90	0.28	0.06	0.05	4.80	<0.30
Min	2.30	0.20	<0.15	0.09	<0.02	<0.50	<0.02	<0.10	<0.10	0.23	0.06	0.20	<0.20	<0.30	<0.10	<0.01	<0.05	<0.05	0.30	<0.30

*Values below the detection limit are set to one-half the detection limit for statistical calculations.

Bay Area Air Quality Management District
Toxic Air Contaminants
2003 Annual Report

Ambient Air Toxics Data - Gases (ppb)
Date Range: Jan 1, 2003 - Dec 31, 2003

Station: Pittsburg
583 W 10th Street
Pittsburg, CA 94565

Station ID: 2010
AIRS ID: 060133001
CARB ID: 0700430

Date	Acetone	Benz	But-1,3	CCl4	CHCl3	DCM	EDB	EDC	EthBenz	Freon 11	Freon 113	M/P Xyl	MEK	MTBE	O Xyl	Perc	TCA	TCE	Tol	VC
03-Jan-03	4.70	0.80	0.26	0.15	0.03	0.60	<0.02	<0.10	0.30	0.28	0.08	1.20	0.50	1.50	0.40	0.08	<0.05	<0.05	2.00	<0.30
15-Jan-03	5.40	0.60	0.24	0.15	<0.02	0.90	<0.02	<0.10	0.50	0.27	0.08	1.30	0.50	1.30	0.60	0.08	<0.05	<0.05	1.90	<0.30
27-Jan-03	2.90	0.60	<0.15	0.11	0.03	0.90	<0.02	<0.10	0.30	0.25	0.07	1.00	1.10	1.00	0.40	0.03	<0.05	<0.05	1.70	<0.30
08-Feb-03	3.90	0.80	<0.15	0.12	<0.02	0.80	<0.02	<0.10	0.40	0.26	0.06	1.50	0.80	1.10	0.50	0.04	<0.05	<0.05	3.20	<0.30
20-Feb-03	3.70	0.50	<0.15	0.12	<0.02	<0.50	<0.02	<0.10	0.20	0.24	0.07	1.00	0.40	0.90	0.20	0.03	<0.05	<0.05	1.20	<0.30
04-Mar-03	1.70	0.30	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	0.10	0.25	0.07	0.70	1.00	0.50	0.30	<0.01	<0.05	<0.05	1.20	<0.30
16-Mar-03	3.00	0.30	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	0.10	0.26	0.06	0.50	0.20	0.30	0.20	0.02	<0.05	<0.05	0.70	<0.30
28-Mar-03	3.10	0.20	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	0.10	0.29	0.07	0.70	0.40	0.30	0.30	<0.01	<0.05	<0.05	0.90	<0.30
09-Apr-03	2.70	0.20	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	<0.10	0.25	0.07	0.40	0.60	<0.30	0.10	<0.01	<0.05	<0.05	1.50	<0.30
21-Apr-03	5.90	0.40	0.16	0.11	<0.02	<0.50	<0.02	<0.10	0.20	0.31	0.07	0.90	2.50	0.60	0.30	<0.01	0.07	<0.05	4.00	<0.30
03-May-03	2.00	0.20	<0.15	0.12	<0.02	<0.50	<0.02	<0.10	0.10	0.24	0.07	0.30	<0.20	0.40	0.10	0.02	<0.05	<0.05	0.80	<0.30
15-May-03	2.50	0.20	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	<0.10	0.28	0.07	0.40	0.30	<0.30	0.10	<0.01	<0.05	<0.05	1.20	<0.30
27-May-03	5.90	0.40	0.19	0.11	0.04	<0.50	<0.02	<0.10	0.10	0.25	0.07	0.60	1.60	1.00	0.20	0.02	<0.05	<0.05	1.20	<0.30
08-Jun-03	2.80	0.10	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	<0.10	0.25	0.07	0.20	0.30	<0.30	0.10	<0.01	<0.05	<0.05	0.50	<0.30
20-Jun-03	2.70	0.10	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	0.10	0.24	0.07	0.30	0.30	0.30	0.10	<0.01	<0.05	<0.05	0.70	<0.30
02-Jul-03	5.30	0.20	<0.15	0.11	0.03	<0.50	<0.02	<0.10	0.30	0.29	0.07	1.10	1.00	0.70	0.30	<0.01	<0.05	<0.05	0.70	<0.30
14-Jul-03	4.80	0.20	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	<0.10	0.27	0.06	0.40	0.40	0.60	0.10	<0.01	<0.05	0.10	0.80	<0.30
26-Jul-03	3.50	0.20	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	<0.10	0.27	0.07	0.30	0.40	0.80	0.10	<0.01	<0.05	<0.05	0.60	<0.30
07-Aug-03	3.10	0.30	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	<0.10	0.29	0.07	0.40	0.30	<0.30	0.20	0.06	<0.05	<0.05	1.00	<0.30
19-Aug-03	2.00	0.20	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	<0.10	0.27	0.06	0.20	0.20	0.40	0.10	<0.01	<0.05	<0.05	0.40	<0.30
31-Aug-03	3.20	0.30	<0.15	0.10	<0.02	<0.50	<0.02	<0.10	0.10	0.25	0.07	0.40	0.30	0.50	0.20	0.02	<0.05	<0.05	0.80	<0.30
12-Sep-03	6.40	0.50	<0.15	0.10	0.06	0.70	<0.02	<0.10	0.20	0.25	0.08	1.10	2.20	2.00	0.30	<0.01	<0.05	<0.05	1.50	<0.30
24-Sep-03	2.90	0.20	<0.15	0.10	<0.02	<0.50	<0.02	<0.10	0.10	0.23	0.06	0.40	0.20	0.40	0.10	<0.01	<0.05	<0.05	0.60	<0.30
06-Oct-03	4.00	0.30	<0.15	0.10	0.03	<0.50	<0.02	<0.10	0.10	0.28	0.09	0.40	0.80	1.00	0.10	<0.01	<0.05	<0.05	0.60	<0.30
18-Oct-03	7.60	0.70	<0.15	0.10	<0.02	0.60	<0.02	<0.10	0.40	0.24	0.06	1.70	0.80	1.50	0.50	0.03	<0.05	<0.05	2.50	<0.30
30-Oct-03	2.60	0.20	<0.15	0.10	<0.02	<0.50	<0.02	<0.10	<0.10	0.29	0.08	0.20	0.20	0.50	<0.10	<0.01	<0.05	<0.05	0.40	<0.30

Bay Area Air Quality Management District
Toxic Air Contaminants
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Ambient Air Toxics Data - Gases (ppb)
Date Range: Jan 1, 2003 - Dec 31, 2003

Station: Pittsburg
583 W 10th Street
Pittsburg, CA 94565

Station ID: 2010
AIRS ID: 060133001
CARB ID: 0700430

Date	Acetone	Benz	But-1,3	CCl4	CHCl3	DCM	EDB	EDC	EthBenz	Freon 11	Freon 113	M/P Xyl	MEK	MTBE	O Xyl	Perc	TCA	TCE	Tol	VC
23-Nov-03	3.20	0.50	<0.15	0.12	0.07	<0.50	<0.02	<0.10	0.20	0.26	0.08	0.60	0.90	0.50	0.20	0.02	<0.05	<0.05	1.00	<0.30
05-Dec-03	3.50	0.70	0.32	0.11	0.04	1.20	<0.02	<0.10	0.30	0.28	0.08	1.20	1.50	2.50	0.40	0.05	<0.05	<0.05	2.20	<0.30
17-Dec-03	3.70	0.40	0.23	0.16	0.04	1.30	<0.02	<0.10	0.20	0.26	0.08	0.70	0.60	<0.30	0.30	0.04	<0.05	<0.05	0.90	<0.30
29-Dec-03	1.80	0.20	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	<0.10	0.25	0.08	0.20	0.20	<0.30	0.10	<0.01	<0.05	<0.05	0.30	<0.30
# Obs	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31
# <LOD	0	0	24	0	21	22	31	31	9	0	0	0	1	6	1	16	30	30	0	31
Mean*	3.77	0.38	0.11	0.11	0.02	0.49	0.01	0.05	0.17	0.27	0.07	0.71	0.78	0.80	0.24	0.02	0.03	0.03	1.27	0.15
Max	7.60	0.90	0.32	0.16	0.07	2.60	<0.02	<0.10	0.50	0.33	0.09	1.70	3.60	3.20	0.60	0.08	0.07	0.10	4.00	<0.30
Min	1.70	0.10	<0.15	0.10	<0.02	<0.50	<0.02	<0.10	<0.10	0.23	0.06	0.20	<0.20	<0.30	<0.10	<0.01	<0.05	<0.05	0.30	<0.30

*Values below the detection limit are set to one-half the detection limit for statistical calculations.

Bay Area Air Quality Management District
Toxic Air Contaminants
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Ambient Air Toxics Data - Gases (ppb)
Date Range: Jan 1, 2003 - Dec 31, 2003

Station: Martinez
521 Jones Street
Martinez, CA 94553

Station ID: 2014
AIRS ID: 060132001
CARB ID: 0700434

Date	Acetone	Benz	But-1,3	CCl4	CHCl3	DCM	EDB	EDC	EthBenz	Freon 11	Freon 113	M/P Xyl	MEK	MTBE	O Xyl	Perc	TCA	TCE	Tol	VC
03-Jan-03	18.90	0.80	<0.15	0.14	<0.02	<0.50	<0.02	<0.10	0.20	0.31	0.09	1.00	0.70	1.00	0.30	0.04	0.06	<0.05	1.70	<0.30
15-Jan-03	23.30	0.40	<0.15	0.11	0.03	<0.50	<0.02	<0.10	0.10	0.27	0.07	0.40	1.20	1.20	0.10	0.02	<0.05	<0.05	1.00	<0.30
27-Jan-03	19.40	0.60	<0.15	0.11	<0.02	0.60	<0.02	<0.10	0.20	0.25	0.07	0.90	1.20	1.00	0.30	0.04	0.06	<0.05	1.80	<0.30
08-Feb-03	13.30	0.50	<0.15	0.12	<0.02	<0.50	<0.02	<0.10	0.10	0.30	0.08	0.40	0.60	0.80	0.20	<0.01	0.05	<0.05	0.70	<0.30
20-Feb-03	11.50	0.20	<0.15	0.10	<0.02	<0.50	<0.02	<0.10	<0.10	0.23	0.08	0.10	0.60	<0.30	<0.10	<0.01	<0.05	<0.05	0.40	<0.30
04-Mar-03	23.00	0.20	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	<0.10	0.25	0.07	0.30	1.30	0.40	0.10	<0.01	0.05	<0.05	0.60	<0.30
16-Mar-03	25.10	0.30	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	<0.10	0.25	0.07	0.30	1.20	0.30	0.10	<0.01	0.05	<0.05	0.50	<0.30
28-Mar-03	31.70	0.20	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	<0.10	0.25	0.07	0.20	1.50	0.50	0.10	<0.01	0.09	<0.05	0.40	<0.30
09-Apr-03	36.40	0.30	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	<0.10	0.27	0.07	0.30	2.00	0.60	0.10	<0.01	0.08	<0.05	0.80	<0.30
21-Apr-03	18.60	0.20	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	<0.10	0.24	0.07	0.10	0.80	<0.30	<0.10	<0.01	0.17	<0.05	0.30	<0.30
03-May-03	39.10	0.10	<0.15	0.12	<0.02	<0.50	<0.02	<0.10	<0.10	0.27	0.07	0.20	2.20	0.30	<0.10	<0.01	0.06	<0.05	0.60	<0.30
15-May-03	30.20	0.10	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	<0.10	0.26	0.08	0.10	1.00	<0.30	<0.10	<0.01	0.05	<0.05	0.20	<0.30
27-May-03	46.00	0.30	<0.15	0.11	<0.02	0.50	<0.02	<0.10	0.10	0.26	0.07	0.40	2.10	0.70	0.10	0.02	0.17	0.05	0.80	<0.30
08-Jun-03	17.60	0.30	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	<0.10	0.28	0.07	0.10	0.90	0.50	<0.10	<0.01	0.11	<0.05	0.60	<0.30
20-Jun-03	48.80	0.60	0.15	0.11	<0.02	<0.50	<0.02	<0.10	0.20	0.25	0.07	0.90	2.10	1.50	0.30	<0.01	0.09	<0.05	1.80	<0.30
02-Jul-03	44.10	0.20	<0.15	0.11	<0.02	0.80	<0.02	<0.10	<0.10	0.27	0.06	0.20	1.60	0.70	0.10	<0.01	0.11	<0.05	0.40	<0.30
14-Jul-03	29.70	0.20	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	0.10	0.28	0.07	0.40	1.40	0.60	0.10	0.02	0.11	<0.05	0.80	<0.30
26-Jul-03	24.80	0.10	<0.15	0.11	<0.02	0.50	<0.02	<0.10	<0.10	0.27	0.07	0.10	1.30	1.00	<0.10	<0.01	0.15	<0.05	0.30	<0.30
07-Aug-03	30.80	0.20	<0.15	0.12	0.03	<0.50	<0.02	<0.10	<0.10	0.28	0.07	0.10	1.20	0.40	<0.10	<0.01	0.09	<0.05	0.50	<0.30
19-Aug-03	21.50	0.10	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	<0.10	0.29	0.07	0.10	1.00	<0.30	<0.10	<0.01	0.23	<0.05	0.30	<0.30
31-Aug-03	22.20	0.10	<0.15	0.09	<0.02	<0.50	<0.02	<0.10	<0.10	0.25	0.07	0.20	1.20	0.40	0.10	<0.01	0.17	<0.05	0.60	<0.30
12-Sep-03	40.60	0.40	<0.15	0.10	<0.02	<0.50	<0.02	<0.10	0.20	0.26	0.08	0.70	1.60	2.00	0.20	<0.01	0.20	<0.05	1.10	<0.30
24-Sep-03	18.80	0.20	<0.15	0.09	<0.02	<0.50	<0.02	<0.10	<0.10	0.28	0.06	0.10	0.70	<0.30	<0.10	<0.01	0.08	<0.05	0.40	<0.30
06-Oct-03	14.90	0.40	<0.15	0.11	0.03	<0.50	<0.02	<0.10	0.10	0.26	0.09	0.60	0.90	2.00	0.20	0.02	0.06	<0.05	1.00	<0.30
18-Oct-03	25.80	0.40	<0.15	0.09	<0.02	<0.50	<0.02	<0.10	0.20	0.24	0.07	0.70	1.10	0.90	0.30	<0.01	0.09	<0.05	1.20	<0.30
30-Oct-03	9.70	0.10	<0.15	0.10	<0.02	<0.50	<0.02	<0.10	<0.10	0.25	0.08	0.10	0.30	<0.30	<0.10	<0.01	<0.05	<0.05	0.20	<0.30

Bay Area Air Quality Management District
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Ambient Air Toxics Data - Gases (ppb)
Date Range: Jan 1, 2003 - Dec 31, 2003

Station: Martinez
521 Jones Street
Martinez, CA 94553

Station ID: 2014
AIRS ID: 060132001
CARB ID: 0700434

Date	Acetone	Benz	But-1,3	CCl4	CHCl3	DCM	EDB	EDC	EthBenz	Freon 11	Freon 113	M/P Xyl	MEK	MTBE	O Xyl	Perc	TCA	TCE	Tol	VC
23-Nov-03	2.30	0.50	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	0.10	0.24	0.08	0.40	0.20	0.50	0.10	0.02	<0.05	<0.05	0.80	<0.30
05-Dec-03	2.90	0.70	0.47	0.11	0.03	<0.50	<0.02	<0.10	0.20	0.28	0.08	0.70	0.30	0.70	0.20	0.04	0.05	<0.05	1.20	<0.30
17-Dec-03	2.60	1.00	0.46	0.12	<0.02	<0.50	<0.02	<0.10	0.30	0.26	0.08	1.20	0.40	1.00	0.50	0.02	0.06	<0.05	2.50	<0.30
29-Dec-03	2.20	0.20	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	<0.10	0.22	0.08	0.20	0.20	<0.30	<0.10	<0.01	0.05	<0.05	0.30	<0.30
# Obs	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31
# <LOD	0	0	28	0	27	27	31	31	18	0	0	0	0	8	11	21	5	30	0	31
Mean*	22.54	0.33	0.10	0.11	0.01	0.30	0.01	0.05	0.10	0.26	0.07	0.38	1.06	0.65	0.13	0.01	0.09	0.03	0.79	0.15
Max	48.80	1.00	0.47	0.14	0.03	0.80	<0.02	<0.10	0.30	0.31	0.09	1.20	2.20	2.00	0.50	0.04	0.23	0.05	2.50	<0.30
Min	2.20	0.10	<0.15	0.09	<0.02	<0.50	<0.02	<0.10	<0.10	0.22	0.06	0.10	0.20	<0.30	<0.10	<0.01	<0.05	<0.05	0.20	<0.30

*Values below the detection limit are set to one-half the detection limit for statistical calculations.

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Ambient Air Toxics Data - Gases (ppb)
Date Range: Jan 1, 2003 - Dec 31, 2003

Station: Crockett
End of Kendall Ave
Crockett, CA 94525

Station ID: 2017
AIRS ID: 060131001
CARB ID: 0700437

Date	Acetone	Benz	But-1,3	CCl4	CHCl3	DCM	EDB	EDC	EthBenz	Freon 11	Freon 113	M/P Xyl	MEK	MTBE	O Xyl	Perc	TCA	TCE	Tol	VC
02-Jan-03	2.50	0.30	<0.15	0.12	<0.02	0.80	<0.02	<0.10	0.60	0.29	0.08	2.00	0.50	0.30	0.90	0.02	<0.05	<0.05	1.10	<0.30
15-Jan-03	1.60	0.30	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	<0.10	0.26	0.07	0.20	<0.20	0.40	0.10	<0.01	<0.05	<0.05	0.50	<0.30
27-Jan-03	1.80	0.30	<0.15	0.11	<0.02	0.60	<0.02	<0.10	<0.10	0.27	0.08	0.30	0.20	0.60	0.10	0.02	0.05	<0.05	0.50	<0.30
08-Feb-03	2.30	0.30	<0.15	0.12	0.03	<0.50	<0.02	<0.10	<0.10	0.30	0.08	0.20	0.20	0.30	0.10	<0.01	0.05	<0.05	0.40	<0.30
20-Feb-03	1.00	0.20	<0.15	0.10	<0.02	0.60	<0.02	<0.10	<0.10	0.23	0.06	0.10	<0.20	<0.30	<0.10	<0.01	<0.05	<0.05	0.50	<0.30
04-Mar-03	1.70	0.30	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	<0.10	0.24	0.06	0.20	<0.20	1.70	<0.10	<0.01	<0.05	<0.05	0.50	<0.30
16-Mar-03	1.30	0.10	<0.15	0.11	<0.02	0.70	<0.02	<0.10	<0.10	0.27	0.08	0.10	<0.20	<0.30	<0.10	<0.01	0.05	<0.05	0.10	<0.30
28-Mar-03	3.00	0.10	<0.15	0.12	<0.02	<0.50	<0.02	<0.10	<0.10	0.26	0.08	<0.10	0.20	<0.30	<0.10	<0.01	0.06	<0.05	0.10	<0.30
09-Apr-03	2.20	0.10	<0.15	0.12	<0.02	0.70	<0.02	<0.10	<0.10	0.26	0.08	0.10	<0.20	<0.30	<0.10	<0.01	0.06	<0.05	0.10	<0.30
21-Apr-03	1.60	0.20	<0.15	0.10	<0.02	<0.50	<0.02	<0.10	<0.10	0.25	0.07	<0.10	<0.20	<0.30	<0.10	<0.01	<0.05	<0.05	0.30	<0.30
03-May-03	3.20	0.20	<0.15	0.11	<0.02	0.60	<0.02	<0.10	<0.10	0.26	0.07	<0.10	<0.20	<0.30	<0.10	<0.01	0.05	<0.05	0.40	<0.30
15-May-03	3.50	0.10	<0.15	0.11	<0.02	0.70	<0.02	<0.10	<0.10	0.25	0.07	<0.10	0.20	<0.30	<0.10	<0.01	0.06	<0.05	0.10	<0.30
27-May-03	9.50	0.30	0.20	0.12	<0.02	<0.50	<0.02	<0.10	0.10	0.28	0.08	0.30	0.60	0.60	0.10	0.02	0.09	<0.05	0.50	<0.30
08-Jun-03	5.60	0.10	<0.15	0.11	<0.02	0.50	<0.02	<0.10	<0.10	0.27	0.07	<0.10	0.20	0.80	<0.10	<0.01	0.07	<0.05	0.10	<0.30
20-Jun-03	7.40	0.20	0.16	0.10	<0.02	1.10	<0.02	<0.10	<0.10	0.26	0.07	0.10	0.30	0.30	<0.10	<0.01	0.06	<0.05	0.40	<0.30
02-Jul-03	14.30	0.40	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	<0.10	0.29	0.07	0.20	0.70	0.40	0.10	<0.01	0.10	<0.05	0.70	<0.30
14-Jul-03	19.00	0.20	0.16	0.11	<0.02	0.90	<0.02	<0.10	<0.10	0.25	0.07	0.20	1.00	0.60	<0.10	<0.01	0.09	<0.05	0.30	<0.30
26-Jul-03	17.20	0.10	<0.15	0.12	<0.02	1.30	<0.02	<0.10	<0.10	0.27	0.07	0.10	0.60	0.40	<0.10	<0.01	0.09	<0.05	0.30	<0.30
07-Aug-03	16.70	0.20	<0.15	0.11	<0.02	1.10	<0.02	<0.10	<0.10	0.27	0.07	<0.10	0.40	<0.30	<0.10	<0.01	0.08	<0.05	0.30	<0.30
19-Aug-03	13.10	0.10	<0.15	0.11	<0.02	3.00	<0.02	<0.10	<0.10	0.28	0.07	0.10	0.50	<0.30	<0.10	<0.01	0.07	<0.05	0.40	<0.30
31-Aug-03	21.40	0.10	<0.15	0.09	<0.02	0.90	<0.02	<0.10	<0.10	0.24	0.08	0.10	0.80	0.30	<0.10	<0.01	0.06	<0.05	0.20	<0.30
12-Sep-03	29.50	0.20	<0.15	0.09	<0.02	<0.50	<0.02	<0.10	0.10	0.23	0.08	0.30	1.20	1.20	0.10	<0.01	0.09	<0.05	0.40	<0.30
24-Sep-03	12.40	0.10	<0.15	0.10	<0.02	1.70	<0.02	<0.10	<0.10	0.27	0.08	0.10	0.40	0.30	<0.10	<0.01	0.06	<0.05	0.20	<0.30
06-Oct-03	23.00	0.20	<0.15	0.10	0.03	0.90	<0.02	<0.10	<0.10	0.29	0.08	0.20	0.80	0.60	<0.10	0.02	0.06	<0.05	0.40	<0.30
18-Oct-03	14.50	0.20	<0.15	0.10	0.03	1.50	<0.02	<0.10	<0.10	0.25	0.08	0.20	0.60	0.40	<0.10	<0.01	0.06	<0.05	0.30	<0.30
30-Oct-03	6.10	<0.10	<0.15	0.10	<0.02	<0.50	<0.02	<0.10	<0.10	0.25	0.08	<0.10	0.30	<0.30	<0.10	<0.01	0.05	<0.05	<0.1	<0.30

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Ambient Air Toxics Data - Gases (ppb)
Date Range: Jan 1, 2003 - Dec 31, 2003

Station: Crockett
End of Kendall Ave
Crockett, CA 94525

Station ID: 2017
AIRS ID: 060131001
CARB ID: 0700437

Date	Acetone	Benz	But-1,3	CCl4	CHCl3	DCM	EDB	EDC	EthBenz	Freon 11	Freon 113	M/P Xyl	MEK	MTBE	O Xyl	Perc	TCA	TCE	Tol	VC
23-Nov-03	8.60	0.30	<0.15	0.11	0.03	0.50	<0.02	<0.10	<0.10	0.28	0.09	0.20	0.40	<0.30	<0.10	<0.01	<0.05	<0.05	0.50	<0.30
05-Dec-03	23.20	0.40	0.16	0.11	0.04	<0.50	<0.02	<0.10	0.10	0.24	0.09	0.30	1.00	0.30	0.10	0.03	<0.05	<0.05	0.60	<0.30
17-Dec-03	10.10	0.20	<0.15	0.11	0.03	0.60	<0.02	<0.10	<0.10	0.23	0.08	0.10	0.30	<0.30	<0.10	<0.01	<0.05	<0.05	0.20	<0.30
29-Dec-03	13.80	0.20	0.19	0.11	0.03	1.40	<0.02	<0.10	<0.10	0.28	0.08	0.10	0.60	<0.30	<0.10	<0.01	<0.05	<0.05	0.20	<0.30
# Obs	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31
# <LOD	0	1	25	0	23	11	31	31	27	0	0	7	7	13	23	26	9	31	1	31
Mean*	10.12	0.20	0.10	0.11	0.02	0.74	0.01	0.05	0.07	0.26	0.08	0.20	0.43	0.38	0.09	0.01	0.05	0.03	0.36	0.15
Max	29.50	0.40	0.30	0.12	0.04	3.00	<0.02	<0.10	0.60	0.30	0.09	2.00	1.20	1.70	0.90	0.03	0.10	<0.05	1.10	<0.30
Min	1.00	<0.10	<0.15	0.09	<0.02	<0.50	<0.02	<0.10	<0.10	0.23	0.06	<0.10	<0.20	<0.30	<0.10	<0.01	<0.05	<0.05	<0.1	<0.30

*Values below the detection limit are set to one-half the detection limit for statistical calculations.

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Toxic Air Contaminants
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Ambient Air Toxics Data - Gases (ppb)
Date Range: Jan 1, 2003 - Dec 31, 2003

Station: Concord
2975 Treat Boulevard
Concord, CA 94518

Station ID: 2018
AIRS ID: 060130002
CARB ID: 0700440

Date	Acetone	Benz	But-1,3	CCl4	CHCl3	DCM	EDB	EDC	EthBenz	Freon 11	Freon 113	M/P Xyl	MEK	MTBE	O Xyl	Perc	TCA	TCE	Tol	VC
03-Jan-03	3.30	0.80	0.18	0.14	0.04	<0.50	<0.02	<0.10	0.20	0.28	0.08	0.80	0.40	1.00	0.30	0.04	0.05	<0.05	2.50	<0.30
15-Jan-03	3.00	0.80	0.28	0.12	0.03	<0.50	<0.02	<0.10	0.20	0.26	0.08	0.90	0.40	1.00	0.30	0.04	<0.05	<0.05	2.70	<0.30
27-Jan-03	3.20	0.80	0.28	0.12	0.04	<0.50	<0.02	<0.10	0.20	0.28	0.09	0.80	0.40	0.80	0.30	0.05	0.05	<0.05	2.70	<0.30
08-Feb-03	3.70	0.80	0.26	0.13	0.05	<0.50	<0.02	<0.10	0.20	0.27	0.08	0.80	0.40	0.70	0.30	0.02	0.05	<0.05	2.20	<0.30
20-Feb-03	2.60	0.40	0.21	0.12	<0.02	<0.50	<0.02	<0.10	0.10	0.24	0.07	0.40	0.20	0.30	0.20	0.02	<0.05	<0.05	1.70	<0.30
04-Mar-03	3.00	0.40	<0.15	0.11	0.04	<0.50	<0.02	<0.10	0.10	0.25	0.07	0.40	0.30	0.30	0.10	0.02	<0.05	<0.05	1.70	<0.30
16-Mar-03	2.50	0.30	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	<0.10	0.25	0.07	0.20	0.20	<0.30	0.10	<0.01	<0.05	<0.05	1.50	<0.30
28-Mar-03	5.00	0.50	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	0.10	0.26	0.07	0.50	0.40	0.40	0.20	<0.01	<0.05	<0.05	2.00	<0.30
09-Apr-03	3.80	0.30	<0.15	0.13	0.03	<0.50	<0.02	<0.10	0.10	0.26	0.08	0.30	0.40	0.30	0.10	0.02	<0.05	<0.05	1.20	<0.30
21-Apr-03	2.20	0.20	<0.15	0.13	<0.02	<0.50	<0.02	<0.10	<0.10	0.28	0.09	0.10	0.20	<0.30	<0.10	<0.01	<0.05	<0.05	1.10	<0.30
03-May-03	3.70	0.20	<0.15	0.12	0.06	<0.50	<0.02	<0.10	<0.10	0.25	0.08	0.20	0.40	<0.30	<0.10	0.02	<0.05	<0.05	1.10	<0.30
15-May-03	2.90	0.20	<0.15	0.13	<0.02	<0.50	<0.02	<0.10	<0.10	0.25	0.08	0.10	0.30	<0.30	<0.10	0.18	<0.05	<0.05	1.00	<0.30
27-May-03	6.20	0.40	0.16	0.13	0.05	<0.50	<0.02	<0.10	0.10	0.29	0.08	0.40	0.90	0.50	0.10	0.03	<0.05	<0.05	1.90	<0.30
08-Jun-03	2.50	0.20	<0.15	0.12	<0.02	<0.50	<0.02	<0.10	<0.10	0.25	0.07	0.10	<0.20	<0.30	<0.10	<0.01	<0.05	<0.05	1.40	<0.30
20-Jun-03	2.90	0.20	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	<0.10	0.27	0.07	0.10	0.20	<0.30	<0.10	<0.01	<0.05	<0.05	1.60	<0.30
02-Jul-03	2.10	0.20	<0.15	0.12	0.03	<0.50	<0.02	<0.10	<0.10	0.27	0.07	0.20	0.40	0.30	0.10	0.02	<0.05	<0.05	1.40	<0.30
14-Jul-03	6.30	0.20	<0.15	0.12	0.04	<0.50	<0.02	<0.10	<0.10	0.28	0.08	0.20	0.60	0.60	<0.10	<0.01	<0.05	<0.05	1.10	<0.30
26-Jul-03	5.10	0.30	0.31	0.11	0.03	<0.50	<0.02	<0.10	0.10	0.28	0.07	0.30	0.60	0.80	0.10	0.02	<0.05	<0.05	1.40	<0.30
07-Aug-03	4.20	0.20	<0.15	0.12	<0.02	<0.50	<0.02	<0.10	<0.10	0.28	0.07	0.10	0.30	0.30	<0.10	0.03	<0.05	<0.05	1.30	<0.30
19-Aug-03	2.70	0.10	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	0.10	0.27	0.07	0.10	0.20	<0.30	0.10	<0.01	<0.05	<0.05	1.00	<0.30
31-Aug-03	6.40	0.30	<0.15	0.10	0.04	<0.50	<0.02	<0.10	0.10	0.25	0.08	0.30	0.60	0.80	0.10	<0.01	<0.05	<0.05	1.40	<0.30
12-Sep-03	8.60	0.60	<0.15	0.11	0.07	<0.50	<0.02	<0.10	0.20	0.26	0.08	0.90	1.00	2.50	0.30	0.02	<0.05	<0.05	2.00	<0.30
24-Sep-03	3.40	0.10	<0.15	0.10	<0.02	<0.50	<0.02	<0.10	<0.10	0.26	0.08	0.20	0.30	<0.30	0.10	<0.01	<0.05	<0.05	0.90	<0.30
06-Oct-03	5.40	0.40	<0.15	0.11	0.06	<0.50	<0.02	<0.10	0.20	0.22	0.08	0.60	0.60	1.10	0.20	0.04	<0.05	<0.05	1.80	<0.30
20-Oct-03	9.20	0.90	<0.15	0.10	0.03	<0.50	<0.02	<0.10	0.30	0.25	0.07	1.60	0.70	1.80	0.60	0.03	<0.05	<0.05	4.20	<0.30
30-Oct-03	2.00	0.20	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	<0.10	0.30	0.08	0.20	0.30	0.40	<0.10	0.02	<0.05	<0.05	1.10	<0.30

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Ambient Air Toxics Data - Gases (ppb)
Date Range: Jan 1, 2003 - Dec 31, 2003

Station: Concord
2975 Treat Boulevard
Concord, CA 94518

Station ID: 2018
AIRS ID: 060130002
CARB ID: 0700440

Date	Acetone	Benz	But-1,3	CCl4	CHCl3	DCM	EDB	EDC	EthBenz	Freon 11	Freon 113	M/P Xyl	MEK	MTBE	O Xyl	Perc	TCA	TCE	Tol	VC
23-Nov-03	4.10	0.70	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	0.20	0.26	0.07	0.80	0.30	<0.30	0.30	0.02	<0.05	<0.05	2.60	<0.30
05-Dec-03	8.70	0.90	0.15	0.10	<0.02	<0.50	<0.02	<0.10	0.30	0.23	0.06	1.50	0.60	0.30	0.50	0.05	<0.05	<0.05	4.00	<0.30
18-Dec-03	4.40	0.80	0.50	0.12	0.04	<0.50	<0.02	<0.10	0.30	0.26	0.08	0.90	0.40	0.30	0.40	0.03	<0.05	<0.05	2.00	<0.30
29-Dec-03	2.00	0.20	0.17	0.12	<0.02	<0.50	<0.02	<0.10	<0.10	0.25	0.08	0.10	0.20	<0.30	<0.10	<0.01	<0.05	<0.05	0.80	<0.30
# Obs	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31
# <LOD	0	0	20	0	14	31	31	31	12	0	0	0	1	10	9	10	28	31	0	31
Mean*	4.17	0.43	0.14	0.12	0.03	0.25	0.01	0.05	0.13	0.26	0.08	0.48	0.41	0.56	0.18	0.03	0.03	0.03	1.79	0.15
Max	9.20	0.90	0.50	0.14	0.07	<0.50	<0.02	<0.10	0.30	0.30	0.09	1.60	1.00	2.50	0.60	0.18	0.05	<0.05	4.20	<0.30
Min	2.00	0.10	<0.15	0.10	<0.02	<0.50	<0.02	<0.10	<0.10	0.22	0.06	0.10	<0.20	<0.30	<0.10	<0.01	<0.05	<0.05	0.80	<0.30

*Values below the detection limit are set to one-half the detection limit for statistical calculations.

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Toxic Air Contaminants
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Ambient Air Toxics Data - Gases (ppb)
Date Range: Jan 1, 2003 - Dec 31, 2003

Station: Richmond
1065-7th Street
Richmond, CA 94801

Station ID: 2019
AIRS ID: 060130006
CARB ID: 0700441

Date	Acetone	Benz	But-1,3	CCl4	CHCl3	DCM	EDB	EDC	EthBenz	Freon 11	Freon 113	M/P Xyl	MEK	MTBE	O Xyl	Perc	TCA	TCE	Tol	VC
03-Jan-03	2.70	0.50	<0.15	0.12	<0.02	<0.50	<0.02	<0.10	0.10	0.29	0.09	0.60	0.20	0.40	0.20	0.05	0.07	0.10	1.20	<0.30
15-Jan-03	3.00	0.40	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	0.20	0.27	0.07	0.70	0.40	0.40	0.20	0.03	<0.05	<0.05	1.30	<0.30
27-Jan-03	6.80	0.60	<0.15	0.10	<0.02	<0.50	<0.02	<0.10	0.20	0.25	0.06	1.10	1.10	0.40	0.40	0.06	<0.05	<0.05	2.90	<0.30
08-Feb-03	2.50	0.60	<0.15	0.10	<0.02	0.60	<0.02	<0.10	0.20	0.24	0.06	0.90	0.30	0.30	0.30	0.02	<0.05	<0.05	2.20	<0.30
20-Feb-03	2.70	0.30	<0.15	0.12	<0.02	<0.50	<0.02	<0.10	<0.10	0.26	0.08	0.30	0.80	0.30	0.10	<0.01	<0.05	<0.05	0.60	<0.30
04-Mar-03	4.50	0.70	<0.15	0.12	0.04	<0.50	<0.02	<0.10	0.20	0.27	0.07	1.00	1.20	0.30	0.30	0.02	<0.05	<0.05	1.90	<0.30
16-Mar-03	2.40	0.30	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	<0.10	0.28	0.06	0.20	0.30	0.30	0.10	<0.01	<0.05	<0.05	0.50	<0.30
28-Mar-03	2.50	0.30	<0.15	0.10	<0.02	<0.50	<0.02	<0.10	<0.10	0.25	0.07	0.40	0.20	<0.30	0.10	<0.01	<0.05	<0.05	0.80	<0.30
09-Apr-03	10.20	0.40	<0.15	0.12	<0.02	<0.50	<0.02	<0.10	0.10	0.26	0.07	0.50	0.90	0.40	0.20	0.02	<0.05	<0.05	2.10	<0.30
21-Apr-03	5.00	0.20	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	<0.10	0.25	0.07	0.80	1.90	<0.30	<0.10	<0.01	<0.05	<0.05	1.20	<0.30
03-May-03	6.30	0.20	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	<0.10	0.19	0.07	0.20	1.50	0.30	0.10	<0.01	<0.05	<0.05	0.60	<0.30
15-May-03	9.70	0.20	0.28	0.11	<0.02	<0.50	<0.02	<0.10	<0.10	0.26	0.07	0.30	0.80	<0.30	0.10	<0.01	<0.05	<0.05	2.10	<0.30
27-May-03	16.20	0.50	0.27	0.11	<0.02	<0.50	<0.02	<0.10	0.20	0.28	0.08	0.60	1.40	0.60	0.20	0.02	<0.05	<0.05	1.20	<0.30
08-Jun-03	10.10	0.20	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	<0.10	0.23	0.08	0.20	0.90	0.30	<0.10	<0.01	<0.05	<0.05	0.70	<0.30
20-Jun-03	14.40	0.20	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	<0.10	0.26	0.07	0.30	1.30	<0.30	0.10	<0.01	<0.05	<0.05	0.60	<0.30
02-Jul-03	8.40	0.10	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	<0.10	0.27	0.07	0.20	0.40	<0.30	<0.10	<0.01	<0.05	<0.05	0.40	<0.30
14-Jul-03	16.10	0.40	0.20	0.11	0.03	<0.50	<0.02	<0.10	0.10	0.30	0.07	0.50	0.60	1.60	0.30	<0.01	<0.05	<0.05	1.30	<0.30
26-Jul-03	13.90	0.20	<0.15	0.12	0.03	<0.50	<0.02	<0.10	<0.10	0.28	0.07	0.30	1.20	0.40	0.10	<0.01	<0.05	<0.05	0.70	<0.30
07-Aug-03	18.20	0.10	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	<0.10	0.28	0.07	0.10	2.80	0.30	<0.10	<0.01	<0.05	<0.05	0.60	<0.30
19-Aug-03	12.00	0.20	0.15	0.11	<0.02	1.50	<0.02	<0.10	0.10	0.29	0.08	0.40	5.40	0.50	0.10	<0.01	0.07	<0.05	2.70	<0.30
31-Aug-03	16.00	0.10	<0.15	0.09	<0.02	<0.50	<0.02	<0.10	<0.10	0.25	0.08	0.10	0.70	0.40	<0.10	<0.01	<0.05	<0.05	0.20	<0.30
12-Sep-03	60.60	0.70	<0.15	0.09	0.05	<0.50	<0.02	<0.10	0.30	0.27	0.08	1.10	3.00	3.90	0.30	0.03	<0.05	<0.05	2.00	<0.30
24-Sep-03	17.90	0.10	<0.15	0.10	<0.02	<0.50	<0.02	<0.10	0.10	0.26	0.08	0.30	5.00	<0.30	0.10	<0.01	<0.05	<0.05	2.00	<0.30
06-Oct-03	14.20	0.30	<0.15	0.09	<0.02	<0.50	<0.02	<0.10	<0.10	0.24	0.07	0.40	0.70	0.50	0.10	<0.01	<0.05	<0.05	0.80	<0.30
18-Oct-03	26.80	0.40	<0.15	0.10	0.03	<0.50	<0.02	<0.10	0.20	0.26	0.08	0.60	1.20	1.40	0.20	0.03	<0.05	<0.05	1.00	<0.30
30-Oct-03	9.90	0.20	<0.15	0.10	<0.02	<0.50	<0.02	<0.10	<0.10	0.27	0.08	0.20	0.50	0.40	<0.10	<0.01	0.13	<0.05	0.40	<0.30

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Ambient Air Toxics Data - Gases (ppb)
Date Range: Jan 1, 2003 - Dec 31, 2003

Station: Richmond
1065-7th Street
Richmond, CA 94801

Station ID: 2019
AIRS ID: 060130006
CARB ID: 0700441

Date	Acetone	Benz	But-1,3	CCl4	CHCl3	DCM	EDB	EDC	EthBenz	Freon 11	Freon 113	M/P Xyl	MEK	MTBE	O Xyl	Perc	TCA	TCE	Tol	VC
23-Nov-03	11.30	0.50	0.15	0.11	0.06	<0.50	<0.02	<0.10	0.10	0.29	0.08	0.40	0.60	0.30	0.10	0.02	<0.05	<0.05	0.80	<0.30
05-Dec-03	5.40	0.50	0.27	0.10	0.03	<0.50	<0.02	<0.10	0.20	0.25	0.08	0.70	3.00	0.40	0.20	0.03	<0.05	<0.05	2.10	<0.30
17-Dec-03	3.00	0.50	0.27	0.11	0.04	<0.50	<0.02	<0.10	0.20	0.23	0.08	0.70	0.20	0.30	0.30	0.03	0.05	<0.05	1.00	<0.30
29-Dec-03	2.00	0.30	0.24	0.12	0.03	<0.50	<0.02	<0.10	0.10	0.25	0.08	0.60	0.20	<0.30	0.20	0.02	<0.05	<0.05	0.50	<0.30
# Obs	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31
# <LOD	0	0	22	0	21	29	31	31	14	0	0	0	0	7	6	17	27	30	0	31
Mean*	11.34	0.35	0.12	0.11	0.02	0.30	0.01	0.05	0.11	0.26	0.07	0.49	1.30	0.53	0.16	0.02	0.03	0.03	1.21	0.15
Max	60.60	0.70	0.28	0.12	0.06	1.50	<0.02	<0.10	0.30	0.30	0.09	1.10	5.40	3.90	0.40	0.06	0.13	0.10	2.90	<0.30
Min	2.00	0.10	<0.15	0.09	<0.02	<0.50	<0.02	<0.10	<0.10	0.19	0.06	0.10	0.20	<0.30	<0.10	<0.01	<0.05	<0.05	0.20	<0.30

*Values below the detection limit are set to one-half the detection limit for statistical calculations.

Bay Area Air Quality Management District
Toxic Air Contaminants
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Ambient Air Toxics Data - Gases (ppb)
Date Range: Jan 1, 2003 - Dec 31, 2003

Station: Bethel Island
5551 Bethel Island Road
Bethel Island, CA 94511

Station ID: 2021
AIRS ID: 060131002
CARB ID: 0700442

Date	Acetone	Benz	But-1,3	CCl4	CHCl3	DCM	EDB	EDC	EthBenz	Freon 11	Freon 113	M/P Xyl	MEK	MTBE	O Xyl	Perc	TCA	TCE	Tol	VC
03-Jan-03	4.10	0.60	<0.15	0.12	<0.02	<0.50	<0.02	<0.10	0.20	0.27	0.08	0.60	0.30	0.70	0.20	0.02	<0.05	<0.05	1.20	<0.30
15-Jan-03	0.60	0.40	<0.15	0.10	<0.02	<0.50	<0.02	<0.10	0.20	0.25	0.07	0.60	<0.20	0.50	0.20	<0.01	<0.05	<0.05	1.00	<0.30
27-Jan-03	3.00	0.40	<0.15	0.10	<0.02	<0.50	<0.02	<0.10	0.10	0.24	0.07	0.40	0.30	0.60	0.20	0.02	<0.05	<0.05	1.00	<0.30
08-Feb-03	2.80	0.60	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	0.20	0.26	0.07	0.90	0.20	0.40	0.30	0.02	<0.05	<0.05	1.60	<0.30
20-Feb-03	3.50	0.20	<0.15	0.12	<0.02	<0.50	<0.02	<0.10	<0.10	0.26	0.08	0.10	0.60	<0.30	<0.10	0.03	<0.05	<0.05	0.30	<0.30
04-Mar-03	1.50	0.40	<0.15	0.12	<0.02	<0.50	<0.02	<0.10	<0.10	0.26	0.07	0.40	<0.20	<0.30	0.10	<0.01	<0.05	<0.05	0.80	<0.30
16-Mar-03	1.30	0.20	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	<0.10	0.25	0.08	0.10	<0.20	<0.30	<0.10	<0.01	<0.05	<0.05	0.20	<0.30
28-Mar-03	5.70	0.20	<0.15	0.12	<0.02	<0.50	<0.02	<0.10	<0.10	0.25	0.07	0.20	0.50	0.30	<0.10	<0.01	<0.05	<0.05	0.40	<0.30
09-Apr-03	3.80	0.20	<0.15	0.12	<0.02	<0.50	<0.02	<0.10	<0.10	0.25	0.07	0.30	0.40	<0.30	0.10	<0.01	<0.05	<0.05	0.60	<0.30
21-Apr-03	2.80	0.20	<0.15	0.10	<0.02	<0.50	<0.02	<0.10	<0.10	0.26	0.07	0.10	0.20	<0.30	<0.10	<0.01	<0.05	<0.05	0.40	<0.30
03-May-03	3.70	0.10	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	<0.10	0.24	0.07	<0.10	0.30	0.30	<0.10	<0.01	<0.05	<0.05	0.10	<0.30
15-May-03	3.60	0.10	<0.15	0.10	<0.02	<0.50	<0.02	<0.10	<0.10	0.26	0.07	0.10	0.20	<0.30	<0.10	<0.01	<0.05	<0.05	0.30	<0.30
27-May-03	32.00	0.20	0.40	0.12	0.03	<0.50	<0.02	<0.10	0.10	0.27	0.07	0.20	2.00	0.50	0.10	0.02	<0.05	<0.05	0.20	<0.30
08-Jun-03	5.30	0.20	<0.15	0.10	<0.02	<0.50	<0.02	<0.10	<0.10	0.24	0.06	<0.10	0.30	<0.30	<0.10	<0.01	<0.05	<0.05	0.40	<0.30
20-Jun-03	4.00	0.10	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	<0.10	0.27	0.07	0.10	0.60	<0.30	<0.10	<0.01	<0.05	<0.05	0.10	<0.30
02-Jul-03	8.70	0.20	<0.15	0.10	<0.02	<0.50	<0.02	<0.10	<0.10	0.28	0.06	0.10	0.40	0.50	<0.10	0.02	<0.05	<0.05	0.30	<0.30
14-Jul-03	28.00	0.10	0.18	0.11	<0.02	<0.50	<0.02	<0.10	<0.10	0.27	0.07	0.10	1.50	0.50	<0.10	<0.01	<0.05	<0.05	0.20	<0.30
26-Jul-03	6.10	0.10	0.15	0.11	<0.02	<0.50	<0.02	<0.10	<0.10	0.23	0.06	<0.10	0.40	0.60	<0.10	<0.01	<0.05	<0.05	0.20	<0.30
07-Aug-03	1.00	0.10	<0.15	0.10	<0.02	1.00	<0.02	<0.10	<0.10	0.29	0.06	<0.10	0.30	0.30	<0.10	<0.01	<0.05	<0.05	0.20	<0.30
19-Aug-03	2.90	0.10	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	<0.10	0.27	0.07	0.10	0.30	<0.30	<0.10	<0.01	<0.05	<0.05	0.40	<0.30
31-Aug-03	3.40	0.10	<0.15	0.09	<0.02	<0.50	<0.02	<0.10	<0.10	0.22	0.08	0.10	0.50	0.60	<0.10	<0.01	<0.05	<0.05	0.20	<0.30
12-Sep-03	2.40	0.30	<0.15	0.10	<0.02	<0.50	<0.02	<0.10	<0.10	0.22	0.08	0.30	0.20	2.30	<0.10	<0.01	<0.05	<0.05	0.50	<0.30
24-Sep-03	1.70	0.10	<0.15	0.12	<0.02	<0.50	<0.02	<0.10	<0.10	0.27	0.08	0.20	0.20	0.40	<0.10	0.02	<0.05	<0.05	0.20	<0.30
06-Oct-03	4.40	0.20	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	<0.10	0.25	0.07	0.40	0.40	0.40	0.10	<0.01	<0.05	<0.05	0.80	<0.30
18-Oct-03	4.20	0.60	<0.15	0.11	0.04	<0.50	<0.02	<0.10	0.10	0.27	0.08	0.50	0.60	1.50	0.10	0.02	<0.05	<0.05	1.10	<0.30
30-Oct-03	1.90	0.10	<0.15	0.10	<0.02	<0.50	<0.02	<0.10	<0.10	0.27	0.08	<0.10	<0.20	<0.30	<0.10	<0.01	<0.05	<0.05	0.10	<0.30

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Ambient Air Toxics Data - Gases (ppb)
Date Range: Jan 1, 2003 - Dec 31, 2003

Station: Bethel Island
5551 Bethel Island Road
Bethel Island, CA 94511

Station ID: 2021
AIRS ID: 060131002
CARB ID: 0700442

Date	Acetone	Benz	But-1,3	CCl4	CHCl3	DCM	EDB	EDC	EthBenz	Freon 11	Freon 113	M/P Xyl	MEK	MTBE	O Xyl	Perc	TCA	TCE	Tol	VC
23-Nov-03	2.80	0.40	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	<0.10	0.27	0.07	0.20	0.50	0.40	<0.10	<0.01	<0.05	<0.05	0.70	<0.30
05-Dec-03	3.00	0.20	0.16	0.11	<0.02	<0.50	<0.02	<0.10	<0.10	0.27	0.08	0.20	0.40	0.30	<0.10	<0.01	<0.05	<0.05	0.40	<0.30
17-Dec-03	2.70	0.40	<0.15	0.11	0.03	<0.50	<0.02	<0.10	0.10	0.29	0.09	0.30	0.30	<0.30	0.10	<0.01	<0.05	<0.05	0.60	<0.30
29-Dec-03	1.70	0.10	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	<0.10	0.25	0.08	<0.10	0.20	<0.30	<0.10	<0.01	<0.05	<0.05	0.10	<0.30
# Obs	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31
# <LOD	0	0	26	0	28	30	31	31	24	0	0	6	4	12	21	23	31	31	0	31
Mean*	4.99	0.24	0.10	0.11	0.01	0.27	0.01	0.05	0.07	0.26	0.07	0.23	0.42	0.43	0.08	0.01	0.03	0.03	0.50	0.15
Max	32.00	0.60	0.40	0.12	0.04	1.00	<0.02	<0.10	0.20	0.29	0.09	0.90	2.00	2.30	0.30	0.03	<0.05	<0.05	1.60	<0.30
Min	0.60	0.10	<0.15	0.09	<0.02	<0.50	<0.02	<0.10	<0.10	0.22	0.06	<0.10	<0.20	<0.30	<0.10	<0.01	<0.05	<0.05	0.10	<0.30

*Values below the detection limit are set to one-half the detection limit for statistical calculations.

Bay Area Air Quality Management District
Toxic Air Contaminants
2003 Annual Report

Ambient Air Toxics Data - Gases (ppb)
Date Range: Jan 1, 2003 - Dec 31, 2003

Station: San Pablo
1865-D Rumrill Boulevard
San Pablo, CA 94806

Station ID: 2035
AIRS ID: 060131004
CARB ID:

Date	Acetone	Benz	But-1,3	CCl4	CHCl3	DCM	EDB	EDC	EthBenz	Freon 11	Freon 113	M/P Xyl	MEK	MTBE	O Xyl	Perc	TCA	TCE	Tol	VC
03-Jan-03	2.80	0.40	<0.15	0.12	<0.02	<0.50	<0.02	<0.10	0.20	0.29	0.08	0.60	0.20	0.50	0.20	0.11	<0.05	<0.05	1.20	<0.30
15-Jan-03	6.40	0.50	<0.15	0.10	<0.02	<0.50	<0.02	<0.10	0.30	0.27	0.07	1.00	0.70	0.80	0.40	0.08	<0.05	<0.05	2.50	<0.30
27-Jan-03	5.90	0.90	0.23	0.11	0.03	1.10	<0.02	<0.10	0.40	0.28	0.08	1.60	0.50	1.10	0.60	0.09	<0.05	<0.05	2.50	<0.30
08-Feb-03	3.60	0.60	<0.15	0.10	<0.02	<0.50	<0.02	<0.10	0.20	0.28	0.07	0.80	0.40	0.40	0.30	0.04	<0.05	<0.05	1.70	<0.30
20-Feb-03	6.70	0.40	<0.15	0.12	<0.02	<0.50	<0.02	<0.10	0.10	0.27	0.07	0.60	0.40	0.70	0.20	<0.01	<0.05	<0.05	1.00	<0.30
04-Mar-03	3.50	0.50	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	0.20	0.25	0.07	0.80	0.30	0.60	0.30	0.02	<0.05	<0.05	1.50	<0.30
16-Mar-03	2.90	0.40	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	0.10	0.25	0.06	0.50	0.20	0.30	0.20	<0.01	<0.05	<0.05	1.00	<0.30
28-Mar-03	2.90	0.30	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	0.10	0.26	0.07	0.50	0.20	0.30	0.20	0.10	<0.05	<0.05	0.90	<0.30
09-Apr-03	6.00	0.40	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	0.20	0.27	0.07	0.80	0.40	0.50	0.30	0.04	<0.05	<0.05	1.50	<0.30
21-Apr-03	4.90	0.20	<0.15	0.10	<0.02	1.90	<0.02	<0.10	0.10	0.25	0.07	0.40	0.20	0.40	0.20	<0.01	<0.05	<0.05	0.90	<0.30
03-May-03	3.80	0.20	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	<0.10	0.28	0.07	0.20	0.30	0.30	0.10	0.03	<0.05	<0.05	0.40	<0.30
15-May-03	2.80	0.20	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	0.20	0.26	0.06	0.70	0.20	0.40	0.30	<0.01	<0.05	<0.05	1.30	<0.30
27-May-03	7.30	0.50	<0.15	0.11	0.03	<0.50	<0.02	<0.10	0.10	0.27	0.07	0.60	0.40	0.70	0.20	0.03	<0.05	<0.05	1.00	<0.30
08-Jun-03	3.50	0.20	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	<0.10	0.25	0.06	0.20	0.20	<0.30	0.10	<0.01	<0.05	<0.05	0.50	<0.30
20-Jun-03	3.40	0.20	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	0.10	0.24	0.09	0.30	0.20	0.40	0.10	<0.01	<0.05	<0.05	0.50	<0.30
02-Jul-03	2.80	0.20	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	<0.10	0.27	0.07	0.30	0.20	0.30	0.10	<0.01	<0.05	<0.05	0.80	<0.30
14-Jul-03	5.00	0.30	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	0.10	0.28	0.07	0.40	0.30	0.50	0.20	<0.01	0.05	<0.05	0.90	<0.30
26-Jul-03	4.00	0.20	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	<0.10	0.27	0.07	0.20	0.20	0.80	<0.10	<0.01	<0.05	<0.05	0.40	<0.30
07-Aug-03	4.90	0.20	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	<0.10	0.25	0.08	0.20	0.30	0.80	<0.10	<0.01	<0.05	<0.05	0.50	<0.30
19-Aug-03	4.70	0.10	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	<0.10	0.23	0.08	0.10	0.30	0.40	<0.10	<0.01	<0.05	<0.05	0.20	<0.30
31-Aug-03	3.20	0.20	<0.15	0.09	<0.02	<0.50	<0.02	<0.10	<0.10	0.25	0.08	0.20	0.20	0.40	<0.10	<0.01	<0.05	<0.05	0.30	<0.30
12-Sep-03	14.80	0.80	<0.15	0.09	0.05	<0.50	<0.02	<0.10	0.30	0.27	0.08	1.20	0.70	2.70	0.40	0.06	<0.05	<0.05	1.90	<0.30
24-Sep-03	4.00	0.20	<0.15	0.10	<0.02	<0.50	<0.02	<0.10	<0.10	0.26	0.08	0.20	0.30	0.50	<0.10	<0.01	<0.05	<0.05	0.30	<0.30
06-Oct-03	4.40	0.30	<0.15	0.11	0.03	<0.50	<0.02	<0.10	0.10	0.28	0.09	0.40	0.20	0.80	0.10	0.02	<0.05	<0.05	0.60	<0.30
18-Oct-03	5.00	0.50	<0.15	0.10	0.04	<0.50	<0.02	<0.10	0.20	0.27	0.08	0.80	0.40	1.50	0.30	0.04	<0.05	<0.05	1.30	<0.30
30-Oct-03	2.40	0.20	<0.15	0.10	<0.02	<0.50	<0.02	<0.10	<0.10	0.27	0.08	0.40	0.20	0.60	0.10	<0.01	<0.05	<0.05	0.50	<0.30

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Ambient Air Toxics Data - Gases (ppb)
Date Range: Jan 1, 2003 - Dec 31, 2003

Station: San Pablo
1865-D Rumrill Boulevard
San Pablo, CA 94806

Station ID: 2035
AIRS ID: 060131004
CARB ID:

Date	Acetone	Benz	But-1,3	CCl4	CHCl3	DCM	EDB	EDC	EthBenz	Freon 11	Freon 113	M/P Xyl	MEK	MTBE	O Xyl	Perc	TCA	TCE	Tol	VC
23-Nov-03	5.40	0.50	0.22	0.11	0.06	<0.50	<0.02	<0.10	0.10	0.31	0.08	0.50	0.40	0.40	0.20	0.02	<0.05	<0.05	1.00	<0.30
05-Dec-03	4.00	0.60	0.30	0.11	0.03	<0.50	<0.02	<0.10	0.20	0.24	0.08	0.90	0.40	0.50	0.30	0.03	<0.05	<0.05	1.40	<0.30
17-Dec-03	4.20	0.50	<0.15	0.09	<0.02	<0.50	<0.02	<0.10	0.20	0.24	0.06	0.80	0.40	<0.30	0.30	0.07	<0.05	<0.05	1.30	<0.30
31-Dec-03	4.40	0.60	0.24	0.11	0.05	<0.50	<0.02	<0.10	0.20	0.34	0.10	0.80	0.30	<0.30	0.40	0.04	<0.05	<0.05	1.20	<0.30
# Obs	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31
# <LOD	0	0	26	0	22	28	31	31	9	0	0	0	0	3	5	14	29	31	0	31
Mean*	4.63	0.38	0.10	0.11	0.02	0.34	0.01	0.05	0.14	0.27	0.07	0.57	0.32	0.63	0.21	0.03	0.03	0.03	1.04	0.15
Max	14.80	0.90	0.30	0.12	0.06	1.90	<0.02	<0.10	0.40	0.34	0.10	1.60	0.70	2.70	0.60	0.11	0.05	<0.05	2.50	<0.30
Min	2.40	0.10	<0.15	0.09	<0.02	<0.50	<0.02	<0.10	<0.10	0.23	0.06	0.10	0.20	<0.30	<0.10	<0.01	<0.05	<0.05	0.20	<0.30

*Values below the detection limit are set to one-half the detection limit for statistical calculations.

Bay Area Air Quality Management District
Toxic Air Contaminants
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Ambient Air Toxics Data - Gases (ppb)
Date Range: Jan 1, 2003 - Dec 31, 2003

Station: San Rafael
534 4th Street
San Rafael, CA 94901

Station ID: 3005
AIRS ID: 060410001
CARB ID: 2100451

Date	Acetone	Benz	But-1,3	CCl4	CHCl3	DCM	EDB	EDC	EthBenz	Freon 11	Freon 113	M/P Xyl	MEK	MTBE	O Xyl	Perc	TCA	TCE	Tol	VC
03-Jan-03	2.80	0.50	0.15	0.11	<0.02	<0.50	<0.02	<0.10	0.20	0.28	0.08	0.70	0.30	0.60	0.30	0.18	<0.05	<0.05	1.00	<0.30
15-Jan-03	5.30	0.70	0.21	0.09	<0.02	<0.50	<0.02	<0.10	0.20	0.26	0.07	0.90	0.30	0.70	0.40	0.25	<0.05	<0.05	1.50	<0.30
27-Jan-03	3.50	0.60	<0.15	0.10	<0.02	<0.50	<0.02	<0.10	0.10	0.24	0.07	0.80	0.40	0.40	0.20	0.07	<0.05	<0.05	1.40	<0.30
08-Feb-03	3.80	0.80	0.23	0.11	<0.02	<0.50	<0.02	<0.10	0.20	0.28	0.08	0.90	0.40	0.40	0.30	0.13	<0.05	<0.05	1.50	<0.30
20-Feb-03	1.50	0.30	0.16	0.10	<0.02	<0.50	<0.02	<0.10	0.10	0.24	0.06	0.40	<0.20	0.30	0.10	0.05	<0.05	<0.05	0.80	<0.30
04-Mar-03	1.70	0.60	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	0.10	0.27	0.07	0.60	<0.20	<0.30	0.20	0.09	<0.05	<0.05	1.20	<0.30
16-Mar-03	1.70	0.40	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	<0.10	0.25	0.14	0.30	<0.20	<0.30	0.10	0.02	<0.05	<0.05	0.60	<0.30
28-Mar-03	2.50	0.30	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	<0.10	0.25	0.07	0.30	0.30	<0.30	0.10	<0.01	<0.05	<0.05	0.60	<0.30
09-Apr-03	2.10	0.40	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	<0.10	0.18	0.07	0.40	<0.20	0.40	0.10	0.05	<0.05	<0.05	0.70	<0.30
21-Apr-03	1.20	0.20	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	<0.10	0.25	0.08	0.20	<0.20	<0.30	<0.10	0.02	<0.05	<0.05	0.40	<0.30
03-May-03	1.80	0.20	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	<0.10	0.25	0.07	0.20	0.20	<0.30	0.10	0.03	<0.05	<0.05	0.40	<0.30
15-May-03	2.10	0.20	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	<0.10	0.19	0.07	0.20	0.20	<0.30	<0.10	0.02	<0.05	<0.05	0.40	<0.30
27-May-03	3.70	0.40	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	0.10	0.28	0.07	0.40	0.30	0.30	0.10	0.11	<0.05	<0.05	0.70	<0.30
08-Jun-03	2.00	0.10	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	<0.10	0.26	0.07	0.10	<0.20	<0.30	<0.10	<0.01	<0.05	<0.05	0.30	<0.30
20-Jun-03	1.70	0.20	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	0.10	0.27	0.07	0.20	0.20	<0.30	0.10	0.03	<0.05	<0.05	0.30	<0.30
02-Jul-03	3.50	0.20	<0.15	0.11	0.03	<0.50	<0.02	<0.10	0.10	0.27	0.07	0.40	0.20	0.30	0.10	0.17	<0.05	<0.05	0.90	<0.30
14-Jul-03	2.70	0.20	0.15	0.11	0.03	0.60	<0.02	<0.10	<0.10	0.28	0.07	0.30	0.30	0.60	0.10	0.08	<0.05	<0.05	0.60	<0.30
26-Jul-03	9.40	0.20	<0.15	0.11	0.04	<0.50	<0.02	<0.10	0.10	0.27	0.08	0.40	1.30	0.70	0.10	0.12	0.09	<0.05	0.70	<0.30
07-Aug-03	2.10	0.20	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	<0.10	0.26	0.08	0.20	0.20	0.30	<0.10	<0.01	<0.05	<0.05	0.40	<0.30
19-Aug-03	2.00	0.20	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	<0.10	0.27	0.08	0.10	<0.20	<0.30	<0.10	0.20	<0.05	<0.05	0.30	<0.30
31-Aug-03	2.30	0.20	<0.15	0.10	<0.02	<0.50	<0.02	<0.10	<0.10	0.23	0.07	0.20	0.20	<0.30	<0.10	<0.01	<0.05	<0.05	0.40	<0.30
12-Sep-03	4.90	0.60	<0.15	0.10	0.03	<0.50	<0.02	<0.10	0.20	0.23	0.07	0.90	0.40	1.70	0.20	0.12	<0.05	<0.05	1.30	<0.30
24-Sep-03	3.40	0.30	<0.15	0.09	0.04	<0.50	<0.02	<0.10	<0.10	0.22	0.07	0.40	0.20	0.30	0.10	0.02	<0.05	<0.05	0.70	<0.30
06-Oct-03	3.60	0.40	<0.15	0.09	<0.02	<0.50	<0.02	<0.10	0.20	0.24	0.07	0.60	0.20	0.40	0.20	0.13	<0.05	<0.05	1.30	<0.30
18-Oct-03	5.00	0.40	<0.15	0.09	<0.02	<0.50	<0.02	<0.10	0.10	0.24	0.07	0.60	0.30	0.40	0.20	0.06	<0.05	<0.05	1.20	<0.30
30-Oct-03	1.90	0.20	<0.15	0.10	<0.02	<0.50	<0.02	<0.10	<0.10	0.26	0.08	0.20	<0.20	0.30	<0.10	0.03	<0.05	<0.05	0.40	<0.30

Bay Area Air Quality Management District
Toxic Air Contaminants
2003 Annual Report

Ambient Air Toxics Data - Gases (ppb)
Date Range: Jan 1, 2003 - Dec 31, 2003

Station: San Rafael
534 4th Street
San Rafael, CA 94901

Station ID: 3005
AIRS ID: 060410001
CARB ID: 2100451

Date	Acetone	Benz	But-1,3	CCl4	CHCl3	DCM	EDB	EDC	EthBenz	Freon 11	Freon 113	M/P Xyl	MEK	MTBE	O Xyl	Perc	TCA	TCE	Tol	VC
23-Nov-03	2.00	0.50	0.17	0.11	0.03	<0.50	<0.02	<0.10	0.10	0.28	0.08	0.50	0.20	<0.30	0.10	0.04	<0.05	<0.05	0.80	<0.30
05-Dec-03	4.80	0.50	0.35	0.11	<0.02	<0.50	<0.02	<0.10	0.20	0.28	0.08	0.70	0.40	0.30	0.20	0.14	<0.05	<0.05	1.20	<0.30
17-Dec-03	2.30	0.80	<0.15	0.09	<0.02	<0.50	<0.02	<0.10	0.30	0.23	0.06	1.20	0.20	<0.30	0.40	0.04	<0.05	<0.05	1.80	<0.30
# Obs	30	30	30	30	30	30	31	31	30	30	30	30	30	30	30	30	30	30	30	31
# <LOD	0	0	22	0	23	29	31	31	13	0	0	0	8	12	7	4	29	30	0	31
Mean*	3.02	0.38	0.11	0.10	0.02	0.26	0.01	0.05	0.11	0.25	0.08	0.47	0.26	0.37	0.15	0.08	0.03	0.03	0.84	0.15
Max	9.40	0.80	0.35	0.11	0.04	0.60	<0.02	<0.10	0.30	0.28	0.14	1.20	1.30	1.70	0.40	0.25	0.09	<0.05	1.80	<0.30
Min	1.20	0.10	<0.15	0.09	<0.02	<0.50	<0.02	<0.10	<0.10	0.18	0.06	0.10	<0.20	<0.30	<0.10	<0.01	<0.05	<0.05	0.30	<0.30

*Values below the detection limit are set to one-half the detection limit for statistical calculations.

Bay Area Air Quality Management District
Toxic Air Contaminants
2003 Annual Report

Ambient Air Toxics Data - Gases (ppb)
Date Range: Jan 1, 2003 - Dec 31, 2003

Station: Ft. Cronkhite Bldg 1049
National Park Service
Sausalito, CA 94965

Station ID: 3007
AIRS ID:
CARB ID:

Date	Acetone	Benz	But-1,3	CCl4	CHCl3	DCM	EDB	EDC	EthBenz	Freon 11	Freon 113	M/P Xyl	MEK	MTBE	O Xyl	Perc	TCA	TCE	Tol	VC
03-Jan-03	1.80	0.10	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	<0.10	0.28	0.08	<0.10	<0.20	<0.30	<0.10	<0.01	<0.05	<0.05	0.30	<0.30
15-Jan-03	2.30	0.20	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	<0.10	0.26	0.07	0.20	<0.20	0.40	0.10	<0.01	<0.05	<0.05	0.40	<0.30
27-Jan-03	1.60	0.10	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	<0.10	0.25	0.06	<0.10	<0.20	<0.30	<0.10	<0.01	<0.05	<0.05	0.30	<0.30
08-Feb-03	1.80	0.20	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	<0.10	0.30	0.07	0.10	<0.20	<0.30	<0.10	0.02	<0.05	<0.05	0.40	<0.30
20-Feb-03	1.00	0.10	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	<0.10	0.26	0.08	<0.10	<0.20	<0.30	<0.10	<0.01	<0.05	<0.05	0.10	<0.30
04-Mar-03	1.40	0.20	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	<0.10	0.25	0.07	<0.10	<0.20	<0.30	<0.10	<0.01	<0.05	<0.05	0.20	<0.30
16-Mar-03	2.10	0.10	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	<0.10	0.25	0.06	<0.10	<0.20	<0.30	<0.10	<0.01	<0.05	<0.05	0.30	<0.30
28-Mar-03	4.60	0.10	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	<0.10	0.24	0.07	<0.10	<0.20	0.40	<0.10	<0.01	<0.05	<0.05	0.40	<0.30
09-Apr-03	2.00	0.10	<0.15	0.12	<0.02	<0.50	<0.02	<0.10	<0.10	0.25	0.08	<0.10	<0.20	<0.30	<0.10	<0.01	0.05	<0.05	0.10	<0.30
21-Apr-03	2.00	0.20	<0.15	0.10	<0.02	<0.50	<0.02	<0.10	<0.10	0.25	0.07	<0.10	<0.20	<0.30	<0.10	<0.01	0.05	<0.05	0.20	<0.30
03-May-03	1.80	0.10	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	<0.10	0.24	0.07	<0.10	<0.20	<0.30	<0.10	<0.01	0.18	<0.05	0.20	<0.30
15-May-03	3.30	0.10	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	<0.10	0.28	0.08	<0.10	0.20	<0.30	<0.10	<0.01	<0.05	<0.05	0.10	<0.30
27-May-03	3.70	0.10	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	<0.10	0.27	0.07	<0.10	<0.20	<0.30	<0.10	<0.01	0.05	<0.05	0.10	<0.30
08-Jun-03	2.50	<0.10	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	<0.10	0.27	0.07	<0.10	<0.20	<0.30	<0.10	<0.01	<0.05	<0.05	<0.1	<0.30
20-Jun-03	1.20	<0.10	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	<0.10	0.23	0.08	<0.10	<0.20	<0.30	<0.10	<0.01	0.05	<0.05	<0.1	<0.30
02-Jul-03	1.70	<0.10	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	<0.10	0.27	0.07	<0.10	<0.20	<0.30	<0.10	<0.01	<0.05	<0.05	<0.1	<0.30
14-Jul-03	1.50	<0.10	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	<0.10	0.28	0.08	<0.10	0.20	<0.30	<0.10	<0.01	<0.05	<0.05	<0.1	<0.30
26-Jul-03	2.00	<0.10	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	<0.10	0.27	0.07	<0.10	<0.20	0.40	<0.10	<0.01	<0.05	<0.05	<0.1	<0.30
07-Aug-03	7.00	<0.10	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	<0.10	0.27	0.07	<0.10	0.20	0.80	<0.10	<0.01	0.13	<0.05	0.10	<0.30
19-Aug-03	1.20	<0.10	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	<0.10	0.27	0.08	<0.10	<0.20	<0.30	<0.10	<0.01	<0.05	<0.05	<0.1	<0.30
31-Aug-03	1.70	0.20	<0.15	0.09	<0.02	<0.50	<0.02	<0.10	<0.10	0.25	0.07	<0.10	<0.20	<0.30	<0.10	<0.01	<0.05	<0.05	0.20	<0.30
12-Sep-03	3.90	0.10	<0.15	0.09	<0.02	<0.50	<0.02	<0.10	<0.10	0.23	0.08	0.10	0.20	<0.30	<0.10	<0.01	0.17	<0.05	0.30	<0.30
24-Sep-03	4.50	0.10	<0.15	0.09	<0.02	<0.50	<0.02	<0.10	<0.10	0.26	0.06	<0.10	0.30	<0.30	<0.10	<0.01	0.06	<0.05	0.10	<0.30
06-Oct-03	2.10	<0.10	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	<0.10	0.25	0.09	<0.10	0.20	<0.30	<0.10	<0.01	0.06	<0.05	<0.1	<0.30
18-Oct-03	1.60	<0.10	<0.15	0.09	<0.02	<0.50	<0.02	<0.10	<0.10	0.23	0.07	<0.10	<0.20	<0.30	<0.10	<0.01	0.07	<0.05	0.20	<0.30
30-Oct-03	6.60	<0.10	<0.15	0.10	<0.02	<0.50	<0.02	<0.10	<0.10	0.25	0.08	<0.10	<0.20	<0.30	<0.10	<0.01	0.07	<0.05	<0.1	<0.30

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Ambient Air Toxics Data - Gases (ppb)
Date Range: Jan 1, 2003 - Dec 31, 2003

Station: Ft. Cronkhite Bldg 1049
National Park Service
Sausalito, CA 94965

Station ID: 3007
AIRS ID:
CARB ID:

Date	Acetone	Benz	But-1,3	CCl4	CHCl3	DCM	EDB	EDC	EthBenz	Freon 11	Freon 113	M/P Xyl	MEK	MTBE	O Xyl	Perc	TCA	TCE	Tol	VC
23-Nov-03	2.00	0.20	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	<0.10	0.26	0.07	0.10	<0.20	<0.30	<0.10	<0.01	0.10	<0.05	0.40	<0.30
05-Dec-03	2.00	0.20	0.19	0.10	<0.02	<0.50	<0.02	<0.10	<0.10	0.25	0.08	0.20	<0.20	<0.30	<0.10	0.02	0.11	<0.05	0.50	<0.30
17-Dec-03	1.80	0.20	<0.15	0.10	<0.02	<0.50	<0.02	<0.10	<0.10	0.25	0.06	0.20	0.20	<0.30	<0.10	<0.01	0.19	<0.05	0.50	<0.30
29-Dec-03	2.20	0.20	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	<0.10	0.27	0.06	0.10	<0.20	0.40	<0.10	<0.01	0.19	<0.05	0.30	<0.30
# Obs	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31
# <LOD	0	10	29	0	30	31	31	31	30	0	0	23	23	25	29	28	16	31	8	31
Mean*	2.85	0.14	0.08	0.11	0.01	0.25	0.01	0.05	0.06	0.26	0.07	0.12	0.15	0.24	0.06	0.01	0.06	0.03	0.27	0.15
Max	13.40	1.00	0.22	0.12	0.04	<0.50	<0.02	<0.10	0.40	0.30	0.09	1.50	0.70	1.40	0.40	0.08	0.19	<0.05	2.30	<0.30
Min	1.00	<0.10	<0.15	0.09	<0.02	<0.50	<0.02	<0.10	<0.10	0.23	0.06	<0.10	<0.20	<0.30	<0.10	<0.01	<0.05	<0.05	<0.1	<0.30

*Values below the detection limit are set to one-half the detection limit for statistical calculations.

Bay Area Air Quality Management District
Toxic Air Contaminants
2003 Annual Report

Ambient Air Toxics Data - Gases (ppb)
Date Range: Jan 1, 2003 - Dec 31, 2003

Station: Napa
2552 Jefferson St
Napa, CA 94558

Station ID: 4001
AIRS ID: 060550003
CARB ID: 2800783

Date	Acetone	Benz	But-1,3	CCl4	CHCl3	DCM	EDB	EDC	EthBenz	Freon 11	Freon 113	M/P Xyl	MEK	MTBE	O Xyl	Perc	TCA	TCE	Tol	VC
04-Jan-03	6.20	1.00	0.35	0.11	0.04	<0.50	<0.02	<0.10	0.30	0.26	0.08	1.10	0.40	1.60	0.40	0.03	0.05	<0.05	1.80	<0.30
15-Jan-03	4.70	1.10	0.35	0.12	0.04	<0.50	<0.02	<0.10	0.40	0.29	0.08	1.40	0.30	1.80	0.60	0.03	<0.05	<0.05	2.20	<0.30
27-Jan-03	5.20	0.70	0.29	0.10	0.03	<0.50	<0.02	<0.10	0.30	0.27	0.08	1.00	0.30	1.10	0.40	0.03	<0.05	<0.05	1.60	<0.30
08-Feb-03	9.50	0.90	0.23	0.10	0.03	<0.50	<0.02	<0.10	0.30	0.28	0.07	1.10	0.60	1.30	0.40	0.02	0.05	<0.05	1.70	<0.30
20-Feb-03	4.80	0.60	<0.15	0.11	0.03	<0.50	<0.02	<0.10	0.20	0.25	0.07	0.80	0.30	0.90	0.30	0.02	<0.05	<0.05	1.60	<0.30
04-Mar-03	5.20	0.70	<0.15	0.11	0.03	<0.50	<0.02	<0.10	0.10	0.26	0.07	0.50	0.30	0.50	0.20	0.03	<0.05	<0.05	1.10	<0.30
16-Mar-03	5.50	0.30	<0.15	0.11	0.03	<0.50	<0.02	<0.10	0.10	0.26	0.07	0.50	0.30	0.50	0.20	<0.01	<0.05	<0.05	1.10	<0.30
28-Mar-03	3.20	0.20	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	<0.10	0.27	0.07	0.30	0.20	0.40	0.10	<0.01	<0.05	<0.05	0.60	<0.30
09-Apr-03	3.40	0.30	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	0.10	0.25	0.07	0.50	0.20	0.30	0.20	0.02	<0.05	<0.05	1.10	<0.30
21-Apr-03	4.40	0.20	<0.15	0.12	<0.02	<0.50	<0.02	<0.10	<0.10	0.27	0.07	0.20	0.30	<0.30	<0.10	<0.01	<0.05	<0.05	0.40	<0.30
03-May-03	3.20	0.20	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	0.10	0.24	0.07	0.30	<0.20	<0.30	0.10	<0.01	<0.05	<0.05	0.60	<0.30
15-May-03	3.20	0.20	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	<0.10	0.26	0.07	0.40	0.20	<0.30	0.10	0.02	<0.05	<0.05	0.70	<0.30
27-May-03	4.80	0.30	<0.15	0.11	0.03	<0.50	<0.02	<0.10	0.10	0.28	0.08	0.40	0.40	0.80	0.10	0.02	<0.05	<0.05	0.70	<0.30
08-Jun-03	5.40	0.10	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	<0.10	0.26	0.08	0.10	0.30	<0.30	<0.10	<0.01	<0.05	<0.05	0.20	<0.30
20-Jun-03	3.00	0.20	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	<0.10	0.23	0.08	0.20	0.20	0.40	0.10	<0.01	<0.05	<0.05	0.50	<0.30
02-Jul-03	4.30	0.30	<0.15	0.11	0.03	<0.50	<0.02	<0.10	<0.10	0.29	0.07	0.30	0.30	0.60	0.10	<0.01	<0.05	<0.05	0.60	<0.30
14-Jul-03	6.60	0.30	<0.15	0.11	0.04	<0.50	<0.02	<0.10	0.10	0.27	0.07	0.40	0.40	0.90	0.10	<0.01	<0.05	<0.05	0.70	<0.30
26-Jul-03	5.80	0.20	<0.15	0.11	0.03	<0.50	<0.02	<0.10	<0.10	0.27	0.07	0.20	0.40	1.10	<0.10	<0.01	<0.05	<0.05	0.40	<0.30
07-Aug-03	5.60	0.20	<0.15	0.11	0.05	<0.50	<0.02	<0.10	<0.10	0.25	0.09	0.20	0.30	0.80	<0.10	0.02	<0.05	<0.05	0.50	<0.30
19-Aug-03	2.00	0.20	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	<0.10	0.27	0.07	0.20	<0.20	0.30	<0.10	<0.01	<0.05	<0.05	0.40	<0.30
31-Aug-03	3.40	0.20	<0.15	0.10	<0.02	<0.50	<0.02	<0.10	<0.10	0.24	0.08	0.20	0.30	0.50	<0.10	<0.01	<0.05	<0.05	0.30	<0.30
12-Sep-03	9.00	0.70	<0.15	0.10	0.07	<0.50	<0.02	<0.10	0.30	0.26	0.08	1.30	0.60	2.70	0.40	0.02	<0.05	<0.05	1.90	<0.30
24-Sep-03	5.10	0.20	<0.15	0.11	0.03	<0.50	<0.02	<0.10	<0.10	0.25	0.08	0.30	0.50	0.50	0.10	<0.01	<0.05	<0.05	0.40	<0.30
06-Oct-03	7.00	0.60	<0.15	0.09	0.03	<0.50	<0.02	<0.10	0.20	0.24	0.06	1.10	0.50	1.20	0.40	0.03	<0.05	<0.05	2.10	<0.30
18-Oct-03	5.20	0.40	<0.15	0.10	0.05	<0.50	<0.02	<0.10	0.20	0.28	0.08	0.60	0.60	1.60	0.20	0.02	<0.05	<0.05	1.10	<0.30
30-Oct-03	3.80	0.50	<0.15	0.11	0.05	<0.50	<0.02	<0.10	0.20	0.27	0.08	0.80	0.30	1.40	0.20	0.04	<0.05	<0.05	1.20	<0.30

Bay Area Air Quality Management District
Toxic Air Contaminants
2003 Annual Report

Ambient Air Toxics Data - Gases (ppb)
Date Range: Jan 1, 2003 - Dec 31, 2003

Station: Napa
2552 Jefferson St
Napa, CA 94558

Station ID: 4001
AIRS ID: 060550003
CARB ID: 2800783

Date	Acetone	Benz	But-1,3	CCl4	CHCl3	DCM	EDB	EDC	EthBenz	Freon 11	Freon 113	M/P Xyl	MEK	MTBE	O Xyl	Perc	TCA	TCE	Tol	VC
25-Nov-03	4.90	0.80	0.44	0.11	0.04	<0.50	<0.02	<0.10	0.20	0.23	0.08	0.90	0.40	1.00	0.30	0.10	<0.05	<0.05	1.60	<0.30
05-Dec-03	4.60	0.50	0.32	0.11	<0.02	<0.50	<0.02	<0.10	0.20	0.22	0.08	0.60	0.30	0.30	0.20	0.02	<0.05	<0.05	1.10	<0.30
17-Dec-03	6.60	1.50	0.75	0.12	0.05	<0.50	<0.02	<0.10	0.50	0.26	0.08	1.60	0.40	0.50	0.80	0.04	<0.05	<0.05	2.80	<0.30
29-Dec-03	2.60	0.20	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	<0.10	0.30	0.10	0.20	0.20	<0.30	<0.10	0.02	<0.05	<0.05	0.40	<0.30
# Obs	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31
# <LOD	0	0	23	0	11	31	31	31	12	0	0	0	2	5	7	12	28	31	0	31
Mean*	4.98	0.48	0.15	0.11	0.03	0.25	0.01	0.05	0.15	0.26	0.08	0.61	0.34	0.82	0.22	0.02	0.03	0.03	1.08	0.15
Max	9.50	1.50	0.75	0.12	0.07	<0.50	<0.02	<0.10	0.50	0.30	0.10	1.60	0.60	2.70	0.80	0.10	0.05	<0.05	2.80	<0.30
Min	2.00	0.10	<0.15	0.09	<0.02	<0.50	<0.02	<0.10	<0.10	0.22	0.06	0.10	<0.20	<0.30	<0.10	<0.01	<0.05	<0.05	0.20	<0.30

*Values below the detection limit are set to one-half the detection limit for statistical calculations.

Bay Area Air Quality Management District
Toxic Air Contaminants
2003 Annual Report

Ambient Air Toxics Data - Gases (ppb)
Date Range: Jan 1, 2003 - Dec 31, 2003

Station: San Francisco
10 Arkansas Street
San Francisco, CA 94107

Station ID: 5011
AIRS ID: 060750005
CARB ID: 9000306

Date	Acetone	Benz	But-1,3	CCl4	CHCl3	DCM	EDB	EDC	EthBenz	Freon 11	Freon 113	M/P Xyl	MEK	MTBE	O Xyl	Perc	TCA	TCE	Tol	VC
03-Jan-03	5.50	0.80	0.24	0.10	<0.02	<0.50	<0.02	<0.10	0.30	0.25	0.07	1.20	0.50	0.80	0.40	0.08	<0.05	<0.05	1.90	<0.30
15-Jan-03	3.40	0.60	<0.15	0.10	<0.02	<0.50	<0.02	<0.10	0.20	0.26	0.07	1.10	0.30	0.40	0.40	0.03	<0.05	<0.05	1.70	<0.30
27-Jan-03	4.70	0.60	0.19	0.11	0.03	<0.50	<0.02	<0.10	0.30	0.28	0.08	1.00	0.70	0.50	0.40	0.05	<0.05	<0.05	1.40	<0.30
08-Feb-03	4.40	0.80	<0.15	0.11	0.04	0.70	<0.02	<0.10	0.40	0.27	0.07	1.80	0.50	0.50	0.50	0.06	<0.05	<0.05	2.80	<0.30
20-Feb-03	8.40	0.70	0.16	0.11	0.04	0.70	<0.02	<0.10	0.20	0.27	0.08	0.90	0.40	<0.30	0.30	0.04	<0.05	<0.05	1.50	<0.30
16-Mar-03	2.60	0.20	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	<0.10	0.27	0.08	0.20	0.30	<0.30	0.10	<0.01	<0.05	<0.05	0.40	<0.30
22-Mar-03	3.00	0.20	<0.15	0.10	<0.02	<0.50	<0.02	<0.10	<0.10	0.26	0.08	0.20	0.30	0.30	0.10	0.02	<0.05	<0.05	0.40	<0.30
28-Mar-03	2.40	0.40	<0.15	0.11	<0.02	1.00	<0.02	<0.10	0.20	0.26	0.07	0.70	0.20	<0.30	0.20	0.02	<0.05	<0.05	1.00	<0.30
09-Apr-03	4.30	0.40	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	0.10	0.27	0.07	0.40	0.50	<0.30	0.20	0.03	<0.05	<0.05	1.00	<0.30
21-Apr-03	3.40	0.20	<0.15	0.10	<0.02	0.60	<0.02	<0.10	<0.10	0.25	0.07	0.30	0.40	<0.30	0.10	0.02	<0.05	<0.05	0.50	<0.30
03-May-03	3.70	0.40	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	<0.10	0.29	0.07	0.30	0.30	0.30	0.20	0.02	<0.05	<0.05	0.70	<0.30
15-May-03	4.60	0.30	0.28	0.11	<0.02	1.00	<0.02	<0.10	<0.10	0.28	0.07	0.40	0.50	<0.30	0.10	0.04	<0.05	<0.05	0.70	<0.30
27-May-03	7.10	0.40	0.19	0.11	0.04	<0.50	<0.02	<0.10	0.10	0.27	0.07	0.60	0.60	0.40	0.20	0.04	<0.05	<0.05	0.90	<0.30
08-Jun-03	3.70	0.10	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	<0.10	0.27	0.07	0.10	0.30	<0.30	<0.10	<0.01	<0.05	<0.05	0.20	<0.30
20-Jun-03	4.50	0.20	0.17	0.11	0.03	<0.50	<0.02	<0.10	0.10	0.25	0.08	0.30	0.60	<0.30	0.10	0.03	0.05	<0.05	0.40	<0.30
02-Jul-03	5.10	0.20	<0.15	0.12	0.04	<0.50	<0.02	<0.10	<0.10	0.25	0.06	0.20	<0.20	<0.30	<0.10	0.05	2.26	<0.05	0.40	<0.30
14-Jul-03	5.90	0.30	<0.15	0.11	0.03	<0.50	<0.02	<0.10	0.10	0.27	0.07	0.40	1.20	0.40	0.10	0.03	<0.05	<0.05	0.70	<0.30
26-Jul-03	3.10	0.20	<0.15	0.11	<0.02	1.20	<0.02	<0.10	<0.10	0.26	0.07	0.30	0.20	0.40	0.10	0.02	<0.05	<0.05	0.70	<0.30
07-Aug-03	8.80	0.20	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	<0.10	0.23	0.07	0.20	0.80	<0.30	<0.10	0.04	<0.05	<0.05	0.40	<0.30
19-Aug-03	3.80	0.20	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	<0.10	0.29	0.08	0.20	0.30	<0.30	<0.10	0.03	<0.05	<0.05	0.50	<0.30
31-Aug-03	2.90	0.10	<0.15	0.10	<0.02	2.20	<0.02	<0.10	<0.10	0.23	0.06	0.30	0.30	<0.30	0.10	<0.01	<0.05	<0.05	0.50	<0.30
12-Sep-03	13.90	1.00	<0.15	0.10	0.08	0.70	<0.02	<0.10	0.40	0.29	0.08	1.60	1.40	2.60	0.50	0.08	0.05	0.05	2.60	<0.30
24-Sep-03	4.80	0.20	<0.15	0.10	<0.02	<0.50	<0.02	<0.10	0.10	0.27	0.08	0.30	0.50	<0.30	0.10	0.02	<0.05	<0.05	0.70	<0.30
06-Oct-03	4.20	0.30	<0.15	0.10	0.03	<0.50	<0.02	<0.10	<0.10	0.28	0.09	0.40	0.40	0.40	0.10	0.04	<0.05	<0.05	0.70	<0.30
18-Oct-03	2.90	0.40	<0.15	0.10	0.03	<0.50	<0.02	<0.10	0.10	0.30	0.08	0.60	0.50	0.60	0.20	0.05	<0.05	<0.05	0.90	<0.30
30-Oct-03	4.10	0.20	<0.15	0.10	<0.02	<0.50	<0.02	<0.10	<0.10	0.29	0.07	0.20	0.70	<0.30	<0.10	0.02	<0.05	<0.05	0.40	<0.30

Bay Area Air Quality Management District
Toxic Air Contaminants
2003 Annual Report

Ambient Air Toxics Data - Gases (ppb)
Date Range: Jan 1, 2003 - Dec 31, 2003

Station: San Francisco
10 Arkansas Street
San Francisco, CA 94107

Station ID: 5011
AIRS ID: 060750005
CARB ID: 9000306

Date	Acetone	Benz	But-1,3	CCl4	CHCl3	DCM	EDB	EDC	EthBenz	Freon 11	Freon 113	M/P Xyl	MEK	MTBE	O Xyl	Perc	TCA	TCE	Tol	VC
23-Nov-03	7.40	0.60	<0.15	0.11	<0.02	1.70	<0.02	<0.10	0.20	0.26	0.07	1.00	0.40	<0.30	0.30	0.02	<0.05	<0.05	1.60	<0.30
05-Dec-03	5.10	0.80	0.39	0.11	0.04	<0.50	<0.02	<0.10	0.60	0.25	0.08	2.40	0.60	0.40	0.60	0.04	<0.05	<0.05	2.10	<0.30
17-Dec-03	6.80	0.70	0.35	0.11	0.04	<0.50	<0.02	<0.10	0.30	0.23	0.08	1.10	0.40	<0.30	0.50	0.03	<0.05	<0.05	2.20	<0.30
29-Dec-03	2.60	0.30	<0.15	0.10	<0.02	<0.50	<0.02	<0.10	0.10	0.24	0.06	0.40	0.30	<0.30	0.10	0.02	<0.05	<0.05	0.80	<0.30
# Obs	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31
# <LOD	0	0	22	0	18	22	31	31	12	0	0	0	1	16	5	3	28	30	0	31
Mean*	4.74	0.40	0.12	0.11	0.02	0.49	0.01	0.05	0.15	0.26	0.07	0.65	0.48	0.37	0.21	0.03	0.10	0.03	1.04	0.15
Max	13.90	1.00	0.39	0.12	0.08	2.20	<0.02	<0.10	0.60	0.30	0.09	2.40	1.40	2.60	0.60	0.08	2.26	0.05	2.80	<0.30
Min	2.40	0.10	<0.15	0.10	<0.02	<0.50	<0.02	<0.10	<0.10	0.23	0.06	0.10	<0.20	<0.30	<0.10	<0.01	<0.05	<0.05	0.20	<0.30

*Values below the detection limit are set to one-half the detection limit for statistical calculations.

Bay Area Air Quality Management District
Toxic Air Contaminants
2003 Annual Report

Ambient Air Toxics Data - Gases (ppb)
Date Range: Jan 1, 2003 - Dec 31, 2003

Station: Redwood City
897 Barron Avenue
Redwood City, CA 94063

Station ID: 6004
AIRS ID: 060811001
CARB ID: 4100541

Date	Acetone	Benz	But-1,3	CCl4	CHCl3	DCM	EDB	EDC	EthBenz	Freon 11	Freon 113	M/P Xyl	MEK	MTBE	O Xyl	Perc	TCA	TCE	Tol	VC
03-Jan-03	15.40	1.40	0.48	0.13	0.07	0.50	<0.02	<0.10	0.60	0.32	0.09	2.10	0.60	1.40	0.80	0.10	0.05	0.08	4.60	<0.30
15-Jan-03	14.70	1.30	0.25	0.11	0.04	0.60	<0.02	<0.10	0.80	0.27	0.07	3.00	1.10	1.50	1.00	0.09	<0.05	0.33	5.70	<0.30
27-Jan-03	7.60	0.90	0.24	0.11	0.05	<0.50	<0.02	<0.10	0.30	0.29	0.07	1.40	0.90	1.00	0.50	0.09	0.05	0.11	2.40	<0.30
08-Feb-03	6.00	0.90	0.22	0.11	0.07	<0.50	<0.02	<0.10	0.50	0.30	0.08	1.80	0.50	0.70	0.60	0.05	<0.05	0.29	3.40	<0.30
20-Feb-03	4.20	0.60	<0.15	0.11	0.03	<0.50	<0.02	<0.10	0.30	0.34	0.07	1.30	1.00	0.40	0.40	0.03	<0.05	0.14	2.30	<0.30
04-Mar-03	8.80	1.70	<0.15	0.11	0.05	0.60	<0.02	<0.10	0.30	0.29	0.07	1.20	1.00	0.60	0.40	0.02	<0.05	0.26	2.10	<0.30
16-Mar-03	3.30	0.30	<0.15	0.11	0.03	<0.50	<0.02	<0.10	0.10	0.26	0.07	0.40	0.30	0.30	0.20	<0.01	<0.05	0.06	0.70	<0.30
28-Mar-03	3.70	0.40	<0.15	0.11	0.04	<0.50	<0.02	<0.10	0.20	0.32	0.07	0.70	0.60	0.50	0.30	<0.01	<0.05	0.06	1.30	<0.30
09-Apr-03	7.50	0.40	<0.15	0.11	0.04	<0.50	<0.02	<0.10	0.10	0.25	0.07	0.60	0.40	0.80	0.20	0.03	<0.05	0.06	1.00	<0.30
21-Apr-03	5.60	0.20	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	<0.10	0.25	0.07	0.30	0.60	<0.30	0.10	0.02	<0.05	0.05	0.70	<0.30
03-May-03	4.00	0.20	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	<0.10	0.27	0.07	0.30	0.40	<0.30	0.10	0.02	<0.05	0.20	0.60	<0.30
15-May-03	4.50	0.20	<0.15	0.11	0.03	<0.50	<0.02	<0.10	<0.10	0.26	0.07	0.30	0.40	<0.30	0.10	<0.01	<0.05	0.16	0.60	<0.30
27-May-03	6.10	0.40	<0.15	0.11	0.06	<0.50	<0.02	<0.10	0.10	0.27	0.07	0.50	0.60	0.70	0.20	0.03	<0.05	0.05	0.90	<0.30
08-Jun-03	3.80	0.10	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	<0.10	0.26	0.07	0.10	0.20	<0.30	<0.10	<0.01	<0.05	0.07	0.30	<0.30
20-Jun-03	6.10	0.10	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	<0.10	0.26	0.08	0.20	0.40	<0.30	<0.10	<0.01	<0.05	<0.05	0.40	<0.30
02-Jul-03	5.20	0.30	<0.15	0.11	0.06	<0.50	<0.02	<0.10	0.10	0.27	0.07	0.50	1.00	0.50	0.10	0.02	<0.05	<0.05	0.70	<0.30
14-Jul-03	4.70	0.30	0.21	0.11	0.05	<0.50	<0.02	<0.10	0.10	0.27	0.06	0.40	0.70	0.60	0.20	0.02	<0.05	0.05	0.90	<0.30
26-Jul-03	2.90	0.20	0.18	0.12	<0.02	<0.50	<0.02	<0.10	<0.10	0.45	0.07	0.20	0.20	0.40	0.10	0.02	<0.05	<0.05	0.50	<0.30
07-Aug-03	6.60	0.30	<0.15	0.12	0.03	<0.50	<0.02	<0.10	0.10	0.27	0.07	0.40	0.40	0.40	0.10	0.04	<0.05	0.09	0.90	<0.30
19-Aug-03	8.20	0.20	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	<0.10	0.26	0.09	0.20	0.40	0.50	<0.10	<0.01	<0.05	<0.05	0.50	<0.30
31-Aug-03	3.40	0.30	<0.15	0.10	<0.02	<0.50	<0.02	<0.10	<0.10	0.33	0.07	0.30	0.20	<0.30	0.10	<0.01	<0.05	<0.05	0.90	<0.30
12-Sep-03	8.70	0.60	<0.15	0.10	0.10	<0.50	<0.02	<0.10	0.30	0.41	0.08	1.20	0.60	2.30	0.40	0.04	0.05	0.11	2.20	<0.30
24-Sep-03	6.60	0.20	<0.15	0.09	<0.02	<0.50	<0.02	<0.10	0.10	0.25	0.06	0.40	0.60	0.70	0.10	<0.01	<0.05	0.05	0.80	<0.30
06-Oct-03	5.40	0.50	<0.15	0.11	0.03	<0.50	<0.02	<0.10	0.30	0.31	0.07	1.10	0.40	1.00	0.30	0.04	<0.05	0.10	1.90	<0.30
18-Oct-03	5.40	0.60	<0.15	0.11	0.08	<0.50	<0.02	<0.10	0.30	0.25	0.07	1.00	0.50	2.30	0.40	0.06	0.05	0.09	1.70	<0.30
30-Oct-03	3.80	0.20	0.20	0.11	<0.02	<0.50	<0.02	<0.10	0.10	0.25	0.07	0.50	0.60	0.40	0.20	<0.01	<0.05	0.11	0.90	<0.30

Bay Area Air Quality Management District
Toxic Air Contaminants
2003 Annual Report

Ambient Air Toxics Data - Gases (ppb)
Date Range: Jan 1, 2003 - Dec 31, 2003

Station: Redwood City
897 Barron Avenue
Redwood City, CA 94063

Station ID: 6004
AIRS ID: 060811001
CARB ID: 4100541

Date	Acetone	Benz	But-1,3	CCl4	CHCl3	DCM	EDB	EDC	EthBenz	Freon 11	Freon 113	M/P Xyl	MEK	MTBE	O Xyl	Perc	TCA	TCE	Tol	VC
23-Nov-03	7.40	0.60	<0.15	0.11	0.03	<0.50	<0.02	<0.10	0.30	0.27	0.07	1.20	0.30	0.50	0.40	0.02	<0.05	0.06	2.00	<0.30
05-Dec-03	35.40	1.00	0.56	0.11	0.06	<0.50	<0.02	<0.10	0.40	0.27	0.08	1.50	0.50	0.90	0.50	0.09	0.08	0.05	3.20	<0.30
17-Dec-03	33.40	0.90	0.15	0.10	0.03	<0.50	<0.02	<0.10	0.50	0.27	0.06	2.10	0.50	0.60	0.70	0.09	0.06	0.06	3.70	<0.30
29-Dec-03	7.10	0.40	<0.15	0.09	<0.02	<0.50	<0.02	<0.10	0.20	0.25	0.06	0.60	0.20	<0.30	0.20	0.02	<0.05	<0.05	0.90	<0.30
# Obs	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31
# <LOD	0	0	21	0	10	27	31	31	8	0	0	0	0	7	3	9	24	6	0	31
Mean*	8.76	0.53	0.14	0.11	0.04	0.29	0.01	0.05	0.23	0.29	0.07	0.91	0.54	0.68	0.31	0.04	0.03	0.09	1.72	0.15
Max	35.40	1.70	0.56	0.13	0.10	0.60	<0.02	<0.10	0.80	0.45	0.09	3.00	1.10	2.30	1.00	0.15	0.08	0.33	5.70	<0.30
Min	2.90	0.10	<0.15	0.09	<0.02	<0.50	<0.02	<0.10	<0.10	0.25	0.06	0.10	0.20	<0.30	<0.10	<0.01	<0.05	<0.05	0.30	<0.30

*Values below the detection limit are set to one-half the detection limit for statistical calculations.

Bay Area Air Quality Management District
Toxic Air Contaminants
2003 Annual Report

Ambient Air Toxics Data - Gases (ppb)
Date Range: Jan 1, 2003 - Dec 31, 2003

Station: Sunnyvale
910 Ticonderoga Drive
Sunnyvale, CA 94087

Station ID: 7030
AIRS ID: 060852007
CARB ID:

Date	Acetone	Benz	But-1,3	CCl4	CHCl3	DCM	EDB	EDC	EthBenz	Freon 11	Freon 113	M/P Xyl	MEK	MTBE	O Xyl	Perc	TCA	TCE	Tol	VC
03-Jan-03	3.30	0.90	0.21	0.12	0.04	<0.50	<0.02	<0.10	0.20	0.31	0.09	0.90	0.30	0.90	0.40	0.06	0.05	<0.05	1.60	<0.30
15-Jan-03	2.20	0.40	0.18	0.11	0.03	1.10	<0.02	<0.10	0.10	0.28	0.08	0.40	0.20	0.60	0.20	0.02	<0.05	<0.05	0.80	<0.30
27-Jan-03	3.60	0.80	0.28	0.11	0.05	<0.50	<0.02	<0.10	0.30	0.30	0.09	1.00	0.40	0.80	0.40	0.06	<0.05	<0.05	1.70	<0.30
08-Feb-03	4.30	0.70	0.20	0.11	0.05	<0.50	<0.02	<0.10	0.20	0.31	0.08	0.80	0.40	0.50	0.30	0.03	0.05	<0.05	1.90	<0.30
20-Feb-03	2.20	0.50	<0.15	0.10	<0.02	<0.50	<0.02	<0.10	0.10	0.27	0.07	0.50	<0.20	<0.30	0.20	0.02	<0.05	<0.05	0.90	<0.30
04-Mar-03	3.10	1.20	<0.15	0.11	0.03	<0.50	<0.02	<0.10	0.10	0.27	0.07	0.50	0.20	0.30	0.20	0.03	<0.05	0.05	1.00	<0.30
16-Mar-03	1.60	0.20	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	<0.10	0.26	0.07	0.20	<0.20	<0.30	<0.10	<0.01	<0.05	<0.05	0.40	<0.30
28-Mar-03	1.70	0.30	<0.15	0.11	0.03	<0.50	<0.02	<0.10	0.10	0.29	0.07	0.30	<0.20	0.30	0.10	<0.01	<0.05	<0.05	0.60	<0.30
09-Apr-03	3.00	0.30	<0.15	0.11	0.04	<0.50	<0.02	<0.10	0.10	0.31	0.08	0.40	<0.20	0.40	0.10	0.02	<0.05	<0.05	0.50	<0.30
24-Apr-03	2.10	0.10	<0.15	0.10	<0.02	<0.50	<0.02	<0.10	<0.10	0.28	0.08	0.10	<0.20	<0.30	<0.10	0.02	<0.05	<0.05	0.20	<0.30
03-May-03	3.60	0.20	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	<0.10	0.26	0.07	0.20	<0.20	<0.30	0.10	<0.01	<0.05	<0.05	0.40	<0.30
15-May-03	2.50	0.10	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	<0.10	0.25	0.07	<0.10	<0.20	<0.30	<0.10	<0.01	<0.05	<0.05	0.10	<0.30
27-May-03	5.20	0.30	<0.15	0.09	0.05	0.80	<0.02	<0.10	0.10	0.28	0.07	0.40	0.30	0.50	0.10	0.04	<0.05	<0.05	0.60	<0.30
08-Jun-03	2.50	0.10	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	<0.10	0.28	0.07	0.10	<0.20	<0.30	<0.10	<0.01	<0.05	<0.05	0.20	<0.30
20-Jun-03	1.60	0.10	<0.15	0.09	0.03	<0.50	<0.02	<0.10	<0.10	0.24	0.06	0.20	0.20	<0.30	0.10	0.02	<0.05	<0.05	0.30	<0.30
02-Jul-03	2.80	0.20	<0.15	0.11	0.05	<0.50	<0.02	<0.10	0.10	0.26	0.06	0.20	0.30	0.40	0.10	0.02	<0.05	<0.05	0.50	<0.30
18-Jul-03	7.10	0.30	<0.15	0.11	0.03	<0.50	<0.02	<0.10	<0.10	0.28	0.07	0.40	0.50	0.40	0.20	0.06	<0.05	<0.05	1.10	<0.30
26-Jul-03	3.90	0.30	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	0.10	0.30	0.07	0.30	0.20	0.40	0.10	0.02	<0.05	<0.05	0.70	<0.30
07-Aug-03	5.20	0.40	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	<0.10	0.23	0.11	0.20	0.40	0.40	<0.10	0.02	<0.05	<0.05	0.70	<0.30
19-Aug-03	2.50	0.20	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	<0.10	0.29	0.07	0.20	0.20	0.40	<0.10	0.02	<0.05	<0.05	0.30	<0.30
05-Sep-03	3.50	0.20	<0.15	0.09	0.04	0.60	<0.02	<0.10	0.10	0.26	0.08	0.30	0.20	0.40	0.10	<0.01	<0.05	<0.05	0.60	<0.30
12-Sep-03	4.50	0.40	<0.15	0.09	0.07	<0.50	<0.02	<0.10	0.20	0.28	0.09	0.60	0.40	1.00	0.20	0.04	<0.05	<0.05	1.00	<0.30
24-Sep-03	4.80	0.30	<0.15	0.10	<0.02	<0.50	<0.02	<0.10	0.10	0.24	0.07	0.40	0.20	0.50	0.10	<0.01	<0.05	<0.05	0.70	<0.30
18-Oct-03	11.20	0.60	<0.15	0.10	0.06	<0.50	<0.02	<0.10	0.20	0.32	0.08	0.60	0.40	1.20	0.20	0.08	<0.05	<0.05	1.10	<0.30
30-Oct-03	3.00	0.20	<0.15	0.10	<0.02	<0.50	<0.02	<0.10	<0.10	0.26	0.07	0.20	0.20	<0.30	<0.10	<0.01	<0.05	<0.05	0.40	<0.30

Bay Area Air Quality Management District
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Ambient Air Toxics Data - Gases (ppb)
Date Range: Jan 1, 2003 - Dec 31, 2003

Station: Sunnyvale
910 Ticonderoga Drive
Sunnyvale, CA 94087

Station ID: 7030
AIRS ID: 060852007
CARB ID:

Date	Acetone	Benz	But-1,3	CCl4	CHCl3	DCM	EDB	EDC	EthBenz	Freon 11	Freon 113	M/P Xyl	MEK	MTBE	O Xyl	Perc	TCA	TCE	Tol	VC
23-Nov-03	2.10	0.40	<0.15	0.09	0.04	<0.50	<0.02	<0.10	0.10	0.30	0.08	0.30	0.20	<0.30	0.10	0.02	<0.05	<0.05	0.60	<0.30
05-Dec-03	4.50	0.60	<0.15	0.09	<0.02	<0.50	<0.02	<0.10	0.30	0.25	0.06	1.10	0.20	<0.30	0.30	0.05	<0.05	<0.05	1.70	<0.30
17-Dec-03	4.00	0.70	0.35	0.11	0.04	<0.50	<0.02	<0.10	0.20	0.24	0.08	0.80	0.30	<0.30	0.40	0.05	<0.05	<0.05	1.20	<0.30
# Obs	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
# <LOD	0	0	25	0	14	27	30	30	10	0	0	1	8	11	7	9	28	29	0	30
Mean*	3.64	0.40	0.10	0.10	0.03	0.31	0.01	0.05	0.12	0.28	0.07	0.43	0.23	0.39	0.16	0.03	0.03	0.03	0.80	0.15
Max	11.20	1.20	0.35	0.12	0.07	1.10	<0.02	<0.10	0.30	0.32	0.11	1.10	0.50	1.20	0.40	0.08	0.05	0.05	1.90	<0.30
Min	1.60	0.10	<0.15	0.09	<0.02	<0.50	<0.02	<0.10	<0.10	0.23	0.06	<0.10	<0.20	<0.30	<0.10	<0.01	<0.05	<0.05	0.10	<0.30

*Values below the detection limit are set to one-half the detection limit for statistical calculations.

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Toxic Air Contaminants
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Ambient Air Toxics Data - Gases (ppb)
Date Range: Jan 1, 2003 - Dec 31, 2003

Station: San Jose
158-B E. Jackson Street
San Jose, CA 95112

Station ID: 7032
AIRS ID: 060850005
CARB ID:

Date	Acetone	Benz	But-1,3	CCl4	CHCl3	DCM	EDB	EDC	EthBenz	Freon 11	Freon 113	M/P Xyl	MEK	MTBE	O Xyl	Perc	TCA	TCE	Tol	VC
03-Jan-03	8.20	2.40	0.80	0.11	0.05	0.50	<0.02	<0.10	0.90	0.30	0.08	3.40	0.60	2.30	1.30	0.15	0.05	0.05	6.00	<0.30
15-Jan-03	3.80	0.80	<0.15	0.10	<0.02	0.60	<0.02	<0.10	0.40	0.27	0.07	1.70	0.40	0.80	0.60	0.05	<0.05	<0.05	2.90	<0.30
27-Jan-03	6.80	0.90	<0.15	0.10	0.04	0.70	<0.02	<0.10	0.40	0.25	0.06	1.70	0.60	1.00	0.60	0.07	<0.05	<0.05	3.00	<0.30
08-Feb-03	6.20	1.40	0.57	0.11	0.04	0.50	<0.02	<0.10	0.50	0.31	0.09	1.90	0.50	0.90	0.70	0.06	0.05	<0.05	3.00	<0.30
20-Feb-03	2.20	0.40	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	0.10	0.26	0.07	0.60	0.20	<0.30	0.20	0.03	<0.05	<0.05	1.00	<0.30
04-Mar-03	3.80	0.50	<0.15	0.11	0.03	<0.50	<0.02	<0.10	0.10	0.26	0.07	0.70	0.40	<0.30	0.20	0.02	<0.05	<0.05	1.30	<0.30
16-Mar-03	1.70	0.40	<0.15	0.11	0.03	<0.50	<0.02	<0.10	0.10	0.27	0.07	0.50	<0.20	0.30	0.20	<0.01	<0.05	<0.05	0.80	<0.30
28-Mar-03	2.90	0.40	<0.15	0.11	0.03	<0.50	<0.02	<0.10	0.10	0.28	0.07	0.70	0.20	0.50	0.30	0.03	<0.05	<0.05	1.30	<0.30
09-Apr-03	5.00	0.40	0.15	0.11	0.03	<0.50	<0.02	<0.10	0.10	0.27	0.07	0.60	0.60	0.90	0.20	0.03	0.05	<0.05	0.90	<0.30
21-Apr-03	1.80	0.20	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	<0.10	0.26	0.08	0.20	0.20	<0.30	<0.10	<0.01	<0.05	<0.05	0.30	<0.30
03-May-03	3.00	0.40	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	0.10	0.27	0.07	0.40	0.20	<0.30	0.10	0.02	<0.05	<0.05	0.80	<0.30
15-May-03	2.50	0.20	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	<0.10	0.30	0.07	0.30	0.20	0.30	0.10	<0.01	<0.05	<0.05	0.50	<0.30
27-May-03	6.00	0.50	0.25	0.11	0.03	<0.50	<0.02	<0.10	0.20	0.27	0.07	0.70	0.50	1.00	0.30	0.02	0.05	<0.05	1.10	<0.30
08-Jun-03	2.70	0.10	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	<0.10	0.27	0.07	0.10	0.30	<0.30	<0.10	<0.01	<0.05	<0.05	0.20	<0.30
20-Jun-03	1.90	0.20	0.17	0.11	<0.02	<0.50	<0.02	<0.10	<0.10	0.28	0.08	0.20	0.20	0.30	<0.10	<0.01	<0.05	<0.05	0.40	<0.30
02-Jul-03	5.60	0.40	<0.15	0.11	0.04	0.60	<0.02	<0.10	0.10	0.27	0.08	0.50	0.40	0.80	0.20	0.02	<0.05	<0.05	1.00	<0.30
14-Jul-03	5.50	0.60	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	0.10	0.28	0.07	0.50	0.40	0.60	0.20	0.02	<0.05	0.05	1.20	<0.30
26-Jul-03	3.50	0.20	0.28	0.12	0.04	<0.50	<0.02	<0.10	<0.10	0.30	0.07	0.30	0.40	0.40	0.10	0.03	0.05	<0.05	0.70	<0.30
07-Aug-03	1.20	0.20	<0.15	0.11	<0.02	1.20	<0.02	<0.10	<0.10	0.30	0.06	0.20	0.30	0.50	<0.10	0.02	<0.05	<0.05	0.40	<0.30
19-Aug-03	3.80	0.10	0.15	0.11	<0.02	0.50	<0.02	<0.10	<0.10	0.29	0.07	0.20	0.20	0.40	0.10	<0.01	<0.05	<0.05	0.50	<0.30
31-Aug-03	2.80	0.20	<0.15	0.10	<0.02	<0.50	<0.02	<0.10	<0.10	0.22	0.08	0.20	0.40	0.40	<0.10	<0.01	<0.05	<0.05	0.40	<0.30
12-Sep-03	5.40	0.80	<0.15	0.10	0.05	<0.50	<0.02	<0.10	0.40	0.25	0.07	1.50	0.60	3.20	0.40	0.05	0.05	<0.05	2.20	<0.30
24-Sep-03	4.40	0.20	<0.15	0.10	<0.02	<0.50	<0.02	<0.10	0.10	0.23	0.06	0.50	0.40	0.40	0.10	<0.01	<0.05	<0.05	0.90	<0.30
06-Oct-03	5.20	0.50	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	0.20	0.27	0.07	0.90	0.30	0.70	0.30	0.03	0.05	<0.05	1.50	<0.30
18-Oct-03	4.40	0.80	<0.15	0.11	0.05	0.60	<0.02	<0.10	0.30	0.24	0.08	1.10	0.50	2.40	0.40	0.05	<0.05	<0.05	1.90	<0.30
30-Oct-03	2.00	0.20	0.15	0.09	<0.02	0.50	<0.02	<0.10	0.10	0.24	0.07	0.40	0.20	0.30	0.10	<0.01	<0.05	<0.05	0.90	<0.30

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Ambient Air Toxics Data - Gases (ppb)
Date Range: Jan 1, 2003 - Dec 31, 2003

Station: San Jose
158-B E. Jackson Street
San Jose, CA 95112

Station ID: 7032
AIRS ID: 060850005
CARB ID:

Date	Acetone	Benz	But-1,3	CCl4	CHCl3	DCM	EDB	EDC	EthBenz	Freon 11	Freon 113	M/P Xyl	MEK	MTBE	O Xyl	Perc	TCA	TCE	Tol	VC
23-Nov-03	5.30	1.10	0.23	0.11	<0.02	<0.50	<0.02	<0.10	0.50	0.28	0.07	1.90	0.40	0.50	0.60	0.04	0.05	<0.05	3.30	<0.30
05-Dec-03	3.80	0.40	0.25	0.11	<0.02	<0.50	<0.02	<0.10	0.20	0.24	0.08	0.60	0.40	0.30	0.20	0.03	<0.05	<0.05	1.10	<0.30
17-Dec-03	9.60	1.90	0.89	0.11	0.05	<0.50	<0.02	<0.10	0.80	0.30	0.08	2.90	0.70	0.50	1.30	0.14	0.05	<0.05	4.80	<0.30
29-Dec-03	1.60	0.20	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	<0.10	0.24	0.08	0.10	0.20	<0.30	<0.10	<0.01	<0.05	<0.05	0.20	<0.30
# Obs	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31
# <LOD	0	0	19	0	17	21	31	31	9	0	0	0	1	6	6	10	21	29	0	31
Mean*	4.16	0.59	0.19	0.11	0.02	0.37	0.01	0.05	0.22	0.27	0.07	0.88	0.37	0.73	0.31	0.03	0.03	0.03	1.54	0.15
Max	9.60	2.40	0.89	0.12	0.05	1.20	<0.02	<0.10	0.90	0.31	0.09	3.40	0.70	3.20	1.30	0.15	0.06	0.05	6.00	<0.30
Min	1.20	0.10	<0.15	0.09	<0.02	<0.50	<0.02	<0.10	<0.10	0.22	0.06	0.10	<0.20	<0.30	<0.10	<0.01	<0.05	<0.05	0.20	<0.30

*Values below the detection limit are set to one-half the detection limit for statistical calculations.

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Toxic Air Contaminants
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Ambient Air Toxics Data - Gases (ppb)
Date Range: Jan 1, 2003 - Dec 31, 2003

Station: Vallejo
304 Tuolumne Street
Vallejo, CA 94590

Station ID: 8004
AIRS ID: 060950004
CARB ID: 4800879

Date	Acetone	Benz	But-1,3	CCl4	CHCl3	DCM	EDB	EDC	EthBenz	Freon 11	Freon 113	M/P Xyl	MEK	MTBE	O Xyl	Perc	TCA	TCE	Tol	VC
05-Jan-03	7.00	1.50	0.58	0.11	0.06	1.00	<0.02	<0.10	0.50	0.32	0.10	1.90	0.40	2.70	0.70	0.06	0.09	<0.05	3.40	<0.30
15-Jan-03	6.10	0.40	0.17	0.12	<0.02	0.50	<0.02	<0.10	0.20	0.25	0.10	0.60	0.30	0.80	0.20	0.02	<0.05	<0.05	1.00	<0.30
27-Jan-03	12.90	0.80	0.30	0.11	0.03	0.80	<0.02	<0.10	0.30	0.32	1.16	1.00	1.10	1.50	0.40	0.03	<0.05	<0.05	1.80	<0.30
08-Feb-03	10.10	1.90	0.61	0.11	0.06	0.80	<0.02	<0.10	0.60	0.30	0.08	2.50	0.80	1.80	0.90	0.10	<0.05	0.05	4.00	<0.30
20-Feb-03	6.80	0.70	0.23	0.12	0.03	0.90	<0.02	<0.10	0.20	0.27	0.09	0.90	0.50	1.20	0.30	0.02	<0.05	<0.05	1.50	<0.30
04-Mar-03	3.30	0.60	<0.15	0.10	0.05	0.50	<0.02	<0.10	0.30	0.26	0.07	1.00	0.30	0.90	0.40	0.02	<0.05	<0.05	1.60	<0.30
16-Mar-03	3.00	0.30	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	<0.10	0.26	0.07	0.30	0.30	0.30	0.10	<0.01	<0.05	<0.05	0.70	<0.30
28-Mar-03	11.20	0.50	<0.15	0.11	0.03	1.10	<0.02	<0.10	0.20	0.29	0.09	0.70	0.40	0.70	0.30	<0.01	<0.05	<0.05	1.10	<0.30
09-Apr-03	2.70	0.40	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	<0.10	0.27	0.07	0.30	0.20	<0.30	0.10	<0.01	<0.05	<0.05	0.60	<0.30
21-Apr-03	2.60	0.10	<0.15	0.11	<0.02	0.60	<0.02	<0.10	<0.10	0.26	0.08	0.10	0.20	<0.30	<0.10	<0.01	<0.05	<0.05	0.20	<0.30
03-May-03	3.90	0.20	<0.15	0.10	<0.02	<0.50	<0.02	<0.10	<0.10	0.26	0.07	0.20	0.30	<0.30	<0.10	<0.01	<0.05	<0.05	0.60	<0.30
15-May-03	2.90	0.20	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	<0.10	0.28	0.07	0.20	0.20	<0.30	<0.10	<0.01	<0.05	<0.05	0.30	<0.30
27-May-03	5.40	0.40	0.17	0.11	0.03	0.80	<0.02	<0.10	0.10	0.27	0.08	0.50	0.50	0.80	0.20	0.02	<0.05	<0.05	0.90	<0.30
08-Jun-03	2.60	0.10	<0.15	0.10	<0.02	0.60	<0.02	<0.10	<0.10	0.26	0.07	0.10	0.20	<0.30	<0.10	<0.01	<0.05	<0.05	0.50	<0.30
20-Jun-03	2.60	0.20	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	<0.10	0.26	0.09	0.20	0.20	<0.30	<0.10	<0.01	<0.05	<0.05	0.30	<0.30
02-Jul-03	4.20	0.40	<0.15	0.12	<0.02	1.00	<0.02	<0.10	<0.10	0.28	0.08	0.20	0.20	<0.30	0.10	<0.01	<0.05	<0.05	0.60	<0.30
14-Jul-03	3.60	0.30	0.23	0.11	<0.02	0.70	<0.02	<0.10	0.10	0.28	0.07	0.40	0.20	0.30	0.10	<0.01	<0.05	<0.05	0.70	<0.30
26-Jul-03	3.10	0.10	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	<0.10	0.27	0.07	0.10	0.20	0.60	<0.10	<0.01	<0.05	<0.05	0.20	<0.30
07-Aug-03	3.00	0.20	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	<0.10	0.27	0.07	0.10	<0.20	<0.30	<0.10	<0.01	<0.05	<0.05	0.30	<0.30
19-Aug-03	1.80	0.10	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	<0.10	0.29	0.08	0.10	0.20	0.30	<0.10	<0.01	<0.05	<0.05	0.20	<0.30
31-Aug-03	2.50	0.10	<0.15	0.10	<0.02	<0.50	<0.02	<0.10	<0.10	0.30	0.08	0.10	0.20	0.30	<0.10	<0.01	<0.05	<0.05	0.20	<0.30
12-Sep-03	7.30	1.20	<0.15	0.10	0.08	1.30	<0.02	<0.10	0.50	0.28	0.09	2.00	0.50	4.80	0.60	0.04	<0.05	<0.05	3.10	<0.30
24-Sep-03	2.10	0.10	<0.15	0.10	<0.02	<0.50	<0.02	<0.10	<0.10	0.27	0.08	0.10	<0.20	<0.30	<0.10	<0.01	<0.05	<0.05	0.20	<0.30
06-Oct-03	2.60	0.30	<0.15	0.10	<0.02	<0.50	<0.02	<0.10	0.10	0.27	0.08	0.50	0.20	0.30	0.20	0.02	<0.05	<0.05	0.80	<0.30
18-Oct-03	4.60	0.60	<0.15	0.09	<0.02	0.50	<0.02	<0.10	0.40	0.24	0.07	1.40	0.30	1.40	0.50	0.02	0.05	<0.05	2.20	<0.30
30-Oct-03	3.90	0.10	<0.15	0.10	<0.02	<0.50	<0.02	<0.10	<0.10	0.27	0.09	0.10	0.30	0.30	<0.10	<0.01	<0.05	<0.05	0.20	<0.30

Bay Area Air Quality Management District
Toxic Air Contaminants
2003 Annual Report

Ambient Air Toxics Data - Gases (ppb)
Date Range: Jan 1, 2003 - Dec 31, 2003

Station: Vallejo
304 Tuolumne Street
Vallejo, CA 94590

Station ID: 8004
AIRS ID: 060950004
CARB ID: 4800879

Date	Acetone	Benz	But-1,3	CCl4	CHCl3	DCM	EDB	EDC	EthBenz	Freon 11	Freon 113	M/P Xyl	MEK	MTBE	O Xyl	Perc	TCA	TCE	Tol	VC
23-Nov-03	3.20	1.00	0.39	0.11	0.05	<0.50	<0.02	<0.10	0.30	0.26	0.08	1.00	0.30	0.80	0.30	0.02	<0.05	<0.05	1.80	<0.30
05-Dec-03	3.80	0.50	0.25	0.11	0.03	<0.50	<0.02	<0.10	0.10	0.28	0.08	0.50	0.50	0.40	0.20	0.02	<0.05	<0.05	1.00	<0.30
17-Dec-03	1.90	0.30	<0.15	0.10	<0.02	<0.50	<0.02	<0.10	0.10	0.23	0.08	0.30	<0.20	<0.30	0.10	<0.01	<0.05	<0.05	0.70	<0.30
31-Dec-03	5.60	0.90	<0.15	0.11	<0.02	1.00	<0.02	<0.10	0.40	0.27	0.07	1.50	0.40	0.30	0.50	0.05	<0.05	<0.05	2.30	<0.30
# Obs	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31
# <LOD	0	0	21	0	20	15	31	31	14	0	0	0	3	10	11	17	28	30	0	31
Mean*	4.97	0.52	0.16	0.11	0.02	0.62	0.01	0.05	0.18	0.27	0.12	0.68	0.36	0.84	0.24	0.02	0.03	0.03	1.18	0.15
Max	17.90	1.90	0.61	0.12	0.08	3.40	<0.02	<0.10	0.60	0.32	1.16	2.50	1.50	4.80	0.90	0.10	0.09	0.05	4.00	<0.30
Min	1.80	0.10	<0.15	0.09	<0.02	<0.50	<0.02	<0.10	<0.10	0.23	0.07	0.10	<0.20	<0.30	<0.10	<0.01	<0.05	<0.05	0.20	<0.30

*Values below the detection limit are set to one-half the detection limit for statistical calculations.

Bay Area Air Quality Management District
Toxic Air Contaminants
2003 Annual Report

Ambient Air Toxics Data - Gases (ppb)
Date Range: Jan 1, 2003 - Dec 31, 2003

Station: Santa Rosa
837 5th Street
Santa Rosa, CA 95404

Station ID: 9004
AIRS ID: 060970003
CARB ID: 4900893

Date	Acetone	Benz	But-1,3	CCl4	CHCl3	DCM	EDB	EDC	EthBenz	Freon 11	Freon 113	M/P Xyl	MEK	MTBE	O Xyl	Perc	TCA	TCE	Tol	VC
03-Jan-03	5.60	1.10	0.37	0.11	0.03	<0.50	<0.02	<0.10	0.30	0.27	0.08	1.20	0.40	1.10	0.50	0.04	0.12	<0.05	2.10	<0.30
15-Jan-03	5.30	0.70	0.18	0.11	<0.02	<0.50	<0.02	<0.10	0.30	0.26	0.07	1.10	0.30	0.60	0.40	0.03	0.11	<0.05	2.00	<0.30
27-Jan-03	5.40	0.50	0.22	0.11	<0.02	<0.50	<0.02	<0.10	0.20	0.26	0.08	0.60	0.40	0.70	0.20	0.02	0.63	<0.05	1.10	<0.30
08-Feb-03	5.50	0.80	0.18	0.12	0.03	<0.50	<0.02	<0.10	0.20	0.30	0.09	0.80	0.40	0.60	0.30	0.02	0.16	<0.05	1.30	<0.30
20-Feb-03	28.30	0.40	0.20	0.12	<0.02	<0.50	<0.02	<0.10	0.10	0.23	0.09	0.40	1.20	0.50	0.10	0.02	0.55	<0.05	0.70	<0.30
04-Mar-03	4.50	0.70	<0.15	0.11	0.03	<0.50	<0.02	<0.10	0.20	0.28	0.07	1.00	1.20	0.30	0.30	0.02	0.23	<0.05	1.90	<0.30
16-Mar-03	2.90	0.30	<0.15	0.10	<0.02	<0.50	<0.02	<0.10	<0.10	0.24	0.06	0.20	0.20	<0.30	0.10	<0.01	0.13	<0.05	0.50	<0.30
28-Mar-03	11.40	0.30	<0.15	0.10	<0.02	0.70	<0.02	<0.10	0.10	0.26	0.07	0.40	0.50	0.40	0.20	<0.01	0.09	<0.05	0.90	<0.30
09-Apr-03	14.40	0.40	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	0.10	0.27	0.08	0.40	0.70	0.40	0.10	0.02	0.12	<0.05	0.70	<0.30
21-Apr-03	10.20	0.20	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	<0.10	0.28	0.09	0.20	0.40	<0.30	<0.10	<0.01	0.90	<0.05	0.40	<0.30
03-May-03	8.50	0.20	<0.15	0.10	<0.02	<0.50	<0.02	<0.10	<0.10	0.26	0.07	0.20	0.60	<0.30	0.10	<0.01	0.21	<0.05	0.60	<0.30
15-May-03	17.30	0.30	<0.15	0.11	0.03	<0.50	<0.02	<0.10	<0.10	0.27	0.08	0.20	1.20	<0.30	0.10	<0.01	0.39	<0.05	0.70	<0.30
27-May-03	15.20	0.40	0.18	0.11	<0.02	<0.50	<0.02	<0.10	0.10	0.27	0.07	0.50	1.00	0.60	0.20	0.02	0.21	<0.05	0.80	<0.30
08-Jun-03	6.40	0.20	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	<0.10	0.27	0.11	0.10	0.50	<0.30	<0.10	<0.01	2.00	<0.05	0.40	<0.30
20-Jun-03	10.30	0.20	<0.15	0.10	<0.02	<0.50	<0.02	<0.10	<0.10	0.25	0.06	0.20	0.50	<0.30	0.10	<0.01	0.25	<0.05	0.70	<0.30
02-Jul-03	8.00	0.30	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	<0.10	0.27	0.07	0.20	0.40	<0.30	0.10	<0.01	0.34	<0.05	0.50	<0.30
14-Jul-03	13.00	0.20	<0.15	0.11	<0.02	<0.50	<0.02	<0.10	0.10	0.27	0.07	0.30	0.80	0.80	0.10	0.02	0.15	<0.05	0.50	<0.30
26-Jul-03	7.50	0.20	0.20	0.12	<0.02	<0.50	<0.02	<0.10	<0.10	0.28	0.07	0.20	0.50	0.30	<0.10	<0.01	0.56	<0.05	0.50	<0.30
07-Aug-03	32.60	0.30	0.30	0.12	0.06	<0.50	<0.02	<0.10	<0.10	0.26	0.07	0.30	1.70	0.40	0.10	<0.01	1.50	<0.05	1.10	<0.30
19-Aug-03	5.80	0.10	<0.15	0.10	<0.02	<0.50	<0.02	<0.10	<0.10	0.30	0.08	0.10	0.40	<0.30	<0.10	<0.01	0.20	<0.05	0.20	<0.30
31-Aug-03	19.60	0.20	0.18	0.10	0.03	<0.50	<0.02	<0.10	<0.10	0.23	0.07	0.20	1.00	0.30	<0.10	<0.01	1.45	<0.05	1.00	<0.30
12-Sep-03	121.40	0.80	<0.15	0.10	0.03	<0.50	<0.02	<0.10	0.20	0.23	0.09	0.90	5.80	2.00	0.20	0.03	1.65	<0.05	1.60	<0.30
24-Sep-03	2.60	0.10	<0.15	0.11	<0.02	0.50	<0.02	<0.10	<0.10	0.26	0.09	0.20	0.20	<0.30	<0.10	<0.01	0.31	<0.05	0.20	<0.30
06-Oct-03	26.70	0.40	<0.15	0.10	<0.02	<0.50	<0.02	<0.10	0.10	0.27	0.09	0.50	1.40	0.70	0.10	0.02	2.47	<0.05	1.30	<0.30
18-Oct-03	11.90	0.50	<0.15	0.09	<0.02	0.90	<0.02	<0.10	0.10	0.24	0.07	0.90	0.60	0.60	0.30	<0.01	0.33	<0.05	1.70	<0.30
30-Oct-03	4.10	0.20	<0.15	0.10	<0.02	<0.50	<0.02	<0.10	<0.10	0.27	0.08	0.20	0.20	0.30	<0.10	<0.01	0.34	<0.05	0.40	<0.30

Bay Area Air Quality Management District
Toxic Air Contaminants
2003 Annual Report

Ambient Air Toxics Data - Gases (ppb)
Date Range: Jan 1, 2003 - Dec 31, 2003

Station: Santa Rosa
837 5th Street
Santa Rosa, CA 95404

Station ID: 9004
AIRS ID: 060970003
CARB ID: 4900893

Date	Acetone	Benz	But-1,3	CCl4	CHCl3	DCM	EDB	EDC	EthBenz	Freon 11	Freon 113	M/P Xyl	MEK	MTBE	O Xyl	Perc	TCA	TCE	Tol	VC
23-Nov-03	5.90	0.40	<0.15	0.11	0.03	<0.50	<0.02	<0.10	0.10	0.25	0.09	0.40	0.40	0.30	0.10	<0.01	2.00	<0.05	1.10	<0.30
05-Dec-03	2.10	0.40	0.32	0.10	<0.02	<0.50	<0.02	<0.10	0.10	0.27	0.08	0.50	0.20	0.30	0.10	0.02	0.16	<0.05	0.80	<0.30
17-Dec-03	3.90	1.10	0.18	0.09	<0.02	<0.50	<0.02	<0.10	0.40	0.24	0.06	1.50	0.30	<0.30	0.50	0.04	0.13	<0.05	2.30	<0.30
29-Dec-03	1.90	0.30	<0.15	0.11	<0.02	0.50	<0.02	<0.10	<0.10	0.28	0.07	0.30	0.20	<0.30	0.10	<0.01	0.30	<0.05	0.60	<0.30
# Obs	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31
# <LOD	0	0	19	0	23	27	31	31	14	0	0	0	0	11	7	17	0	31	0	31
Mean*	13.68	0.41	0.13	0.11	0.02	0.30	0.01	0.05	0.11	0.26	0.08	0.48	0.77	0.45	0.16	0.01	0.66	0.03	0.97	0.15
Max	121.40	1.10	0.37	0.12	0.06	0.90	<0.02	<0.10	0.40	0.30	0.11	1.50	5.80	2.00	0.50	0.04	2.47	<0.05	2.30	<0.30
Min	1.90	0.10	<0.15	0.09	<0.02	<0.50	<0.02	<0.10	<0.10	0.23	0.06	0.10	0.20	<0.30	<0.10	<0.01	0.09	<0.05	0.20	<0.30

*Values below the detection limit are set to one-half the detection limit for statistical calculations.

APPENDIX C-2

AMBIENT AIR MONITORING
DATA SUMMARY BY POLLUTANT

DIRECTORY OF ACTIVE TOXIC AIR CONTAMINANT MONITORING STATIONS

Station	Location	Address
1018	Oakland – Davie Stadium	198 Oak Road
1022	San Leandro	15400 Foothill Boulevard
1023	Livermore	793 Rincon Avenue
1024	Oakland – Filbert Street	2419 Filbert Street
2010	Pittsburg	583 West 10th Street
2014	Martinez	521 Jones Street
2017	Crockett	End of Kendall Avenue
2018	Concord – Treat Blvd.	2975 Treat Boulevard
2019	Richmond	1065 7th Street
2021	Bethel Island	5551 Bethel Island Road
2035	San Pablo – Rumrill Blvd.	1865-D Rumrill Boulevard
3005	San Rafael	534 4th Street
3007	Fort Cronkhite – Sausalito	National Park Service Bldg 1049
4001	Napa	2552 Jefferson Street
5011	San Francisco	10 Arkansas Street
6004	Redwood City	897 Barron Avenue
7030	Sunnyvale	910 Ticonderoga Avenue
7032	San Jose – Jackson Street	158 East Jackson Street, Suite B
8004	Vallejo	304 Tuolumne Street
9004	Santa Rosa	837 5th Street

20 stations total

Bay Area Air Quality Management District
Toxic Air Contaminants
2003 Annual Report

Ambient Air Toxics Data

Date Range: Jan 1, 2003 to Dec 31, 2003

Pollutant: Acetone (PPB)

Station ID Numbers

	1018	1022	1023	1024	2010	2014	2017	2018	2019	2021	2035	3005	3007	4001	5011	6004	7030	7032	8004	9004
02-Jan-03							2.50													
03-Jan-03	2.10		5.10	13.20	4.70	18.90		3.30	2.70	4.10	2.8	2.80	1.80		5.50	15.40	3.30	8.20		5.60
04-Jan-03														6.20						
05-Jan-03																			7.00	
08-Jan-03		4.20																		
15-Jan-03	2.10	3.70	4.90	12.20	5.40	23.30	1.60	3.00	3.00	0.60	6.40	5.30	2.30	4.70	3.40	14.70	2.20	3.80	6.10	5.30
27-Jan-03	2.80	4.50	4.70	12.90	2.90	19.40	1.80	3.20	6.80	3.00	5.90	3.50	1.60	5.20	4.70	7.60	3.60	6.80	12.90	5.40
08-Feb-03	2.50	2.20	4.60	16.20	3.90	13.30	2.30	3.70	2.50	2.80	3.60	3.80	1.80	9.50	4.40	6.00	4.30	6.20	10.10	5.50
20-Feb-03	2.20	2.20	3.90	8.30	3.70	11.50	1.00	2.60	2.70	3.50	6.70	1.50	1.00	4.80	8.40	4.20	2.20	2.20	6.80	28.30
04-Mar-03	2.30	2.40	3.20	12.90	1.70	23.00	1.70	3.00	4.50	1.50	3.50	1.70	1.40	5.20		8.80	3.10	3.80	3.30	4.50
16-Mar-03	1.50	2.30	2.30	11.60	3.00	25.10	1.30	2.50	2.40	1.30	2.90	1.70	2.10	5.50	2.60	3.30	1.60	1.70	3.00	2.90
22-Mar-03															3.00					
28-Mar-03	1.80		11.50	16.10	3.10	31.70	3.00	5.00	2.50	5.70	2.90	2.50	4.60	3.20	2.40	3.70	1.70	2.90	11.20	11.40
02-Apr-03		2.80																		
09-Apr-03		7.50	4.00	3.90	2.70	36.40	2.20	3.80	10.20	3.80	6.00	2.10	2.00	3.40	4.30	7.50	3.00	5.00	2.70	14.40
21-Apr-03		7.30	4.00	3.60	5.90	18.60	1.60	2.20	5.00	2.80	4.90	1.20	2.00	4.40	3.40	5.60		1.80	2.60	10.20
24-Apr-03																	2.10			
03-May-03			2.30	3.50	2.00	39.10	3.20	3.70	6.30	3.70	3.80	1.80	1.80	3.20	3.70	4.00	3.60	3.00	3.90	8.50
06-May-03		4.30																		
15-May-03		3.20	3.10	2.30	2.50	30.20	3.50	2.90	9.70	3.60	2.80	2.10	3.30	3.20	4.60	4.50	2.50	2.50	2.90	17.30
27-May-03		6.40	7.40	5.50	5.90	46.00	9.50	6.20	16.20	32.00	7.30	3.70	3.70	4.80	7.10	6.10	5.20	6.00	5.40	15.20
08-Jun-03		3.40	3.20	3.40	2.80	17.60	5.60	2.50	10.10	5.30	3.50	2.00	2.50	5.40	3.70	3.80	2.50	2.70	2.60	6.40
20-Jun-03		2.30	2.30	2.90	2.70	48.80	7.40	2.90	14.40	4.00	3.40	1.70	1.20	3.00	4.50	6.10	1.60	1.90	2.60	10.30
02-Jul-03		4.60	4.80	7.00	5.30	44.10	14.30	2.10	8.40	8.70	2.80	3.50	1.70	4.30	5.10	5.20	2.80	5.60	4.20	8.00
14-Jul-03		4.50	4.80	8.10	4.80	29.70	19.00	6.30	16.10	28.00	5.00	2.70	1.50	6.60	5.90	4.70		5.50	3.60	13.00
18-Jul-03																	7.10			
26-Jul-03		3.90	4.10	6.00	3.50	24.80	17.20	5.10	13.90	6.10	4.00	9.40	2.00	5.80	3.10	2.90	3.90	3.50	3.10	7.50
07-Aug-03		3.20	3.80	3.70	3.10	30.80	16.70	4.20	18.20	1.00	4.90	2.10	7.00	5.60	8.80	6.60	5.20	1.20	3.00	32.60
19-Aug-03		1.60	3.40	7.50	2.00	21.50	13.10	2.70	12.00	2.90	4.70	2.00	1.20	2.00	3.80	8.20	2.50	3.80	1.80	5.80
31-Aug-03		3.40	4.20	7.00	3.20	22.20	21.40	6.40	16.00	3.40	3.20	2.30	1.70	3.40	2.90	3.40		2.80	2.50	19.60
05-Sep-03																	3.50			
12-Sep-03		6.20	7.60	18.50	6.40	40.60	29.50	8.60	60.60	2.40	14.80	4.90	3.90	9.00	13.90	8.70	4.50	5.40	7.30	121.40
24-Sep-03		1.80	4.00	7.20	2.90	18.80	12.40	3.40	17.90	1.70	4.00	3.40	4.50	5.10	4.80	6.60	4.80	4.40	2.10	2.60
06-Oct-03		3.30	4.60	15.80	4.00	14.90	23.00	5.40	14.20	4.40	4.40	3.60	2.10	7.00	4.20	5.40		5.20	2.60	26.70
18-Oct-03		3.80	11.60	14.30	7.60	25.80	14.50		26.80	4.20	5.00	5.00	1.60	5.20	2.90	5.40	11.20	4.40	4.60	11.90

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Ambient Air Toxics Data

Date Range: Jan 1, 2003 to Dec 31, 2003 **Pollutant: Acetone (PPB)**

Station ID Numbers

	1018	1022	1023	1024	2010	2014	2017	2018	2019	2021	2035	3005	3007	4001	5011	6004	7030	7032	8004	9004
20-Oct-03								9.20												
30-Oct-03		3.10	2.60	8.80	2.60	9.70	6.10	2.00	9.90	1.90	2.40	1.90	6.60	3.80	4.10	3.80	3.00	2.00	3.90	4.10
11-Nov-03		2.80	6.00	12.50	6.40	3.00	22.60	4.10	16.70	2.10	3.80	3.20	13.40		6.00	26.20	3.70	6.50	17.90	5.80
13-Nov-03														6.10						
23-Nov-03		1.70	5.40	10.70	3.20	2.30	8.60	4.10	11.30	2.80	5.40	2.00	2.00		7.40	7.40	2.10	5.30	3.20	5.90
25-Nov-03														4.90						
05-Dec-03		3.10	9.60	6.50	3.50	2.90	23.20	8.70	5.40	3.00	4.00	4.80	2.00	4.60	5.10	35.40	4.50	3.80	3.80	2.10
17-Dec-03		1.50	6.70	14.70	3.70	2.60	10.10		3.00	2.70	4.20	2.30	1.80	6.60	6.80	33.40	4.00	9.60	1.90	3.90
18-Dec-03								4.40												
29-Dec-03		1.80	2.60	5.00	1.80	2.20	13.80	2.00	2.00	1.70			2.20	2.60	2.60	7.10		1.60		1.90
31-Dec-03											4.40								5.60	
# Obs	8	31	31	31	31	31	31	31	31	31	31	30	31	31	31	31	29	31	31	31
# <LOD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mean*	2.16	3.52	4.91	9.09	3.77	22.54	10.12	4.17	11.34	4.99	4.63	3.02	2.85	4.98	4.74	8.76	3.63	4.16	4.97	13.68
Max	2.80	7.50	11.60	18.50	7.60	48.80	29.50	9.20	60.60	32.00	14.80	9.40	13.40	9.50	13.90	35.40	11.20	9.60	17.90	121.40
Min	1.50	1.50	2.30	2.30	1.70	2.20	1.00	2.00	2.00	0.60	2.40	1.20	1.00	2.00	2.40	2.90	1.60	1.20	1.80	1.90

*Values below the detection limit are set to one-half the detection limit for statistical calculations.

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Ambient Air Toxics Data

Date Range: Jan 1, 2003 to Dec 31, 2003 **Pollutant: Benzene (PPB)**

Station ID Numbers

	1018	1022	1023	1024	2010	2014	2017	2018	2019	2021	2035	3005	3007	4001	5011	6004	7030	7032	8004	9004
02-Jan-03							0.30													
03-Jan-03	0.50		0.80	1.20	0.80	0.80		0.80	0.50	0.60	0.40	0.50	0.10		0.80	1.40	0.90	2.40		1.10
04-Jan-03														1.00						
05-Jan-03																			1.50	
08-Jan-03		0.30																		
15-Jan-03	0.30	0.40	0.40	0.80	0.60	0.40	0.30	0.80	0.40	0.40	0.50	0.70	0.20	1.10	0.60	1.30	0.40	0.80	0.40	0.70
27-Jan-03	0.60	0.40	0.50	0.70	0.60	0.60	0.30	0.80	0.60	0.40	0.90	0.60	0.10	0.70	0.60	0.90	0.80	0.90	0.80	0.50
08-Feb-03	0.60	0.40	0.80	1.80	0.80	0.50	0.30	0.80	0.60	0.60	0.60	0.80	0.20	0.90	0.80	0.90	0.70	1.40	1.90	0.80
20-Feb-03	0.30	0.20	0.60	0.30	0.50	0.20	0.20	0.40	0.30	0.20	0.40	0.30	0.10	0.60	0.70	0.60	0.50	0.40	0.70	0.40
04-Mar-03	0.80	0.30	0.70	0.50	0.30	0.20	0.30	0.40	0.70	0.40	0.50	0.60	0.20	0.70		1.70	1.20	0.50	0.60	0.70
16-Mar-03	0.20	0.20	0.20	0.40	0.30	0.30	0.10	0.30	0.30	0.20	0.40	0.40	0.10	0.30	0.20	0.30	0.20	0.40	0.30	0.30
22-Mar-03															0.20					
28-Mar-03	0.20		0.30	0.30	0.20	0.20	0.10	0.50	0.30	0.20	0.30	0.30	0.10	0.20	0.40	0.40	0.30	0.40	0.50	0.30
02-Apr-03		0.20																		
09-Apr-03		0.30	0.30	0.50	0.20	0.30	0.10	0.30	0.40	0.20	0.40	0.40	0.10	0.30	0.40	0.40	0.30	0.40	0.40	0.40
21-Apr-03		0.20	0.10	0.20	0.40	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20		0.20	0.10	0.20
24-Apr-03																	0.10			
03-May-03			0.20	0.30	0.20	0.10	0.20	0.20	0.20	0.10	0.20	0.20	0.10	0.20	0.40	0.20	0.20	0.40	0.20	0.20
06-May-03		0.20																		
15-May-03		0.20	0.10	0.20	0.20	0.10	0.10	0.20	0.20	0.10	0.20	0.20	0.10	0.20	0.30	0.20	0.10	0.20	0.20	0.30
27-May-03		0.40	0.40	0.50	0.40	0.30	0.30	0.40	0.50	0.20	0.50	0.40	0.10	0.30	0.40	0.40	0.30	0.50	0.40	0.40
08-Jun-03		0.10	0.10	0.20	0.10	0.30	0.10	0.20	0.20	0.20	0.20	0.10	< 0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.20
20-Jun-03		0.10	0.10	0.20	0.10	0.60	0.20	0.20	0.20	0.10	0.20	0.20	< 0.10	0.20	0.20	0.10	0.10	0.20	0.20	0.20
02-Jul-03		0.20	0.30	0.30	0.20	0.20	0.40	0.20	0.10	0.20	0.20	0.20	< 0.10	0.30	0.20	0.30	0.20	0.40	0.40	0.30
14-Jul-03		0.40	0.40	0.30	0.20	0.20	0.20	0.20	0.40	0.10	0.30	0.20	< 0.10	0.30	0.30	0.30		0.60	0.30	0.20
18-Jul-03																	0.30			
26-Jul-03		0.20	0.20	0.20	0.20	0.10	0.10	0.30	0.20	0.10	0.20	0.20	< 0.10	0.20	0.20	0.20	0.30	0.20	0.10	0.20
07-Aug-03		0.30	0.20	0.20	0.30	0.20	0.20	0.20	0.10	0.10	0.20	0.20	< 0.10	0.20	0.20	0.30	0.40	0.20	0.20	0.30
19-Aug-03		0.20	0.20	0.30	0.20	0.10	0.10	0.10	0.20	0.10	0.10	0.20	< 0.10	0.20	0.20	0.20	0.20	0.10	0.10	0.10
31-Aug-03		0.30	0.20	0.20	0.30	0.10	0.10	0.30	0.10	0.10	0.20	0.20	0.20	0.20	0.10	0.30		0.20	0.10	0.20
05-Sep-03																	0.20			
12-Sep-03		0.50	0.60	1.00	0.50	0.40	0.20	0.60	0.70	0.30	0.80	0.60	0.10	0.70	1.00	0.60	0.40	0.80	1.20	0.80
24-Sep-03		0.10	0.20	0.20	0.20	0.20	0.10	0.10	0.10	0.10	0.20	0.30	0.10	0.20	0.20	0.20	0.30	0.20	0.10	0.10
06-Oct-03		0.50	0.60	0.60	0.30	0.40	0.20	0.40	0.30	0.20	0.30	0.40	< 0.10	0.60	0.30	0.50		0.50	0.30	0.40
18-Oct-03		0.50	0.60	0.50	0.70	0.40	0.20		0.40	0.60	0.50	0.40	< 0.10	0.40	0.40	0.60	0.60	0.80	0.60	0.50

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Ambient Air Toxics Data

Date Range: Jan 1, 2003 to Dec 31, 2003 **Pollutant: Benzene (PPB)**

Station ID Numbers

	1018	1022	1023	1024	2010	2014	2017	2018	2019	2021	2035	3005	3007	4001	5011	6004	7030	7032	8004	9004
20-Oct-03								0.90												
30-Oct-03		0.20	0.10	0.20	0.20	0.10	< 0.10	0.20	0.20	0.10	0.20	0.20	< 0.10	0.50	0.20	0.20	0.20	0.20	0.10	0.20
11-Nov-03		0.40	0.70	1.00	0.90	0.30	0.20	0.70	0.50	0.20	0.50	0.60	1.00		0.70	0.80	0.50	1.40	1.50	0.50
13-Nov-03														1.00						
23-Nov-03		0.20	0.60	1.00	0.50	0.50	0.30	0.70	0.50	0.40	0.50	0.50	0.20		0.60	0.60	0.40	1.10	1.00	0.40
25-Nov-03														0.80						
05-Dec-03		0.40	0.80	0.40	0.70	0.70	0.40	0.90	0.50	0.20	0.60	0.50	0.20	0.50	0.80	1.00	0.60	0.40	0.50	0.40
17-Dec-03		0.20	0.70	0.80	0.40	1.00	0.20		0.50	0.40	0.50	0.80	0.20	1.50	0.70	0.90	0.70	1.90	0.30	1.10
18-Dec-03								0.80												
29-Dec-03		0.20	0.20	0.30	0.20	0.20	0.20	0.20	0.30	0.10			0.20	0.20	0.30	0.40		0.20		0.30
31-Dec-03											0.60								0.90	
# Obs	8	31	31	31	31	31	31	31	31	31	31	30	31	31	31	31	29	31	31	31
# <LOD	0	0	0	0	0	0	1	0	0	0	0	0	10	0	0	0	0	0	0	0
Mean*	0.44	0.28	0.39	0.50	0.38	0.33	0.20	0.43	0.35	0.24	0.38	0.38	0.14	0.48	0.40	0.53	0.40	0.59	0.52	0.41
Max	0.80	0.50	0.80	1.80	0.90	1.00	0.40	0.90	0.70	0.60	0.90	0.80	1.00	1.50	1.00	1.70	1.20	2.40	1.90	1.10
Min	0.20	0.10	0.10	0.20	0.10	0.10	< 0.1	0.10	0.10	0.10	0.10	0.10	< 0.1	0.10	0.10	0.10	0.10	0.10	0.10	0.10

*Values below the detection limit are set to one-half the detection limit for statistical calculations.

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Ambient Air Toxics Data

Date Range: Jan 1, 2003 to Dec 31, 2003 **Pollutant: 1,3-Butabiene (PPB)**

Station ID Numbers

	1018	1022	1023	1024	2010	2014	2017	2018	2019	2021	2035	3005	3007	4001	5011	6004	7030	7032	8004	9004
02-Jan-03							<0.15													
03-Jan-03	<0.15		0.24	<0.15	0.26	<0.15		0.18	<0.15	<0.15	<0.15	0.15	<0.15		0.24	0.48	0.21	0.80		0.37
04-Jan-03														0.35						
05-Jan-03																			0.58	
08-Jan-03		<0.15																		
15-Jan-03	<0.15	<0.15	0.16	0.17	0.24	<0.15	<0.15	0.28	<0.15	<0.15	<0.15	0.21	<0.15	0.35	<0.15	0.25	0.18	<0.15	0.17	0.18
27-Jan-03	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	0.28	<0.15	<0.15	0.23	<0.15	<0.15	0.29	0.19	0.24	0.28	<0.15	0.30	0.22
08-Feb-03	<0.15	<0.15	<0.15	0.50	<0.15	<0.15	<0.15	0.26	<0.15	<0.15	<0.15	0.23	<0.15	0.23	<0.15	0.22	0.20	0.57	0.61	0.18
20-Feb-03	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	0.21	<0.15	<0.15	<0.15	0.16	<0.15	<0.15	0.16	<0.15	<0.15	<0.15	0.23	0.20
04-Mar-03	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15		<0.15	<0.15	<0.15	<0.15	<0.15
16-Mar-03	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15
22-Mar-03															<0.15					
28-Mar-03	<0.15		<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15
02-Apr-03		<0.15																		
09-Apr-03		<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	0.15	<0.15	<0.15
21-Apr-03		<0.15	<0.15	<0.15	0.16	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15		<0.15	<0.15	<0.15
24-Apr-03																	<0.15			
03-May-03			<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15
06-May-03		<0.15																		
15-May-03		<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	0.28	<0.15	<0.15	<0.15	<0.15	<0.15	0.28	<0.15	<0.15	<0.15	<0.15	<0.15
27-May-03		<0.15	<0.15	<0.15	0.19	<0.15	0.20	0.16	0.27	0.40	<0.15	<0.15	<0.15	<0.15	0.19	<0.15	<0.15	0.25	0.17	0.18
08-Jun-03		<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15
20-Jun-03		<0.15	<0.15	<0.15	<0.15	0.15	0.16	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	0.17	<0.15	<0.15	0.17	<0.15	<0.15
02-Jul-03		<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15
14-Jul-03		0.17	<0.15	<0.15	<0.15	<0.15	0.16	<0.15	0.20	0.18	<0.15	0.15	<0.15	<0.15	<0.15	0.21		<0.15	0.23	<0.15
18-Jul-03																	<0.15			
26-Jul-03		<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	0.31	<0.15	0.15	<0.15	<0.15	<0.15	<0.15	<0.15	0.18	<0.15	0.28	<0.15	0.20
07-Aug-03		<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	0.30
19-Aug-03		<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	0.15	<0.15	<0.15
31-Aug-03		<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15		<0.15	<0.15	0.18
05-Sep-03																	<0.15			
12-Sep-03		<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15
24-Sep-03		<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15
06-Oct-03		<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15		<0.15	<0.15	<0.15
18-Oct-03		<0.15	<0.15	<0.15	<0.15	<0.15	<0.15		<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15

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Ambient Air Toxics Data

Date Range: Jan 1, 2003 to Dec 31, 2003 **Pollutant: 1,3-Butabiene (PPB)**

Station ID Numbers

	1018	1022	1023	1024	2010	2014	2017	2018	2019	2021	2035	3005	3007	4001	5011	6004	7030	7032	8004	9004
30-Oct-03		<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	0.20	<0.15	0.15	<0.15	<0.15
11-Nov-03		0.19	0.30	0.32	0.29	<0.15	0.30	0.31	0.19	0.23	0.17	0.18	0.22		0.24	0.16	<0.15	0.52	0.56	0.17
13-Nov-03														0.30						
23-Nov-03		<0.15	0.26	0.37	<0.15	<0.15	<0.15	<0.15	0.15	<0.15	0.22	0.17	<0.15		<0.15	<0.15	<0.15	0.23	0.39	<0.15
25-Nov-03														0.44						
05-Dec-03		0.22	0.29	0.22	0.32	0.47	0.16	0.15	0.27	0.16	0.30	0.35	0.19	0.32	0.39	0.56	<0.15	0.25	0.25	0.32
17-Dec-03		<0.15	0.40	0.30	0.23	0.46	<0.15		0.27	<0.15	<0.15	<0.15	<0.15	0.75	0.35	0.15	0.35	0.89	<0.15	0.18
18-Dec-03								0.50												
29-Dec-03		<0.15	0.19	0.18	<0.15	<0.15	0.19	0.17	0.24	<0.15			<0.15	<0.15	<0.15	<0.15		<0.15		<0.15
31-Dec-03											0.24								<0.15	
# Obs	8	31	31	31	31	31	31	31	31	31	31	30	31	31	31	31	29	31	31	31
# <LOD	8	28	24	24	24	28	25	20	22	26	26	22	29	23	22	21	24	19	21	19
Mean*	0.08	0.09	0.12	0.12	0.11	0.10	0.10	0.14	0.12	0.10	0.10	0.11	0.08	0.15	0.12	0.14	0.10	0.19	0.16	0.13
Max	<0.15	0.22	0.40	0.50	0.32	0.47	0.30	0.50	0.28	0.40	0.30	0.35	0.22	0.75	0.39	0.56	0.35	0.89	0.61	0.37
Min	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15

*Values below the detection limit are set to one-half the detection limit for statistical calculations.

Bay Area Air Quality Management District
Toxic Air Contaminants
2003 Annual Report

Ambient Air Toxics Data

Date Range: Jan 1, 2003 to Dec 31, 2003 **Pollutant: Carbon tetrachloride (PPB)**

Station ID Numbers

	1018	1022	1023	1024	2010	2014	2017	2018	2019	2021	2035	3005	3007	4001	5011	6004	7030	7032	8004	9004
02-Jan-03							0.12													
03-Jan-03	0.12		0.11	0.11	0.15	0.14		0.14	0.12	0.12	0.12	0.11	0.11		0.10	0.13	0.12	0.11		0.11
04-Jan-03														0.11						
05-Jan-03																			0.11	
08-Jan-03		0.09																		
15-Jan-03	0.11	0.11	0.11	0.11	0.15	0.11	0.11	0.12	0.11	0.10	0.10	0.09	0.11	0.12	0.10	0.11	0.11	0.10	0.12	0.11
27-Jan-03	0.10	0.10	0.10	0.09	0.11	0.11	0.11	0.12	0.10	0.10	0.11	0.10	0.11	0.10	0.11	0.11	0.11	0.10	0.11	0.11
08-Feb-03	0.11	0.10	0.12	0.11	0.12	0.12	0.12	0.13	0.10	0.11	0.10	0.11	0.11	0.10	0.11	0.11	0.11	0.11	0.11	0.12
20-Feb-03	0.11	0.11	0.11	0.10	0.12	0.10	0.10	0.12	0.12	0.12	0.12	0.10	0.11	0.11	0.11	0.11	0.10	0.11	0.12	0.12
04-Mar-03	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.12	0.12	0.11	0.11	0.11	0.11		0.11	0.11	0.11	0.10	0.11
16-Mar-03	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.10
22-Mar-03															0.10					
28-Mar-03	0.12		0.11	0.11	0.11	0.11	0.12	0.11	0.10	0.12	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.10
02-Apr-03		0.11																		
09-Apr-03		0.11	0.11	0.11	0.11	0.11	0.12	0.13	0.12	0.12	0.11	0.11	0.12	0.11	0.11	0.11	0.11	0.11	0.11	0.11
21-Apr-03		0.11	0.11	0.11	0.11	0.11	0.10	0.13	0.11	0.10	0.10	0.11	0.10	0.12	0.10	0.11		0.11	0.11	0.11
24-Apr-03																	0.10			
03-May-03			0.11	0.10	0.12	0.12	0.11	0.12	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.10	0.10
06-May-03		0.11																		
15-May-03		0.11	0.11	0.11	0.11	0.11	0.11	0.13	0.11	0.10	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11
27-May-03		0.12	0.11	0.11	0.11	0.11	0.12	0.13	0.11	0.12	0.11	0.11	0.11	0.11	0.11	0.11	0.09	0.11	0.11	0.11
08-Jun-03		0.11	0.11	0.11	0.11	0.11	0.11	0.12	0.11	0.10	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.10	0.11
20-Jun-03		0.11	0.11	0.11	0.11	0.11	0.10	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.09	0.11	0.11	0.10
02-Jul-03		0.12	0.11	0.11	0.11	0.11	0.11	0.12	0.11	0.10	0.11	0.11	0.11	0.11	0.12	0.11	0.11	0.11	0.12	0.11
14-Jul-03		0.11	0.11	0.11	0.11	0.11	0.11	0.12	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11		0.11	0.11	0.11
18-Jul-03																	0.11			
26-Jul-03		0.11	0.11	0.11	0.11	0.11	0.12	0.11	0.12	0.11	0.11	0.11	0.11	0.11	0.11	0.12	0.11	0.12	0.11	0.12
07-Aug-03		0.11	0.11	0.11	0.11	0.12	0.11	0.12	0.11	0.10	0.11	0.11	0.11	0.11	0.11	0.12	0.11	0.11	0.11	0.12
19-Aug-03		0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.10
31-Aug-03		0.10	0.10	0.09	0.10	0.09	0.09	0.10	0.09	0.09	0.09	0.10	0.09	0.10	0.10	0.10		0.10	0.10	0.10
05-Sep-03																	0.09			
12-Sep-03		0.10	0.10	0.10	0.10	0.10	0.09	0.11	0.09	0.10	0.09	0.10	0.09	0.10	0.10	0.10	0.09	0.10	0.10	0.10
24-Sep-03		0.12	0.10	0.11	0.10	0.09	0.10	0.10	0.10	0.12	0.10	0.09	0.09	0.11	0.10	0.09	0.10	0.10	0.10	0.11
06-Oct-03		0.12	0.11	0.09	0.10	0.11	0.10	0.11	0.09	0.11	0.11	0.09	0.11	0.09	0.10	0.11		0.11	0.10	0.10
18-Oct-03		0.09	0.09	0.10	0.10	0.09	0.10		0.10	0.11	0.10	0.09	0.09	0.10	0.10	0.11	0.10	0.11	0.09	0.09

Bay Area Air Quality Management District
Toxic Air Contaminants
2003 Annual Report

Ambient Air Toxics Data

Date Range: Jan 1, 2003 to Dec 31, 2003 **Pollutant: Carbon tetrachloride (PPB)**

Station ID Numbers

	1018	1022	1023	1024	2010	2014	2017	2018	2019	2021	2035	3005	3007	4001	5011	6004	7030	7032	8004	9004
20-Oct-03								0.10												
30-Oct-03		0.10	0.10	0.09	0.10	0.10	0.10	0.11	0.10	0.10	0.10	0.10	0.10	0.11	0.10	0.11	0.10	0.09	0.10	0.10
11-Nov-03		0.11	0.10	0.10	0.12	0.10	0.10	0.10	0.10	0.09	0.09	0.09	0.09		0.10	0.09	0.10	0.10	0.09	0.09
13-Nov-03														0.11						
23-Nov-03		0.09	0.11	0.11	0.12	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11		0.11	0.11	0.09	0.11	0.11	0.11
25-Nov-03														0.11						
05-Dec-03		0.09	0.09	0.11	0.11	0.11	0.11	0.10	0.10	0.11	0.11	0.11	0.10	0.11	0.11	0.11	0.09	0.11	0.11	0.10
17-Dec-03		0.11	0.11	0.11	0.16	0.12	0.11		0.11	0.11	0.09	0.09	0.10	0.12	0.11	0.10	0.11	0.11	0.10	0.09
18-Dec-03								0.12												
29-Dec-03		0.10	0.10	0.10	0.11	0.11	0.11	0.12	0.12	0.11			0.11	0.11	0.10	0.09		0.11		0.11
31-Dec-03											0.11								0.11	
# Obs	8	31	31	31	31	31	31	31	31	31	31	30	31	31	31	31	29	31	31	31
# <LOD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mean*	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.12	0.11	0.11	0.11	0.10	0.11	0.11	0.11	0.11	0.10	0.11	0.11	0.11
Max	0.12	0.12	0.12	0.11	0.16	0.14	0.12	0.14	0.12	0.12	0.12	0.11	0.12	0.12	0.12	0.13	0.12	0.12	0.12	0.12
Min	0.10	0.09	0.09	0.09	0.10	0.09	0.09	0.10	0.09	0.09	0.09	0.09	0.09	0.09	0.10	0.09	0.09	0.09	0.09	0.09

*Values below the detection limit are set to one-half the detection limit for statistical calculations.

Bay Area Air Quality Management District
Toxic Air Contaminants
2003 Annual Report

Ambient Air Toxics Data

Date Range: Jan 1, 2003 to Dec 31, 2003 **Pollutant: Chloroform (PPB)**

Station ID Numbers

	1018	1022	1023	1024	2010	2014	2017	2018	2019	2021	2035	3005	3007	4001	5011	6004	7030	7032	8004	9004
02-Jan-03							<0.02													
03-Jan-03	<0.02		0.03	0.03	0.03	<0.02		0.04	<0.02	<0.02	<0.02	<0.02	<0.02		<0.02	0.07	0.04	0.05		0.03
04-Jan-03														0.04						
05-Jan-03																			0.06	
08-Jan-03		<0.02																		
15-Jan-03	<0.02	<0.02	<0.02	<0.02	<0.02	0.03	<0.02	0.03	<0.02	<0.02	<0.02	<0.02	<0.02	0.04	<0.02	0.04	0.03	<0.02	<0.02	<0.02
27-Jan-03	<0.02	<0.02	<0.02	0.03	0.03	<0.02	<0.02	0.04	<0.02	<0.02	0.03	<0.02	<0.02	0.03	0.03	0.05	0.05	0.04	0.03	<0.02
08-Feb-03	0.03	<0.02	0.03	0.07	<0.02	<0.02	0.03	0.05	<0.02	<0.02	<0.02	<0.02	<0.02	0.03	0.04	0.07	0.05	0.04	0.06	0.03
20-Feb-03	<0.02	<0.02	0.03	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.03	0.04	0.03	<0.02	<0.02	0.03	<0.02
04-Mar-03	<0.02	1.47	0.03	<0.02	<0.02	<0.02	<0.02	0.04	0.04	<0.02	<0.02	<0.02	<0.02	0.03		0.05	0.03	0.03	0.05	0.03
16-Mar-03	<0.02	0.08	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.03	<0.02	0.03	<0.02	0.03	<0.02	<0.02
22-Mar-03															<0.02					
28-Mar-03	<0.02		<0.02	0.04	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.04	0.03	0.03	0.03	<0.02
02-Apr-03		0.06																		
09-Apr-03		<0.02	0.03	<0.02	<0.02	<0.02	<0.02	0.03	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.04	0.04	0.03	<0.02	<0.02
21-Apr-03		0.21	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02		<0.02	<0.02	<0.02
24-Apr-03																	<0.02			
03-May-03			<0.02	0.03	<0.02	<0.02	<0.02	0.06	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
06-May-03		<0.02																		
15-May-03		<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.03	<0.02	<0.02	<0.02	0.03
27-May-03		0.05	0.03	0.04	0.04	<0.02	<0.02	0.05	<0.02	0.03	0.03	<0.02	<0.02	0.03	0.04	0.06	0.05	0.03	0.03	<0.02
08-Jun-03		<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
20-Jun-03		0.16	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.03	<0.02	0.03	<0.02	<0.02	<0.02
02-Jul-03		0.07	<0.02	0.03	0.03	<0.02	<0.02	0.03	<0.02	<0.02	<0.02	0.03	<0.02	0.03	0.04	0.06	0.05	0.04	<0.02	<0.02
14-Jul-03		0.06	<0.02	0.03	<0.02	<0.02	<0.02	0.04	0.03	<0.02	<0.02	0.03	<0.02	0.04	0.03	0.05		<0.02	<0.02	<0.02
18-Jul-03																	0.03			
26-Jul-03		0.04	<0.02	<0.02	<0.02	<0.02	<0.02	0.03	0.03	<0.02	<0.02	0.04	<0.02	0.03	<0.02	<0.02	<0.02	0.04	<0.02	<0.02
07-Aug-03		<0.02	<0.02	<0.02	<0.02	0.03	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.05	<0.02	0.03	<0.02	<0.02	<0.02	0.06
19-Aug-03		<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
31-Aug-03		<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.04	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02		<0.02	<0.02	0.03
05-Sep-03																	0.04			
12-Sep-03		0.05	0.03	0.06	0.06	<0.02	<0.02	0.07	0.05	<0.02	0.05	0.03	<0.02	0.07	0.08	0.10	0.07	0.05	0.08	0.03
24-Sep-03		<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.04	<0.02	0.03	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
06-Oct-03		0.05	0.04	<0.02	0.03	0.03	0.03	0.06	<0.02	<0.02	0.03	<0.02	<0.02	0.03	0.03	0.03		<0.02	<0.02	<0.02
18-Oct-03		0.04	<0.02	0.04	<0.02	<0.02	0.03		0.03	0.04	0.04	<0.02	<0.02	0.05	0.03	0.08	0.06	0.05	<0.02	<0.02

Bay Area Air Quality Management District
Toxic Air Contaminants
2003 Annual Report

Ambient Air Toxics Data

Date Range: Jan 1, 2003 to Dec 31, 2003 **Pollutant: Chloroform (PPB)**

Station ID Numbers

	1018	1022	1023	1024	2010	2014	2017	2018	2019	2021	2035	3005	3007	4001	5011	6004	7030	7032	8004	9004
20-Oct-03								0.03												
30-Oct-03		<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.05	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
11-Nov-03		0.03	0.04	0.06	0.06	<0.02	0.03	0.03	0.03	<0.02	0.03	0.03	0.04		0.05	0.03	<0.02	0.05	0.08	<0.02
13-Nov-03														0.06						
23-Nov-03		0.03	0.06	0.06	0.07	<0.02	0.03	<0.02	0.06	<0.02	0.06	0.03	<0.02		<0.02	0.03	0.04	<0.02	0.05	0.03
25-Nov-03														0.04						
05-Dec-03		<0.02	<0.02	0.03	0.04	0.03	0.04	<0.02	0.03	<0.02	0.03	<0.02	<0.02	<0.02	0.04	0.06	<0.02	<0.02	0.03	<0.02
17-Dec-03		<0.02	0.03	0.04	0.04	<0.02	0.03		0.04	0.03	<0.02	<0.02	<0.02	0.05	0.04	0.03	0.04	0.05	<0.02	<0.02
18-Dec-03								0.04												
29-Dec-03		<0.02	<0.02	<0.02	<0.02	<0.02	0.03	<0.02	0.03	<0.02			<0.02	<0.02	<0.02	<0.02		<0.02		<0.02
31-Dec-03											0.05								<0.02	
# Obs	8	31	31	31	31	31	31	31	31	31	31	30	31	31	31	31	29	31	31	31
# <LOD	7	17	20	17	21	27	23	14	21	28	22	23	30	11	18	10	13	17	20	23
Mean*	0.01	0.08	0.02	0.02	0.02	0.01	0.02	0.03	0.02	0.01	0.02	0.02	0.01	0.03	0.02	0.04	0.03	0.02	0.02	0.02
Max	0.03	1.47	0.06	0.07	0.07	0.03	0.04	0.07	0.06	0.04	0.06	0.04	0.04	0.07	0.08	0.10	0.07	0.05	0.08	0.06
Min	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02

*Values below the detection limit are set to one-half the detection limit for statistical calculations.

Bay Area Air Quality Management District
Toxic Air Contaminants
2003 Annual Report

Ambient Air Toxics Data

Date Range: Jan 1, 2003 to Dec 31, 2003 **Pollutant: Methylene chloride (PPB)**

Station ID Numbers

	1018	1022	1023	1024	2010	2014	2017	2018	2019	2021	2035	3005	3007	4001	5011	6004	7030	7032	8004	9004
02-Jan-03							0.80													
03-Jan-03	<0.50		<0.50	0.80	0.60	<0.50		<0.50	<0.50	<0.50	<0.50	<0.50	<0.50		<0.50	0.50	<0.50	0.50		<0.50
04-Jan-03														<0.50						
05-Jan-03																			1.00	
08-Jan-03		<0.50																		
15-Jan-03	<0.50	<0.50	<0.50	<0.50	0.90	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0.60	1.10	0.60	0.50	<0.50
27-Jan-03	<0.50	<0.50	<0.50	<0.50	0.90	0.60	0.60	<0.50	<0.50	<0.50	1.10	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0.70	0.80	<0.50
08-Feb-03	0.60	<0.50	0.60	0.90	0.80	<0.50	<0.50	<0.50	0.60	<0.50	<0.50	<0.50	<0.50	<0.50	0.70	<0.50	<0.50	0.50	0.80	<0.50
20-Feb-03	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0.60	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0.70	<0.50	<0.50	<0.50	0.90	<0.50
04-Mar-03	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50		0.60	<0.50	<0.50	0.50	<0.50
16-Mar-03	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0.70	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
22-Mar-03															<0.50					
28-Mar-03	<0.50		<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	1.00	<0.50	<0.50	<0.50	1.10	0.70
02-Apr-03		<0.50																		
09-Apr-03		<0.50	0.60	<0.50	<0.50	<0.50	0.70	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
21-Apr-03		<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	1.90	<0.50	<0.50	<0.50	0.60	<0.50		<0.50	0.60	<0.50
24-Apr-03																	<0.50			
03-May-03			<0.50	<0.50	<0.50	<0.50	0.60	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
06-May-03		<0.50																		
15-May-03		<0.50	<0.50	<0.50	<0.50	<0.50	0.70	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	1.00	<0.50	<0.50	<0.50	<0.50	<0.50
27-May-03		<0.50	<0.50	<0.50	<0.50	0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0.80	<0.50	0.80	<0.50
08-Jun-03		<0.50	<0.50	<0.50	<0.50	<0.50	0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0.60	<0.50
20-Jun-03		<0.50	<0.50	0.50	<0.50	<0.50	1.10	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
02-Jul-03		<0.50	<0.50	<0.50	<0.50	0.80	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0.60	1.00	<0.50
14-Jul-03		<0.50	<0.50	<0.50	<0.50	<0.50	0.90	<0.50	<0.50	<0.50	<0.50	0.60	<0.50	<0.50	<0.50	<0.50		<0.50	0.70	<0.50
18-Jul-03																	<0.50			
26-Jul-03		<0.50	<0.50	<0.50	<0.50	0.50	1.30	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	1.20	<0.50	<0.50	<0.50	<0.50	<0.50
07-Aug-03		<0.50	<0.50	1.00	<0.50	<0.50	1.10	<0.50	<0.50	1.00	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	1.20	<0.50	<0.50
19-Aug-03		0.70	<0.50	<0.50	<0.50	<0.50	3.00	<0.50	1.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0.50	<0.50	<0.50
31-Aug-03		<0.50	<0.50	<0.50	<0.50	<0.50	0.90	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	2.20	<0.50		<0.50	<0.50	<0.50
05-Sep-03																	0.60			
12-Sep-03		<0.50	<0.50	0.70	0.70	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0.70	<0.50	<0.50	<0.50	1.30	<0.50
24-Sep-03		<0.50	<0.50	<0.50	<0.50	<0.50	1.70	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0.50
06-Oct-03		<0.50	<0.50	<0.50	<0.50	<0.50	0.90	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50		<0.50	<0.50	<0.50
18-Oct-03		0.60	<0.50	<0.50	0.60	<0.50	1.50		<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0.60	0.50	0.90

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Ambient Air Toxics Data

Date Range: Jan 1, 2003 to Dec 31, 2003 **Pollutant: Methylene chloride (PPB)**

Station ID Numbers

	1018	1022	1023	1024	2010	2014	2017	2018	2019	2021	2035	3005	3007	4001	5011	6004	7030	7032	8004	9004
20-Oct-03								<0.50												
30-Oct-03		<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0.50	<0.50	<0.50
11-Nov-03		<0.50	<0.50	<0.50	2.60	<0.50	<0.50	<0.50	<0.50	<0.50	0.50	<0.50	<0.50		<0.50	0.50	<0.50	0.60	3.40	<0.50
13-Nov-03														<0.50						
23-Nov-03		<0.50	<0.50	<0.50	<0.50	<0.50	0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50		1.70	<0.50	<0.50	<0.50	<0.50	<0.50
25-Nov-03														<0.50						
05-Dec-03		<0.50	<0.50	<0.50	1.20	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
17-Dec-03		<0.50	<0.50	<0.50	1.30	<0.50	0.60		<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
18-Dec-03								<0.50												
29-Dec-03		<0.50	<0.50	<0.50	<0.50	<0.50	1.40	<0.50	<0.50	<0.50			<0.50	<0.50	<0.50	<0.50		<0.50		0.50
31-Dec-03											<0.50								1.00	
# Obs	8	31	31	31	31	31	31	31	31	31	31	30	31	31	31	31	29	31	31	31
# <LOD	7	29	29	26	22	27	11	31	29	30	28	29	31	31	22	27	26	21	15	27
Mean*	0.29	0.28	0.27	0.34	0.49	0.30	0.74	0.25	0.30	0.27	0.34	0.26	0.25	0.25	0.49	0.29	0.31	0.37	0.62	0.30
Max	0.60	0.70	0.60	1.00	2.60	0.80	3.00	<0.50	1.50	1.00	1.90	0.60	<0.50	<0.50	2.20	0.60	1.10	1.20	3.40	0.90
Min	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50

*Values below the detection limit are set to one-half the detection limit for statistical calculations.

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Ambient Air Toxics Data

Date Range: Jan 1, 2003 to Dec 31, 2003 **Pollutant: Ethylbenzene (PPB)**

Station ID Numbers

	1018	1022	1023	1024	2010	2014	2017	2018	2019	2021	2035	3005	3007	4001	5011	6004	7030	7032	8004	9004
02-Jan-03							0.60													
03-Jan-03	<0.10		0.20	0.60	0.30	0.20		0.20	0.10	0.20	0.20	0.20	<0.10		0.30	0.60	0.20	0.90		0.30
04-Jan-03														0.30						
05-Jan-03																			0.50	
08-Jan-03		0.10																		
15-Jan-03	0.10	0.10	0.10	0.30	0.50	0.10	<0.10	0.20	0.20	0.20	0.30	0.20	<0.10	0.40	0.20	0.80	0.10	0.40	0.20	0.30
27-Jan-03	0.30	0.10	0.20	0.40	0.30	0.20	<0.10	0.20	0.20	0.10	0.40	0.10	<0.10	0.30	0.30	0.30	0.30	0.40	0.30	0.20
08-Feb-03	0.10	0.10	0.20	0.60	0.40	0.10	<0.10	0.20	0.20	0.20	0.20	0.20	<0.10	0.30	0.40	0.50	0.20	0.50	0.60	0.20
20-Feb-03	<0.10	<0.10	0.20	0.10	0.20	<0.10	<0.10	0.10	<0.10	<0.10	0.10	0.10	<0.10	0.20	0.20	0.30	0.10	0.10	0.20	0.10
04-Mar-03	0.10	0.10	0.10	0.20	0.10	<0.10	<0.10	0.10	0.20	<0.10	0.20	0.10	<0.10	0.10		0.30	0.10	0.10	0.30	0.20
16-Mar-03	<0.10	<0.10	<0.10	0.10	0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0.10	<0.10	<0.10	0.10	<0.10	0.10	<0.10	0.10	<0.10	<0.10
22-Mar-03															<0.10					
28-Mar-03	0.10		<0.10	0.10	0.10	<0.10	<0.10	0.10	<0.10	<0.10	0.10	<0.10	<0.10	<0.10	0.20	0.20	0.10	0.10	0.20	0.10
02-Apr-03		<0.10																		
09-Apr-03		0.10	0.10	0.20	<0.10	<0.10	<0.10	0.10	0.10	<0.10	0.20	<0.10	<0.10	0.10	0.10	0.10	0.10	0.10	<0.10	0.10
21-Apr-03		<0.10	<0.10	<0.10	0.20	<0.10	<0.10	<0.10	<0.10	<0.10	0.10	<0.10	<0.10	<0.10	<0.10	<0.10		<0.10	<0.10	<0.10
24-Apr-03																	<0.10			
03-May-03			<0.10	<0.10	0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0.10	<0.10	<0.10	<0.10	0.10	<0.10	<0.10
06-May-03		<0.10																		
15-May-03		<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0.20	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
27-May-03		0.10	0.10	0.20	0.10	0.10	0.10	0.10	0.20	0.10	0.10	0.10	<0.10	0.10	0.10	0.10	0.10	0.20	0.10	0.10
08-Jun-03		<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
20-Jun-03		<0.10	<0.10	<0.10	0.10	0.20	<0.10	<0.10	<0.10	<0.10	0.10	0.10	<0.10	<0.10	0.10	<0.10	<0.10	<0.10	<0.10	<0.10
02-Jul-03		<0.10	0.10	0.10	0.30	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0.10	<0.10	<0.10	<0.10	0.10	0.10	0.10	<0.10	<0.10
14-Jul-03		0.10	<0.10	0.10	<0.10	0.10	<0.10	<0.10	0.10	<0.10	0.10	<0.10	<0.10	0.10	0.10	0.10		0.10	0.10	0.10
18-Jul-03																	<0.10			
26-Jul-03		<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0.10	<0.10	<0.10	<0.10	0.10	<0.10	<0.10	<0.10	<0.10	0.10	<0.10	<0.10	<0.10
07-Aug-03		<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0.10	<0.10	<0.10	<0.10	<0.10
19-Aug-03		<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0.10	0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
31-Aug-03		0.10	0.10	<0.10	0.10	<0.10	<0.10	0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10		<0.10	<0.10	<0.10
05-Sep-03																	0.10			
12-Sep-03		0.20	0.20	0.40	0.20	0.20	0.10	0.20	0.30	<0.10	0.30	0.20	<0.10	0.30	0.40	0.30	0.20	0.40	0.50	0.20
24-Sep-03		<0.10	<0.10	<0.10	0.10	<0.10	<0.10	<0.10	0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0.10	0.10	0.10	0.10	<0.10	<0.10
06-Oct-03		0.20	0.20	0.20	0.10	0.10	<0.10	0.20	<0.10	<0.10	0.10	0.20	<0.10	0.20	<0.10	0.30		0.20	0.10	0.10
18-Oct-03		0.20	0.30	0.20	0.40	0.20	<0.10		0.20	0.10	0.20	0.10	<0.10	0.20	0.10	0.30	0.20	0.30	0.40	0.10

Bay Area Air Quality Management District
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Ambient Air Toxics Data

Date Range: Jan 1, 2003 to Dec 31, 2003 **Pollutant: Ethylbenzene (PPB)**

Station ID Numbers

	1018	1022	1023	1024	2010	2014	2017	2018	2019	2021	2035	3005	3007	4001	5011	6004	7030	7032	8004	9004
20-Oct-03								0.30												
30-Oct-03		<0.10	<0.10	0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0.20	<0.10	0.10	<0.10	0.10	<0.10	<0.10
11-Nov-03		0.10	0.20	0.30	0.50	<0.10	<0.10	0.20	0.20	<0.10	0.20	0.20	0.40		0.30	0.60	0.20	0.50	0.60	0.10
13-Nov-03														0.30						
23-Nov-03		<0.10	0.20	0.40	0.20	0.10	<0.10	0.20	0.10	<0.10	0.10	0.10	<0.10		0.20	0.30	0.10	0.50	0.30	0.10
25-Nov-03														0.20						
05-Dec-03		0.10	0.30	0.10	0.30	0.20	0.10	0.30	0.20	<0.10	0.20	0.20	<0.10	0.20	0.60	0.40	0.30	0.20	0.10	0.10
17-Dec-03		<0.10	0.30	0.40	0.20	0.30	<0.10		0.20	0.10	0.20	0.30	<0.10	0.50	0.30	0.50	0.20	0.80	0.10	0.40
18-Dec-03								0.30												
29-Dec-03		<0.10	<0.10	0.10	<0.10	<0.10	<0.10	<0.10	0.10	<0.10			<0.10	<0.10	0.10	0.20		<0.10		<0.10
31-Dec-03											0.20								0.40	
# Obs	8	31	31	31	31	31	31	31	31	31	31	30	31	31	31	31	29	31	31	31
# <LOD	3	17	14	10	9	18	27	12	14	24	9	13	30	12	12	8	10	9	14	14
Mean*	0.11	0.08	0.12	0.18	0.17	0.10	0.07	0.13	0.11	0.07	0.14	0.11	0.06	0.15	0.15	0.23	0.12	0.22	0.18	0.11
Max	0.30	0.20	0.30	0.60	0.50	0.30	0.60	0.30	0.30	0.20	0.40	0.30	0.40	0.50	0.60	0.80	0.30	0.90	0.60	0.40
Min	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10

*Values below the detection limit are set to one-half the detection limit for statistical calculations.

Bay Area Air Quality Management District
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Ambient Air Toxics Data

Date Range: Jan 1, 2003 to Dec 31, 2003 **Pollutant: Ethylene dibromide (PPB)**

Station ID Numbers

	1018	1022	1023	1024	2010	2014	2017	2018	2019	2021	2035	3005	3007	4001	5011	6004	7030	7032	8004	9004
02-Jan-03							<0.02													
03-Jan-03	<0.02		<0.02	<0.02	<0.02	<0.02		<0.02	<0.02	<0.02	<0.02	<0.02	<0.02		<0.02	<0.02	<0.02	<0.02		<0.02
04-Jan-03														<0.02						
05-Jan-03																			<0.02	
08-Jan-03		<0.02																		
15-Jan-03	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
27-Jan-03	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
08-Feb-03	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
20-Feb-03	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
04-Mar-03	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02		<0.02	<0.02	<0.02	<0.02	<0.02
16-Mar-03	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
22-Mar-03															<0.02					
28-Mar-03	<0.02		<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
02-Apr-03		<0.02																		
09-Apr-03		<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
21-Apr-03		<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02		<0.02	<0.02	<0.02
24-Apr-03																	<0.02			
03-May-03			<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
06-May-03		<0.02																		
15-May-03		<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
27-May-03		<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
08-Jun-03		<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
20-Jun-03		<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
02-Jul-03		<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
14-Jul-03		<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02		<0.02	<0.02	<0.02
18-Jul-03																	<0.02			
26-Jul-03		<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
07-Aug-03		<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
19-Aug-03		<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
31-Aug-03		<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02		<0.02	<0.02	<0.02
05-Sep-03																	<0.02			
12-Sep-03		<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
24-Sep-03		<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
06-Oct-03		<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02		<0.02	<0.02	<0.02
18-Oct-03		<0.02	<0.02	<0.02	<0.02	<0.02	<0.02		<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02

Bay Area Air Quality Management District
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Ambient Air Toxics Data

Date Range: Jan 1, 2003 to Dec 31, 2003 **Pollutant: Ethylene dibromide (PPB)**

Station ID Numbers

	1018	1022	1023	1024	2010	2014	2017	2018	2019	2021	2035	3005	3007	4001	5011	6004	7030	7032	8004	9004
20-Oct-03								<0.02												
30-Oct-03		<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
11-Nov-03		<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02		<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
13-Nov-03														<0.02						
23-Nov-03		<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02		<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
25-Nov-03														<0.02						
05-Dec-03		<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
17-Dec-03		<0.02	<0.02	<0.02	<0.02	<0.02	<0.02		<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
18-Dec-03								<0.02												
29-Dec-03		<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02		<0.02	<0.02	<0.02	<0.02	<0.02		<0.02		<0.02
31-Dec-03											<0.02								<0.02	
# Obs	8	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	29	31	31	31
# <LOD	8	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	29	31	31	31
Mean*	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Max	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Min	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02

*Values below the detection limit are set to one-half the detection limit for statistical calculations.

Bay Area Air Quality Management District
Toxic Air Contaminants
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Ambient Air Toxics Data

Date Range: Jan 1, 2003 to Dec 31, 2003 **Pollutant: Ethylene dichloride (PPB)**

Station ID Numbers

	1018	1022	1023	1024	2010	2014	2017	2018	2019	2021	2035	3005	3007	4001	5011	6004	7030	7032	8004	9004
02-Jan-03							<0.10													
03-Jan-03	<0.10		<0.10	<0.10	<0.10	<0.10		<0.10	<0.10	<0.10	<0.10	<0.10	<0.10		<0.10	<0.10	<0.10	<0.10		<0.10
04-Jan-03														<0.10						
05-Jan-03																			<0.10	
08-Jan-03		<0.10																		
15-Jan-03	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
27-Jan-03	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
08-Feb-03	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
20-Feb-03	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
04-Mar-03	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10		<0.10	<0.10	<0.10	<0.10	<0.10
16-Mar-03	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
22-Mar-03															<0.10					
28-Mar-03	<0.10		<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
02-Apr-03		<0.10																		
09-Apr-03		<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
21-Apr-03		<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10		<0.10	<0.10	<0.10
24-Apr-03																	<0.10			
03-May-03			<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
06-May-03		<0.10																		
15-May-03		<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
27-May-03		<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
08-Jun-03		<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
20-Jun-03		<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
02-Jul-03		<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
14-Jul-03		<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10		<0.10	<0.10	<0.10
18-Jul-03																	<0.10			
26-Jul-03		<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
07-Aug-03		<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
19-Aug-03		<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
31-Aug-03		<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10		<0.10	<0.10	<0.10
05-Sep-03																	<0.10			
12-Sep-03		<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
24-Sep-03		<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
06-Oct-03		<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10		<0.10	<0.10	<0.10
18-Oct-03		<0.10	<0.10	<0.10	<0.10	<0.10	<0.10		<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10

Bay Area Air Quality Management District
Toxic Air Contaminants
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Ambient Air Toxics Data

Date Range: Jan 1, 2003 to Dec 31, 2003 **Pollutant: Ethylene dichloride (PPB)**

Station ID Numbers

	1018	1022	1023	1024	2010	2014	2017	2018	2019	2021	2035	3005	3007	4001	5011	6004	7030	7032	8004	9004
20-Oct-03								<0.10												
30-Oct-03		<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
11-Nov-03		<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10		<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
13-Nov-03														<0.10						
23-Nov-03		<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10		<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
25-Nov-03														<0.10						
05-Dec-03		<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
17-Dec-03		<0.10	<0.10	<0.10	<0.10	<0.10	<0.10		<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
18-Dec-03								<0.10												
29-Dec-03		<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10		<0.10	<0.10	<0.10	<0.10	<0.10		<0.10		<0.10
31-Dec-03											<0.10								<0.10	
# Obs	8	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	29	31	31	31
# <LOD	8	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	29	31	31	31
Mean*	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Max	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Min	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10

*Values below the detection limit are set to one-half the detection limit for statistical calculations.

Bay Area Air Quality Management District
Toxic Air Contaminants
2003 Annual Report

Ambient Air Toxics Data

Date Range: Jan 1, 2003 to Dec 31, 2003 **Pollutant: Freon 11 (PPB)**

Station ID Numbers

	1018	1022	1023	1024	2010	2014	2017	2018	2019	2021	2035	3005	3007	4001	5011	6004	7030	7032	8004	9004
02-Jan-03							0.29													
03-Jan-03	0.31		0.28	0.33	0.28	0.31		0.28	0.29	0.27	0.29	0.28	0.28		0.25	0.32	0.31	0.30		0.27
04-Jan-03														0.26						
05-Jan-03																			0.32	
08-Jan-03		0.27																		
15-Jan-03	0.29	0.25	0.25	0.30	0.27	0.27	0.26	0.26	0.27	0.25	0.27	0.26	0.26	0.29	0.26	0.27	0.28	0.27	0.25	0.26
27-Jan-03	0.27	0.24	0.26	0.27	0.25	0.25	0.27	0.28	0.25	0.24	0.28	0.24	0.25	0.27	0.28	0.29	0.30	0.25	0.32	0.26
08-Feb-03	0.27	0.27	0.29	0.34	0.26	0.30	0.30	0.27	0.24	0.26	0.28	0.28	0.30	0.28	0.27	0.30	0.31	0.31	0.30	0.30
20-Feb-03	0.26	0.26	0.26	0.24	0.24	0.23	0.23	0.24	0.26	0.26	0.27	0.24	0.26	0.25	0.27	0.34	0.27	0.26	0.27	0.23
04-Mar-03	0.26	0.26	0.26	0.29	0.25	0.25	0.24	0.25	0.27	0.26	0.25	0.27	0.25	0.26		0.29	0.27	0.26	0.26	0.28
16-Mar-03	0.28	0.25	0.24	0.26	0.26	0.25	0.27	0.25	0.28	0.25	0.25	0.25	0.25	0.26	0.27	0.26	0.26	0.27	0.26	0.24
22-Mar-03															0.26					
28-Mar-03	0.27		0.27	0.26	0.29	0.25	0.26	0.26	0.25	0.25	0.26	0.25	0.24	0.27	0.26	0.32	0.29	0.28	0.29	0.26
02-Apr-03		0.24																		
09-Apr-03		0.25	0.25	0.26	0.25	0.27	0.26	0.26	0.26	0.25	0.27	0.18	0.25	0.25	0.27	0.25	0.31	0.27	0.27	0.27
21-Apr-03		0.27	0.26	0.26	0.31	0.24	0.25	0.28	0.25	0.26	0.25	0.25	0.25	0.27	0.25	0.25		0.26	0.26	0.28
24-Apr-03																	0.28			
03-May-03			0.28	0.25	0.24	0.27	0.26	0.25	0.19	0.24	0.28	0.25	0.24	0.24	0.29	0.27	0.26	0.27	0.26	0.26
06-May-03		0.27																		
15-May-03		0.26	0.26	0.26	0.28	0.26	0.25	0.25	0.26	0.26	0.26	0.19	0.28	0.26	0.28	0.26	0.25	0.30	0.28	0.27
27-May-03		0.24	0.27	0.31	0.25	0.26	0.28	0.29	0.28	0.27	0.27	0.28	0.27	0.28	0.27	0.27	0.28	0.27	0.27	0.27
08-Jun-03		0.28	0.26	0.27	0.25	0.28	0.27	0.25	0.23	0.24	0.25	0.26	0.27	0.26	0.27	0.26	0.28	0.27	0.26	0.27
20-Jun-03		0.23	0.23	0.25	0.24	0.25	0.26	0.27	0.26	0.27	0.24	0.27	0.23	0.23	0.25	0.26	0.24	0.28	0.26	0.25
02-Jul-03		0.28	0.24	0.28	0.29	0.27	0.29	0.27	0.27	0.28	0.27	0.27	0.27	0.29	0.25	0.27	0.26	0.27	0.28	0.27
14-Jul-03		0.27	0.27	0.46	0.27	0.28	0.25	0.28	0.30	0.27	0.28	0.28	0.28	0.27	0.27	0.27		0.28	0.28	0.27
18-Jul-03																	0.28			
26-Jul-03		0.29	0.26	0.26	0.27	0.27	0.27	0.28	0.28	0.23	0.27	0.27	0.27	0.27	0.26	0.45	0.30	0.30	0.27	0.28
07-Aug-03		0.26	0.26	0.29	0.29	0.28	0.27	0.28	0.28	0.29	0.25	0.26	0.27	0.25	0.23	0.27	0.23	0.30	0.27	0.26
19-Aug-03		0.28	0.28	0.28	0.27	0.29	0.28	0.27	0.29	0.27	0.23	0.27	0.27	0.27	0.29	0.26	0.29	0.29	0.29	0.30
31-Aug-03		0.24	0.24	0.24	0.25	0.25	0.24	0.25	0.25	0.22	0.25	0.23	0.25	0.24	0.23	0.33		0.22	0.30	0.23
05-Sep-03																	0.26			
12-Sep-03		0.27	0.24	0.40	0.25	0.26	0.23	0.26	0.27	0.22	0.27	0.23	0.23	0.26	0.29	0.41	0.28	0.25	0.28	0.23
24-Sep-03		0.30	0.25	0.29	0.23	0.28	0.27	0.26	0.26	0.27	0.26	0.22	0.26	0.25	0.27	0.25	0.24	0.23	0.27	0.26
06-Oct-03		0.28	0.27	0.28	0.28	0.26	0.29	0.22	0.24	0.25	0.28	0.24	0.25	0.24	0.28	0.31		0.27	0.27	0.27
18-Oct-03		0.23	0.27	0.26	0.24	0.24	0.25		0.26	0.27	0.27	0.24	0.23	0.28	0.30	0.25	0.32	0.24	0.24	0.24

Bay Area Air Quality Management District
Toxic Air Contaminants
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Ambient Air Toxics Data

Date Range: Jan 1, 2003 to Dec 31, 2003

Pollutant: Freon 11 (PPB)

Station ID Numbers

	1018	1022	1023	1024	2010	2014	2017	2018	2019	2021	2035	3005	3007	4001	5011	6004	7030	7032	8004	9004
20-Oct-03								0.25												
30-Oct-03		0.25	0.25	0.23	0.29	0.25	0.25	0.30	0.27	0.27	0.27	0.26	0.25	0.27	0.29	0.25	0.26	0.24	0.27	0.27
11-Nov-03		0.26	0.28	0.29	0.33	0.26	0.24	0.26	0.27	0.22	0.27	0.26	0.26		0.27	0.26	0.28	0.23	0.28	0.26
13-Nov-03														0.28						
23-Nov-03		0.27	0.26	0.29	0.26	0.24	0.28	0.26	0.29	0.27	0.31	0.28	0.26		0.26	0.27	0.30	0.28	0.26	0.25
25-Nov-03														0.23						
05-Dec-03		0.23	0.25	0.29	0.28	0.28	0.24	0.23	0.25	0.27	0.24	0.28	0.25	0.22	0.25	0.27	0.25	0.24	0.28	0.27
17-Dec-03		0.24	0.25	0.35	0.26	0.26	0.23		0.23	0.29	0.24	0.23	0.25	0.26	0.23	0.27	0.24	0.30	0.23	0.24
18-Dec-03								0.26												
29-Dec-03		0.25	0.24	0.25	0.25	0.22	0.28	0.25	0.25	0.25			0.27	0.30	0.24	0.25		0.24		0.28
31-Dec-03											0.34								0.27	
# Obs	8	31	31	31	31	31	31	31	31	31	31	30	31	31	31	31	29	31	31	31
# <LOD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mean*	0.28	0.26	0.26	0.29	0.27	0.26	0.26	0.26	0.26	0.26	0.27	0.25	0.26	0.26	0.26	0.29	0.28	0.27	0.27	0.26
Max	0.31	0.30	0.29	0.46	0.33	0.31	0.30	0.30	0.30	0.29	0.34	0.28	0.30	0.30	0.30	0.45	0.32	0.31	0.32	0.30
Min	0.26	0.23	0.23	0.23	0.23	0.22	0.23	0.22	0.19	0.22	0.23	0.18	0.23	0.22	0.23	0.25	0.23	0.22	0.23	0.23

*Values below the detection limit are set to one-half the detection limit for statistical calculations.

Bay Area Air Quality Management District
Toxic Air Contaminants
2003 Annual Report

Ambient Air Toxics Data

Date Range: Jan 1, 2003 to Dec 31, 2003 **Pollutant: Freon 113 (PPB)**

Station ID Numbers

	1018	1022	1023	1024	2010	2014	2017	2018	2019	2021	2035	3005	3007	4001	5011	6004	7030	7032	8004	9004
02-Jan-03							0.08													
03-Jan-03	0.08		0.08	0.14	0.08	0.09		0.08	0.09	0.08	0.08	0.08	0.08		0.07	0.09	0.09	0.08		0.08
04-Jan-03														0.08						
05-Jan-03																			0.10	
08-Jan-03		0.08																		
15-Jan-03	0.07	0.07	0.08	0.10	0.08	0.07	0.07	0.08	0.07	0.07	0.07	0.07	0.07	0.08	0.07	0.07	0.08	0.07	0.10	0.07
27-Jan-03	0.07	0.08	0.07	0.08	0.07	0.07	0.08	0.09	0.06	0.07	0.08	0.07	0.06	0.08	0.08	0.07	0.09	0.06	1.16	0.08
08-Feb-03	0.07	0.07	0.08	0.09	0.06	0.08	0.08	0.08	0.06	0.07	0.07	0.08	0.07	0.07	0.07	0.08	0.08	0.09	0.08	0.09
20-Feb-03	0.07	0.08	0.07	0.07	0.07	0.08	0.06	0.07	0.08	0.08	0.07	0.06	0.08	0.07	0.08	0.07	0.07	0.07	0.09	0.09
04-Mar-03	0.07	0.07	0.07	0.08	0.07	0.07	0.06	0.07	0.07	0.07	0.07	0.07	0.07	0.07		0.07	0.07	0.07	0.07	0.07
16-Mar-03	0.07	0.06	0.08	0.09	0.06	0.07	0.08	0.07	0.06	0.08	0.06	0.14	0.06	0.07	0.08	0.07	0.07	0.07	0.07	0.06
22-Mar-03															0.08					
28-Mar-03	0.07		0.08	0.09	0.07	0.07	0.08	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.09	0.07
02-Apr-03		0.08																		
09-Apr-03		0.07	0.07	0.07	0.07	0.07	0.08	0.08	0.07	0.07	0.07	0.07	0.08	0.07	0.07	0.07	0.08	0.07	0.07	0.08
21-Apr-03		0.07	0.07	0.07	0.07	0.07	0.07	0.09	0.07	0.07	0.07	0.08	0.07	0.07	0.07	0.07		0.08	0.08	0.09
24-Apr-03																	0.08			
03-May-03			0.08	0.07	0.07	0.07	0.07	0.08	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07
06-May-03		0.07																		
15-May-03		0.07	0.07	0.07	0.07	0.08	0.07	0.08	0.07	0.07	0.06	0.07	0.08	0.07	0.07	0.07	0.07	0.07	0.07	0.08
27-May-03		0.08	0.07	0.07	0.07	0.07	0.08	0.08	0.08	0.07	0.07	0.07	0.07	0.08	0.07	0.07	0.07	0.07	0.08	0.07
08-Jun-03		0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.08	0.06	0.06	0.07	0.07	0.08	0.07	0.07	0.07	0.07	0.07	0.11
20-Jun-03		0.08	0.08	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.09	0.07	0.08	0.08	0.08	0.08	0.06	0.08	0.09	0.06
02-Jul-03		0.06	0.07	0.07	0.07	0.06	0.07	0.07	0.07	0.06	0.07	0.07	0.07	0.07	0.06	0.07	0.06	0.08	0.08	0.07
14-Jul-03		0.07	0.07	0.06	0.06	0.07	0.07	0.08	0.07	0.07	0.07	0.07	0.08	0.07	0.07	0.06		0.07	0.07	0.07
18-Jul-03																	0.07			
26-Jul-03		0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.06	0.07	0.08	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07
07-Aug-03		0.07	0.07	0.06	0.07	0.07	0.07	0.07	0.07	0.06	0.08	0.08	0.07	0.09	0.07	0.07	0.11	0.06	0.07	0.07
19-Aug-03		0.09	0.07	0.07	0.06	0.07	0.07	0.07	0.08	0.07	0.08	0.08	0.08	0.07	0.08	0.09	0.07	0.07	0.08	0.08
31-Aug-03		0.07	0.07	0.08	0.07	0.07	0.08	0.08	0.08	0.08	0.08	0.07	0.07	0.08	0.06	0.07		0.08	0.08	0.07
05-Sep-03																	0.08			
12-Sep-03		0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.07	0.08	0.08	0.08	0.08	0.09	0.07	0.09	0.09
24-Sep-03		0.08	0.06	0.08	0.06	0.06	0.08	0.08	0.08	0.08	0.08	0.07	0.06	0.08	0.08	0.06	0.07	0.06	0.08	0.09
06-Oct-03		0.09	0.09	0.07	0.09	0.09	0.08	0.08	0.07	0.07	0.09	0.07	0.09	0.06	0.09	0.07		0.07	0.08	0.09
18-Oct-03		0.08	0.07	0.08	0.06	0.07	0.08		0.08	0.08	0.08	0.07	0.07	0.08	0.08	0.07	0.08	0.08	0.07	0.07

Bay Area Air Quality Management District
Toxic Air Contaminants
2003 Annual Report

Ambient Air Toxics Data

Date Range: Jan 1, 2003 to Dec 31, 2003 **Pollutant: Freon 113 (PPB)**

Station ID Numbers

	1018	1022	1023	1024	2010	2014	2017	2018	2019	2021	2035	3005	3007	4001	5011	6004	7030	7032	8004	9004
20-Oct-03								0.07												
30-Oct-03		0.07	0.07	0.07	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.07	0.07	0.07	0.07	0.09	0.08
11-Nov-03		0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.07	0.08	0.08		0.08	0.07	0.07	0.09	0.29	0.09
13-Nov-03														0.08						
23-Nov-03		0.08	0.08	0.09	0.08	0.08	0.09	0.07	0.08	0.07	0.08	0.08	0.07		0.07	0.07	0.08	0.07	0.08	0.09
25-Nov-03														0.08						
05-Dec-03		0.06	0.06	0.08	0.08	0.08	0.09	0.06	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.06	0.08	0.08	0.08
17-Dec-03		0.06	0.08	0.08	0.08	0.08	0.08		0.08	0.09	0.06	0.06	0.06	0.08	0.08	0.06	0.08	0.08	0.08	0.06
18-Dec-03								0.08												
29-Dec-03		0.06	0.06	0.06	0.08	0.08	0.08	0.08	0.08	0.08			0.06	0.10	0.06	0.06		0.08		0.07
31-Dec-03											0.10								0.07	
# Obs	8	31	31	31	31	31	31	31	31	31	31	30	31	31	31	31	29	31	31	31
# <LOD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mean*	0.07	0.07	0.07	0.08	0.07	0.07	0.08	0.08	0.07	0.07	0.07	0.08	0.07	0.08	0.07	0.07	0.08	0.07	0.12	0.08
Max	0.08	0.09	0.09	0.14	0.09	0.09	0.09	0.09	0.09	0.09	0.10	0.14	0.09	0.10	0.09	0.09	0.11	0.09	1.16	0.11
Min	0.07	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.07	0.06

*Values below the detection limit are set to one-half the detection limit for statistical calculations.

Bay Area Air Quality Management District
Toxic Air Contaminants
2003 Annual Report

Ambient Air Toxics Data

Date Range: Jan 1, 2003 to Dec 31, 2003 **Pollutant: Methyl ethyl ketone (PPB)**

Station ID Numbers

	1018	1022	1023	1024	2010	2014	2017	2018	2019	2021	2035	3005	3007	4001	5011	6004	7030	7032	8004	9004
02-Jan-03							0.50													
03-Jan-03	0.20		0.30	0.60	0.50	0.70		0.40	0.20	0.30	0.20	0.30	<0.20		0.50	0.60	0.30	0.60		0.40
04-Jan-03														0.40						
05-Jan-03																			0.40	
08-Jan-03		0.30																		
15-Jan-03	0.20	0.30	0.60	0.80	0.50	1.20	<0.20	0.40	0.40	<0.20	0.70	0.30	<0.20	0.30	0.30	1.10	0.20	0.40	0.30	0.30
27-Jan-03	0.20	0.40	0.50	0.70	1.10	1.20	0.20	0.40	1.10	0.30	0.50	0.40	<0.20	0.30	0.70	0.90	0.40	0.60	1.10	0.40
08-Feb-03	0.20	0.20	0.90	0.90	0.80	0.60	0.20	0.40	0.30	0.20	0.40	0.40	<0.20	0.60	0.50	0.50	0.40	0.50	0.80	0.40
20-Feb-03	<0.20	<0.20	0.50	0.40	0.40	0.60	<0.20	0.20	0.80	0.60	0.40	<0.20	<0.20	0.30	0.40	1.00	<0.20	0.20	0.50	1.20
04-Mar-03	0.20	0.20	0.40	0.50	1.00	1.30	<0.20	0.30	1.20	<0.20	0.30	<0.20	<0.20	0.30		1.00	0.20	0.40	0.30	1.20
16-Mar-03	<0.20	0.20	0.20	0.50	0.20	1.20	<0.20	0.20	0.30	<0.20	0.20	<0.20	<0.20	0.30	0.30	0.30	<0.20	<0.20	0.30	0.20
22-Mar-03															0.30					
28-Mar-03	0.20		0.50	0.60	0.40	1.50	0.20	0.40	0.20	0.50	0.20	0.30	<0.20	0.20	0.20	0.60	<0.20	0.20	0.40	0.50
02-Apr-03		0.20																		
09-Apr-03		0.20	0.30	0.30	0.60	2.00	<0.20	0.40	0.90	0.40	0.40	<0.20	<0.20	0.20	0.50	0.40	<0.20	0.60	0.20	0.70
21-Apr-03		0.20	0.30	0.20	2.50	0.80	<0.20	0.20	1.90	0.20	0.20	<0.20	<0.20	0.30	0.40	0.60		0.20	0.20	0.40
24-Apr-03																	<0.20			
03-May-03			0.20	0.20	<0.20	2.20	<0.20	0.40	1.50	0.30	0.30	0.20	<0.20	<0.20	0.30	0.40	<0.20	0.20	0.30	0.60
06-May-03		<0.20																		
15-May-03		0.20	0.20	<0.20	0.30	1.00	0.20	0.30	0.80	0.20	0.20	0.20	0.20	0.20	0.50	0.40	<0.20	0.20	0.20	1.20
27-May-03		0.30	0.50	0.40	1.60	2.10	0.60	0.90	1.40	2.00	0.40	0.30	<0.20	0.40	0.60	0.60	0.30	0.50	0.50	1.00
08-Jun-03		0.20	0.20	0.30	0.30	0.90	0.20	<0.20	0.90	0.30	0.20	<0.20	<0.20	0.30	0.30	0.20	<0.20	0.30	0.20	0.50
20-Jun-03		0.20	0.30	0.30	0.30	2.10	0.30	0.20	1.30	0.60	0.20	0.20	<0.20	0.20	0.60	0.40	0.20	0.20	0.20	0.50
02-Jul-03		0.20	0.30	0.30	1.00	1.60	0.70	0.40	0.40	0.40	0.20	0.20	<0.20	0.30	<0.20	1.00	0.30	0.40	0.20	0.40
14-Jul-03		0.30	0.40	0.60	0.40	1.40	1.00	0.60	0.60	1.50	0.30	0.30	0.20	0.40	1.20	0.70		0.40	0.20	0.80
18-Jul-03																	0.50			
26-Jul-03		0.30	0.30	0.30	0.40	1.30	0.60	0.60	1.20	0.40	0.20	1.30	<0.20	0.40	0.20	0.20	0.20	0.40	0.20	0.50
07-Aug-03		0.20	0.20	0.60	0.30	1.20	0.40	0.30	2.80	0.30	0.30	0.20	0.20	0.30	0.80	0.40	0.40	0.30	<0.20	1.70
19-Aug-03		0.20	0.20	0.40	0.20	1.00	0.50	0.20	5.40	0.30	0.30	<0.20	<0.20	<0.20	0.30	0.40	0.20	0.20	0.20	0.40
31-Aug-03		0.20	0.30	0.40	0.30	1.20	0.80	0.60	0.70	0.50	0.20	0.20	<0.20	0.30	0.30	0.20		0.40	0.20	1.00
05-Sep-03																	0.20			
12-Sep-03		0.40	0.60	1.10	2.20	1.60	1.20	1.00	3.00	0.20	0.70	0.40	0.20	0.60	1.40	0.60	0.40	0.60	0.50	5.80
24-Sep-03		0.20	0.20	0.50	0.20	0.70	0.40	0.30	5.00	0.20	0.30	0.20	0.30	0.50	0.50	0.60	0.20	0.40	<0.20	0.20
06-Oct-03		0.30	0.80	0.80	0.80	0.90	0.80	0.60	0.70	0.40	0.20	0.20	0.20	0.50	0.40	0.40		0.30	0.20	1.40
18-Oct-03		0.40	1.00	1.00	0.80	1.10	0.60		1.20	0.60	0.40	0.30	<0.20	0.60	0.50	0.50	0.40	0.50	0.30	0.60

Bay Area Air Quality Management District
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Ambient Air Toxics Data

Date Range: Jan 1, 2003 to Dec 31, 2003 **Pollutant: Methyl ethyl ketone (PPB)**

Station ID Numbers

	1018	1022	1023	1024	2010	2014	2017	2018	2019	2021	2035	3005	3007	4001	5011	6004	7030	7032	8004	9004
20-Oct-03								0.70												
30-Oct-03		0.20	0.20	0.40	0.20	0.30	0.30	0.30	0.50	<0.20	0.20	<0.20	<0.20	0.30	0.70	0.60	0.20	0.20	0.30	0.20
11-Nov-03		0.20	0.60	0.70	3.60	0.20	0.60	0.40	1.60	0.50	0.40	0.20	0.70		0.70	0.70	0.20	0.40	1.50	0.40
13-Nov-03														0.60						
23-Nov-03		0.20	0.60	0.60	0.90	0.20	0.40	0.30	0.60	0.50	0.40	0.20	<0.20		0.40	0.30	0.20	0.40	0.30	0.40
25-Nov-03														0.40						
05-Dec-03		0.20	0.40	0.50	1.50	0.30	1.00	0.60	3.00	0.40	0.40	0.40	<0.20	0.30	0.60	0.50	0.20	0.40	0.50	0.20
17-Dec-03		0.20	0.70	0.70	0.60	0.40	0.30		0.20	0.30	0.40	0.20	0.20	0.40	0.40	0.50	0.30	0.70	<0.20	0.30
18-Dec-03								0.40												
29-Dec-03		<0.20	0.20	0.40	0.20	0.20	0.60	0.20	0.20	0.20			<0.20	0.20	0.30	0.20		0.20		0.20
31-Dec-03											0.30								0.40	
# Obs	8	31	31	31	31	31	31	31	31	31	31	30	31	31	31	31	29	31	31	31
# <LOD	2	3	0	1	1	0	7	1	0	4	0	8	23	2	1	0	8	1	3	0
Mean*	0.18	0.23	0.42	0.52	0.78	1.06	0.43	0.41	1.30	0.42	0.32	0.26	0.15	0.34	0.48	0.54	0.23	0.37	0.36	0.77
Max	0.20	0.40	1.00	1.10	3.60	2.20	1.20	1.00	5.40	2.00	0.70	1.30	0.70	0.60	1.40	1.10	0.50	0.70	1.50	5.80
Min	<0.20	<0.20	0.20	<0.20	<0.20	0.20	<0.20	<0.20	0.20	<0.20	0.20	<0.20	<0.20	<0.20	<0.20	0.20	<0.20	<0.20	<0.20	0.20

*Values below the detection limit are set to one-half the detection limit for statistical calculations.

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Ambient Air Toxics Data

Date Range: Jan 1, 2003 to Dec 31, 2003 **Pollutant: Methyl tertiary-butyl ether (PPB)**

Station ID Numbers

	1018	1022	1023	1024	2010	2014	2017	2018	2019	2021	2035	3005	3007	4001	5011	6004	7030	7032	8004	9004
02-Jan-03							0.30													
03-Jan-03	0.30		1.10	1.20	1.50	1.00		1.00	0.40	0.70	0.50	0.60	<0.30		0.80	1.40	0.90	2.30		1.10
04-Jan-03														1.60						
05-Jan-03																			2.70	
08-Jan-03		0.40																		
15-Jan-03	<0.30	0.30	0.50	0.80	1.30	1.20	0.40	1.00	0.40	0.50	0.80	0.70	0.40	1.80	0.40	1.50	0.60	0.80	0.80	0.60
27-Jan-03	0.50	0.40	0.60	0.80	1.00	1.00	0.60	0.80	0.40	0.60	1.10	0.40	<0.30	1.10	0.50	1.00	0.80	1.00	1.50	0.70
08-Feb-03	<0.30	<0.30	0.40	1.10	1.10	0.80	0.30	0.70	0.30	0.40	0.40	0.40	<0.30	1.30	0.50	0.70	0.50	0.90	1.80	0.60
20-Feb-03	<0.30	<0.30	0.60	<0.30	0.90	<0.30	<0.30	0.30	0.30	<0.30	0.70	0.30	<0.30	0.90	<0.30	0.40	<0.30	<0.30	1.20	0.50
04-Mar-03	<0.30	<0.30	0.30	0.30	0.50	0.40	1.70	0.30	0.30	<0.30	0.60	<0.30	<0.30	0.50		0.60	0.30	<0.30	0.90	0.30
16-Mar-03	<0.30	<0.30	<0.30	0.30	0.30	0.30	<0.30	<0.30	0.30	<0.30	0.30	<0.30	<0.30	0.50	<0.30	0.30	<0.30	0.30	0.30	<0.30
22-Mar-03															0.30					
28-Mar-03	<0.30		0.30	0.30	0.30	0.50	<0.30	0.40	<0.30	0.30	0.30	<0.30	0.40	0.40	<0.30	0.50	0.30	0.50	0.70	0.40
02-Apr-03		<0.30																		
09-Apr-03		<0.30	0.50	0.30	<0.30	0.60	<0.30	0.30	0.40	<0.30	0.50	0.40	<0.30	0.30	<0.30	0.80	0.40	0.90	<0.30	0.40
21-Apr-03		<0.30	<0.30	<0.30	0.60	<0.30	<0.30	<0.30	<0.30	<0.30	0.40	<0.30	<0.30	<0.30	<0.30	<0.30		<0.30	<0.30	<0.30
24-Apr-03																	<0.30			
03-May-03			<0.30	<0.30	0.40	0.30	<0.30	<0.30	0.30	0.30	0.30	<0.30	<0.30	<0.30	0.30	<0.30	<0.30	<0.30	<0.30	<0.30
06-May-03		<0.30																		
15-May-03		<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	0.40	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	0.30	<0.30	<0.30
27-May-03		0.40	0.70	0.50	1.00	0.70	0.60	0.50	0.60	0.50	0.70	0.30	<0.30	0.80	0.40	0.70	0.50	1.00	0.80	0.60
08-Jun-03		<0.30	<0.30	<0.30	<0.30	0.50	0.80	<0.30	0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30
20-Jun-03		<0.30	<0.30	<0.30	0.30	1.50	0.30	<0.30	<0.30	<0.30	0.40	<0.30	<0.30	0.40	<0.30	<0.30	<0.30	0.30	<0.30	<0.30
02-Jul-03		0.30	0.50	<0.30	0.70	0.70	0.40	0.30	<0.30	0.50	0.30	0.30	<0.30	0.60	<0.30	0.50	0.40	0.80	<0.30	<0.30
14-Jul-03		0.40	0.40	0.50	0.60	0.60	0.60	0.60	1.60	0.50	0.50	0.60	<0.30	0.90	0.40	0.60		0.60	0.30	0.80
18-Jul-03																	0.40			
26-Jul-03		0.80	0.50	0.30	0.80	1.00	0.40	0.80	0.40	0.60	0.80	0.70	0.40	1.10	0.40	0.40	0.40	0.40	0.60	0.30
07-Aug-03		<0.30	<0.30	0.40	<0.30	0.40	<0.30	0.30	0.30	0.30	0.80	0.30	0.80	0.80	<0.30	0.40	0.40	0.50	<0.30	0.40
19-Aug-03		<0.30	<0.30	<0.30	0.40	<0.30	<0.30	<0.30	0.50	<0.30	0.40	<0.30	<0.30	0.30	<0.30	0.50	0.40	0.40	0.30	<0.30
31-Aug-03		0.40	0.30	0.30	0.50	0.40	0.30	0.80	0.40	0.60	0.40	<0.30	<0.30	0.50	<0.30	<0.30		0.40	0.30	0.30
05-Sep-03																	0.40			
12-Sep-03		1.30	1.90	2.10	2.00	2.00	1.20	2.50	3.90	2.30	2.70	1.70	<0.30	2.70	2.60	2.30	1.00	3.20	4.80	2.00
24-Sep-03		<0.30	<0.30	<0.30	0.40	<0.30	0.30	<0.30	<0.30	0.40	0.50	0.30	<0.30	0.50	<0.30	0.70	0.50	0.40	<0.30	<0.30
06-Oct-03		0.80	1.40	0.30	1.00	2.00	0.60	1.10	0.50	0.40	0.80	0.40	<0.30	1.20	0.40	1.00		0.70	0.30	0.70
18-Oct-03		1.00	1.00	0.80	1.50	0.90	0.40		1.40	1.50	1.50	0.40	<0.30	1.60	0.60	2.30	1.20	2.40	1.40	0.60

Bay Area Air Quality Management District
Toxic Air Contaminants
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Ambient Air Toxics Data

Date Range: Jan 1, 2003 to Dec 31, 2003 **Pollutant: Methyl tertiary-butyl ether (PPB)**

Station ID Numbers

	1018	1022	1023	1024	2010	2014	2017	2018	2019	2021	2035	3005	3007	4001	5011	6004	7030	7032	8004	9004
20-Oct-03								1.80												
30-Oct-03		0.30	<0.30	<0.30	0.50	<0.30	<0.30	0.40	0.40	<0.30	0.60	0.30	<0.30	1.40	<0.30	0.40	<0.30	0.30	0.30	0.30
11-Nov-03		0.50	0.90	1.50	3.20	<0.30	0.40	1.40	1.00	0.50	1.40	1.00	1.40		1.00	1.10	0.40	2.00	3.90	1.10
13-Nov-03														1.80						
23-Nov-03		<0.30	0.40	0.50	0.50	0.50	<0.30	<0.30	0.30	0.40	0.40	<0.30	<0.30		<0.30	0.50	<0.30	0.50	0.80	0.30
25-Nov-03														1.00						
05-Dec-03		<0.30	0.30	0.30	2.50	0.70	0.30	0.30	0.40	0.30	0.50	0.30	<0.30	0.30	0.40	0.90	<0.30	0.30	0.40	0.30
17-Dec-03		<0.30	<0.30	<0.30	<0.30	1.00	<0.30		0.30	<0.30	<0.30	<0.30	<0.30	0.50	<0.30	0.60	<0.30	0.50	<0.30	<0.30
18-Dec-03								0.30												
29-Dec-03		<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30			0.40	<0.30	<0.30	<0.30		<0.30		<0.30
31-Dec-03											<0.30								0.30	
# Obs	8	31	31	31	31	31	31	31	31	31	31	30	31	31	31	31	29	31	31	31
# <LOD	6	18	12	12	6	8	13	10	7	12	3	12	25	5	16	7	11	6	10	11
Mean*	0.21	0.32	0.46	0.46	0.80	0.65	0.38	0.56	0.53	0.43	0.63	0.37	0.24	0.82	0.37	0.68	0.39	0.73	0.84	0.45
Max	0.50	1.30	1.90	2.10	3.20	2.00	1.70	2.50	3.90	2.30	2.70	1.70	1.40	2.70	2.60	2.30	1.20	3.20	4.80	2.00
Min	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30

*Values below the detection limit are set to one-half the detection limit for statistical calculations.

Bay Area Air Quality Management District
Toxic Air Contaminants
2003 Annual Report

Ambient Air Toxics Data

Date Range: Jan 1, 2003 to Dec 31, 2003 **Pollutant: Perchloroethylene (PPB)**

Station ID Numbers

	1018	1022	1023	1024	2010	2014	2017	2018	2019	2021	2035	3005	3007	4001	5011	6004	7030	7032	8004	9004
02-Jan-03							0.02													
03-Jan-03	0.04		0.03	0.28	0.08	0.04		0.04	0.05	0.02	0.11	0.18	<0.01		0.08	0.10	0.06	0.15		0.04
04-Jan-03														0.03						
05-Jan-03																			0.06	
08-Jan-03		0.03																		
15-Jan-03	0.04	0.03	0.02	0.07	0.08	0.02	<0.01	0.04	0.03	<0.01	0.08	0.25	<0.01	0.03	0.03	0.09	0.02	0.05	0.02	0.03
27-Jan-03	0.07	0.04	0.04	0.10	0.03	0.04	0.02	0.05	0.06	0.02	0.09	0.07	<0.01	0.03	0.05	0.09	0.06	0.07	0.03	0.02
08-Feb-03	0.03	0.02	0.03	0.20	0.04	<0.01	<0.01	0.02	0.02	0.02	0.04	0.13	0.02	0.02	0.06	0.05	0.03	0.06	0.10	0.02
20-Feb-03	0.04	0.02	0.03	0.09	0.03	<0.01	<0.01	0.02	<0.01	0.03	<0.01	0.05	<0.01	0.02	0.04	0.03	0.02	0.03	0.02	0.02
04-Mar-03	0.03	<0.01	0.02	0.03	<0.01	<0.01	<0.01	0.02	0.02	<0.01	0.02	0.09	<0.01	0.03		0.02	0.03	0.02	0.02	0.02
16-Mar-03	<0.01	<0.01	<0.01	0.02	0.02	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.02	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
22-Mar-03															0.02					
28-Mar-03	<0.01		0.02	0.02	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.10	<0.01	<0.01	<0.01	0.02	<0.01	<0.01	0.03	<0.01	<0.01
02-Apr-03		<0.01																		
09-Apr-03		0.03	0.02	0.06	<0.01	<0.01	<0.01	0.02	0.02	<0.01	0.04	0.05	<0.01	0.02	0.03	0.03	0.02	0.03	<0.01	0.02
21-Apr-03		0.02	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.02	<0.01	<0.01	0.02	0.02		<0.01	<0.01	<0.01
24-Apr-03																	0.02			
03-May-03			<0.01	0.02	0.02	<0.01	<0.01	0.02	<0.01	<0.01	0.03	0.03	<0.01	<0.01	0.02	0.02	<0.01	0.02	<0.01	<0.01
06-May-03		0.02																		
15-May-03		<0.01	<0.01	0.02	<0.01	<0.01	<0.01	0.18	<0.01	<0.01	<0.01	0.02	<0.01	0.02	0.04	<0.01	<0.01	<0.01	<0.01	<0.01
27-May-03		0.04	0.03	0.05	0.02	0.02	0.02	0.03	0.02	0.02	0.03	0.11	<0.01	0.02	0.04	0.03	0.04	0.02	0.02	0.02
08-Jun-03		<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
20-Jun-03		<0.01	<0.01	0.02	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.03	<0.01	<0.01	0.03	<0.01	0.02	<0.01	<0.01	<0.01
02-Jul-03		0.02	0.02	0.03	<0.01	<0.01	<0.01	0.02	<0.01	0.02	<0.01	0.17	<0.01	<0.01	0.05	0.02	0.02	0.02	<0.01	<0.01
14-Jul-03		0.03	0.02	0.03	<0.01	0.02	<0.01	<0.01	<0.01	<0.01	<0.01	0.08	<0.01	<0.01	0.03	0.02		0.02	<0.01	0.02
18-Jul-03																	0.06			
26-Jul-03		0.03	0.02	0.02	<0.01	<0.01	<0.01	0.02	<0.01	<0.01	<0.01	0.12	<0.01	<0.01	0.02	0.02	0.02	0.03	<0.01	<0.01
07-Aug-03		<0.01	<0.01	0.02	0.06	<0.01	<0.01	0.03	<0.01	<0.01	<0.01	<0.01	<0.01	0.02	0.04	0.04	0.02	0.02	<0.01	<0.01
19-Aug-03		<0.01	0.02	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.20	<0.01	<0.01	0.03	<0.01	0.02	<0.01	<0.01	<0.01
31-Aug-03		<0.01	<0.01	<0.01	0.02	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01		<0.01	<0.01	<0.01
05-Sep-03																	<0.01			
12-Sep-03		0.04	0.03	0.10	<0.01	<0.01	<0.01	0.02	0.03	<0.01	0.06	0.12	<0.01	0.02	0.08	0.04	0.04	0.05	0.04	0.03
24-Sep-03		<0.01	<0.01	0.02	<0.01	<0.01	<0.01	<0.01	<0.01	0.02	<0.01	0.02	<0.01	<0.01	0.02	<0.01	<0.01	<0.01	<0.01	<0.01
06-Oct-03		0.05	0.03	0.04	<0.01	0.02	0.02	0.04	<0.01	<0.01	0.02	0.13	<0.01	0.03	0.04	0.04		0.03	0.02	0.02
18-Oct-03		0.04	0.04	0.03	0.03	<0.01	<0.01		0.03	0.02	0.04	0.06	<0.01	0.02	0.05	0.06	0.08	0.05	0.02	<0.01

Bay Area Air Quality Management District
Toxic Air Contaminants
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Ambient Air Toxics Data

Date Range: Jan 1, 2003 to Dec 31, 2003 **Pollutant: Perchloroethylene (PPB)**

Station ID Numbers

	1018	1022	1023	1024	2010	2014	2017	2018	2019	2021	2035	3005	3007	4001	5011	6004	7030	7032	8004	9004
20-Oct-03								0.03												
30-Oct-03		<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.02	<0.01	<0.01	<0.01	0.03	<0.01	0.04	0.02	<0.01	<0.01	<0.01	<0.01	<0.01
11-Nov-03		0.03	0.03	0.08	0.02	0.02	<0.01	0.02	0.02	<0.01	0.03	0.20	0.08		0.07	0.15	0.03	0.08	0.02	0.02
13-Nov-03														0.04						
23-Nov-03		0.02	0.02	0.04	0.02	0.02	<0.01	0.02	0.02	<0.01	0.02	0.04	<0.01		0.02	0.02	0.02	0.04	0.02	<0.01
25-Nov-03														0.10						
05-Dec-03		0.03	0.04	0.03	0.05	0.04	0.03	0.05	0.03	<0.01	0.03	0.14	0.02	0.02	0.04	0.09	0.05	0.03	0.02	0.02
17-Dec-03		<0.01	0.03	0.04	0.04	0.02	<0.01		0.03	<0.01	0.07	0.04	<0.01	0.04	0.03	0.09	0.05	0.14	<0.01	0.04
18-Dec-03								0.03												
29-Dec-03		<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.02	<0.01			<0.01	0.02	0.02	0.02		<0.01		<0.01
31-Dec-03											0.04								0.05	
# Obs	8	31	31	31	31	31	31	31	31	31	31	30	31	31	31	31	29	31	31	31
# <LOD	2	13	11	6	16	21	26	10	17	23	14	4	28	12	3	9	8	10	17	17
Mean*	0.03	0.02	0.02	0.05	0.02	0.01	0.01	0.03	0.02	0.01	0.03	0.08	0.01	0.02	0.03	0.04	0.03	0.03	0.02	0.01
Max	0.07	0.05	0.04	0.28	0.08	0.04	0.03	0.18	0.06	0.03	0.11	0.25	0.08	0.10	0.08	0.15	0.08	0.15	0.10	0.04
Min	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01

*Values below the detection limit are set to one-half the detection limit for statistical calculations.

Bay Area Air Quality Management District
Toxic Air Contaminants
2003 Annual Report

Ambient Air Toxics Data

Date Range: Jan 1, 2003 to Dec 31, 2003 **Pollutant: Methyl chloroform (PPB)**

Station ID Numbers

	1018	1022	1023	1024	2010	2014	2017	2018	2019	2021	2035	3005	3007	4001	5011	6004	7030	7032	8004	9004
02-Jan-03							<0.05													
03-Jan-03	<0.05		0.25	0.05	<0.05	0.06		0.05	0.07	<0.05	<0.05	<0.05	<0.05		<0.05	0.05	0.05	0.05		0.12
04-Jan-03														0.05						
05-Jan-03																			0.09	
08-Jan-03		<0.05																		
15-Jan-03	<0.05	<0.05	0.19	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.11
27-Jan-03	<0.05	<0.05	0.20	<0.05	<0.05	0.06	0.05	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.05	<0.05	<0.05	<0.05	0.63
08-Feb-03	<0.05	<0.05	0.19	0.05	<0.05	0.05	0.05	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.05	<0.05	<0.05	0.05	0.05	<0.05	0.16
20-Feb-03	<0.05	<0.05	0.23	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.55
04-Mar-03	<0.05	<0.05	0.23	<0.05	<0.05	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05		<0.05	<0.05	<0.05	<0.05	0.23
16-Mar-03	<0.05	<0.05	0.20	<0.05	<0.05	0.05	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.13
22-Mar-03															<0.05					
28-Mar-03	<0.05		0.27	<0.05	<0.05	0.09	0.06	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.09
02-Apr-03		<0.05																		
09-Apr-03		<0.05	0.27	<0.05	<0.05	0.08	0.06	<0.05	<0.05	<0.05	<0.05	<0.05	0.05	<0.05	<0.05	<0.05	<0.05	0.05	<0.05	0.12
21-Apr-03		<0.05	0.21	<0.05	0.07	0.17	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.05	<0.05	<0.05	<0.05		<0.05	<0.05	0.90
24-Apr-03																	<0.05			
03-May-03			0.24	<0.05	<0.05	0.06	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.18	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.21
06-May-03		<0.05																		
15-May-03		<0.05	0.23	<0.05	<0.05	0.05	0.06	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.39
27-May-03		0.05	0.28	<0.05	<0.05	0.17	0.09	<0.05	<0.05	<0.05	<0.05	<0.05	0.05	<0.05	<0.05	<0.05	<0.05	0.05	<0.05	0.21
08-Jun-03		<0.05	0.26	<0.05	<0.05	0.11	0.07	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	2.00
20-Jun-03		<0.05	0.26	<0.05	<0.05	0.09	0.06	<0.05	<0.05	<0.05	<0.05	<0.05	0.05	<0.05	0.05	<0.05	<0.05	<0.05	<0.05	0.25
02-Jul-03		<0.05	0.29	<0.05	<0.05	0.11	0.10	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	2.26	<0.05	<0.05	<0.05	<0.05	0.34
14-Jul-03		0.05	0.45	<0.05	<0.05	0.11	0.09	<0.05	<0.05	<0.05	0.05	<0.05	<0.05	<0.05	<0.05	<0.05		<0.05	<0.05	0.15
18-Jul-03																	<0.05			
26-Jul-03		<0.05	0.28	<0.05	<0.05	0.15	0.09	<0.05	<0.05	<0.05	<0.05	0.09	<0.05	<0.05	<0.05	<0.05	<0.05	0.05	<0.05	0.56
07-Aug-03		<0.05	0.38	<0.05	<0.05	0.09	0.08	<0.05	<0.05	<0.05	<0.05	<0.05	0.13	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	1.50
19-Aug-03		<0.05	0.82	<0.05	<0.05	0.23	0.07	<0.05	0.07	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.20
31-Aug-03		<0.05	0.39	<0.05	<0.05	0.17	0.06	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05		<0.05	<0.05	1.45
05-Sep-03																	<0.05			
12-Sep-03		<0.05	0.28	0.06	<0.05	0.20	0.09	<0.05	<0.05	<0.05	<0.05	<0.05	0.17	<0.05	0.05	0.05	<0.05	0.05	<0.05	1.65
24-Sep-03		<0.05	0.40	<0.05	<0.05	0.08	0.06	<0.05	<0.05	<0.05	<0.05	<0.05	0.06	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.31
06-Oct-03		0.05	0.24	<0.05	<0.05	0.06	0.06	<0.05	<0.05	<0.05	<0.05	<0.05	0.06	<0.05	<0.05	<0.05		0.05	<0.05	2.47
18-Oct-03		<0.05	1.02	<0.05	<0.05	0.09	0.06		<0.05	<0.05	<0.05	<0.05	0.07	<0.05	<0.05	0.05	<0.05	<0.05	0.05	0.33

Bay Area Air Quality Management District
Toxic Air Contaminants
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Ambient Air Toxics Data

Date Range: Jan 1, 2003 to Dec 31, 2003 **Pollutant: Methyl chloroform (PPB)**

Station ID Numbers

	1018	1022	1023	1024	2010	2014	2017	2018	2019	2021	2035	3005	3007	4001	5011	6004	7030	7032	8004	9004
20-Oct-03								<0.05												
30-Oct-03		<0.05	0.31	<0.05	<0.05	<0.05	0.05	<0.05	0.13	<0.05	<0.05	<0.05	0.07	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.34
11-Nov-03		<0.05	0.23	0.05	<0.05	<0.05	0.05	<0.05	<0.05	<0.05	0.05	<0.05	<0.05		<0.05	0.05	<0.05	0.06	0.05	2.34
13-Nov-03														0.05						
23-Nov-03		<0.05	0.18	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.10		<0.05	<0.05	<0.05	0.05	<0.05	2.00
25-Nov-03														<0.05						
05-Dec-03		<0.05	0.36	<0.05	<0.05	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.11	<0.05	<0.05	0.08	<0.05	<0.05	<0.05	0.16
17-Dec-03		<0.05	0.22	<0.05	<0.05	0.06	<0.05		0.05	<0.05	<0.05	<0.05	0.19	<0.05	<0.05	0.06	<0.05	0.05	<0.05	0.13
18-Dec-03								<0.05												
29-Dec-03		<0.05	0.16	<0.05	<0.05	0.05	<0.05	<0.05	<0.05	<0.05			0.19	<0.05	<0.05	<0.05		<0.05		0.30
31-Dec-03											<0.05								<0.05	
# Obs	8	31	31	31	31	31	31	31	31	31	31	30	31	31	31	31	29	31	31	31
# <LOD	8	28	0	27	30	5	9	28	27	31	29	29	16	28	28	24	27	21	28	0
Mean*	0.03	0.03	0.31	0.03	0.03	0.09	0.05	0.03	0.03	0.03	0.03	0.03	0.06	0.03	0.10	0.03	0.03	0.03	0.03	0.66
Max	<0.05	0.05	1.02	0.06	0.07	0.23	0.10	0.05	0.13	<0.05	0.05	0.09	0.19	0.05	2.26	0.08	0.05	0.06	0.09	2.47
Min	<0.05	<0.05	0.16	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.09

*Values below the detection limit are set to one-half the detection limit for statistical calculations.

Bay Area Air Quality Management District
Toxic Air Contaminants
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Ambient Air Toxics Data

Date Range: Jan 1, 2003 to Dec 31, 2003 **Pollutant: Trichloroethylene (PPB)**

Station ID Numbers

	1018	1022	1023	1024	2010	2014	2017	2018	2019	2021	2035	3005	3007	4001	5011	6004	7030	7032	8004	9004
02-Jan-03							<0.05													
03-Jan-03	<0.05		<0.05	0.05	<0.05	<0.05		<0.05	0.10	<0.05	<0.05	<0.05	<0.05		<0.05	0.08	<0.05	0.05		<0.05
04-Jan-03														<0.05						
05-Jan-03																			<0.05	
08-Jan-03		<0.05																		
15-Jan-03	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.33	<0.05	<0.05	<0.05	<0.05
27-Jan-03	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.11	<0.05	<0.05	<0.05	<0.05
08-Feb-03	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.29	<0.05	<0.05	0.05	<0.05
20-Feb-03	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.14	<0.05	<0.05	<0.05	<0.05
04-Mar-03	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05		0.26	0.05	<0.05	<0.05	<0.05
16-Mar-03	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.06	<0.05	<0.05	<0.05	<0.05
22-Mar-03															<0.05					
28-Mar-03	<0.05		<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.06	<0.05	<0.05	<0.05	<0.05
02-Apr-03		<0.05																		
09-Apr-03		<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.06	<0.05	<0.05	<0.05	<0.05
21-Apr-03		<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.05		<0.05	<0.05	<0.05
24-Apr-03																	<0.05			
03-May-03			<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.20	<0.05	<0.05	<0.05	<0.05
06-May-03		<0.05																		
15-May-03		<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.16	<0.05	<0.05	<0.05	<0.05
27-May-03		<0.05	<0.05	<0.05	<0.05	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.05	<0.05	<0.05	<0.05	<0.05
08-Jun-03		<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.07	<0.05	<0.05	<0.05	<0.05
20-Jun-03		<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
02-Jul-03		<0.05	<0.05	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
14-Jul-03		<0.05	<0.05	<0.05	0.10	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.05		0.05	<0.05	<0.05
18-Jul-03																	<0.05			
26-Jul-03		<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
07-Aug-03		<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.09	<0.05	<0.05	<0.05	<0.05
19-Aug-03		<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
31-Aug-03		<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05		<0.05	<0.05	<0.05
05-Sep-03																	<0.05			
12-Sep-03		<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.05	0.11	<0.05	<0.05	<0.05	<0.05
24-Sep-03		<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.05	<0.05	<0.05	<0.05	<0.05
06-Oct-03		<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.10		<0.05	<0.05	<0.05
18-Oct-03		<0.05	<0.05	<0.05	<0.05	<0.05	<0.05		<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.09	<0.05	<0.05	<0.05	<0.05

Bay Area Air Quality Management District
Toxic Air Contaminants
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Ambient Air Toxics Data

Date Range: Jan 1, 2003 to Dec 31, 2003 **Pollutant: Trichloroethylene (PPB)**

Station ID Numbers

	1018	1022	1023	1024	2010	2014	2017	2018	2019	2021	2035	3005	3007	4001	5011	6004	7030	7032	8004	9004
20-Oct-03								<0.05												
30-Oct-03		<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.11	<0.05	<0.05	<0.05	<0.05
11-Nov-03		<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05		<0.05	0.09	<0.05	<0.05	<0.05	<0.05
13-Nov-03														<0.05						
23-Nov-03		<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05		<0.05	0.06	<0.05	<0.05	<0.05	<0.05
25-Nov-03														<0.05						
05-Dec-03		<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.05	<0.05	<0.05	<0.05	<0.05
17-Dec-03		<0.05	<0.05	<0.05	<0.05	<0.05	<0.05		<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.06	<0.05	<0.05	<0.05	<0.05
18-Dec-03								<0.05												
29-Dec-03		<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05			<0.05	<0.05	<0.05	<0.05		<0.05		<0.05
31-Dec-03											<0.05								<0.05	
# Obs	8	31	31	31	31	31	31	31	31	31	31	30	31	31	31	31	29	31	31	31
# <LOD	8	31	31	29	30	30	31	31	30	31	31	30	31	31	30	6	28	29	30	31
Mean*	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.09	0.03	0.03	0.03	0.03
Max	<0.05	<0.05	<0.05	0.05	0.10	0.05	<0.05	<0.05	0.10	<0.05	<0.05	<0.05	<0.05	<0.05	0.05	0.33	0.05	0.05	0.05	<0.05
Min	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05

*Values below the detection limit are set to one-half the detection limit for statistical calculations.

Bay Area Air Quality Management District
Toxic Air Contaminants
2003 Annual Report

Ambient Air Toxics Data

Date Range: Jan 1, 2003 to Dec 31, 2003 — Pollutant: Toluene (PPB)

Station ID Numbers

	1018	1022	1023	1024	2010	2014	2017	2018	2019	2021	2035	3005	3007	4001	5011	6004	7030	7032	8004	9004
02-Jan-03							1.10													
03-Jan-03	0.90		1.50	4.80	2.00	1.70		2.50	1.20	1.20	1.20	1.00	0.30		1.90	4.60	1.60	6.00		2.10
04-Jan-03														1.80						
05-Jan-03																			3.40	
08-Jan-03		1.20																		
15-Jan-03	0.70	1.80	0.70	1.90	1.90	1.00	0.50	2.70	1.30	1.00	2.50	1.50	0.40	2.20	1.70	5.70	0.80	2.90	1.00	2.00
27-Jan-03	1.70	2.30	1.50	2.70	1.70	1.80	0.50	2.70	2.90	1.00	2.50	1.40	0.30	1.60	1.40	2.40	1.70	3.00	1.80	1.10
08-Feb-03	2.00	1.20	1.80	4.20	3.20	0.70	0.40	2.20	2.20	1.60	1.70	1.50	0.40	1.70	2.80	3.40	1.90	3.00	4.00	1.30
20-Feb-03	0.70	1.20	1.40	0.80	1.20	0.40	0.50	1.70	0.60	0.30	1.00	0.80	0.10	1.60	1.50	2.30	0.90	1.00	1.50	0.70
04-Mar-03	0.70	0.90	1.00	1.20	1.20	0.60	0.50	1.70	1.90	0.80	1.50	1.20	0.20	1.10		2.10	1.00	1.30	1.60	1.90
16-Mar-03	0.40	1.20	0.40	0.60	0.70	0.50	0.10	1.50	0.50	0.20	1.00	0.60	0.30	1.10	0.40	0.70	0.40	0.80	0.70	0.50
22-Mar-03															0.40					
28-Mar-03	0.40		0.50	0.80	0.90	0.40	0.10	2.00	0.80	0.40	0.90	0.60	0.40	0.60	1.00	1.30	0.60	1.30	1.10	0.90
02-Apr-03		0.40																		
09-Apr-03		1.00	0.70	1.60	1.50	0.80	0.10	1.20	2.10	0.60	1.50	0.70	0.10	1.10	1.00	1.00	0.50	0.90	0.60	0.70
21-Apr-03		1.50	0.20	0.70	4.00	0.30	0.30	1.10	1.20	0.40	0.90	0.40	0.20	0.40	0.50	0.70		0.30	0.20	0.40
24-Apr-03																	0.20			
03-May-03			0.30	1.10	0.80	0.60	0.40	1.10	0.60	0.10	0.40	0.40	0.20	0.60	0.70	0.60	0.40	0.80	0.60	0.60
06-May-03		0.50																		
15-May-03		0.50	0.10	0.50	1.20	0.20	0.10	1.00	2.10	0.30	1.30	0.40	0.10	0.70	0.70	0.60	0.10	0.50	0.30	0.70
27-May-03		1.00	0.90	1.00	1.20	0.80	0.50	1.90	1.20	0.20	1.00	0.70	0.10	0.70	0.90	0.90	0.60	1.10	0.90	0.80
08-Jun-03		0.20	0.20	0.60	0.50	0.60	0.10	1.40	0.70	0.40	0.50	0.30	- 0.10	0.20	0.20	0.30	0.20	0.20	0.50	0.40
20-Jun-03		0.40	0.10	0.40	0.70	1.80	0.40	1.60	0.60	0.10	0.50	0.30	- 0.10	0.50	0.40	0.40	0.30	0.40	0.30	0.70
02-Jul-03		0.80	0.70	0.70	0.70	0.40	0.70	1.40	0.40	0.30	0.80	0.90	- 0.10	0.60	0.40	0.70	0.50	1.00	0.60	0.50
14-Jul-03		1.10	0.80	0.60	0.80	0.80	0.30	1.10	1.30	0.20	0.90	0.60	<0.10	0.70	0.70	0.90		1.20	0.70	0.50
18-Jul-03																	1.10			
26-Jul-03		0.90	0.50	0.60	0.60	0.30	0.30	1.40	0.70	0.20	0.40	0.70	- 0.10	0.40	0.70	0.50	0.70	0.70	0.20	0.50
07-Aug-03		0.60	0.30	0.40	1.00	0.50	0.30	1.30	0.60	0.20	0.50	0.40	0.10	0.50	0.40	0.90	0.70	0.40	0.30	1.10
19-Aug-03		0.50	0.40	0.60	0.40	0.30	0.40	1.00	2.70	0.40	0.20	0.30	- 0.10	0.40	0.50	0.50	0.30	0.50	0.20	0.20
31-Aug-03		0.90	0.70	0.80	0.80	0.60	0.20	1.40	0.20	0.20	0.30	0.40	0.20	0.30	0.50	0.90		0.40	0.20	1.00
05-Sep-03																	0.60			
12-Sep-03		1.20	1.70	2.40	1.50	1.10	0.40	2.00	2.00	0.50	1.90	1.30	0.30	1.90	2.60	2.20	1.00	2.20	3.10	1.60
24-Sep-03		0.30	0.40	0.30	0.60	0.40	0.20	0.90	2.00	0.20	0.30	0.70	0.10	0.40	0.70	0.80	0.70	0.90	0.20	0.20
06-Oct-03		1.10	1.40	1.40	0.60	1.00	0.40	1.80	0.80	0.80	0.60	1.30	- 0.10	2.10	0.70	1.90		1.50	0.80	1.30
18-Oct-03		1.10	2.40	1.00	2.50	1.20	0.30		1.00	1.10	1.30	1.20	0.20	1.10	0.90	1.70	1.10	1.90	2.20	1.70

Bay Area Air Quality Management District
Toxic Air Contaminants
2003 Annual Report

Ambient Air Toxics Data

Date Range: Jan 1, 2003 to Dec 31, 2003 **Pollutant: Toluene (PPB)**

Station ID Numbers

	1018	1022	1023	1024	2010	2014	2017	2018	2019	2021	2035	3005	3007	4001	5011	6004	7030	7032	8004	9004
20-Oct-03								4.20												
30-Oct-03		0.80	0.30	1.10	0.40	0.20	<0.10	1.10	0.40	0.10	0.50	0.40	0.10	1.20	0.40	0.90	0.40	0.90	0.20	0.40
11-Nov-03		0.70	1.50	2.40	2.40	0.60	0.40	2.10	1.20	0.80	1.30	1.30	2.30		1.90	4.60	1.50	3.20	3.60	1.50
13-Nov-03														2.00						
23-Nov-03		0.30	1.10	2.20	1.00	0.80	0.50	2.60	0.80	0.70	1.00	0.80	0.40		1.60	2.00	0.60	3.30	1.80	1.10
25-Nov-03														1.60						
05-Dec-03		1.10	2.60	1.00	2.20	1.20	0.60	4.00	2.10	0.40	1.40	1.20	0.50	1.10	2.10	3.20	1.70	1.10	1.00	0.80
17-Dec-03		0.50	1.40	1.90	0.90	2.50	0.20		1.00	0.60	1.30	1.80	0.50	2.80	2.20	3.70	1.20	4.80	0.70	2.30
18-Dec-03								2.00												
29-Dec-03		0.50	0.50	0.80	0.30	0.30	0.20	0.80	0.50	0.10			0.30	0.40	0.80	0.90		0.20		0.60
31-Dec-03											1.20								2.30	
# Obs	8	31	31	31	31	31	31	31	31	31	31	30	31	31	31	31	29	31	31	31
# <LOD	0	0	0	0	0	0	1	0	0	0	0	0	8	0	0	0	0	0	0	0
Mean*	0.94	0.89	0.90	1.33	1.27	0.79	0.36	1.79	1.21	0.50	1.04	0.84	0.27	1.08	1.04	1.72	0.80	1.54	1.18	0.97
Max	2.00	2.30	2.60	4.80	4.00	2.50	1.10	4.20	2.90	1.60	2.50	1.80	2.30	2.80	2.80	5.70	1.90	6.00	4.00	2.30
Min	0.40	0.20	0.10	0.30	0.30	0.20	<0.10	0.80	0.20	0.10	0.20	0.30	<0.10	0.20	0.20	0.30	0.10	0.20	0.20	0.20

*Values below the detection limit are set to one-half the detection limit for statistical calculations.

Bay Area Air Quality Management District
Toxic Air Contaminants
2003 Annual Report

Ambient Air Toxics Data

Date Range: Jan 1, 2003 to Dec 31, 2003 **Pollutant: Vinyl chloride (PPB)**

Station ID Numbers

	1018	1022	1023	1024	2010	2014	2017	2018	2019	2021	2035	3005	3007	4001	5011	6004	7030	7032	8004	9004
02-Jan-03							<0.30													
03-Jan-03	<0.30		<0.30	<0.30	<0.30	<0.30		<0.30	<0.30	<0.30	<0.30	<0.30	<0.30		<0.30	<0.30	<0.30	<0.30		<0.30
04-Jan-03														<0.30						
05-Jan-03																			<0.30	
08-Jan-03		<0.30																		
15-Jan-03	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0:30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30
27-Jan-03	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30
08-Feb-03	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30
20-Feb-03	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30
04-Mar-03	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30		<0.30	<0.30	<0.30	<0.30	<0.30
16-Mar-03	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30
22-Mar-03															<0.30					
28-Mar-03	<0.30		<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30
02-Apr-03		<0.30																		
09-Apr-03		<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30
21-Apr-03		<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30		<0.30	<0.30	<0.30
24-Apr-03																	<0.30			
03-May-03			<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30
06-May-03		<0.30																		
15-May-03		<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30
27-May-03		<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30
08-Jun-03		<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30
20-Jun-03		<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30
02-Jul-03		<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30
14-Jul-03		<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30		<0.30	<0.30	<0.30
18-Jul-03																	<0.30			
26-Jul-03		<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30
07-Aug-03		<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30
19-Aug-03		<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30
31-Aug-03		<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30		<0.30	<0.30	<0.30
05-Sep-03																	<0.30			
12-Sep-03		<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30
24-Sep-03		<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30
06-Oct-03		<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30		<0.30	<0.30	<0.30
18-Oct-03		<0.30	<0.30	<0.30	<0.30	<0.30	<0.30		<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30

Bay Area Air Quality Management District
Toxic Air Contaminants
2003 Annual Report

Ambient Air Toxics Data

Date Range: Jan 1, 2003 to Dec 31, 2003 **Pollutant: Vinyl chloride (PPB)**

Station ID Numbers

	1018	1022	1023	1024	2010	2014	2017	2018	2019	2021	2035	3005	3007	4001	5011	6004	7030	7032	8004	9004
20-Oct-03								<0.30												
30-Oct-03		<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30
11-Nov-03		<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30		<0.30	<0.30	<0.30	<0.30	<0.30	<0.30
13-Nov-03														<0.30						
23-Nov-03		<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30		<0.30	<0.30	<0.30	<0.30	<0.30	<0.30
25-Nov-03														<0.30						
05-Dec-03		<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30
17-Dec-03		<0.30	<0.30	<0.30	<0.30	<0.30	<0.30		<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30
18-Dec-03								<0.30												
29-Dec-03		<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30		<0.30	<0.30	<0.30	<0.30	<0.30		<0.30		<0.30
31-Dec-03											<0.30								<0.30	
# Obs	8	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	29	31	31	31
# <LOD	8	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	29	31	31	31
Mean*	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
Max	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30
Min	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30

*Values below the detection limit are set to one-half the detection limit for statistical calculations.

Bay Area Air Quality Management District
Toxic Air Contaminants
2003 Annual Report

Ambient Air Toxics Data

Date Range: Jan 1, 2003 to Dec 31, 2003 **Pollutant: M/P xylene (PPB)**

Station ID Numbers

	1018	1022	1023	1024	2010	2014	2017	2018	2019	2021	2035	3005	3007	4001	5011	6004	7030	7032	8004	9004
02-Jan-03							2.00													
03-Jan-03	0.40		0.90	2.60	1.20	1.00		0.80	0.60	0.60	0.60	0.70	<0.10		1.20	2.10	0.90	3.40		1.20
04-Jan-03														1.10						
05-Jan-03																			1.90	
08-Jan-03		0.30																		
15-Jan-03	0.40	0.50	0.40	1.20	1.30	0.40	0.20	0.90	0.70	0.60	1.00	0.90	0.20	1.40	1.10	3.00	0.40	1.70	0.60	1.10
27-Jan-03	1.00	0.40	0.90	1.40	1.00	0.90	0.30	0.80	1.10	0.40	1.60	0.80	<0.10	1.00	1.00	1.40	1.00	1.70	1.00	0.60
08-Feb-03	0.50	0.40	1.00	2.60	1.50	0.40	0.20	0.80	0.90	0.90	0.80	0.90	0.10	1.10	1.80	1.80	0.80	1.90	2.50	0.80
20-Feb-03	0.30	0.20	0.80	0.50	1.00	0.10	0.10	0.40	0.30	0.10	0.60	0.40	<0.10	0.80	0.90	1.30	0.50	0.60	0.90	0.40
04-Mar-03	0.30	0.30	0.50	0.80	0.70	0.30	0.20	0.40	1.00	0.40	0.80	0.60	<0.10	0.50		1.20	0.50	0.70	1.00	1.00
16-Mar-03	0.20	0.20	0.20	0.40	0.50	0.30	0.10	0.20	0.20	0.10	0.50	0.30	<0.10	0.50	0.20	0.40	0.20	0.50	0.30	0.20
22-Mar-03															0.20					
28-Mar-03	0.10		0.30	0.40	0.70	0.20	<0.10	0.50	0.40	0.20	0.50	0.30	<0.10	0.30	0.70	0.70	0.30	0.70	0.70	0.40
02-Apr-03		0.10																		
09-Apr-03		0.40	0.50	0.90	0.40	0.30	0.10	0.30	0.50	0.30	0.80	0.40	<0.10	0.50	0.40	0.60	0.40	0.60	0.30	0.40
21-Apr-03		0.20	0.10	0.30	0.90	0.10	<0.10	0.10	0.80	0.10	0.40	0.20	<0.10	0.20	0.30	0.30		0.20	0.10	0.20
24-Apr-03																	0.10			
03-May-03			0.10	0.30	0.30	0.20	<0.10	0.20	0.20	<0.10	0.20	0.20	<0.10	0.30	0.30	0.30	0.20	0.40	0.20	0.20
06-May-03		0.20																		
15-May-03		0.10	<0.10	0.30	0.40	0.10	<0.10	0.10	0.30	0.10	0.70	0.20	<0.10	0.40	0.40	0.30	<0.10	0.30	0.20	0.20
27-May-03		0.40	0.50	0.70	0.60	0.40	0.30	0.40	0.60	0.20	0.60	0.40	<0.10	0.40	0.60	0.50	0.40	0.70	0.50	0.50
08-Jun-03		0.10	0.10	0.20	0.20	0.10	<0.10	0.10	0.20	<0.10	0.20	0.10	<0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
20-Jun-03		0.10	<0.10	0.20	0.30	0.90	0.10	0.10	0.30	0.10	0.30	0.20	<0.10	0.20	0.30	0.20	0.20	0.20	0.20	0.20
02-Jul-03		0.20	0.30	0.40	1.10	0.20	0.20	0.20	0.20	0.10	0.30	0.40	<0.10	0.30	0.20	0.50	0.20	0.50	0.20	0.20
14-Jul-03		0.40	0.40	0.40	0.40	0.40	0.20	0.20	0.50	0.10	0.40	0.30	<0.10	0.40	0.40	0.40		0.50	0.40	0.30
18-Jul-03																	0.40			
26-Jul-03		0.40	0.20	0.20	0.30	0.10	0.10	0.30	0.30	<0.10	0.20	0.40	<0.10	0.20	0.30	0.20	0.30	0.30	0.10	0.20
07-Aug-03		0.20	0.10	0.20	0.40	0.10	<0.10	0.10	0.10	<0.10	0.20	0.20	<0.10	0.20	0.20	0.40	0.20	0.20	0.10	0.30
19-Aug-03		0.10	0.20	0.20	0.20	0.10	0.10	0.10	0.40	0.10	0.10	0.10	<0.10	0.20	0.20	0.20	0.20	0.20	0.10	0.10
31-Aug-03		0.40	0.30	0.30	0.40	0.20	0.10	0.30	0.10	0.10	0.20	0.20	<0.10	0.20	0.30	0.30		0.20	0.10	0.20
05-Sep-03																	0.30			
12-Sep-03		0.70	1.00	1.60	1.10	0.70	0.30	0.90	1.10	0.30	1.20	0.90	0.10	1.30	1.60	1.20	0.60	1.50	2.00	0.90
24-Sep-03		0.10	0.20	0.30	0.40	0.10	0.10	0.20	0.30	0.20	0.20	0.40	<0.10	0.30	0.30	0.40	0.40	0.50	0.10	0.20
06-Oct-03		0.60	0.80	0.80	0.40	0.60	0.20	0.60	0.40	0.40	0.40	0.60	<0.10	1.10	0.40	1.10		0.90	0.50	0.50
18-Oct-03		0.60	1.20	0.70	1.70	0.70	0.20		0.60	0.50	0.80	0.60	<0.10	0.60	0.60	1.00	0.60	1.10	1.40	0.90

Bay Area Air Quality Management District
Toxic Air Contaminants
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Ambient Air Toxics Data

Date Range: Jan 1, 2003 to Dec 31, 2003 **Pollutant: M/P xylene (PPB)**

Station ID Numbers

	1018	1022	1023	1024	2010	2014	2017	2018	2019	2021	2035	3005	3007	4001	5011	6004	7030	7032	8004	9004
20-Oct-03								1.60												
30-Oct-03		0.20	0.10	0.70	0.20	0.10	<0.10	0.20	0.20	<0.10	0.40	0.20	<0.10	0.80	0.20	0.50	0.20	0.40	0.10	0.20
11-Nov-03		0.40	0.90	1.50	1.70	0.30	0.20	0.90	0.60	0.20	0.80	0.80	1.50		1.00	2.40	0.90	1.80	2.20	0.60
13-Nov-03														1.20						
23-Nov-03		0.10	0.70	2.00	0.60	0.40	0.20	0.80	0.40	0.20	0.50	0.50	0.10		1.00	1.20	0.30	1.90	1.00	0.40
25-Nov-03														0.90						
05-Dec-03		0.60	1.40	0.50	1.20	0.70	0.30	1.50	0.70	0.20	0.90	0.70	0.20	0.60	2.40	1.50	1.10	0.60	0.50	0.50
17-Dec-03		0.20	0.90	1.40	0.70	1.20	0.10		0.70	0.30	0.80	1.20	0.20	1.60	1.10	2.10	0.80	2.90	0.30	1.50
18-Dec-03								0.90												
29-Dec-03		0.20	0.30	0.50	0.20	0.20	0.10	0.10	0.60	<0.10			0.10	0.20	0.40	0.60		0.10		0.30
31-Dec-03											0.80								1.50	
# Obs	8	31	31	31	31	31	31	31	31	31	31	30	31	31	31	31	29	31	31	31
# <LOD	0	0	2	0	0	0	7	0	0	6	0	0	23	0	0	0	1	0	0	0
Mean*	0.40	0.30	0.50	0.79	0.71	0.38	0.20	0.48	0.49	0.23	0.57	0.47	0.12	0.61	0.65	0.91	0.43	0.88	0.68	0.48
Max	1.00	0.70	1.40	2.60	1.70	1.20	2.00	1.60	1.10	0.90	1.60	1.20	1.50	1.60	2.40	3.00	1.10	3.40	2.50	1.50
Min	0.10	0.10	<0.10	0.20	0.20	0.10	<0.10	0.10	0.10	<0.10	0.10	0.10	<0.10	0.10	0.10	0.10	<0.10	0.10	0.10	0.10

*Values below the detection limit are set to one-half the detection limit for statistical calculations.

Bay Area Air Quality Management District
Toxic Air Contaminants
2003 Annual Report

Ambient Air Toxics Data

Date Range: Jan 1, 2003 to Dec 31, 2003

Pollutant: O xylene (PPB)

Station ID Numbers

	1018	1022	1023	1024	2010	2014	2017	2018	2019	2021	2035	3005	3007	4001	5011	6004	7030	7032	8004	9004
02-Jan-03							0.90													
03-Jan-03	0.20		0.30	0.90	0.40	0.30		0.30	0.20	0.20	0.20	0.30	<0.10		0.40	0.80	0.40	1.30		0.50
04-Jan-03														0.40						
05-Jan-03																			0.70	
08-Jan-03		0.10																		
15-Jan-03	0.20	0.20	0.10	0.40	0.60	0.10	0.10	0.30	0.20	0.20	0.40	0.40	0.10	0.60	0.40	1.00	0.20	0.60	0.20	0.40
27-Jan-03	0.30	0.10	0.30	0.50	0.40	0.30	0.10	0.30	0.40	0.20	0.60	0.20	<0.10	0.40	0.40	0.50	0.40	0.60	0.40	0.20
08-Feb-03	0.20	0.10	0.30	0.90	0.50	0.20	0.10	0.30	0.30	0.30	0.30	0.30	<0.10	0.40	0.50	0.60	0.30	0.70	0.90	0.30
20-Feb-03	0.10	<0.10	0.30	0.20	0.20	<0.10	<0.10	0.20	0.10	<0.10	0.20	0.10	<0.10	0.30	0.30	0.40	0.20	0.20	0.30	0.10
04-Mar-03	0.10	0.10	0.20	0.30	0.30	0.10	<0.10	0.10	0.30	0.10	0.30	0.20	<0.10	0.20		0.40	0.20	0.20	0.40	0.30
16-Mar-03	0.10	0.10	0.10	0.10	0.20	0.10	<0.10	0.10	0.10	<0.10	0.20	0.10	<0.10	0.20	0.10	0.20	<0.10	0.20	0.10	0.10
22-Mar-03															0.10					
28-Mar-03	0.10		0.10	0.10	0.30	0.10	<0.10	0.20	0.10	<0.10	0.20	0.10	<0.10	0.10	0.20	0.30	0.10	0.30	0.30	0.20
02-Apr-03		<0.10																		
09-Apr-03		0.10	0.20	0.30	0.10	0.10	<0.10	0.10	0.20	0.10	0.30	0.10	<0.10	0.20	0.20	0.20	0.10	0.20	0.10	0.10
21-Apr-03		<0.10	<0.10	0.10	0.30	<0.10	<0.10	<0.10	<0.10	<0.10	0.20	<0.10	<0.10	<0.10	0.10	0.10		<0.10	<0.10	<0.10
24-Apr-03																	<0.10			
03-May-03			<0.10	0.10	0.10	<0.10	<0.10	<0.10	0.10	<0.10	0.10	0.10	<0.10	0.10	0.20	0.10	0.10	0.10	<0.10	0.10
06-May-03		<0.10																		
15-May-03		<0.10	<0.10	0.10	0.10	<0.10	<0.10	<0.10	0.10	<0.10	0.30	<0.10	<0.10	0.10	0.10	0.10	<0.10	0.10	<0.10	0.10
27-May-03		0.10	0.20	0.30	0.20	0.10	0.10	0.10	0.20	0.10	0.20	0.10	<0.10	0.10	0.20	0.20	0.10	0.30	0.20	0.20
08-Jun-03		<0.10	<0.10	0.10	0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
20-Jun-03		<0.10	<0.10	<0.10	0.10	0.30	<0.10	<0.10	0.10	<0.10	0.10	0.10	<0.10	0.10	0.10	<0.10	0.10	<0.10	<0.10	0.10
02-Jul-03		<0.10	0.10	0.10	0.30	0.10	0.10	0.10	<0.10	<0.10	0.10	0.10	<0.10	0.10	<0.10	0.10	0.10	0.20	0.10	0.10
14-Jul-03		0.20	0.10	0.10	0.10	0.10	<0.10	<0.10	0.30	<0.10	0.20	0.10	<0.10	0.10	0.10	0.20		0.20	0.10	0.10
18-Jul-03																	0.20			
26-Jul-03		0.10	<0.10	<0.10	0.10	<0.10	<0.10	0.10	0.10	<0.10	<0.10	0.10	<0.10	<0.10	0.10	0.10	0.10	0.10	<0.10	<0.10
07-Aug-03		<0.10	<0.10	<0.10	0.20	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0.10	<0.10	<0.10	<0.10	0.10
19-Aug-03		<0.10	<0.10	0.10	0.10	<0.10	<0.10	0.10	0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0.10	<0.10	<0.10
31-Aug-03		0.10	0.10	0.10	0.20	0.10	<0.10	0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0.10	0.10		<0.10	<0.10	<0.10
05-Sep-03																	0.10			
12-Sep-03		0.20	0.30	0.50	0.30	0.20	0.10	0.30	0.30	<0.10	0.40	0.20	<0.10	0.40	0.50	0.40	0.20	0.40	0.60	0.20
24-Sep-03		<0.10	<0.10	0.10	0.10	<0.10	<0.10	0.10	0.10	<0.10	<0.10	0.10	<0.10	0.10	0.10	0.10	0.10	0.10	<0.10	<0.10
06-Oct-03		0.20	0.20	0.30	0.10	0.20	<0.10	0.20	0.10	0.10	0.10	0.20	<0.10	0.40	0.10	0.30		0.30	0.20	0.10
18-Oct-03		0.20	0.40	0.20	0.50	0.30	<0.10		0.20	0.10	0.30	0.20	<0.10	0.20	0.20	0.40	0.20	0.40	0.50	0.30

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	1018	1022	1023	1024	2010	2014	2017	2018	2019	2021	2035	3005	3007	4001	5011	6004	7030	7032	8004	9004
20-Oct-03								0.60												
30-Oct-03		<0.10	<0.10	0.20	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0.10	<0.10	<0.10	0.20	<0.10	0.20	<0.10	0.10	<0.10	<0.10
11-Nov-03		0.10	0.30	0.50	0.60	0.10	<0.10	0.20	0.20	<0.10	0.30	0.20	0.40		0.30	0.70	0.30	0.50	0.60	0.20
13-Nov-03														0.40						
23-Nov-03		<0.10	0.20	0.40	0.20	0.10	<0.10	0.30	0.10	<0.10	0.20	0.10	<0.10		0.30	0.40	0.10	0.60	0.30	0.10
25-Nov-03														0.30						
05-Dec-03		0.20	0.50	0.10	0.40	0.20	0.10	0.50	0.20	<0.10	0.30	0.20	<0.10	0.20	0.60	0.50	0.30	0.20	0.20	0.10
17-Dec-03		<0.10	0.40	0.60	0.30	0.50	<0.10		0.30	0.10	0.30	0.40	<0.10	0.80	0.50	0.70	0.40	1.30	0.10	0.50
18-Dec-03								0.40												
29-Dec-03		<0.10	0.10	0.20	0.10	<0.10	<0.10	<0.10	0.20	<0.10			<0.10	<0.10	0.10	0.20		<0.10		0.10
31-Dec-03											0.40								0.50	
# Obs	8	31	31	31	31	31	31	31	31	31	31	30	31	31	31	31	29	31	31	31
# <LOD	0	15	10	3	1	11	23	9	6	21	5	7	29	7	5	3	7	6	11	7
Mean*	0.16	0.10	0.17	0.26	0.24	0.13	0.09	0.18	0.16	0.08	0.21	0.15	0.06	0.22	0.21	0.31	0.16	0.31	0.24	0.16
Max	0.30	0.20	0.50	0.90	0.60	0.50	0.90	0.60	0.40	0.30	0.60	0.40	0.40	0.80	0.60	1.00	0.40	1.30	0.90	0.50
Min	0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10

*Values below the detection limit are set to one-half the detection limit for statistical calculations.

APPENDIX C-3

AIR MONITORING PROGRAMS

AIR MONITORING PROGRAMS

PM10

Agency: **BAAQMD**
Sample medium: **Quartz fiber filter**
Frequency: **Every 6th day**

Analysis	Site	Collocated site
Mass	Bethel Island	Napa
Chemicals:	Concord	Redwood City
Ammonium	Fremont	
Chloride	Livermore	
Nitrate	Napa	
Potassium	Pittsburg	
Sulfate	Redwood City	
	San Francisco - Arkansas St.	
	San Jose - Jackson St.	
	San Jose - Tully Rd.	
	San Pablo	
	San Rafael	
	Santa Rosa	
	Vallejo	

Agency: **CARB**
Sample medium: **Quartz fiber filter**
Frequency: **Every 6th day**

Analysis	Site	Collocated site
Mass	San Francisco - Bayview/Hunter's Pt.	None
Chemicals:		
Ammonium		
Chloride		
Nitrate		
Potassium		
Sulfate		
PAH	Fremont	None
	San Francisco - Arkansas St.	
	San Francisco - Bayview/Hunter's Pt.	
	San Jose - Jackson St.	

Agency: **CARB**
Sample medium: **Quartz fiber filter**
Frequency: **One sample per month**

Analysis	Site	Collocated site
Elemental carbon	San Francisco - Bayview/Hunter's Pt.	None

AIR MONITORING PROGRAMS

TOXICS

Agency: **BAAQMD**
Sample medium: **Canister**
Frequency: **Every 12th day**

Analysis	Site	Collocated site
1,1,1-Trichloroethane	Bethel Island	San Francisco - Arkansas St.
1,1,2 Trichlorotrifluoroethane	Concord	
1,3-Butadiene	Crockett	
Acetone	Ft. Cronkhite	
Benzene	Livermore	
Carbon tetrachloride	Martinez	
Chloroform	Napa	
Dichloromethane	Oakland – Filbert St.	
Ethylbenzene	Pittsburg	
Ethylene dibromide	Redwood City	
Ethylene Dichloride	Richmond – 7th St.	
M/P Xylene	San Francisco - Arkansas St.	
Methyl ethyl ketone	San Jose – Jackson St.	
Methyl tertiary-butyl ether	San Leandro	
O-Xylene	San Pablo	
Perchloroethylene	San Rafael	
Toluene	Santa Rosa	
Trichloroethylene	Sunnyvale	
Trichlorofluoromethane	Vallejo	
Vinyl chloride		

Agency: **CARB**
Sample medium: **Canister**
Frequency: **Every 12th day**

Analysis		Site	Collocated site
1,1,1-Trichloroethane	Dichloromethane	Fremont	None
1,3-Butadiene	Ethylbenzene	San Francisco – Arkansas St.	
Acetone	m/p-Xylene	San Jose – Jackson St	
Acetonitrile	Methyl tertiary-butyl ether		
Acrolein	o-Dichlorobenzene		
Acrolyonitrile	o-Xylene		
Benzene	p-Dichlorobenzene		
Bromomethane	Perchloroethylene		
Carbon disulfide	Styrene		
Carbon tetrachloride	Toluene		
Chloroform	trans-1,3-Dichloropropene		
cis-1,3-Dichloropropene	Trichloroethylene		

AIR MONITORING PROGRAMS

TOXICS (cont)

Agency: CARB
Sample medium: Canister
Frequency: Every 6th day

Analysis		Site	Collocated site
Acetone	Dichloromethane	San Francisco - Bayview/Hunter's Pt.	None
Acetonitrile	Ethylbenzene		
Acrolein	m/p-Xylene		
Acrolyonitrile	o-Dichlorobenzene		
1,1,1-Trichloroethane	o-Xylene		
1,3-Butadiene	p-Dichlorobenzene		
Benzene	Perchloroethylene		
Bromomethane	Styrene		
Carbon disulfide	Toluene		
Carbon tetrachloride	trans-1,3-Dichloropropene		
Chloroform	Trichloroethylene		
cis-1,3-Dichloropropene	Perchloroethylene		

TOTAL METALS

Agency: CARB
Sample medium: Teflon filter
Frequency: Every 12th day

Analysis		Site	Collocated site
Aluminum	Phosphorus	Fremont	None
Antimony	Potassium	San Francisco - Arkansas St.	
Barium	Rubidium	San Jose - Jackson St.	
Bromine	Selenium		
Calcium	Silicon		
Chlorine	Strontium		
Chromium	Sulfur		
Cobalt	Tin		
Copper	Titanium		
Iron	Uranium		
Lead	Vanadium		
Manganese	Yttrium		
Mercury	Zinc		
Molybdenum	Zirconium		
Nickel			

AIR MONITORING PROGRAMS

TOTAL METALS (cont)

Agency: **CARB**
Sample medium: **Teflon filter**
Frequency: **Every 6th day**

Analysis		Site	Collocated site
Aluminum	Nickel	San Francisco - Bayview/Hunter's Pt.	None
Antimony	Phosphorus		
Arsenic	Potassium		
Barium	Rubidium		
Bromine	Selenium		
Calcium	Silicon		
Chlorine	Strontium		
Chromium	Sulfur		
Cobalt	Tin		
Copper	Titanium		
Iron	Uranium		
Lead	Vanadium		
Manganese	Yttrium		
Mercury	Zinc		
Molybdenum	Zirconium		

HEXAVALENT CHROMIUM

Agency: **CARB**
Sample medium: **Cellulose filter**
Frequency: **Every 12th day**

Analysis	Site	Collocated site
Chromium VI	Fremont	None
	San Francisco - Arkansas St.	
	San Jose - Jackson St.	

Agency: **CARB**
Sample medium: **Cellulose filter**
Frequency: **Every 6th day**

Analysis	Site	Collocated site
Chromium VI	San Francisco - Bayview/Hunter's Pt.	None

AIR MONITORING PROGRAMS

CARBONYLS

Agency: **CARB**
Sample medium: **Solid adsorbent cartridge**
Frequency: **Every 12th day**

Analysis	Site	Collocated site
Acetaldehyde	Fremont	None
Formaldehyde	San Francisco - Arkansas St.	
Methyl Ethyl Ketone	San Jose - Jackson St.	

Agency: **CARB**
Sample medium: **Solid adsorbent cartridge**
Frequency: **Every 6th day**

Analysis	Site	Collocated site
Acetaldehyde	San Francisco - Bayview/Hunter's Pt.	None
Formaldehyde		
Methyl Ethyl Ketone		

PM2.5

Agency: **BAAQMD**
Sample medium: **Teflon filer**
Frequency: **Every 6th day (summer) and every day (winter)**

Analysis	Site	Collocated site
Mass	Concord	(Met One BAM continuous PM2.5)
	San Francisco - Arkansas St.	Oakland - Filbert St.
	San Jose - Jackson St.	Livermore
	San Jose - Tully Rd.	San Francisco - Arkansas St.
		San Francisco - Bayview/Hunter's Pt.
		Redwood City
		San Jose - Jackson St.
		Vallejo

Agency: **BAAQMD**
Sample medium: **Teflon filer**
Frequency: **Every 6th day (summer) and every 3rd day (winter)**

Analysis	Site	Collocated site
Mass	Fremont	See above
	Livermore	
	Redwood City	
	Santa Rosa	
	Vallejo	

AIR MONITORING PROGRAMS

PM2.5 (cont)

Agency: **BAAQMD**
Sample medium: **Teflon filer**
Frequency: **Every 6th day**

Analysis	Site	Collocated site
Mass		Concord

Agency: **EPA**
Sample medium: **Teflon filer**
Frequency: **Every 3rd day**

Analysis		Site	Collocated site
Mass	Cation	San Jose - Jackson St.	None
	Ammonium		
Carbon	Sodium		
Total	Potassium		
Organic			
Elemental	Anion		
Carbonate	Nitrate		
	Sulfate		

AIR MONITORING PROGRAMS

DIOXINS

Agency: **CARB**
Sample medium: **Polyurethane foam plug**
Frequency: **20-24 days every 28-day period**

Analysis	Site	Collocated site
Polychlorinated dibenzo-p-dioxins	Livermore	None
	Richmond - 7th St.	
	San Jose - JacksonSt.	

Sample medium: **Quartz fiber filter**
Frequency: **20-24 days every 28-day period**

Analysis	Site	Collocated site
Polychlorinated dibenzofurans	Livermore	None
Dioxin-like polychlorinated biphenyls	Richmond - 7th St.	
	San Jose - JacksonSt.	

Agency: **EPA**
Sample medium: **Polyurethane foam plug**
Frequency: **24 days every 28-day period, four times/year**

Analysis	Site	Collocated site
Polychlorinated dibenzo-p-dioxins	Fort Cronkhite	None
	San Francisco - Arkansas St.	

Sample medium: **Quartz fiber filter**
Frequency: **24 days every 28-day period, four times/year**

Analysis	Site	Collocated site
Polychlorinated dibenzofurans	Fort Cronkhite	None
Dioxin-like polychlorinated biphenyls	San Francisco - Arkansas St.	

Plans & Climate

Learn about Air Quality and other plans, efforts to reduce climate change, engage our communities, provide CEQA and other tools to local governments, and to assess health risk at regulated facilities.

Air Quality Plans...

Air Quality Plans (or Clean Air Plans) provide a road map to the Air District's activities to improve air quality and address climate change. Plans are also geared towards helping Bay Area residents, businesses, local governments and other interested parties to understand air quality in the region and how we can all work to protect it, public health, and the climate.

The Air District has been preparing plans to fulfill State and federal air pollution reduction requirements since 1982. The most recent, the 2010 Clean Air Plan, was developed as a multi-pollutant plan - an integrated control strategy to reduce ozone, particulate matter (PM), toxic air contaminants, and greenhouse gases.

The control strategy consists of: a combination of proposed regulations to be adopted and enforced by the Air District; grant and incentive programs; public education and outreach programs; and partnerships with other agencies and stakeholders. The Bay Area's air quality plans are prepared in cooperation with the Metropolitan Transportation Commission, the Bay Conservation and Development Commission, and the Association of Bay Area Governments. An update to the *2010 Clean Air Plan* is currently underway.

Climate Protection

In addition to measures to lower the exposure of Bay Area residents to ozone, particulate matter and toxic air contaminants in the near-term, the 2015 Clean Air Plan will include a Regional Climate Protection Strategy to achieve significant, long-term reductions in greenhouse gas emissions.

Public Participation Plan

The *Public Participation Plan* serves as a guide to provide meaningful opportunities for communities to engage with the Air District as we conduct our mission to protect and improve public health, air quality and global climate.

Health Risk Assessments

To assist the public in understanding actions to control air pollution, the Air District publishes assessments of health risks posed by selected industrial sources and emissions minimization plans developed under Air District regulations.

Other Plans, Tools and Programs

The Air District provides tools and technical assistance to help Bay Area communities address air quality impacts and participate in developing and implementing solutions. The PEV Readiness Plan is helping cities, businesses and residents prepare for electric vehicles, a key component of the *2010 Clean Air Plan*. Through the CEQA Guidelines and the Community Air Risk Evaluation (CARE) program, the Air District is providing key technical information and tools to assist residents, businesses and local government agencies to assess and mitigate air quality problems.

Last Updated: 5/29/2015

939 Ellis St. San Francisco, CA 94109
415.771.6000 | 1.800.HELP AIR

Monitor Values Report

Geographic Area: Alameda County, CA
Pollutant: CO
Year: 2011
Exceptional Events: Included (if any)

Duration Description=1 HOUR

Duration Description	Obs	First Max	Second Max	Actual Exc	Exc Events	Monitor Number	Site ID	Address	City	County	State	EPA Region
1 HOUR	8325	4.1	3.7	0	None	1	060010009	9925 International Blvd	Oakland	Alameda	CA	09
1 HOUR	8263	3.5	3.5	0	None	1	060010011	1100 21st Street	Oakland	Alameda	CA	09

Get detailed information about this report, including column descriptions, at http://www.epa.gov/airquality/airdata/ad_about_reports.html#mon

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Source: U.S. EPA AirData <http://www.epa.gov/airdata>
Generated: August 25, 2014

Monitor Values Report

Geographic Area: Alameda County, CA
Pollutant: CO
Year: 2011
Exceptional Events: Included (if any)

Duration Description=8-HR RUN AVG END HOUR

Duration Description	Obs	First Max	Second Max	Actual Exc	Exc Events	Monitor Number	Site ID	Address	City	County	State	EPA Region
8-HR RUN AVG END HOUR	8659	1.5	1.3	0	None	1	060010009	9925 International Blvd	Oakland	Alameda	CA	09
8-HR RUN AVG END HOUR	8568	2.7	2.6	0	None	1	060010011	1100 21st Street	Oakland	Alameda	CA	09

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Source: U.S. EPA AirData <http://www.epa.gov/airdata>
Generated: August 25, 2014

Monitor Values Report

Geographic Area: Alameda County, CA
Pollutant: CO
Year: 2012
Exceptional Events: Included (if any)

Duration Description=1 HOUR

Duration Description	Obs	First Max	Second Max	Actual Exc	Exc Events	Monitor Number	Site ID	Address	City	County	State	EPA Region
1 HOUR	8219	2.9	2.7	0	None	1	060010009	9925 International Blvd	Oakland	Alameda	CA	09
1 HOUR	8331	2.8	2.7	0	None	1	060010011	1100 21st Street	Oakland	Alameda	CA	09

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Source: U.S. EPA AirData <http://www.epa.gov/airdata>
Generated: August 25, 2014

Monitor Values Report

Geographic Area: Alameda County, CA
Pollutant: CO
Year: 2012
Exceptional Events: Included (if any)

Duration Description=8-HR RUN AVG END HOUR

Duration Description	Obs	First Max	Second Max	Actual Exc	Exc Events	Monitor Number	Site ID	Address	City	County	State	EPA Region
8-HR RUN AVG END HOUR	8511	1.6	1.3	0	None	1	060010009	9925 International Blvd	Oakland	Alameda	CA	09
8-HR RUN AVG END HOUR	8666	2.4	2.4	0	None	1	060010011	1100 21st Street	Oakland	Alameda	CA	09

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Source: U.S. EPA AirData <http://www.epa.gov/airdata>
Generated: August 25, 2014

Monitor Values Report

Geographic Area: Alameda County, CA
Pollutant: CO
Year: 2013
Exceptional Events: Included (if any)

Duration Description=1 HOUR

Duration Description	Obs	First Max	Second Max	Actual Exc	Exc Events	Monitor Number	Site ID	Address	City	County	State	EPA Region
1 HOUR	8267	3.6	3.6	0	None	1	060010009	9925 International Blvd	Oakland	Alameda	CA	09
1 HOUR	8178	3.8	3.6	0	None	1	060010011	1100 21st Street	Oakland	Alameda	CA	09

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Source: U.S. EPA AirData <http://www.epa.gov/airdata>
Generated: August 25, 2014

Monitor Values Report

Geographic Area: Alameda County, CA
Pollutant: CO
Year: 2013
Exceptional Events: Included (if any)

Duration Description=8-HR RUN AVG END HOUR

Duration Description	Obs	First Max	Second Max	Actual Exc	Exc Events	Monitor Number	Site ID	Address	City	County	State	EPA Region
8-HR RUN AVG END HOUR	8593	2	1.9	0	None	1	060010009	9925 International Blvd	Oakland	Alameda	CA	09
8-HR RUN AVG END HOUR	8472	3.2	2.6	0	None	1	060010011	1100 21st Street	Oakland	Alameda	CA	09

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Source: U.S. EPA AirData <http://www.epa.gov/airdata>
Generated: August 25, 2014

http://www.epa.gov/airdata/ad_rep_mon.html

AirData

Monitor Values Report

This report displays criteria pollutant summary data for individual monitoring sites. Read more about what's in this report.

1. Pollutant

CO

2. Year

2014

3. Geographic Area

Select a State ...

-- or --

Select a City (defined as CBSA) ...

-- or --

CA - Alameda

4. Exceptional Events

(•) Include exceptional events data

( ) Exclude exceptional events data

Geographic Area: Alameda County, CA
Pollutant: CO
Year: 2014
Exceptional Events: Included (if any)
About this report

EPA Air Quality Standards:
Carbon Monoxide: 35 ppm (1-hour), 9 ppm (8-hour)

The following data links are active for the next 10 minutes, after which you must resubmit your query.
Download PDF (printable page)
Download CSV (spreadsheet)

To sort a column in the table below, click on the column heading.

Duration Description=1 HOUR

Duration Description	Obs	First Max	Second Max	Actual Exceedances	Exc Events	Monitor Number	Site ID	Address	City	County	Sta
1 HOUR	8242	2.8	2.6	0	None	1	060010009	9925 International Blvd	Oakland	Alameda	(
1 HOUR	8306	3	3	0	None	1	060010011	1100 21st Street	Oakland	Alameda	(
1 HOUR	7577	2	1.6	0	None	1	060010012	Laney College Eighth St. Parking Lot Aisle J	Oakland	Alameda	(

Duration Description=8-HR RUN AVG END HOUR

Duration Description	Obs	First Max	Second Max	Actual Exceedances	Exc Events	Monitor Number	Site ID	Address	City	County	Sta
8-HR RUN AVG END HOUR	8624	1.7	1.6	0	None	1	060010009	9925 International Blvd	Oakland	Alameda	(
8-HR RUN AVG END HOUR	8635	2.6	2.5	0	None	1	060010011	1100 21st Street	Oakland	Alameda	(
8-HR RUN AVG END HOUR	7882	1.1	1.1	0	None	1	060010012	Laney College Eighth St. Parking Lot Aisle J	Oakland	Alameda	(

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Last updated on Wednesday, October 08, 2014

California Environmental Protection Agency
Air Resources Board

Top 4 Summary: Highest 4 Daily Maximum Hourly Nitrogen Dioxide Measurements

at Oakland-West

iADAM

	2012		2013		2014	
	Date	Measurement	Date	Measurement	Date	Measurement
National:						
First High:	Feb 24	53.2	Dec 27	63.9	Jan 21	56.0
Second High:	Nov 6	53.2	Dec 26	61.3	Jan 17	54.9
Third High:	Feb 3	50.3	Nov 6	59.8	Oct 2	54.9
Fourth High:	Jan 10	49.8	Dec 17	59.8	Jan 24	54.7
California:						
First High:	Feb 24	53	Dec 27	63	Jan 21	56
Second High:	Nov 6	53	Dec 26	61	Jan 1	54
Third High:	Feb 3	50	Nov 6	59	Jan 2	54
Fourth High:	Jan 10	49	Dec 17	59	Jan 17	54
National:						
1-Hour Standard Design Value:		48		50		51
1-Hour Standard 98th Percentile:		47.5		52.7		52.0
# Days Above the Standard:		0		0		0
Annual Standard Design Value:		15		17		14
California:						
1-Hour Std Designation Value:		60		60		60
Expected Peak Day Concentration:		57		59		61
# Days Above the Standard:		0		0		0
Annual Std Designation Value:		15		16		16
Annual Average:		15		16		14
Year Coverage:		99		97		98

Notes:

Hourly nitrogen dioxide measurements and related statistics are available at Oakland-West between 2009 and 2014. Some years in this range may not be represented.
All concentrations expressed in parts per billion.
An exceedance of a standard is not necessarily related to a violation of the standard.
Year Coverage indicates the extent to which available monitoring data represent the time of the year when concentrations are expected to be highest. 0 means that data represent none of the high period; 100 means that data represent the entire high period. A high Year Coverage does not mean that there was sufficient data for annual statistics to be considered valid.
means there was insufficient data available to determine the value.

Available Pollutants:

8-Hour Ozone | Hourly Ozone | PM2.5 | PM10 | Carbon Monoxide | Nitrogen Dioxide | State Sulfur Dioxide | Hydrogen Sulfide

California Environmental Protection Agency
Air Resources Board

Top 4 Summary: Highest 4 Daily Maximum Hourly Nitrogen Dioxide Measurements

at Oakland-West

	2011		2012		2013	
	Date	Measurement	Date	Measurement	Date	Measurement
National:						
First High:	Dec 9	62.4	Feb 24	53.2	Dec 27	63.9
Second High:	Nov 11	54.8	Nov 6	53.2	Dec 26	61.3
Third High:	Oct 27	52.0	Feb 3	50.3	Nov 6	59.8
Fourth High:	Dec 10	51.4	Jan 10	49.8	Dec 17	59.8
California:						
First High:	Dec 9	62	Feb 24	53	Dec 27	63
Second High:	Nov 11	54	Nov 6	53	Dec 26	61
Third High:	Oct 27	52	Feb 3	50	Nov 6	59
Fourth High:	Dec 10	51	Jan 10	49	Dec 17	59
National:						
1-Hour Standard Design Value:		*		48		50
1-Hour Standard 98th Percentile:		49.6		47.5		52.7
# Days Above the Standard:		0		0		0
Annual Standard Design Value:		16		15		17
California:						
1-Hour Std Designation Value:		60		60		60
Expected Peak Day Concentration:		58		57		59
# Days Above the Standard:		0		0		0
Annual Std Designation Value:		15		15		16
Annual Average:		15		15		16
Year Coverage:		98		99		97

Notes:

Hourly nitrogen dioxide measurements and related statistics are available at Oakland-West between 2009 and 2013. Some years in this range may not be represented.
All concentrations expressed in parts per billion.
An exceedance of a standard is not necessarily related to a violation of the standard.
Year Coverage indicates the extent to which available monitoring data represent the time of the year when concentrations are expected to be highest. 0 means that data represent none of the high period; 100 means that data represent the entire high period. A high Year Coverage does not mean that there was sufficient data for annual statistics to be considered valid.
* means there was insufficient data available to determine the value.

Available Pollutants:

8-Hour Ozone | Hourly Ozone | PM2.5 | PM10 | Carbon Monoxide | Nitrogen Dioxide | State Sulfur Dioxide | Hydrogen Sulfide

California Environmental Protection Agency
Air Resources Board

Top 4 Summary: Highest 4 Daily Maximum 8-Hour Ozone Averages

at Oakland-West

iADAM

	2012		2013		2014	
	Date	8-Hr Average	Date	8-Hr Average	Date	8-Hr Average
National:						
First High:	Apr 12	0.048	May 2	0.059	Apr 30	0.059
Second High:	May 6	0.047	May 3	0.046	May 14	0.055
Third High:	Mar 31	0.046	May 5	0.045	Oct 4	0.052
Fourth High:	Apr 13	0.046	Oct 6	0.045	May 1	0.051
California:						
First High:	Apr 12	0.049	May 2	0.060	Apr 30	0.059
Second High:	Mar 31	0.047	May 3	0.046	May 14	0.055
Third High:	May 6	0.047	May 5	0.045	Oct 4	0.053
Fourth High:	Apr 13	0.046	Oct 6	0.045	May 1	0.051
National:						
# Days Above the Standard:		0		0		0
Nat'l Standard Design Value:		*		0.045		0.047
National Year Coverage:		98		95		99
California:						
# Days Above the Standard:		0		0		0
California Designation Value:		0.049		0.049		0.053
Expected Peak Day Concentration:		0.050		0.050		0.053
California Year Coverage:		97		94		98

Notes:

Eight-hour ozone averages and related statistics are available at Oakland-West between 2010 and 2014. Some years in this range may not be represented.
All averages expressed in parts per million.
An exceedance of a standard is not necessarily related to a violation of the standard.
Year Coverage indicates the extent to which available monitoring data represent the time of the year when concentrations are expected to be highest. 0 means that data represent none of the high period; 100 means that data represent the entire high period. A high Year Coverage does not mean that there was sufficient data for annual statistics to be considered valid.
means there was insufficient data available to determine the value.

Available Pollutants:

8-Hour Ozone | Hourly Ozone | PM2.5 | PM10 | Carbon Monoxide | Nitrogen Dioxide | State Sulfur Dioxide | Hydrogen Sulfide

California Environmental Protection Agency
Air Resources Board

Top 4 Summary: Highest 4 Daily Maximum Hourly Ozone Measurements

at Oakland-West

	2011		2012		2013	
	Date	Measurement	Date	Measurement	Date	Measurement
First High:	Oct 23	0.057	Sep 30	0.061	May 2	0.071
Second High:	Sep 20	0.054	Oct 18	0.061	Oct 6	0.061
Third High:	Mar 20	0.052	Oct 2	0.059	May 1	0.055
Fourth High:	May 4	0.052	Apr 12	0.051	May 3	0.055
California:						
# Days Above the Standard:		0		0		0
California Designation Value:		0.06		0.06		0.06
Expected Peak Day Concentration:		*		0.056		0.057
National:						
# Days Above the Standard:		*0*		*0*		*0*
Nat'l Standard Design Value:		*0.054*		*0.059*		*0.061*
Year Coverage:		99		98		97

Notes:

Hourly ozone measurements and related statistics are available at Oakland-West between 2010 and 2013. Some years in this range may not be represented.
All concentrations expressed in parts per million.
The national 1-hour ozone standard was revoked in June 2005 and is no longer in effect. Statistics related to the revoked standard are shown in *italics* or *italics* .
An exceedance of a standard is not necessarily related to a violation of the standard.
Year Coverage indicates the extent to which available monitoring data represent the time of the year when concentrations are expected to be highest. 0 means that data represent none of the high period; 100 means that data represent the entire high period. A high Year Coverage does not mean that there was sufficient data for annual statistics to be considered valid.
* means there was insufficient data available to determine the value.

Available Pollutants:

8-Hour Ozone | Hourly Ozone | PM2.5 | PM10 | Carbon Monoxide | Nitrogen Dioxide | State Sulfur Dioxide | Hydrogen Sulfide

Monitor Values Report

Geographic Area: Alameda County, CA
Pollutant: SO2
Year: 2011
Exceptional Events: Included (if any)

Duration Description=1 HOUR

Duration Description	Obs	First Max	Second Max	99th Percentile	Actual Exc	Exc Events	Monitor Number	Site ID	Address	City	County	State	EPA Region
1 HOUR	7917	19	18	14	0	None	1	060010011	1100 21st Street	Oakland	Alameda	CA	09

Get detailed information about this report, including column descriptions, at http://www.epa.gov/airquality/airdata/ad_about_reports.html#mon

AirData reports are produced from a direct query of the AQS Data Mart. The data represent the best and most recent information available to EPA from state agencies. However, some values may be absent due to incomplete reporting, and some values may change due to quality assurance activities. The AQS database is updated daily by state, local, and tribal organizations who own and submit the data. Please contact the appropriate air quality monitoring agency to report any data problems. <http://www.epa.gov/airquality/airdata/ad_contacts.html>

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This report is based on monitor-level summary statistics. Air quality standards for some pollutants (PM2.5 and Pb) allow for combining data from multiple monitors into a site-level summary statistic that can be compared to the standard. In those cases, the site-level statistics may differ from the monitor-level statistics upon which this report is based.

Source: U.S. EPA AirData <http://www.epa.gov/airdata>
Generated: August 25, 2014

Monitor Values Report

Geographic Area: Alameda County, CA
Pollutant: SO2
Year: 2011
Exceptional Events: Included (if any)

Duration Description=24-HR BLK AVG

Duration Description	Obs	First Max	Second Max	99th Percentile	Actual Exc	Exc Events	Monitor Number	Site ID	Address	City	County	State	EPA Region
24-HR BLK AVG	359	4	3	3	0	None	1	060010011	1100 21st Street	Oakland	Alameda	CA	09

Get detailed information about this report, including column descriptions, at http://www.epa.gov/airquality/airdata/ad_about_reports.html#mon

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This report is based on monitor-level summary statistics. Air quality standards for some pollutants (PM2.5 and Pb) allow for combining data from multiple monitors into a site-level summary statistic that can be compared to the standard. In those cases, the site-level statistics may differ from the monitor-level statistics upon which this report is based.

Source: U.S. EPA AirData <http://www.epa.gov/airdata>
Generated: August 25, 2014

Monitor Values Report

Geographic Area: Alameda County, CA
Pollutant: SO2
Year: 2012
Exceptional Events: Included (if any)

Duration Description=1 HOUR

Duration Description	Obs	First Max	Second Max	99th Percentile	Actual Exc	Exc Events	Monitor Number	Site ID	Address	City	County	State	EPA Region
1 HOUR	7968	68	19	15	0	None	1	060010011	1100 21st Street	Oakland	Alameda	CA	09

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This report is based on monitor-level summary statistics. Air quality standards for some pollutants (PM2.5 and Pb) allow for combining data from multiple monitors into a site-level summary statistic that can be compared to the standard. In those cases, the site-level statistics may differ from the monitor-level statistics upon which this report is based.

Source: U.S. EPA AirData <http://www.epa.gov/airdata>
Generated: August 25, 2014

Monitor Values Report

Geographic Area: Alameda County, CA
Pollutant: SO2
Year: 2012
Exceptional Events: Included (if any)

Duration Description=24-HR BLK AVG

Duration Description	Obs	First Max	Second Max	99th Percentile	Actual Exc	Exc Events	Monitor Number	Site ID	Address	City	County	State	EPA Region
24-HR BLK AVG	363	8	4	3	0	None	1	060010011	1100 21st Street	Oakland	Alameda	CA	09

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This report is based on monitor-level summary statistics. Air quality standards for some pollutants (PM2.5 and Pb) allow for combining data from multiple monitors into a site-level summary statistic that can be compared to the standard. In those cases, the site-level statistics may differ from the monitor-level statistics upon which this report is based.

Source: U.S. EPA AirData <http://www.epa.gov/airdata>
Generated: August 25, 2014

Monitor Values Report

Geographic Area: Alameda County, CA
Pollutant: SO2
Year: 2013
Exceptional Events: Included (if any)

Duration Description=1 HOUR

Duration Description	Obs	First Max	Second Max	99th Percentile	Actual Exc	Exc Events	Monitor Number	Site ID	Address	City	County	State	EPA Region
1 HOUR	7866	50	17	17	0	None	1	060010011	1100 21st Street	Oakland	Alameda	CA	09

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This report is based on monitor-level summary statistics. Air quality standards for some pollutants (PM2.5 and Pb) allow for combining data from multiple monitors into a site-level summary statistic that can be compared to the standard. In those cases, the site-level statistics may differ from the monitor-level statistics upon which this report is based.

Source: U.S. EPA AirData <http://www.epa.gov/airdata>
Generated: August 25, 2014

Monitor Values Report

Geographic Area: Alameda County, CA
Pollutant: SO2
Year: 2013
Exceptional Events: Included (if any)

Duration Description=24-HR BLK AVG

Duration Description	Obs	First Max	Second Max	99th Percentile	Actual Exc	Exc Events	Monitor Number	Site ID	Address	City	County	State	EPA Region
24-HR BLK AVG	353	7	3	2	0	None	1	060010011	1100 21st Street	Oakland	Alameda	CA	09

Get detailed information about this report, including column descriptions, at http://www.epa.gov/airquality/airdata/ad_about_reports.html#mon

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Source: U.S. EPA AirData <http://www.epa.gov/airdata>
Generated: August 25, 2014

California Environmental Protection Agency
Air Resources Board

Top 4 Summary: Highest 4 Daily Maximum 8-Hour Ozone Averages

at Oakland-West

	2011		2012		2013	
	Date	8-Hr Average	Date	8-Hr Average	Date	8-Hr Average
National:						
First High:	Mar 19	0.048	Apr 12	0.048	May 2	0.059
Second High:	Apr 6	0.046	May 6	0.047	May 3	0.046
Third High:	Mar 20	0.045	Mar 31	0.046	May 5	0.045
Fourth High:	Mar 26	0.045	Apr 13	0.046	Oct 6	0.045
California:						
First High:	Mar 19	0.048	Apr 12	0.049	May 2	0.060
Second High:	Apr 6	0.046	Mar 31	0.047	May 3	0.046
Third High:	Mar 20	0.045	May 6	0.047	May 5	0.045
Fourth High:	Mar 26	0.045	Apr 13	0.046	Oct 6	0.045
National:						
# Days Above the Standard:		0		0		0
Nat'l Standard Design Value:		*		*		0.045
National Year Coverage:		97		98		95
California:						
# Days Above the Standard:		0		0		0
California Designation Value:		0.048		0.049		0.049
Expected Peak Day Concentration:		*		0.050		0.050
California Year Coverage:		95		97		94

Notes:

Eight-hour ozone averages and related statistics are available at Oakland-West between 2010 and 2013. Some years in this range may not be represented.
All averages expressed in parts per million.
An exceedance of a standard is not necessarily related to a violation of the standard.
Year Coverage indicates the extent to which available monitoring data represent the time of the year when concentrations are expected to be highest. 0 means that data represent none of the high period; 100 means that data represent the entire high period. A high Year Coverage does not mean that there was sufficient data for annual statistics to be considered valid.
* means there was insufficient data available to determine the value.

Available Pollutants:

8-Hour Ozone | Hourly Ozone | PM2.5 | PM10 | Carbon Monoxide | Nitrogen Dioxide | State Sulfur Dioxide | Hydrogen Sulfide

California Environmental Protection Agency
Air Resources Board

Top 4 Summary: Highest 4 Daily Maximum 8-Hour Carbon Monoxide Averages

at Oakland-West

	2012		2013		2014	
	Date	8-Hr Average	Date	8-Hr Average	Date	8-Hr Average
National:						
First High:	Jan 14	2.40		*		*
Second High:	Jan 4	2.38		*		*
Third High:	Jan 10	2.28		*		*
Fourth High:	Jan 14	2.02		*		*
California:						
First High:	Jan 14	2.40		*		*
Second High:	Jan 3	2.38		*		*
Third High:	Jan 9	2.28		*		*
Fourth High:	Jan 12	1.82		*		*
National:						
# Days Above the Standard:		0		0		0
California:						
# Days Above the Standard:		0		0		0
Expected Peak Day Concentration:		2.53				
Year Coverage:		51		*		*

Notes:

Eight-hour carbon monoxide averages and related statistics are available at Oakland-West between 2009 and 2012. Some years in this range may not be represented.
All averages expressed in parts per million.
An exceedance of a standard is not necessarily related to a violation of the standard.
Year Coverage indicates the extent to which available monitoring data represent the time of the year when concentrations are expected to be highest. 0 means that data represent none of the high period; 100 means that data represent the entire high period. A high Year Coverage does not mean that there was sufficient data for annual statistics to be considered valid.
means there was insufficient data available to determine the value.

Available Pollutants:

8-Hour Ozone | Hourly Ozone | PM2.5 | PM10 | Carbon Monoxide | Nitrogen Dioxide | State Sulfur Dioxide | Hydrogen Sulfide

California Environmental Protection Agency
Air Resources Board

Top 4 Summary: Highest 4 Daily Maximum Hourly Ozone Measurements

at Oakland-West

	2012		2013		2014	
	Date	Measurement	Date	Measurement	Date	Measurement
First High:	Sep 30	0.061	May 2	0.071	Oct 4	0.072
Second High:	Oct 18	0.061	Oct 6	0.061	Apr 30	0.069
Third High:	Oct 2	0.059	May 1	0.055	May 14	0.067
Fourth High:	Apr 12	0.051	May 3	0.055	May 13	0.064
California:						
# Days Above the Standard:		0		0		0
California Designation Value:		0.06		0.06		0.06
Expected Peak Day Concentration:		0.056		0.057		0.060
National:						
# Days Above the Standard:		*0*		*0*		*0*
Nat'l Standard Design Value:		*0.059*		*0.061*		*0.067*
Year Coverage:		98		97		99

Notes:

Hourly ozone measurements and related statistics are available at Oakland-West between 2010 and 2014. Some years in this range may not be represented.
All concentrations expressed in parts per million.
The national 1-hour ozone standard was revoked in June 2005 and is no longer in effect. Statistics related to the revoked standard are shown in *italics* or *italics*.
An exceedance of a standard is not necessarily related to a violation of the standard.
Year Coverage indicates the extent to which available monitoring data represent the time of the year when concentrations are expected to be highest. 0 means that data represent none of the high period; 100 means that data represent the entire high period. A high Year Coverage does not mean that there was sufficient data for annual statistics to be considered valid.
means there was insufficient data available to determine the value.

Available Pollutants:

8-Hour Ozone | Hourly Ozone | PM2.5 | PM10 | Carbon Monoxide | Nitrogen Dioxide | State Sulfur Dioxide | Hydrogen Sulfide

California Environmental Protection Agency
Air Resources Board

Top 4 Summary: Highest 4 Daily 24-Hour PM2.5 Averages

at Oakland-West

	2012		2013		2014	
	Date	24-Hr Average	Date	24-Hr Average	Date	24-Hr Average
National:						
First High:	Dec 31	12.4	Dec 17	42.7	Jan 1	38.8
Second High:	Dec 28	12.3	Jan 23	37.4	Jan 17	33.8
Third High:	Dec 30	11.2	Jan 16	33.2	Jan 24	30.9
Fourth High:	Dec 29	10.1	Dec 23	32.5	Jan 19	27.2
California:						
First High:	Jan 10	29.2	Dec 17	42.7	Jan 1	38.8
Second High:	Jan 14	27.0	Jan 23	37.4	Jan 17	33.8
Third High:	Jan 9	26.5	Jan 16	33.2	Jan 24	30.9
Fourth High:	Nov 6	20.3	Dec 23	32.5	Jan 19	27.2
National:						
Estimated # Days > 24-Hour Std:		*		2.2		1.0
Measured # Days > 24-Hour Std:		0		2		1
24-Hour Standard Design Value:		*		*		*
24-Hour Standard 98th Percentile:		*		30.0		25.7
Annual Standard Design Value:		*		*		*
Annual Average:		*		12.7		9.5
California:						
Annual Std Designation Value:		*		*		10
Annual Average:		*		*		9.6
Year Coverage:		4		93		98

Notes:

Daily PM2.5 averages and related statistics are available at Oakland-West between 2009 and 2014. Some years in this range may not be represented.
All averages expressed in micrograms per cubic meter.
An exceedance of a standard is not necessarily related to a violation of the standard.
State statistics are based on California approved samplers, whereas national statistics are based on samplers using federal reference or equivalent methods. State and national statistics may therefore be based on different samplers.
Year Coverage indicates the extent to which available monitoring data represent the time of the year when concentrations are expected to be highest. 0 means that data represent none of the high period; 100 means that data represent the entire high period. A high Year Coverage does not mean that there was sufficient data for annual statistics to be considered valid.
means there was insufficient data available to determine the value.

Available Pollutants:

8-Hour Ozone | Hourly Ozone | PM2.5 | PM10 | Carbon Monoxide | Nitrogen Dioxide | State Sulfur Dioxide | Hydrogen Sulfide

California Environmental Protection Agency
Air Resources Board

Top 4 Summary: Highest 4 Daily 24-Hour PM2.5 Averages

at Oakland-West

	2011		2012		2013	
	Date	24-Hr Average	Date	24-Hr Average	Date	24-Hr Average
National:						
First High:		*	Dec 31	12.4	Dec 17	42.7
Second High:		*	Dec 28	12.3	Jan 23	37.4
Third High:		*	Dec 30	11.2	Jan 16	33.2
Fourth High:		*	Dec 29	10.1	Dec 23	32.5
California:						
First High:	Dec 25	43.1	Jan 10	29.2	Dec 17	42.7
Second High:	Dec 10	29.4	Jan 14	27.0	Jan 23	37.4
Third High:	Dec 9	27.4	Jan 9	26.5	Jan 16	33.2
Fourth High:	Dec 17	27.2	Nov 6	20.3	Dec 23	32.5
National:						
Estimated # Days > 24-Hour Std:		*		*		2.2
Measured # Days > 24-Hour Std:		*		0		2
24-Hour Standard Design Value:		*		*		*
24-Hour Standard 98th Percentile:		*		*		30.0
Annual Standard Design Value:		*		*		*
Annual Average:		*		*		12.7
California:						
Annual Std Designation Value:		*		*		*
Annual Average:		*		*		*
Year Coverage:		*		4		93

Notes:

Daily PM2.5 averages and related statistics are available at Oakland-West between 2009 and 2013. Some years in this range may not be represented.
All averages expressed in micrograms per cubic meter.
An exceedance of a standard is not necessarily related to a violation of the standard.
State statistics are based on California approved samplers, whereas national statistics are based on samplers using federal reference or equivalent methods. State and national statistics may therefore be based on different samplers.
Year Coverage indicates the extent to which available monitoring data represent the time of the year when concentrations are expected to be highest. 0 means that data represent none of the high period; 100 means that data represent the entire high period. A high Year Coverage does not mean that there was sufficient data for annual statistics to be considered valid.
* means there was insufficient data available to determine the value.

Available Pollutants:

8-Hour Ozone | Hourly Ozone | PM2.5 | PM10 | Carbon Monoxide | Nitrogen Dioxide | State Sulfur Dioxide | Hydrogen Sulfide

California Environmental Protection Agency
Air Resources Board

Top 4 Summary: Highest 4 Daily 24-Hour PM10 Averages

at San Pablo-Rumrill Blvd

	2012		2013		2014	
	Date	24-Hr Average	Date	24-Hr Average	Date	24-Hr Average
National:						
First High:	May 9	45.1	Dec 30	45.6	Jan 17	44.3
Second High:	Jun 14	44.0	Nov 6	42.4	Jan 23	34.9
Third High:	Oct 18	39.0	May 4	36.0	Oct 14	29.7
Fourth High:	Jan 10	36.4	Dec 24	33.5	Apr 17	29.3
California:						
First High:	May 9	46.7	Dec 30	48.1	Jan 17	46.3
Second High:	Jun 14	45.3	Nov 6	43.8	Jan 23	36.4
Third High:	Oct 18	39.4	May 4	37.1	Oct 14	30.5
Fourth High:	Jan 10	38.4	Dec 24	35.2	Apr 17	30.3
National:						
Estimated # Days > 24-Hour Std:		0.0		0.0		0.0
Measured # Days > 24-Hour Std:		0		0		0
3-Yr Avg Est # Days > 24-Hr Std:		*		0.0		0.0
Annual Average:		*15.2*		*17.8*		*16.0*
3-Year Average:		*17*		*17*		*16*
California:						
Estimated # Days > 24-Hour Std:		0.0		*		*
Measured # Days > 24-Hour Std:		0		0		0
Annual Average:		15.7		*		*
3-Year Maximum Annual Average:		20		20		16
Year Coverage:		100		96		94

Notes:

Daily PM10 averages and related statistics are available at San Pablo-Rumrill Blvd between 2002 and 2014. Some years in this range may not be represented.
All averages expressed in micrograms per cubic meter.
The national annual average PM10 standard was revoked in December 2006 and is no longer in effect. Statistics related to the revoked standard are shown in *italics* or *italics*.
An exceedance of a standard is not necessarily related to a violation of the standard.
All values listed above represent midnight-to-midnight 24-hour averages and may be related to an exceptional event.
State and national statistics may differ for the following reasons:
State statistics are based on California approved samplers, whereas national statistics are based on samplers using federal reference or equivalent methods. State and national statistics may therefore be based on different samplers.

State statistics for 1998 and later are based on local conditions (except for sites in the South Coast Air Basin, where State statistics for 2002 and later are based on local conditions). National statistics are based on standard conditions.

State criteria for ensuring that data are sufficiently complete for calculating valid annual averages are more stringent than the national criteria.

Measurements are usually collected every six days. Measured days counts the days that a measurement was greater than the level of the standard; Estimated days mathematically estimates how many days concentrations would have been greater than the level of the standard had each day been monitored.

3-Year statistics represent the listed year and the 2 years before the listed year.

Year Coverage indicates the extent to which available monitoring data represent the time of the year when concentrations are expected to be highest. 0 means that data represent none of the high period; 100 means that data represent the entire high period. A high Year Coverage does not mean that there was sufficient data for annual statistics to be considered valid.

-- means there was insufficient data available to determine the value.

Available Pollutants:

8-Hour Ozone | Hourly Ozone | PM2.5 | PM10 | Carbon Monoxide | Nitrogen Dioxide | State Sulfur Dioxide | Hydrogen Sulfide

Monitor Values Report

Geographic Area: Contra Costa County, CA
Pollutant: PM10
Year: 2012
Exceptional Events: Included (if any)

Duration Description=24 HOUR

Duration Description	Obs	First Max	Second Max	Actual Exc	Est Exc	Exc Events	Monitor Number	Site ID	Address	City	County	State	EPA Region
24 HOUR	61	33	33	0	0.00	None	1	060130002	2956-A Treat Boulevard	Concord	Contra Costa	CA	09
24 HOUR	61	51	29	0	0.00	None	1	060131002	5551 Bethel Island Rd	Bethel Island	Contra Costa	CA	09
24 HOUR	61	45	44	0	0.00	None	1	060131004	1865 D Rumrill Blvd, San Pablo	San Pablo	Contra Costa	CA	09

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This report is based on monitor-level summary statistics. Air quality standards for some pollutants (PM2.5 and Pb) allow for combining data from multiple monitors into a site-level summary statistic that can be compared to the standard. In those cases, the site-level statistics may differ from the monitor-level statistics upon which this report is based.

Source: U.S. EPA AirData <http://www.epa.gov/airdata>
Generated: August 25, 2014

Monitor Values Report

Geographic Area: Contra Costa County, CA
Pollutant: PM10
Year: 2011
Exceptional Events: Included (if any)

Duration Description=24 HOUR

Duration Description	Obs	First Max	Second Max	Actual Exc	Est Exc	Exc Events	Monitor Number	Site ID	Address	City	County	State	EPA Region
24 HOUR	61	55	40	0	0.00	None	1	060130002	2956-A Treat Boulevard	Concord	Contra Costa	CA	09
24 HOUR	60	46	44	0	0.00	None	1	060131002	5551 Bethel Island Rd	Bethel Island	Contra Costa	CA	09
24 HOUR	61	69	37	0	0.00	None	1	060131004	1865 D Rumrill Blvd, San Pablo	San Pablo	Contra Costa	CA	09

Get detailed information about this report, including column descriptions, at http://www.epa.gov/airquality/airdata/ad_about_reports.html#mon

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Source: U.S. EPA AirData <http://www.epa.gov/airdata>
Generated: August 25, 2014

Monitor Values Report

Geographic Area: Contra Costa County, CA
Pollutant: PM10
Year: 2013
Exceptional Events: Included (if any)

Duration Description=24 HOUR

Duration Description	Obs	First Max	Second Max	Actual Exc	Est Exc	Exc Events	Monitor Number	Site ID	Address	City	County	State	EPA Region
24 HOUR	31	47	32	0	0.00	None	1	060130002	2956-A Treat Boulevard	Concord	Contra Costa	CA	09
24 HOUR	23	47	45	0	0.00	None	1	060131002	5551 Bethel Island Rd	Bethel Island	Contra Costa	CA	09
24 HOUR	59	45	42	0	0.00	None	1	060131004	1865 D Rumrill Blvd, San Pablo	San Pablo	Contra Costa	CA	09

Get detailed information about this report, including column descriptions, at http://www.epa.gov/airquality/airdata/ad_about_reports.html#mon

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Source: U.S. EPA AirData <http://www.epa.gov/airdata>
Generated: August 25, 2014

California Environmental Protection Agency
Air Resources Board

Top 4 Summary: Highest 4 Daily Maximum State 24-Hour Sulfur Dioxide Averages

at Oakland-West

	2012		2013		2014	
	Date	24-Hr Average	Date	24-Hr Average	Date	24-Hr Average
First High:	Jan 4	0.008	Jan 16	0.007		*
Second High:	Jan 11	0.005	Feb 27	0.003		*
Third High:	Jul 25	0.004	Jan 21	0.003		*
Fourth High:	Mar 7	0.004	Jan 30	0.002		*
Annual Average:		*		*		*
Year Coverage:		66		*		*

Notes:

Hourly sulfur dioxide measurements and related statistics are available at Oakland-West between 2009 and 2012. Some years in this range may not be represented.
All averages expressed in parts per million.
An exceedance of a standard is not necessarily related to a violation of the standard.
Year Coverage indicates the extent to which available monitoring data represent the time of the year when concentrations are expected to be highest. 0 means that data represent none of the high period; 100 means that data represent the entire high period. A high Year Coverage does not mean that there was sufficient data for annual statistics to be considered valid.
* means there was insufficient data available to determine the value.

Available Pollutants:

8-Hour Ozone | Hourly Ozone | PM2.5 | PM10 | Carbon Monoxide | Nitrogen Dioxide | State Sulfur Dioxide | Hydrogen Sulfide

Monitor Values Report

Geographic Area: Alameda County, CA
Pollutant: CO
Year: 2014
Exceptional Events: Included (if any)

Duration Description=1 HOUR

Duration Description	Obs	First Max	Second Max	Actual Exc	Exc Events	Monitor Number	Site ID	Address	City	County	State	EPA Region
1 HOUR	8242	2.8	2.6	0	None	1	060010009	9925 International Blvd	Oakland	Alameda	CA	09
1 HOUR	8306	3	3	0	None	1	060010011	1100 21st Street	Oakland	Alameda	CA	09
1 HOUR	7577	2	1.6	0	None	1	060010012	Laney College Eighth St. Parking Lot Aisle J	Oakland	Alameda	CA	09

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Source: U.S. EPA AirData <http://www.epa.gov/airdata>
Generated: May 20, 2015

Monitor Values Report

Geographic Area: Alameda County, CA
Pollutant: CO
Year: 2014
Exceptional Events: Included (if any)

Duration Description=8-HR RUN AVG END HOUR

Duration Description	Obs	First Max	Second Max	Actual Exc	Exc Events	Monitor Number	Site ID	Address	City	County	State	EPA Region
8-HR RUN AVG END HOUR	8624	1.7	1.6	0	None	1	060010009	9925 International Blvd	Oakland	Alameda	CA	09
8-HR RUN AVG END HOUR	8635	2.6	2.5	0	None	1	060010011	1100 21st Street	Oakland	Alameda	CA	09
8-HR RUN AVG END HOUR	7882	1.1	1.1	0	None	1	060010012	Laney College Eighth St. Parking Lot Aisle J	Oakland	Alameda	CA	09

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Source: U.S. EPA AirData <http://www.epa.gov/airdata>
Generated: May 20, 2015

Greenhouse Gas Emission Factors: Guidance for PG&E Customers

April 2013

In recent years, an increasing number of PG&E customers have started to track the greenhouse gas (GHG) emissions from their business operations, generated within their city, or saved through energy efficiency. This document is intended to help PG&E customers understand the different emission factors they can use to estimate GHG emissions for their own climate action planning or voluntary GHG emissions tracking or reporting. PG&E's latest GHG emission factor for delivered electricity is available online.

Please note: The information in this document is not to be used for mandatory GHG reporting, financial analysis, or regulatory compliance, and does not necessarily reflect the approaches taken by PG&E for its own regulatory compliance purposes.

What is a GHG emission factor?

A GHG emission factor[1] is a measure of the pounds of carbon dioxide (CO_2) emitted per megawatt-hour of electricity or per therm of natural gas.

- **Electricity** generated from fossil fuels such as natural gas or coal emit CO_2, while other sources of electricity such as hydropower, wind, solar, and nuclear power are considered to be carbon-free. The electricity that PG&E delivers to customers comes from a mix of these generation sources. PG&E's emission factor for delivered electricity incorporates the annual energy and associated emissions from each generation source for the given year. Variance in PG&E's mix of electricity sources largely account for changes in PG&E's GHG emission factor from year to year.
- The **natural gas** emission factor represents the amount of GHGs emitted per therm of natural gas combusted. This emission factor does not vary because the composition of PG&E's natural gas does not change significantly over time.

Electricity Emission Factors

If you are estimating the GHG emissions generated by a business, city, county, or related entity over the course of a year, and if 100% of your electricity was purchased from PG&E, you can use the average emission factor for all the PG&E electricity delivered during that specific year.

Historic emissions: Historic average emissions factors take into account all of the sources of electricity that PG&E delivered to customers during a specific year in the past. As a founding member of the California Climate Action Registry (CCAR), PG&E

[1] An emission factor is also known as an emission rate or emission coefficient.

has emission factors that have been third-party verified starting in the year 2003. For factors prior to 2003, please see FAQ #2.

Current/Future emissions: Because of the multiple sources of power used in the course of a year and the rigorous process PG&E follows to have its emissions independently verified by a third party, the emission factor for delivered electricity lags by a year. To estimate GHG emissions in a recent or future year for which an emission factor is not yet available, use the emissions factor forecast for PG&E's electricity in the CPUC GHG Calculator. The calculator is a publicly-available document that provides emission factor forecasts from 2012–2020 which are listed in the table below.

Avoided emissions: When you implement an energy efficiency project or install a renewable generation project (e.g., a solar photovoltaic system), you are reducing your use of electricity from the utility, and therefore are avoiding the associated GHG emissions. Determining the emissions avoided from these projects can be complicated, depending on the season and time of day the electricity was saved.

For simplicity, you can use the relevant annual emission factor to estimate the GHGs avoided from these projects. See FAQ #5 for more information.

PG&E Emissions Factor Summary

Emission Type	Emission Factor			Source
	Year	*Lbs CO_2 /MWh*	*Metric tons CO_2/MWh*	
Historical Emissions	2003	620	0.281	PG&E's third-party-verified GHG inventory submitted to the California Climate Action Registry (CCAR)[2] (2003-2008) or The Climate Registry (TCR) (2009-2011)
	2004	566	0.257	
	2005	489	0.222	
	2006	456	0.207	
	2007	636	0.288	
	2008	641	0.291	
	2009	575	0.261	
	2010	445	0.202	
	2011	393	0.178	
Future Emissions (estimated)	2012[3]	453	0.205	CPUC GHG Calculator, which provides an independent forecast of PG&E's emission factors as part of a model on how the electricity sector
	2013	431	0.196	
	2014	412	0.187	
	2015	391	0.177	
	2016	370	0.168	

[2] The 2003-2008 factors are in the Power/Utility Protocol (PUP) spreadsheet of PG&E's CCAR reports. The 2009-2011factors are in the Additional Optional Information tab of the Electric Power Sector (EPS) Report spreadsheet of PG&E's TCR report.

[3] PG&E's actual 2012 emission factor will be available in January 2014.

	2017	349	0.158	would reduce emissions under AB 32[4]
	2018	328	0.149	
	2019	307	0.139	
	2020	290	0.131	

Natural Gas Emission Factors

Historic, Current, and/or Future: The combustion of natural gas (in your stove, a furnace, or a natural gas power plant) releases CO_2. The emission factor for natural gas represents the amount of GHGs emitted per therm of natural gas combusted. Since the composition of PG&E natural gas does not change significantly over time, this factor does not change from year to year.

Emission Type		Emission Factor		Source
	Year	*Lbs CO_2/therm*	*Metric ton CO_2/therm*	
Historic, Current, or Future	All years	11.7	0.00531	U.S. Energy Information Administration[5]

UPDATES: The emissions factors will be updated annually, so please check with your PG&E account manager or the PG&E website at www.pge.com/environment for the most recent version.

Frequently Asked Questions:

1. Why do the emission factors for PG&E electricity vary from year to year? 4
2. Does PG&E have emission factors from years prior to 2003? 4
3. What emission factor should I use to calculate the emissions from electricity use in 1990? 4
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5. What emission factor should I use if I want to estimate the emissions avoided through participation in PG&E's demand response programs? 5
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9. Does PG&E have emission factors for smaller geographic areas like cities or counties within its service territory? 6
10. What measures can I use to compare a reduction of one metric tonne of CO_2? 6
11. Why are PG&E's emission factors in CO_2 and not CO_2e (i.e. CO_2 equivalent)? 7

[4] E3, GHG Calculator version 3c, worksheet tab "CO_2 Allocations," cells AH35 - AH44.
[5] U.S. Energy Information Administration, Voluntary Reporting of Greenhouse Gases Program.

12. Why don't PG&E's emission factors include the emissions associated with the delivery of electricity or natural gas? 7
13. Who can I contact at PG&E to ask questions about emission factors? 7

1. Q: Why do the emission factors for PG&E electricity vary from year to year?
   A: PG&E's electricity emission factors vary primarily because the amount of available hydroelectricity varies from year to year. During drought years, less hydroelectricity is available and other power sources (usually natural gas generation) are used instead.

   Emission factors also change, but less significantly, based on variables such as change in demand due to weather (hot summers mean more air conditioning demand). Increased demand on a short-term basis is generally met by fossil fuel generation, which raises the average emission factor. PG&E works to mitigate demand by following California's "loading order," which involves reducing electricity demand by increasing energy efficiency and demand response, and meeting new long-term generation needs first with renewable and distributed generation resources, and second with clean fossil-fueled generation. The loading order was adopted in the 2003 Energy Action Plan prepared by the California energy agencies[6].

   Over time, PG&E's emission factor is also decreasing as we make steady progress toward California's target of 33% renewables by the end of 2020.

2. Q: Does PG&E have emission factors from years prior to 2003?
   A: PG&E was among the earliest companies to voluntarily quantify and report its GHG emissions using rigorous, publicly-vetted GHG reporting standards. As a charter member of the California Climate Action Registry which later grew into The Climate Registry, PG&E has voluntarily registered and publicly reported its third-party verified GHG inventory every year since 2003. Prior to 2003, there were no commonly-accepted guidelines to report the GHG emission factors from a utility. If you would like to calculate emissions prior to 2003, you can use the 1990 emission factor in FAQ #3 below.

3. Q: What emission factor should I use to calculate the emissions from electricity use in 1990?
   A: You can use the factor from a study published by Lawrence Berkeley National Laboratory, which cites an emission factor of 0.070 kg C/kWh for PG&E in 1990.[7] This figure translates to approximately 572 lbs CO_2/MWh or 0.259 metric tons CO_2/MWh.[8]

[6] Implementing California's Loading Order for Electricity Resources.
[7] LBNL-49945, Marnay *et al*, Estimating the CO_2 emissions factors for the California Electric Power Sector, August 2002.
[8] Assuming 1 kg CO_2 = 0.27 kg C and 2.2046 lbs/kg.

4. Q:Why do you use an average emission factor to estimate avoided emissions and not a marginal[9] or project-specific emission factor?
   A: For the purposes of climate action planning or voluntary tracking and reporting, using an average emission factor simplifies the emissions calculation process. While some large entities may be required to estimate the amount of GHGs avoided by using emission factors specific to the hours of the day, the days of the year, or the seasons in which the energy use was avoided, the use of an average emission factor is appropriate for most customers.

5. Q: What emission factor should I use if I want to estimate the emissions avoided through participation in PG&E's demand response programs[10]?
   A: For the purposes of climate action planning or voluntary tracking or reporting, an average emission factor is appropriate. If you are participating in a third-party Demand Response program, you may reach out to your program manager for further guidance. Using the average factor is a simplification and may not reflect the approach taken by large entities for regulatory compliance purposes.

6. Q: If I am a direct access electricity customer, what emission factor should I use?
   A: If you are a direct access customer, you should contact your direct access electricity provider for the appropriate emission factor. If the emission factor is unavailable, The Climate Registry's Local Government Operations Protocol and the World Resources Institute's GHG Protocol recommend using the EPA Emissions & Generation Resource Integrated Database (eGRID) annual output emission factors for the WECC California (CAMX) sub-region.

7. Q: Can PG&E customers use the U.S. EPA carbon calculator to calculate the emissions from PG&E electricity?
   A: PG&E does not recommend that customers use this calculator. The EPA calculator uses an average emission factor for electricity generated nationwide. PG&E's emission factor is independently verified and based on the PG&E-specific mix of electricity delivered to PG&E customers. Because of PG&E's higher use of lower- and zero-emission generation sources, PG&E's emission factor is more than 60 percent cleaner than the national average.[11] Using the EPA carbon calculator would dramatically overstate PG&E customers' emissions and any emissions savings associated with energy efficiency projects.

---

[9] A marginal emission factor represents the emissions from electricity generated "at the margin", i.e., electricity generated in response to an additional unit of electricity demand. In California, this factor is typically that of a natural gas power plant, because this type of plant is most frequently deployed when electricity demand increases in the state. The California Air Resources Board (ARB) uses a marginal emission factor for California of 944 lbs CO_2e/MWh. *See*: ARB, Mandatory Reporting Requirement Final Regulation, Section 95111(b)(1).

[10] PG&E's demand response programs offer incentives to customers that volunteer and participate by temporarily reducing their electricity use when demand could outpace supply.

[11] PG&E website: http://www.pge.com/myhome/environment/pge/cleanenergy/index.shtml.

8. Q: What is the difference between the emission factors used in the U.S. EPA's Portfolio Manager benchmarking tool and PG&E's emission factors?
   A: The EPA tool uses emission factors from the EPA Emissions & Generation Resource Integrated Database (eGRID), which are derived from utility data for each of the 26 sub-regions of the U.S. power grid. Users are not able to enter a PG&E-specific emission factor into the tool. Instead, based on the zip code of each building entered, Portfolio Manager identifies the appropriate sub-region and emission factor, and provides a graphic comparison of the sub-region's emission factor and electric generation fuel mix to the national factor. PG&E customers are in the WECC[12] California (CAMX) sub-region. Because eGRID's WECC California emission factor has consistently been higher than PG&E's historic emission factors, customers should understand that this tool overestimates emissions from buildings that use PG&E electricity.

   The tool also gives users the choice of selecting a specific power generation facility, which is not generally appropriate for the purposes of climate action planning or voluntary tracking and reporting, since the electricity delivered by PG&E to customers comes from a variety of sources.

9. Q: Does PG&E have emission factors for smaller geographic areas like cities or counties within its service territory?
   A: No, PG&E's emission factor is based on the electricity delivered to all of its customers. Because electricity enters PG&E's electrical transmission and distribution system from multiple sources and gets distributed throughout the system to customers, it is not possible to calculate emission factors for specific geographic areas.

10. Q: What measures can I use to compare a reduction of one metric tonne of CO_2?
    A: Reducing one metric ton (2204.6 lbs) of CO_2 is approximately equivalent to:
    - Taking 0.21 of an average passenger car in California off the road for a year in 2011;[13]
    - Avoiding the use of 112 gallons of gasoline;[14] or
    - Eliminating the GHGs associated with about 3.3 homes in PG&E's service territory for a month.[15]

[12] The Western Energy Coordinating Council (WECC) is a regional organization that promotes reliable electric service by establishing operating criteria and facilitating electric system support between utilities.
[13] California Air Resources Board's EMFAC 2011 model indicates an average passenger car in California in 2011 emitted 4.76 metric tons (5.24 short tons) of CO_2 per car per year.
[14] U.S. EPA website: http://www.epa.gov/cleanenergy/energy-resources/refs.html#gasoline.
[15] In PG&E's service territory in 2011, the average residential customer consumed 0.584 MWh and 38 therms per month. 0.584 MWh/home times 0.178 metric tonnes (MT) CO2/MWh in 2011 is approximately 0.104 MT of CO2 per home each month for electricty. 38 therms/home times 0.00531 MT of CO2 per therm is approximately 0.202 MT of CO2 per month. Combined energy use per house accounts for about 0.306 MT per month. Therefore, reducing 1 MT of CO2 is equivalent to reducing the emissions for about 3.3 homes per month.

11. Q: Why are PG&E's emission factors in CO_2 (carbon dioxide) and not CO_2e (i.e. CO_2 equivalent)?[16]
    A: The electricity emission factors reported via CCAR and TCR are in pounds of CO_2 and not CO_2e because their methodology for calculating emission factors only includes CO_2 and not methane (CH_4) or nitrous oxide (N_2O) from electricity generation. CCAR and TCR do not include CH_4 or N_2O because these emissions are considered to be *de minimis*.

    However, PG&E customers can still estimate the CH_4 and N_2O emissions associated with their electricity use by using the California-specific emission factors provided by The Climate Registry's Local Government Operations Protocol[17]. For natural gas, customers can use the relevant default emission factors for natural gas provided by the same protocol[18].

12. Q: Why don't PG&E's emission factors include the emissions associated with the delivery of electricity or natural gas?
    A: The emissions associated with the delivery of electricity or natural gas are not included in PG&E's emission factors for delivered electricity or natural gas because those emissions are reported separately by PG&E in its own GHG inventory. Standard voluntary reporting practice is to report such emissions, like the emissions associated with transmission and distribution line losses, natural gas compressor stations, and vehicles used to service electricity and natural gas delivery systems, separately from the emissions attributed to the generation or use of the energy itself.

13. Q: Who can I contact at PG&E to ask questions about emission factors?
    A: Email ghgdatarequests@pge.com and a PG&E employee will get back to you shortly.

[16] CO_2e or CO_2 equivalent is a measure used to compare the emissions from various GHGs based upon their global warming potential (GWP). The CO_2e for a gas is derived by multiplying the amount of the gas by the GWP of the gas.
[17] Version 1.1, May 2010. Page 209, Table G.7: California Grid Average Electricity Emission Factors (1990-2007).
[18] Page 205, Table G.3: Default Methane and Nitrous Oxide Emission Factors by Fuel Type and Sector.

Monitor Values Report

Geographic Area: Alameda County, CA
Pollutant: SO2
Year: 2014
Exceptional Events: Included (if any)

Duration Description=1 HOUR

Duration Description	Obs	First Max	Second Max	99th Percentile	Actual Exc	Exc Events	Monitor Number	Site ID	Address	City	County	State	EPA Region
1 HOUR	7943	17	13	10	0	None	1	060010011	1100 21st Street	Oakland	Alameda	CA	09

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Source: U.S. EPA AirData <http://www.epa.gov/airdata>
Generated: May 20, 2015

Monitor Values Report

Geographic Area: Alameda County, CA
Pollutant: SO2
Year: 2014
Exceptional Events: Included (if any)

Duration Description=24-HR BLK AVG

Duration Description	Obs	First Max	Second Max	99th Percentile	Actual Exc	Exc Events	Monitor Number	Site ID	Address	City	County	State	EPA Region
24-HR BLK AVG	360	3	3	3	0	None	1	060010011	1100 21st Street	Oakland	Alameda	CA	09

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Source: U.S. EPA AirData <http://www.epa.gov/airdata>
Generated: May 20, 2015

Air Toxics Hot Spots Program Risk Assessment Guidelines

The Air Toxics Hot Spots Program Guidance Manual for Preparation of Health Risk Assessments

August 2003

Secretary for Environmental Protection
California Environmental Protection Agency
Winston H. Hickox

Director
Office of Environmental Health Hazard Assessment
Joan E. Denton, Ph.D.



The Air Toxics Hot Spots Program Guidance Manual for Preparation of Health Risk Assessments

August 2003

Office of Environmental Health Hazard Assessment
California Environmental Protection Agency
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The Air Toxics Hot Spots Program Guidance Manual for Preparation of Health Risk Assessments. August 2003.

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The Air Toxics Hot Spots Program Guidance Manual for Preparation of Health Risk Assessments. August 2003.

The Air Toxics Hot Spots Program

Guidance Manual for Preparation of Health Risk Assessments

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Executive Summary

The Air Toxics Hot Spots Program Guidance Manual for Preparation of Health Risk Assessments (OEHHA, 2003) (Guidance Manual) is a concise description of the algorithms, recommended exposure variates, and cancer and noncancer health values needed to perform a health risk assessment (HRA) under the Air Toxics Hot Spots Information and Assessment Act of 1987 (Hot Spots or AB 2588) (AB 2588, Connelly, Statutes of 1987; Health and Safety Code Section 44300 et seq.) (see Appendix B). The information presented in the Guidance Manual is a compilation of information presented in the four technical support documents (TSDs) released by the Office of Environmental Health Hazard Assessment (OEHHA) for the Hot Spots Program. The four TSDs underwent public comment and peer review and were adopted for use in the Air Toxics Hot Spots program by the Director of OEHHA. These four TSDs present detailed information on cancer and noncancer health effects values and exposure pathway information. Excerpts of these four documents are presented in this document. All four TSDs are available on OEHHA's web site at *www.oehha.ca.gov*. There is relatively little new information in the Guidance Manual since the previously adopted TSDs form the basis of the Guidance Manual.

The Guidance Manual supercedes the risk assessment methods presented in *The California Air Pollution Control Officer's Association (CAPCOA) Air Toxics Hot Spots Program; Revised 1992; Risk Assessment Guidelines, October 1993* (CAPCOA, 1993). The Guidance Manual scientifically updates health effects values, exposure pathway variates (e.g., breathing rates), and presents a tiered approach for performing HRAs. The tiered approach provides a risk assessor with flexibility and allows consideration of site-specific differences. Furthermore, risk assessors can tailor the level of effort and refinement of an HRA by using the point-estimate exposure assumptions or the stochastic treatment of data distributions. The four-tiered approach to risk assessment primarily applies to residential cancer risk assessment. OEHHA is not recommending a stochastic approach (Tier-3 and Tier-4) for worker receptors or for noncancer chronic evaluations. Only Tier-1 applies to acute exposure evaluations. Compared to the CAPCOA 1993 document, the exposure pathways in the Guidance Manual remain the same, the exposure algorithms are similar, and risk algorithms have been revised to accept the data needed for the tiered risk assessment approach.

The Guidance Manual also contains example calculations and an outline for a modeling protocol and a HRA report. A software program, the Hot Spots Analysis and Reporting Program (HARP), has been developed by a contractor in consultation with OEHHA, the Air Resources Board (ARB), and the Air Pollution Control or Air Quality Management District (District) representatives. The HARP software is the recommended model for calculating and presenting HRA results for the Hot Spots Program. Information on obtaining the HARP software can be found on the ARB's web site at *www.arb.ca.gov* under the Hot Spots Program.

The intent in developing this Guidance Manual and the HARP software is to provide consistent risk assessment procedures. The use of consistent risk assessment methods and report presentation has many benefits, such as, expediting the preparation and review of HRAs, minimizing revision and resubmission of HRAs, allowing a format for facility comparisons, and cost-effective implementation of

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HRAs and the Hot Spots Program. Risk assessments prepared with this Guidance Manual may be used for permitting new or modified stationary sources, or public notification, and risk reduction requirements of the Hot Spots Program.

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1. Introduction

1.1 Development of Guidelines

The Hot Spots Act is designed to provide information to state and local agencies and to the general public on the extent of airborne emissions from stationary sources and the potential public health impacts of those emissions. The Hot Spots Act requires that OEHHA develop risk assessment guidelines for the Hot Spots program (Health and Safety Code (HSC) Section 44360(b)(2)) (see Appendix B for the text of the HSC). In addition, the Hot Spots Act specifically requires OEHHA to develop a "likelihood of risks" approach to health risk assessment. In response, OEHHA developed a tiered approach to risk assessment where a point-estimate approach is first employed. If a more detailed analysis is needed, OEHHA has developed a stochastic, or probabilistic, approach using exposure factor distributions that can be applied in a stochastic estimate of the exposure. A detailed presentation of the tiered approach, risk assessment algorithms, selected exposure variates (e.g., breathing rate), and distributions with a literature review is presented in the *Air Toxics Hot Spots Risk Assessment Guidelines*; *Part IV; Exposure Assessment and Stochastic Analysis Technical Support Document (OEHHA, 2000b)* (Part IV TSD). A summary of this information can be found in Chapter 5 of this document.

Cancer and noncancer (acute and chronic) dose-response relationships (health effects values) for many Hot Spots substances are presented in the first three Technical Support Documents. *The Air Toxics Hot Spots Program Risk Assessment Guidelines; Part I; The Determination of Acute Reference Exposure Levels for Airborne Toxicants (OEHHA, 1999a)* presents acute Reference Exposure Levels (RELs) for 51 toxicants and toxicant compound classes. *The Air Toxics Hot Spots Program Risk Assessment Guidelines; Part II; Technical Support Document for Describing Available Cancer Potency Factors (OEHHA, 1999b and 2002)* contains inhalation cancer potency factors and oral cancer potency factors for 122 toxicants and toxicant compound classes developed by OEHHA or developed by other authoritative bodies and endorsed by OEHHA. *The Air Toxics Hot Spots Program Risk Assessment Guidelines; Part III; Technical Support Document for the Determination of Noncancer Chronic Reference Exposure Levels (OEHHA, 2000a)* documents the development of chronic noncancer inhalation RELs for 72 toxicants and toxicant classes. The OEHHA website (*www.oehha.ca.gov*) should be consulted for chronic RELs adopted subsequent to (OEHHA, 2000a). In addition, for a small subset of these substances that are subject to airborne deposition and hence human oral and dermal exposure, oral chronic RELs are presented. A summary of cancer and noncancer health effects values can be found in Appendix L and Chapters 6 and 7 of the Guidance Manual. All four Technical Support Documents have undergone public and peer review and have been endorsed by the state's Scientific Review Panel on Toxic Air Contaminants and adopted by OEHHA. The Guidance Manual has also undergone the same public and peer review process.

The Guidance Manual contains a concise description of the algorithms, recommended exposure variates, and cancer and noncancer health values needed to perform a Hot Spots risk assessment under the Hot Spots Act (see Appendix B). The information for the Guidance Manual is taken from the other four TSDs. The Guidance Manual is the successor document to *The CAPCOA Air Toxics "Hot*

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Spots" Program; Revised 1992; Risk Assessment Guidelines, October 1993 prepared by CAPCOA (CAPCOA, 1993). The Guidance Manual scientifically updates risk assessment variates and presents a tiered approach including a stochastic as well as a point-estimate approach to exposure and risk assessment. The exposure pathways remain the same and the algorithms are similar to the 1993 CAPCOA document.

The Guidance Manual is intended to address health risks from airborne contaminants released by stationary sources. Some of the methodology used is common to other regulatory risk assessment applications, particularly for California programs. However, if the reader needs to prepare an HRA under another program, the HRA may need additional analyses. Therefore, appropriate California and federal agencies should be contacted. For example, if a facility must comply with HRA requirements under the Resource Conservation and Recovery Act (RCRA) or the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), the California Department of Toxic Substances Control (DTSC) must be contacted to determine if an HRA written to comply with AB 2588 will also satisfy RCRA/CERCLA requirements.

1.2 Use of the Guidance Manual

The intent in developing this Guidance Manual is to provide HRA procedures for use in the Air Toxics Hot Spots Program or for the permitting of new or modified stationary sources. See the ARB's website at *www.arb.ca.gov* for more information on the Hot Spots Program and for risk management guidelines that provide recommendations for permitting new or modified stationary sources. The use of consistent risk assessment procedures and report presentation allows comparison of one facility to another, expedites the review of HRAs by reviewing agencies, and minimizes revision and resubmission of HRAs. However, OEHHA recognizes that no one risk assessment procedure or set of exposure variates could perfectly address the many types of stationary facilities in diverse locations in California. Therefore a tiered risk assessment approach was developed to provide flexibility and allow consideration of site-specific differences.

These guidelines should be used in conjunction with the emission data collected and reported pursuant to requirements of the ARB's *Emission Inventory Criteria and Guidelines Regulations (Title 17, California Code of Regulations, Sections 93300-93300.5*), and the *Emission Inventory Criteria and Guidelines Report for the Air Toxics "Hot Spots" Program* (EICG Report), which is incorporated by reference therein (ARB, 1997*)*. This regulation outlines requirements for the collection of emission data, based on an inventory plan, which must be approved by the Air Pollution Control or Air Quality Management District (District). The emissions reported under this program are routine or predictable and include continuous and intermittent releases and predictable process upsets or leaks. Emissions for unpredictable releases (e.g., accidental catastrophic releases) are not reported under this program.

For landfill sites, these guidelines should be applied to the results of the landfill testing required under Health and Safety Code Section 41805.5 as well as to any emissions reported under the emission

inventory requirements of the Air Toxics Hot Spots Act (e.g., from flares or other on-site equipment). Districts should be consulted to determine the specific landfill testing data to be used.

1.3 Who is Required to Conduct a Risk Assessment

The Hot Spots Act requires that each local District determine which facilities will prepare an HRA. As defined under the Hot Spots Act, an HRA includes a comprehensive analysis of the dispersion of hazardous substances in the environment, their potential for human exposure, and a quantitative assessment of both individual and populationwide health risks associated with those levels of exposure.

Districts are to determine which facilities will prepare an HRA based on a prioritization process outlined in the law. The process by which Districts identify priority facilities for risk assessment involves consideration of potency, toxicity, quantity of emissions, and proximity to sensitive receptors such as hospitals, daycare centers, schools, work-sites, and residences. The District may also consider other factors that may contribute to an increased potential for significant risk to human receptors. As part of this process Districts are to categorize facilities as high, intermediate, or low priority. The District prioritization process is described in the *CAPCOA Air Toxics Hot Spots Program Facility Prioritization Guidelines, July 1990 (CAPCOA, 1990)*. Consult the District for updates to the Prioritization Guidelines. See the Hot Spots Program on ARB's web site at *www.arb.ca.gov* for more information on facility prioritization procedures.

Facilities designated by a District as "high priority" are required to submit an HRA to the District within 150 days. Districts may grant a 30-day extension. However, a District may require any facility to prepare and submit an HRA according to the District priorities established for purposes of the Hot Spots Act.

1.4 The Hot Spots Analysis and Reporting Program (HARP) Software

The ARB and the Districts have identified a critical need for software to assist with the programmatic aspects of the Hot Spots Program. HARP is a single integrated software package used by the ARB, OEHHA, Districts, and facility operators to promote statewide consistency, efficiency, and cost-effective implementation of HRAs and the Hot Spots Program. The HARP software package consists of three modules that include: 1) the Emissions Inventory Database Module, 2) the Air Dispersion Modeling Module, and 3) the Risk Analysis and Mapping Module. The user-friendly Windows-based package provides for:

1. Electronic implementation of the risk assessment methods presented in the OEHHA guidelines (Guidance Manual);
2. Electronic data transfer from facilities and Districts;
3. The production of reports;
4. Facility prioritization and identification;
5. Air dispersion modeling (ISCST3) of multiple emission releases or facilities for cumulative impact evaluations;

6. A summary report of acute and chronic health hazard quotients or indices, and cancer risk at the point of maximum impact (PMI), maximally exposed individual resident (MEIR), and the maximally exposed individual worker (MEIW). (Other receptors may be evaluated as needed.);
7. Mapping displays of facility property boundaries, risk isopleths, street maps, and elevation contours;
8. The ability to display combined risk contours from multiple facilities;
9. Output of data for use in other "off-the-shelf" Geographic Information Systems (GIS) programs for additional types of analysis; and
10. Census data for determining the number of people exposed at various cancer risk levels and cancer burden.

1.5 Risk Assessment Review Process

The Hot Spots Act risk assessments are reviewed by the local District and by OEHHA. The Districts focus their review on the emissions data and the air dispersion modeling. OEHHA provides comments on the HRA's general concordance with the Guidelines Manual and the completeness of the reported health risks. The District, taking into account the comments of OEHHA, approves the HRA or returns it to the facility for revision and resubmission. If the HRA is not revised and resubmitted by the facility within 60 days, the District may modify the HRA and approve it as modified. Based on the approved HRA, the District determines if there is a significant health risk associated with emissions from the facility. If the District determines that facility emissions pose a significant health risk, the facility operator provides notice to all exposed individuals regarding the results of the HRA and may be required to take steps to reduce emissions by implementing a risk reduction audit and plan. Notification is to be made according to procedures specified by the District. Each District determines its own levels of significance for cancer and noncancer health effects for notification and risk reduction. See the Hot Spots Program on ARB's web site at *www.arb.ca.gov* for more information on significance levels selected by each District.

1.6 Uncertainty in Risk Assessment

OEHHA has striven to use the best science available in developing these risk assessment guidelines. However, there is a great deal of uncertainty associated with the process of risk assessment. The uncertainty arises from lack of data in many areas necessitating the use of assumptions. The assumptions used in these guidelines are designed to err on the side of health protection in order to avoid underestimation of risk to the public. Sources of uncertainty, which may either overestimate or underestimate risk, include: 1) extrapolation of toxicity data in animals to humans, 2) uncertainty in the estimation of emissions, 3) uncertainty in the air dispersion models, and 4) uncertainty in the exposure estimates. Uncertainty may be defined as what is not known and may be reduced with further scientific studies. In addition to uncertainty, there is a natural range or variability in the human population in such properties as height, weight, and susceptibility to chemical toxicants. Scientific studies with representative individuals and large enough sample size can characterize this variability.

Interactive effects of exposure to more than one carcinogen or toxicant are also not necessarily quantified in the HRA. Cancer risks from all emitted carcinogens are typically added, and hazard quotients for substances impacting the same target organ/system are added to determine the hazard index (HI). Many examples of additivity and synergism (interactive effects greater than additive) are known. For substances that act synergistically, the HRA could underestimate the risks. Some substances may have antagonistic effects (lessen the toxic effects produced by another substance). For substances that act antagonistically, the HRA could overestimate the risks.

Other sources of uncertainty, which may underestimate or overestimate risk, can be found in exposure estimates where little or no data are available (e.g., soil half-life and dermal penetration of some substances from a soil matrix).

The differences among species and within human populations usually cannot be easily quantified and incorporated into risk assessments. Factors including metabolism, target site sensitivity, diet, immunological responses, and genetics may influence the response to toxicants. The human population is much more diverse both genetically and culturally (e.g., lifestyle, diet) than inbred experimental animals. The intraspecies variability among humans is expected to be much greater than in laboratory animals. Adjustment for tumors at multiple sites induced by some carcinogens could result in a higher potency. Other uncertainties arise 1) in the assumptions underlying the dose-response model used, and 2) in extrapolating from large experimental doses, where, for example, other toxic effects may compromise the assessment of carcinogenic potential, to usually much smaller environmental doses. Also, only single tumor sites induced by a substance are usually considered. When epidemiological data are used to generate a carcinogenic potency, less uncertainty is involved in the extrapolation from workplace exposures to environmental exposures. However, children, a subpopulation whose hematological, nervous, endocrine, and immune systems, for example, are still developing and who may be more sensitive to the effects of carcinogens on their developing systems, are not included in the worker population and risk estimates based on occupational epidemiological data are more uncertain for children than adults. Finally, the quantification of each uncertainty applied in the estimate of cancer potency is itself uncertain.

Thus, risk estimates generated by an HRA should not be interpreted as the expected rates of disease in the exposed population but rather as estimates of potential risk, based on current knowledge and a number of assumptions. Additionally, the uncertainty factors integrated within the estimates of noncancer RELs are meant to err on the side of public health protection in order to avoid underestimation of risk. Risk assessment is best used as a ruler to compare one source with another and to prioritize concerns. Consistent approaches to risk assessment are necessary to fulfill this function.

2. Overview of Health Risk Assessment

2.1 The Model for Risk Assessment

The standard approach currently used for health risk assessment (HRA) was originally proposed by the National Academy of Sciences in the 1983 book: *Risk Assessment in the Federal Government: Managing the Process* (NAS, 1983) and was updated in the Academy's 1994 book: *Science and Judgment in Risk Assessment* (NAS, 1994). The four steps involved in the risk assessment process are 1) hazard identification, 2) exposure assessment, 3) dose-response assessment, and 4) risk characterization. These four steps are briefly discussed below.

2.2 Hazard Identification

For air toxics sources, hazard identification involves identifying if a hazard exists, and if so, what are the exact pollutant(s) of concern and whether a pollutant is a potential human carcinogen or is associated with other types of adverse health effects. For the Air Toxics Hot Spots Program (Hot Spots), the emitted substances that are addressed in a risk assessment are found in the list of hazardous substances designated in the ARB's *Emission Inventory Criteria and Guidelines Regulations (Title 17, California Code of Regulations, Sections 93300-93300.5), and the Emission Inventory Criteria and Guidelines Report* (EICG Report), which is incorporated by reference therein (ARB, 1997). This list of substances is contained in Appendix A of this document and the EICG Report. The list of substances also identifies those substances that are considered human carcinogens or potential human carcinogens.

2.3 Exposure Assessment

The purpose of the exposure assessment is to estimate the extent of public exposure to each substance for which potential cancer risk or acute and chronic noncancer effects will be evaluated. This involves emission quantification, modeling of environmental transport, evaluation of environmental fate, identification of exposure routes, identification of exposed populations, and estimation of short-term and long-term exposure levels. These activities are described in Chapters 4 and 5. Chapter 5 also discusses the tiered approach to risk assessment.

The ARB's EICG Report provides assistance in determining those substances that must be evaluated in an HRA and the reporting requirements of facilities, while the Hot Spots Analysis and Reporting Program (HARP) software can be used to model ground level concentrations at specific off-site locations resulting from facility emissions. Currently, the most commonly used air modeling software is the ISCST3 (Industrial Source Complex Dispersion Model). This air modeling software is incorporated into HARP, which allows the user to input all dispersion parameters directly into the program to generate air dispersion data. Alternatively, the air dispersion data may be generated separately from HARP using other air dispersion models, and then imported into HARP to generate risk estimates. Data imported into HARP must already be in the format required by HARP. HARP has the

flexibility to generate a summary of the risk data necessary for an HRA by either of the above approaches.

Most of the toxicants assessed under the Hot Spots program are volatile organic compounds that remain as gases when emitted into the air. These chemicals are not subject to appreciable deposition to soil, surface waters, or plants. Therefore, human exposure does not occur to any appreciable extent via ingestion or dermal exposure. Significant exposure to these volatile organic toxicants emitted into the air only occurs through the inhalation pathway. A small subset of Hot Spots substances, semi-volatile organic and metal toxicants, is emitted partially or totally as particles subject to deposition. Ingestion and dermal pathways as well as the inhalation pathway must be evaluated for these chemicals. Table 5.1 in Chapter 5, Table 6.3 in Chapter 6, and Table 7.1 in Chapter 7 list the substances that must be evaluated for multipathway impacts. HARP is designed to assess potential health impacts posed by substances that must be analyzed by a multipathway approach.

2.4 Dose-Response Assessment

Dose-response assessment is the process of characterizing the relationship between exposure to an agent and incidence of an adverse health effect in exposed populations. In quantitative carcinogenic risk assessment, the dose-response relationship is expressed in terms of a potency slope that is used to calculate the probability or risk of cancer associated with an estimated exposure. Cancer potency factors are expressed as the 95th percent upper confidence limit of the slope of the dose response curve estimated assuming continuous lifetime exposure to a substance at a dose of one milligram per kilogram of body weight-day and commonly expressed in units of inverse dose (i.e., $(mg/kg/day)^{-1}$). It is assumed in cancer risk assessments that risk is directly proportional to dose and that there is no threshold for carcinogenesis. The Office of Environmental Health Hazard Assessment (OEHHA) has compiled cancer potency factors, which should be used in risk assessments for the Hot Spots program, in Table 7.1. For clarity, consistency, and to assure proper use in risk assessment, cancer potencies should not be modified. Cancer potency factors listed in Table 7.1 were derived either by the United States Environmental Protection Agency (U.S. EPA) or by OEHHA and underwent public and peer-review and were adopted for use in the program. Chapter 8 describes procedures for use of potency values in estimating excess cancer risk. For a detailed description of cancer potency factors, refer to *The Air Toxics Hot Spots Program Risk Assessment Guidelines; Part II; Technical Support Document for Describing Available Cancer Potency Factors (OEHHA, 1999b and 2002).*

For noncarcinogenic effects, dose-response data developed from animal or human studies are used to develop acute and chronic noncancer Reference Exposure Levels (RELs). The acute and chronic RELs are defined as the concentration at which no adverse noncancer adverse health effects are anticipated. The most sensitive health effect is chosen to determine the REL if the chemical affects multiple organ systems. Unlike cancer health effects, noncancer acute and chronic health effects are generally assumed to have thresholds for adverse effects. In other words, acute or chronic injury from a pollutant will not occur until exposure to that pollutant has reached or exceeded a certain concentration (i.e., threshold). The acute and chronic RELs are intended to be below the threshold for health effects for the general population. The actual threshold for health effects in the general population is generally

not known with any precision. Uncertainty factors are applied to the Lowest Observed Adverse Effects Level (LOAEL) or No Observed Adverse Effects Level (NOAEL) or Benchmark Concentration values from animal or human studies to help ensure that the chronic and acute REL values are below the threshold for human health for nearly all individuals. This guidance manual provides the acute and chronic Reference Exposure Levels in Tables 6.1 and 6.2, respectively. Some substances that pose a chronic inhalation hazard may also present a chronic hazard via non-inhalation routes of exposure (e.g., ingestion of contaminated water, foods, or soils, and dermal absorption). The 'oral' RELs for these substances are presented in Table 6.3. The methodology and derivations for acute and chronic RELs are described in the *Air Toxics Hot Spots Program Risk Assessment Guidelines; Part I; The Determination of Acute Reference Exposure Levels for Airborne Toxicants (Part I TSD) (OEHHA 1999a)* and *Air Toxics Hot Spots Program Risk Assessment Guidelines; Part III; Technical Support Document for the Determination of Chronic Reference Exposure Levels (Part III TSD)(OEHHA 2000a).*

2.5 Risk Characterization

This is the final step of risk assessment. In this step, modeled concentrations and public exposure information, which are determined through exposure assessment, are combined with potency factors and RELs that are developed through dose-response assessment. The use of cancer potency factors to assess total cancer risk and the use of the hazard index approach for evaluating the potential for noncarcinogenic health effects are described in Chapter 8. Example calculations for determining (inhalation) cancer risk and acute and chronic hazard quotients and hazard indices are presented in Appendix I. Chapter 9 provides an outline that specifies the content and recommended format of HRA results.

Under the Hot Spots Act, health risk assessments are to quantify both individual and population-wide health impacts (Health and Safety Code, Section 44306). The health risk assessments are facility specific and the calculated risk should be combined for all pollutants emitted by a single facility. For example, cancer risk from multiple carcinogens is considered additive. For exposures to multiple non-carcinogen pollutants, a hazard index approach is applied for air contaminants affecting the same organ system. Any emitted toxicant, that is not included in the quantitative analysis due to lack of a potency value or REL, should be qualitatively identified.

For assessing risk, OEHHA has developed two methods for determining dose via inhalation, dermal absorption, and ingestion pathways. These two methods, the point-estimate approach and the stochastic exposure assessment approach, are described below and in Chapters 5 and 8. Detailed presentations of these methods can be found in *The Air Toxics Hot Spots Program Risk Assessment Guidelines; Part IV; Technical Support Document for Exposure Assessment and Stochastic Analysis (OEHHA, 2000b)* (Part IV TSD).

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2.5.1 Point-Estimate Approach

The traditional approach used in the previous *California Air Pollution Control Officer's Association (CAPCOA) Air Toxics Hot Spots Program; Revised 1992; Risk Assessment Guidelines, October 1993* (CAPCOA, 1993) (CAPCOA Guidelines) for exposure and risk assessment has been to assign a single high-end point-estimate for each exposure pathway (e.g., breathing rate). A high-end value was generally chosen so that the potential cancer risk will not be underestimated. However, in the past, the high-end point-estimate has not been well defined as to where it fell on a data distribution. An improvement over the single point-estimate approach is to select two values, one representing an average and another representing a defined high-end value. OEHHA provides information in this document on average and high-end values for key exposure pathways (e.g., breathing rate). The average and high-end of point-estimates in this document are defined in terms of the probability distribution of values for that variate. The mean represents the average values for point-estimates and the 95th percentiles represent the high-end point-estimates from the distributions identified in OEHHA (2000b). Thus, within the limitations of the data, average, and high-end point-estimates are supported by the distribution.

Tier-1 of the tiered approach to risk assessment, which is briefly discussed in Section 2.5.3 and presented in more detail in Chapter 8, utilizes a combination of the average and high-end point-estimates to more realistically estimate exposure. This method uses high-end exposure estimates for driving exposure pathways and the average point-estimate for non-driving exposure pathways. The HARP software can perform this analysis.

In addition to using an estimate of average and high-end consumption rates, cancer risk evaluations for 9, 30, and 70-year exposure durations can be presented instead of just a single 70-year exposure duration. While 9 and 30-year exposure durations are available to present potential impacts over a range of residency periods, all HRAs must present the results based on 70-year exposure. The 9-and 30-year durations correspond to the central tendency and high-end estimates for residency time recommended by (U.S. EPA, 1997b). The parameters used for the 9-year exposure scenario are for the first 9-years of life and are thus protective of children. Children have higher intake rates on a per kilogram body weight basis and thus receive a higher dose from contaminated media. See Chapter 5 for the point-estimates that can be used to estimate impacts for children. Chapters 5 and 8 discuss how to calculate cancer risk based on various exposure durations and point-estimates. Appendix I contains an example calculation and Chapter 9 clarifies how to present the findings in an HRA.

2.5.2 Stochastic Exposure Assessment

OEHHA was directed under Senate Bill (SB) 1731 to develop a "likelihood of risk" approach to risk assessment. To satisfy this requirement, OEHHA developed a stochastic approach to risk assessment that utilizes distributions for exposure variates such as breathing rate and water consumption rate rather than a single point-estimate. The variability in exposure can be propagated through the risk assessment model using the distributions as input and a Monte Carlo or similar method. The result of such an analysis is a range of risks that at least partially characterizes variability in exposure.

Distributions of key exposure variates that are presented in the Part IV TSD were taken from the literature, if adequate, or developed from raw data of original studies. Intake variates such as vegetable consumption are relatively data rich; for these variates reasonable probability distributions can be constructed. However, the data necessary to characterize the variability in risk assessment variates are not always available. For example, for the fate and transport parameters (e.g., fish bioconcentration factors), there are only a few measurements available which precludes the adequate characterization of a probability distribution. We only developed distributions for those key exposure variates that were adequately characterized by data. Development of distributions is described in detail in the Part IV TSD.

2.5.3 Tiered Approach to Risk Assessment

OEHHA recommends using a tiered approach to risk assessment. Tier-1 is a standard point-estimate approach using the recommended point-estimates presented in this document. If site-specific information is available to modify some point-estimates developed in the Part IV TSD and is more appropriate to use than the recommended point-estimates in this document, then Tier-2 allows use of that site-specific information. In Tier-3, a stochastic approach to exposure assessment is used with the data distributions developed in Part IV TSD and presented in this document. Tier-4 is also a stochastic approach but allows for utilization of site-specific distributions, if they are justifiable and more appropriate for the site under evaluation than those recommended in this document. Persons preparing an HRA that has a Tier-2 through Tier-4 evaluation must also include the results of a Tier-1 evaluation. Tier-1 evaluations are required for all HRAs prepared for the Hot Spots Program. Chapter 8 provides a summary of the tiered approach and the Part IV TSD discusses it in detail. Chapter 9 provides an outline that specifies the content and recommended format of HRA results.

3. Hazard Identification - Air Toxics Hot Spots Emissions

3.1 The Air Toxics Hot Spots List of Substances and Emissions Inventory

For air toxics sources, hazard identification involves identifying pollutants of concern and whether these pollutants are potential human carcinogens or associated with other types of adverse health effects. For the Air Toxics Hot Spots (Hot Spots) Program, the emitted substances that are addressed in a health risk assessment (HRA) are found in the list of hazardous substances designated in the Air Resources Board's (ARB's) *Emission Inventory Criteria and Guidelines Regulations (Title 17, California Code of Regulations, Sections 93300-93300.5), and the Emission Inventory Criteria and Guidelines Report* (EICG Report), which is incorporated by reference therein (ARB, 1997*)*. This list of substances is contained in Appendix A of this document and the EICG Report. The list of substances also identifies those substances that are considered human carcinogens or potential human carcinogens.

The substances included on the Hot Spots Program list of substances are defined in the statute as those substances found on lists developed by the following sources:

- International Agency for Research on Cancer (IARC);
- U.S. Environmental Protection Agency (U.S. EPA);
- U.S. National Toxicology Program (NTP);
- ARB Toxic Air Contaminant Identification Program List;
- Hazard Evaluation System and Information Service (HESIS) (State of California);
- Proposition 65 Safe Drinking Water and Toxic Enforcement Act of 1986 list of carcinogens and reproductive toxicants (State of California).

All substances emitted by the facility that are on the Hot Spots Act list of substances must be identified in the HRA.

The ARB EICG Report specifies that each facility subject to the Hot Spots Act must submit an Emission Inventory Report to the local air pollution control or air quality management district. This Emission Inventory Report must identify and account for all listed substances used, manufactured, formulated, or released by the facility. All routine, predictable releases must be reported. These inventory reports include the emission data necessary to estimate off-site levels of facility-released Hot Spots substances. These inventory reports will be discussed in further detail in Chapter 4. See Chapter 9 for an outline that specifies the content and recommended format for presenting the air dispersion modeling and HRA results. As presented in Appendix A, the EICG Report divides the list into three groups for reporting purposes. Potency or severity of toxic effects and potential for facility emission were considered in placing compounds into the three groups.

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For the first group (listed in these guidelines in Appendix A-I), all emissions of these substances must be quantified in the HRA. For substances in the second group (listed in these guidelines in Appendix A-II), emissions are not quantified; however, facilities must report whether the substance is used, produced, or otherwise present on-site (i.e., these substances are simply listed in a table in the HRA). Lastly, substances in the third group (Appendix A-III) also only need to be reported in a table in the HRA if they are manufactured by the reporting facility.

Facilities that must comply with the Resource Conservation and Recovery Act and Comprehensive Environmental Response, Compensation and Liability Act (RCRA/CERCLA) requirements for risk assessment need to consult the California Department of Toxic Substances Control (DTSC) Remedial Project Manager to determine which substances must be evaluated in their risk assessment. Some RCRA/CERCLA facilities may emit substances which are not currently listed under the Hot Spots Program but which may require evaluation in a RCRA/CERCLA risk assessment.

4. Air Dispersion Modeling

The information contained in this section is primarily an abbreviated version of the material found in Chapter II of the *Air Toxics Hot Spots Risk Assessment Guidelines*; *Part IV; Exposure Assessment and Stochastic Analysis Technical Support Document (OEHHA, 2000b)* (Part IV TSD). Several references have been included in this section to indicate those areas that are covered in more detail in the Part IV TSD. However, some air dispersion concepts and procedures have been added or updated to assist the reader in the health risk assessment (HRA) process. In particular, a brief summary of the Hot Spots Analysis and Reporting Program (HARP) software applicability to air dispersion analysis has been included. The HARP software has been developed by a contractor through the consultation of OEHHA, Air Resources Board (ARB), and Air Pollution Control or Air Quality Management District (District) representatives. The HARP software is the recommended model for calculating and presenting HRA results for the Air Toxics Hot Spots Program (Hot Spots). Information on obtaining the HARP software can be found under the Hot Spots Program on the ARB's web site at *www.arb.ca.gov*. See Chapter 9 for an outline that specifies the content and recommended format for presenting the air dispersion modeling and HRA results.

Additionally, there are many direct references to the United States Environmental Protection Agency (U.S. EPA) ISCST3 air dispersion model. Recently the U.S. EPA has been promoting a new air dispersion model to effectively replace the ISCST3 model. Currently this new model, AERMOD, is available for testing and review. Once the U.S. EPA adopts the AERMOD air dispersion model into their list of regulatory approved models, the references and recommendations to specific models in this document are likely to change.

4.1 Air Dispersion Modeling in Exposure Assessment: Overview

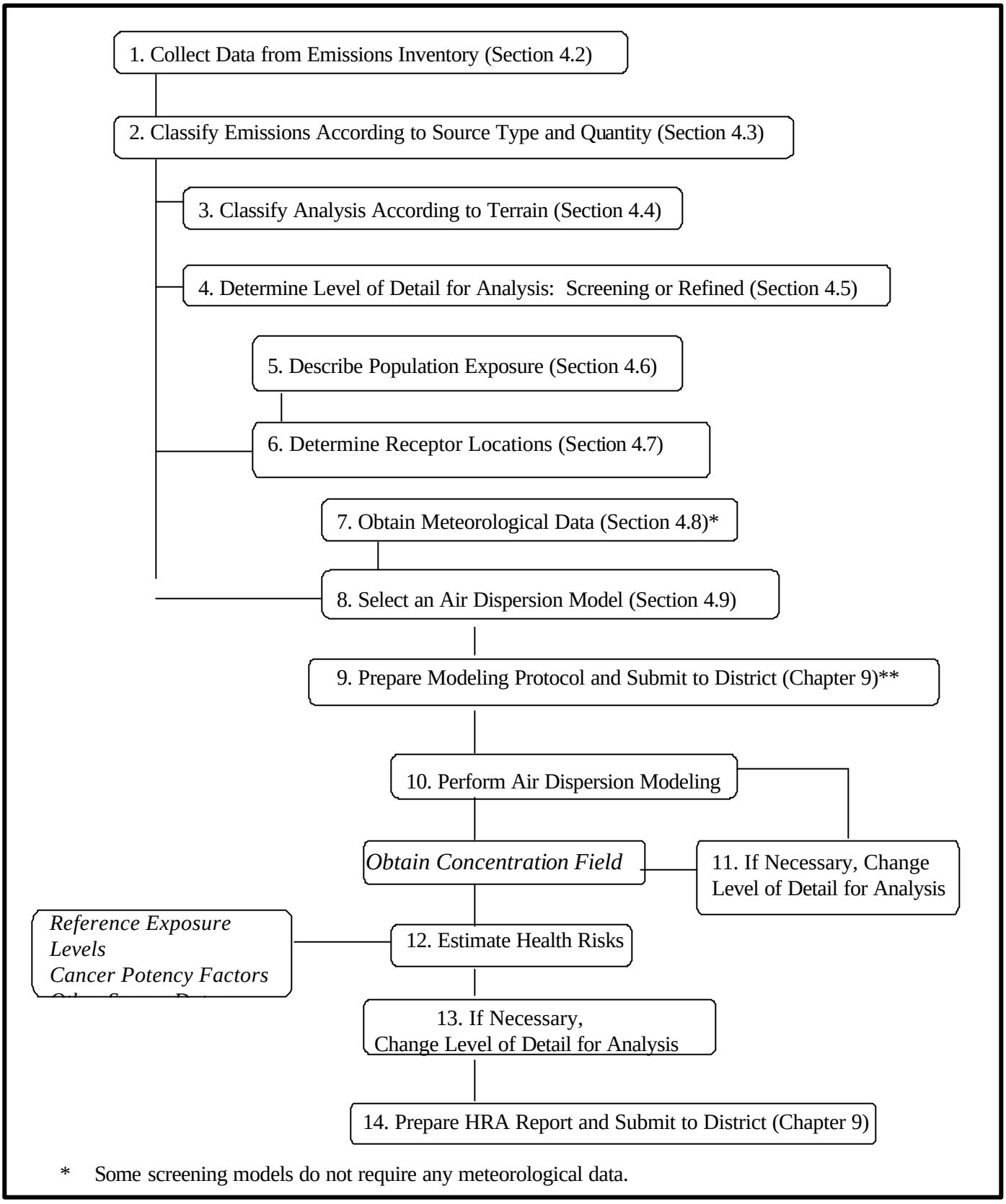
The concentration of pollutants in ambient air is needed to characterize both inhalation and noninhalation exposure pathways. Pollutant concentrations are required in HRA calculations to estimate the potential cancer risk or hazard indices associated with the emissions of any given facility. Although monitoring of a pollutant provides excellent characterization of its concentrations, it is time consuming, costly, and typically limited to a few receptor locations and snapshots in time. Air dispersion modeling has the advantage of being relatively inexpensive and is less time consuming, provided that all the model inputs are available. In addition, air dispersion modeling provides greater flexibility for placement of receptors, assessment of individual and cumulative source contributions, and characterization of concentration over greater spatial extents.

Air dispersion modeling requires the execution of the following steps (see Fig 1):

1. Complete an emission inventory of the toxic releases (Section 4.2);
2. Classify the emissions according to source type and source quantity (Section 4.3);
3. Classify the analysis according to terrain (Section 4.4);

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Figure 1. Overview of the Air Dispersion Modeling Process.



* Some screening models do not require any meteorological data.

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** Optional but strongly recommended.

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4. Determine level of detail for the analysis: refined or screening analysis (Section 4.5);
5. Identify the population exposure (Section 4.6);
6. Determine the receptor locations where impacts need to be analyzed (Section 4.7);
7. Obtain meteorological data (for refined air dispersion modeling only) (Section 4.8);
8. Select an air dispersion model (Section 4.9);
9. Prepare modeling protocol and submit to the local Air District (Chapter 9);
10. Perform an air dispersion analysis;
11. If necessary, redefine the receptor network and return to Step 10;
12. Perform HRA;
13. If necessary, change from screening to refined model and return to Step 8; and
14. Present the HRA results (Chapter 9 provides an outline that specifies the content and recommended format of HRA results).

The output of an air dispersion modeling analysis will be a receptor field of concentrations of the pollutant in ambient air. These concentrations in air need to be coupled with Reference Exposure Levels and cancer potency factors to estimate the hazard indices and potential carcinogenic risks. It should be noted that in the Hot Spots program emissions are considered inert for the purpose of transport and dispersion towards downwind receptors. Atmospheric transformations are not currently estimated.

4.2 Emission Inventories

The Emission Inventory Reports (Inventory Reports) developed under the Hot Spots Program provide data to be used in the HRA and in the air dispersion modeling process. The Inventory Reports contain information regarding emission sources, emitted substances, emission rates, emission factors, process rates, and release parameters (area and volume sources may require additional release data beyond that generally available in Emissions Inventory reports). This information is developed according to the ARB's *Emission Inventory Criteria and Guidelines Regulations (Title 17, California Code of Regulations, Sections 93300-93300.5)*, and the *Emission Inventory Criteria and Guidelines Report* (EICG Report), which is incorporated by reference therein (ARB, 1997*)*.

4.2.1 Air Toxics Hot Spots Emissions

As noted in Chapter 3, Hazard Identification, the HRA should identify all substances emitted by the facility, which are on the Hot Spots Act list of substances (see Appendix A of the Guidance Manual or the EICG Report). The EICG Report specifies that Inventory Reports must identify and account for all listed substances used, manufactured, formulated, or released by the facility. All routine, predictable releases must be reported. Substances on the "list to be quantified" must be listed with emission quantities in a table in the HRA. For substances in the second and third groups, emissions do not need to be quantified; these substances should be listed in a separate table in the HRA. Chapter 9 provides an outline that specifies the content and recommended format of HRA results.

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4.2.1.1 Emission Estimates Used in the Risk Assessment

The HRA must include emission estimates for all substances that are required to be quantified in the facility's emission inventory report. Specifically, HRAs should include both annual average emissions and maximum 1-hour emissions for each pollutant. Emissions for each substance must be reported for individual emitting processes associated with unique devices within a facility. Total facility emissions for an individual air contaminant will be the sum of emissions, reported by process, for that facility. Information on daily and annual hours of operation, and relative monthly activity, must be reported for each emitting process. Devices and emitting processes must be clearly identified and described and must be consistent with those reported in the emissions inventory report.

The HRA should include tables that present the emission information (i.e., emission rates for each substance released from each process) in a clear and concise manner. The District may allow the facility operator to base the HRA on more current emission estimates than those presented in the previously submitted emission inventory report (i.e., actual enforceable emission reductions realized by the time the HRA is submitted to the District). If the District allows the use of more current emission estimates, the District must review and approve the new emissions estimates prior to use in the HRA. The HRA report must clearly state what emissions are being used and when any reductions became effective. Specifically, a table presenting emission estimates included in the previously submitted emission inventory report as well as those used for the HRA should be presented. The District should be consulted concerning the specific format for presenting the emission information. Chapter 9 provides an outline that specifies the content and recommended format of HRA results. A revised emission inventory report must be submitted to the District prior to submitting the HRA and forwarded by the District to the ARB, if revised emission data are used.

Facilities that must also comply with RCRA/CERCLA requirements for HRAs need to consult the Cal/EPA Department of Toxic Substances Control (DTSC) Remedial Project Manager to determine what constitutes appropriate emissions data for use in the HRA. Source testing may be required for such facilities even if it is not required under the Hot Spots Program. Additional requirements for statistical treatment of source test results may also be imposed by DTSC on RCRA/CERCLA facilities.

A. Molecular Weight Adjustments for the Emissions of Metal Compounds

For most of the Hot Spots toxic metals, the OEHHA cancer potency factors apply to the weight of the toxic metal atom contained in the overall compound. Some of the Hot Spots compounds contain various elements along with the toxic metal atom (e.g., "Nickel hydroxide", CAS number 12054-48-7, has a formula of H_2NiO_2). Therefore, an adjustment to the reported pounds of the overall compound is needed before applying the OEHHA cancer potency factor for "Nickel and compounds" to such a compound. This ensures that the cancer potency factor is applied only to the fraction of the overall weight of the emissions that are associated with health effects of the metal. In other cases, the Hot Spots metals are already reported as the metal atom equivalent (e.g., CAS 7440-02-0, "Nickel"), and these cases do not use any further molecular weight adjustment. (Refer to Note [7] in Appendix A,

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List of Substances in the EICG Report for further information on how the emissions of various Hot Spots metal compounds are reported.)

The appropriate molecular weight adjustment factors (MWAF) to be used along with the OEHHA cancer potency factors for Hot Spots metals can be found in the MWAF column[1] of the table containing OEHHA/ARB Approved Health Values For Use In Hot Spots Facility Risk Assessments that is in Appendix L of this document.

As an example, the compound "Nickel hydroxide" has a molecular formula of H_2NiO_2. The atomic weight of each of the elements in this compound, and the fraction they represent of the total weight, are therefore as follows:

Element	Atomic Weight	Fraction of Total Weight = MWAF
1 x Nickel (Ni) 1 x	58.70	58.70 / 92.714 = **0.6332** (MWAF for Nickel)
2 x Oxygen (O)	2 x 15.999	
2 x Hydrogen (H)	2 x 1.008	
Total Molecular Weight of H_2NiO_2:	92.714	

So, for example, assume that 100 pounds of "Nickel hydroxide" emissions are reported under CAS number 12054-48-7. To get the Nickel atom equivalent of these emissions, multiply by the listed MWAF (0.6332) for Nickel hydroxide:

- 100 pounds x 0.6332 = 63.32 pounds of Nickel atom equivalent.

This step should be completed prior to applying the OEHHA cancer potency factor for "Nickel and compounds" in a calculation for a prioritization score or risk assessment calculation. **Note, however, that the HARP software automatically applies the appropriate MWAF for each Hot Spots chemical (by CAS number), so the emissions should not be manually adjusted when using HARP. Therefore, if using HARP, you would use 100 pounds for Nickel hydroxide and HARP will make the MWAF adjustment for you.**

4.2.1.2 Release Parameters

In order to use air dispersion models, release parameters (e.g., stack height and inside diameter, stack gas exit velocity, release temperature, and emission source location in actual UTM coordinates) need to be reported. The EICG Report specifies that the release parameters must be reported for each

[1] The value listed in the MWAF column for Asbestos is not a molecular weight adjustment. This is a conversion factor for adjusting mass and fibers or structures. See Appendix C for more information on Asbestos or the EICG report for reporting guidance.

stack, vent, ducted building, exhaust site, or other site of exhaust release. Additional information may be required to characterize releases from non-stack (volume and area) sources; see U.S. EPA air dispersion modeling guidelines or specific user's manuals. This information should also be included in the air dispersion portion of the HRA. This information must be presented in tables included in the HRA. Note that some dimensional units needed for the dispersion model may require conversion from the units reported in the Inventory Report (e.g., degrees K vs. degrees F). Chapter 9 provides an outline that specifies the content and recommended format of HRA results.

4.2.1.3 Operation Schedule

The HRA should include a discussion of the facility operation schedule and daily emission patterns. Special weekly or seasonal emission patterns may vary and should be discussed. This is especially important in a refined HRA. Diurnal emission patterns should match the diurnal dispersion characteristics of the ambient air. Hourly emission scalars are needed to best represent emissions from facilities, especially for diurnal pattern. Air dispersion models, such as ISCST3, readily accept hourly emissions scalars and these scalars are fully functional in the HARP software with ISCST3. In addition, for the purposes of exposure adjustment for an off-site work receptor the emission schedule and exposure schedule should corroborate any exposure adjustment factors. (For example, no exposure adjustment factor should be made when an off-site receptor and the emissions are on a coincident schedule.) Some fugitive emission patterns may be continuous. Additionally, these data are used for adjustments in a screening air dispersion analysis (see Appendix H for further details). A table should be included with the emission schedule on an hourly, weekly and yearly basis. Chapter 9 provides an outline that specifies the content and recommended format of HRA results.

4.2.1.4 Emission Controls

The HRA should include a description of control equipment, the emitting processes it serves, and its efficiency in reducing emissions of substances on the Air Toxics Hot Spots list. The EICG Report requires that this information be included in the Inventory Reports, along with the emission data for each emitting process. If the control equipment did not operate full-time, the reported overall control efficiency must be adjusted to account for downtime of control equipment. Any entrainment of toxic substances to the atmosphere from control equipment should be accounted for; this includes fugitive releases during maintenance and cleaning of control devices (e.g., baghouses and cyclones). Contact the District for guidance with control equipment adjustments. Recommended default deposition rates that are used when calculating potential noninhalation health impacts are listed in Section 8.2.4. Chapter 9 provides an outline that specifies the content and recommended format of HRA results.

4.2.2 Landfill Emissions

Emission estimates for landfill sites should be based on testing required under Health and Safety Code, Section (HSC) 41805.5 (AB 3374, Calderon) and any supplemental AB 2588 source tests or emission estimates used to characterize air toxics emissions from landfill surfaces or through off-site migration. The District should be consulted to determine the specific Calderon data to be used in the

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HRA. The Hot Spots Program HRA for landfills should also include emissions of listed substances for all applicable power generation and maintenance equipment at the landfill site. Processes that need to be addressed include stationary internal combustion engines, flares, evaporation ponds, composting operations, boilers, and gasoline dispensing systems.

4.3 Source Characterization

The types of sources and quantity of sources at a facility need to be characterized in order to select an appropriate air dispersion model.

4.3.1 Classification According to Source Type

Air dispersion models can be classified according to the type of source that they are designed to simulate, including, but not limited to, point, line, area, and volume sources. Several models have the capability to simulate more than one type of source.

4.3.1.1 Point Sources

Point sources are probably the most common type of source and most air dispersion models have the capability to simulate them. Typical examples of point sources include isolated vents from buildings and exhaust stacks from facility processes.

4.3.1.2 Line Sources

In practical terms, line sources are a special case of either an area or a volume source. Consequently, they are normally modeled using either an area or volume source model as described below. Examples of line sources include conveyor belts and rail lines. A roadway is a unique line source. Models designed to simulate the enhanced mixing due to motor vehicle movements have been developed (i.e., CALINE4 and CAL3QHCR).

4.3.1.3 Area Sources

Emissions, that are to be modeled as area sources, include fugitive sources characterized by non-buoyant emissions containing negligible vertical extent of release (e.g., no plume rise or distributed over a fixed level).

Fugitive particulate ($PM_{2.5}$, PM_{10}, TSP) emission sources include areas of disturbed ground (open pits, unpaved roads, parking lots), which may be present during operational phases of a facility's life. Also included are areas of exposed material (e.g., storage piles and slag dumps) and segments of material transport where potential fugitive emissions may occur (uncovered haul trucks or rail cars, emissions from unpaved roads). Fugitive emissions may also occur during stages of material handling where particulate material is exposed to the atmosphere (uncovered conveyors, hoppers, and crushers).

Other fugitive emissions emanating from many points of release at the same elevation may be modeled as area sources. Examples include fugitive emissions from valves, flanges, venting, and other connections that occur at ground level, or at an elevated level or deck if on a building or structure.

4.3.1.4 Volume Sources

Non-point sources with emissions containing an initial vertical extent should be modeled as volume sources. The initial vertical extent may be due to plume rise or a vertical distribution of numerous smaller sources over a given area. Examples of volume sources include buildings with natural fugitive or passive ventilation, and line sources such as conveyor belts and rail lines.

4.3.2 Classification According to Quantity of Sources

The selection of an air dispersion model also requires the consideration of the number of distinct sources. Some dispersion models are capable of simulating only one source at a time, and therefore are referred to as single-source models (e.g., SCREEN3).

In some cases, for screening purposes, single-source models may be used in situations involving more than one source using one of the following approaches:

1. Combining all sources into one single "representative" source.

   In order to be able to combine all sources into one single source, the individual sources must have similar release parameters. For example, when modeling more than one stack as a single "representative" stack, the stack gas exit velocities and temperatures must be similar. In order to obtain a conservative estimate, the values leading to the higher concentration estimates should typically be used (e.g., the lowest stack gas exit velocity and temperature, the height of the shortest stack, and the shortest distance from the receptor to the nearest stack).

2. Run the model separately for each individual source and superimposing the results.

   Superposition of results from each source is the approach used by all the Gaussian models capable of simulating more than one source. Simulating sources in this manner may lead to conservative estimates if worst-case meteorological data are used or if the approach is used with a model that automatically selects worst-case meteorological conditions, especially wind direction. The approach will typically be more conservative the farther apart the sources are, because each run would use a different worst-case wind direction.

   Additional guidance regarding source merging is provided by the U.S. EPA (1995a).

4.4 Terrain Characterization

Two types of terrain characterizations are required to select the appropriate model. One classification is made according to land type and another one according to terrain topography.

4.4.1 Land Type Classification

Most air dispersion models use different dispersion coefficients (sigmas) depending on the land use over which the pollutants are being transported. The type of land use is also used by some models to select appropriate wind profile exponents. Traditionally, the land type has been categorized into two broad divisions for the purposes of dispersion modeling: urban and rural. Accepted procedures for determining the appropriate category are those suggested by Irwin (1978): one based on land use classification and the other based on population. AERMOD does not depend on the dispersion coefficients used by models such as ISCST3. Therefore AERMOD does not need to classify the land type into urban or rural. When AERMOD becomes adopted as a Guideline model and is more widely used, these recommendations on land use classifications will need to be modified. Until that time, the following recommendations are relevant.

The land use procedure is generally considered more definitive. Population density should be used with caution and should not be applied to highly industrialized areas where the population density may be low. For example, in low population density areas a rural classification would be indicated, but if the area is sufficiently industrialized the classification should already be "urban" and urban dispersion parameters should be used.

If the facility is located in an area where land use or terrain changes abruptly (e.g., on the coast) the District should be consulted concerning the classification. The District may require a classification that biases estimated concentrations towards over-prediction. As an alternative, the District may require that receptors be grouped according to the terrain between source and receptor.

4.4.1.1 Land Use Procedure

1. Classify the land use within the total area '*A*', circumscribed by a 3 km radius circle centered at the source, using the meteorological land use typing scheme proposed by Auer (1978) and shown in Table 4.1.

2. If land use types I1, I2, C1, R2 and R3 account for 50 percent or more of the total area '*A*' described in (1), use urban dispersion coefficients. Otherwise, use appropriate rural dispersion coefficients.

4.4.1.2 Population Density Procedure

1. Compute the average population density (p) per square kilometer with '*A*' as defined in the Land Use procedure described above. (Population estimates are also required to determine the exposed population; for more information see Section 4.6.2 and 4.6.3.).

2. If p is greater than 750 people/km^2 use urban dispersion coefficients; otherwise, use appropriate rural dispersion coefficients.

Table 4.1 Identification and classification of land use types (Auer, 1978).

Type	Use and Structures	Vegetation
I1	*Heavy Industrial* Major chemical, steel and fabrication industries; generally 3-5 story buildings, flat roofs	Grass and tree growth extremely rare; <5% vegetation
I2	*Light-moderate industrial* Rail yards, truck depots, warehouses, industrial parks, minor fabrications; generally 1-3 story buildings, flat roofs	Very limited grass, trees almost totally absent; <5% vegetation
C1	*Commercial* Office and apartment buildings, hotels; >10 story heights, flat roofs	Limited grass and trees; <15% vegetation
R1	*Common residential* Single family dwelling with normal easements; generally one story, pitched roof structures; frequent driveways	Abundant grass lawns and light-moderately wooded; >70% vegetation
R2	*Compact residential* Single, some multiple, family dwelling with close spacing; generally <2 story, pitched roof structures; garages (via alley), no driveways	Limited lawn sizes and shade trees; <30% vegetation
R3	*Compact residential* Old multi-family dwellings with close (<2 m) lateral separation; generally 2 story, flat roof structures; garages (via alley) and ash pits, no driveways	Limited lawn sizes, old established shade trees; <35% vegetation
R4	*Estate residential* Expansive family dwelling on multi-acre tracts	Abundant grass lawns and lightly wooded; >80% vegetation
A1	*Metropolitan natural* Major municipal, state, or federal parks, golf courses, cemeteries, campuses; occasional single story structures	Nearly total grass and lightly wooded; >95% vegetation
A2	*Agricultural rural*	Local crops (e.g., corn, soybean); >95% vegetation
A3	*Undeveloped* Uncultivated; wasteland	Mostly wild grasses and weeds, lightly wooded; >90% vegetation
A4	*Undeveloped rural*	Heavily wooded; >95% vegetation
A5	*Water surfaces* Rivers, lakes	

4.4.2 Terrain Topography Classification

Surface conditions and topographic features generate turbulence, modify vertical and horizontal winds, and change the temperature and humidity distributions in the boundary layer of the atmosphere. These in turn affect pollutant dispersion and various models differ in their needs to adjust for these variables.

The classification according to terrain topography should ultimately be based on the topography at the receptor location with careful consideration of the topographical features between the receptor and the source. The ISCST3 model uses a screening approach to complex terrain. AERMOD also provides algorithms for complex terrain.

Topography can be classified according to the following sections.

4.4.2.1 Simple Terrain (also referred to as "Rolling Terrain")

Simple terrain is all terrain located below stack height including gradually rising terrain (i.e., rolling terrain). Note that *Flat Terrain* also falls in the category of simple terrain.

4.4.2.2 Complex Terrain

Complex terrain is terrain located above plume height. Complex terrain models are necessarily more complicated than simple terrain models. There may be situations in which a facility is "overall" located in complex terrain but in which the nearby surroundings of the facility can be considered simple terrain. In such cases, receptors close to the facility in this area of simple terrain will "dominate" the risk analysis and there may be no need to use a complex terrain model.

4.5 Level of Detail: Screening vs. Refined Analysis

Air dispersion models can be classified as "screening" or "refined" according to the level of detail that is used in the assessment of the concentration estimates. Refined air dispersion models use more robust algorithms that are capable of using representative meteorological data to predict more representative and usually less conservative estimates. Refined air dispersion models are, however, more resource intensive than their screening counterparts. It is advisable to first use a screening model to obtain conservative concentration estimates and calculate health risks. If the health risks are estimated to be above the threshold of concern, then use of a refined model to calculate more representative concentrations and health risk estimates would be warranted. There are situations when screening models represent the only viable alternative (e.g., when representative meteorological data are not available). The HARP software addresses these situations by incorporating the capability of using either representative meteorological data or the default meteorological conditions from the SCREEN3 model as inputs to the ISCST3 air dispersion model.

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It is acceptable to use a refined air dispersion model in a "screening" mode for this program's HRAs. In this case, worst-case hourly meteorological data are used to estimate the maximum 1-hour concentration with the ISCST3 model. Conservative conversion factors are used to estimate longer term averaging periods based on the maximum 1-hour concentration. (See Table 4.3 and Appendix H for guidance on the use of the conversion factors.)

4.6 Population Exposure

Population exposure can be assessed by determining the number of people at a particular cancer risk level such as 1×10^{-5} or 1×10^{-6}. For noncancer risk it can be the number of people exposed to the Hazard Index over a certain level such as one or five. The traditional way of estimating population exposure for cancer has been the cancer burden or the number of excess cancer cases in the exposed population.

The detail required for the analysis (e.g., screening or refined), and the procedures to be used in determining geographic resolution and exposed population, require case-by-case analysis and professional judgment. The District or reviewing authority should be consulted before beginning the population exposure estimates. As results are generated, further consultation may be necessary. Some suggested approaches and methods for handling the breakdown of population and performance of a screening or detailed risk analysis are provided in this section. In addition, the HARP software can provide population exposure estimates as cancer burden or as the number of persons exposed to a selected potential (user identified) health risk/impact level. Information on obtaining the HARP software can be found under the Hot Spots Program on the ARB's web site at *www.arb.ca.gov*. Chapter 9 provides an outline that specifies the content and recommended format of HRA results.

4.6.1 Zone of Impact

The first step of population exposure estimate in an HRA is to define the zone of impact. The zone of impact is the area around the facility that is affected by the facility's emissions. This zone is commonly defined as the area surrounding the facility where receptors have a potential multipathway (inhalation and noninhalation exposure) cancer risk greater than 10^{-6} (one in a million), an acute (inhalation) hazard index (HI) of 1.0, and/or a chronic multipathway HI of 1.0. Some Districts may prefer to use a cancer risk of 10^{-7} or an HI of 0.5 as the zone of impact. Therefore, the District should be consulted before modeling efforts are initiated. If the zone of impact is greater than 25 km from the facility at any point, the District should be consulted. The District may specify limits on the area of the zone of impact. Ideally, these preferences would be discussed with the District before being presented in the modeling protocol and HRA.

Note that when depicting the HRA results, potential cancer and noncancer isopleths must present the total cancer and noncancer health impacts from both inhalation and noninhalation pathways, when appropriate. The zone of impact should be clearly shown on a map with geographic markers of adequate resolution (see Section 4.6.3.1). The text below discusses methodology for defining the zone

of impact and has format recommendations. Chapter 9 provides an outline that specifies the content and recommended format of all HRA results.

The zone of impact can be defined once the exposure assessment (air dispersion modeling) process has determined the pollutant concentrations at each designated off-site receptor and a risk analysis (see Chapter 8) has been performed. For clarity, the cancer and noncancer zone(s) of impact should be presented on separate maps. A map illustrating the carcinogenic zone of impact is required. The District may at their discretion ask for the map illustrating the potential carcinogenic zone of impact to identify the zone of impact for the minimum exposure pathways (inhalation, soil, dermal, and mothers milk) and the zone of impact for all applicable pathways of exposure (minimum pathways plus site/route dependent pathways). Two maps may be needed to accomplish this. The legend of these maps should state the level(s) used for the zone of impact and identify the exposure pathways that were included in the assessment.

The noncancer maps should also clearly identify the noncancer zones of impact. These include the acute (inhalation) zone of impact and the chronic (including both inhalation, multipathway) zone of impact. The District may at its discretion require separate chronic inhalation and chronic multipathway zones of impact maps. For clarity, presentation of the two chronic zones of impact may also require two or more maps. The legend of these maps should state the level(s) used for the zone of impact and identify the exposure pathways (and target organs) that were included in the assessment. Further information regarding the methods for determination of hazard indices and cancer risk are discussed in Chapter 8 and Appendices I.

4.6.2 Screening Population Estimates for Risk Assessments

Not all HRAs require refined population exposure assessments and at times a screening estimate may be appropriate. A screening population estimate should include an estimate of the maximum exposed population. The impact area to be considered should be selected to be health protective (i.e., will not underestimate the number of exposed individuals). A health-protective assumption is to assume that all individuals within a large radius of the facility are exposed to the maximum concentration. If a facility must also comply with the RCRA/CERCLA HRA requirements, health effects to on-site workers may also need to be addressed. The DTSC's Remedial Project Manager should be consulted on this issue. The District should be consulted to determine the population estimate to be used for screening purposes. Guidance for one screening method is presented here.

1. Use a screening dispersion model (e.g., SCREEN3) to obtain concentration estimates for each emitted pollutant at varying receptor distances from the source. Several screening models feature the generation of an automatic array of receptors that is particularly useful for determining the zone of impact. In order for the model to generate the array of receptors, the user needs to provide some information normally consisting of starting distance, increment, and number of intervals.

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2. Calculate the potential cancer risk and hazard index for each receptor location by using the methods provided in the risk characterization sections of this document (Chapter 8).

3. Find the distance where the potential cancer risk is equal to District specified levels (e.g., 10^{-6}); this may require redefining the receptor array in order to have two receptor locations that bound a total cancer risk of 10^{-6}. This exercise should be repeated for the noncancer health impacts.

4. Calculate cancer burden by estimating the number of people in the grid and stipulate that all are exposed at the highest level.

4.6.3 Refined Population Estimates for Risk Assessments

The refined HRA requires a more detailed analysis of the population distribution that is exposed to emissions from the facility. These populations can include exposure estimates for workers and residents through the use of land use maps. The District may require that locations with high densities of sensitive individuals be identified (e.g., schools, daycare centers, hospitals). The overall exposed residential and worker populations should be apportioned into smaller geographic subareas. The information needed for each subarea is:

1. the number of exposed persons, and
2. the receptor location at which the calculated ambient air concentration is assumed to be representative of the exposure to the entire population in the subarea.

A multi-tiered approach is suggested for the population analysis. Census tracts, which the facility could significantly impact, should be identified (see Section 4.6.3.1). A census tract should be divided into smaller subareas if it is close to the facility where ambient concentrations vary widely. The District may determine that census tracts provide sufficient resolution near the facility to adequately characterize population exposure or they may prefer the census information to be evaluated using smaller blocks. Further downwind where ambient concentrations are less variable, the census tract level may be acceptable to the District. The District may determine that the aggregation of census tracts (e.g., when the census tracts making up a city are combined) is appropriate for receptors that are considerable distances from the facility.

If a facility must also comply with the RCRA/CERCLA HRA requirements, health effects to on-site workers may also need to be addressed. The DTSC's Remedial Project Manager should be consulted on this issue. In some cases it may be appropriate to evaluate risks to on-site receptors. The district should be consulted about special cases for which evaluation of on-site receptors is appropriate, such as facilities frequented by the public or where people may reside (e.g., military facilities).

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4.6.3.1 Census Tracts

For a refined HRA, the boundaries of census tracts can be used to define the geographic area to be included in the population exposure analysis. Maps showing census tract boundaries and numbers can be obtained from "The Thomas Guide® - Census Tract Edition". Statistics for each census tract can be obtained from the U.S. Census Bureau. Numerous additional publicly accessible or commercially available sources of census data can be found on the World Wide Web. A specific example of a census tract is given in Appendix K.

The two basic steps in defining the area under analysis are:

1. Identify the "zone of impact" (as defined previously in Section 4.6.1) on a map detailed enough to provide for resolution of the population to the subcensus tract level. (The U.S. Geological Survey (USGS) 7.5-minute series maps provide sufficient detail.) This is necessary to clearly identify the zone of impact, location of the facility, and sensitive receptors within the zone of impact. If significant development has occurred since the USGS survey, this should be indicated. A specific example of a 7.5-minute series map is given in Appendix K.

2. Identify all census tracts within the zone of impact using a U.S. Bureau of Census or equivalent map (e.g., Thomas Brothers®). If only a portion of the census tract lies within the zone of impact, the population used in the burden calculation should include the proportion of the population in that isopleth zone. The census tract boundaries should be transferred to a map, such as a USGS map (referred to hereafter as the "base map").

An alternative approach for estimating population exposure in heavily populated urban areas is to apportion census tracts to a Cartesian grid cell coordinate system. This method allows a Cartesian coordinate receptor concentration field to be merged with the population grid cells. Each receptor located on the Cartesian grid must be identified with actual UTM coordinates. This process may be computerized and minimizes manual mapping of centroids and census tracts. The HARP software can provide population exposure estimates as cancer burden or as the number of persons exposed at the block level to a selected potential (user identified) health risk/impact level.

The District may determine that aggregation of census tracts (e.g., which census tracts making up a city can be combined) is appropriate for receptors that are located at considerable distances from the facility. If the District permits such an approach, it is suggested that the census tract used to represent the aggregate be selected in a manner to ensure that the approach is health protective. For example, the census tract included in the aggregate that is nearest (downwind) to the facility should be used to represent the aggregate.

Subcensus Tract

Within each census tract are smaller population units. These units (urban block groups (BG) and rural enumeration districts (ED)) contain about 1,100 persons. BGs are further broken down into statistical units called blocks. Blocks are generally bounded by four streets and contain an average of 70 to 100 persons. However, the populations presented above are average figures and population units may vary significantly. In some cases, the EDs are very large and identical to a census tract.

The area requiring detailed (subcensus tract) resolution of the exposed residential and worker population will need to be determined on a case-by-case basis through consultation with the District. The District may determine that census tracts provide sufficient resolution near the facility to adequately characterize population exposure.

It is necessary to limit the size of the detailed analysis area because inclusion of all subcensus tracts would greatly increase the resource requirements of the analysis. For example, an urban area of 100,000 persons would involve approximately 25 census tracts, approximately 100 to 150 block groups, and approximately 1,000 to 1,400 blocks. Furthermore, a high degree of resolution at large distances from a source would not significantly affect the analysis because the concentration gradient at these distances is generally small. Thus, the detailed analysis of census tracts within several kilometers of a facility should be sufficient. The District should be consulted to determine the area that requires detailed analysis.

The District should also be consulted to determine the degree of resolution required. In some cases, resolution of residential populations to the BG/ED level may be sufficient. However, resolution to the block level may also be required for those BG/EDs closest to the facility or those having maximum concentration impacts. The identified employment subareas should be resolved to a similar degree of resolution as the residential population. For each subarea analyzed, the number of residents and/or workers exposed should be estimated.

Employment population data can be obtained at the census tract level from the U.S. Census Bureau or from local planning agencies. This degree of resolution will generally not be sufficient for most HRAs. For the area requiring detailed analysis, zoning maps, general plans, and other planning documents should be consulted to identify subareas with worker populations.

The boundaries of each residential and employment population area should be transferred to the base map.

4.6.4 Sensitive Receptor Locations

Individuals who may be more sensitive to toxic exposures than the general population are distributed throughout the total population. Sensitive populations may include young children and chronically ill individuals. The District may require that locations with high densities of sensitive individuals be identified (e.g., schools, nursing homes, residential care facilities, daycare centers,

hospitals). The HRA should state what the District requirements are regarding identification of sensitive receptor locations.

Although sensitive individuals are protected by general assumptions made in the dose response assessment, their identification may be useful to assure the public that such individuals are being considered in the analysis. For cancer and noncancer effects, the identification of sensitive receptor locations may be crucial in evaluating the potential impact of the toxic effect.

4.7 Receptor Siting

4.7.1 Receptor Points

The modeling analysis should contain a network of receptor points with sufficient detail (in number and density) to permit the estimation of the maximum concentrations. Locations that must be identified include the maximum estimated off-site impact or point of maximum impact (PMI), the maximum exposed individual at an existing residential receptor (MEIR), and the maximum exposed individual at an existing occupational worker receptor (MEIW). Note, however, some situations may require that on-site receptor (worker or residential) locations be evaluated. Some examples where the health impacts of on-site receptors may be appropriate could be military base housing, prisons, universities, or locations where the public may have regular access for the appropriate exposure period (e.g., a lunch time café or museum for acute exposures). The risk assessor should contact the District for guidance if on-site exposure situations are present at the emitting facility. These on-site locations should be included in the HRA. All of these locations (i.e., PMI, MEIR, and MEIW) must be identified for potential multipathway carcinogenic and noncarcinogenic effects. Some facilities will not have off-site workers in the vicinity of the facility and will not need to evaluate worker exposure. The approval to omit the MEIW receptor should be verified in writing with the District or reviewing authority and included in the HRA.

Other sensitive receptor locations may also be of interest and required to be included in the HRA. The District or reviewing authority should be consulted to determine which sensitive receptor locations must be included. It is possible that the estimated PMI, MEIR, and MEIW risk for carcinogenic, chronic noncarcinogenic, and acute noncarcinogenic health effects occur at different locations. Methods used to determine dose are provided in Chapter 5 and methods for calculating potential health impacts are included in Chapter 8 and Appendix I .

The results from a screening model (if available) can be used to identify the area(s) where the maximum concentrations are likely to occur. Receptor points should also be located at the population centroids (see Section 4.7.2) and sensitive receptor locations (see Section 4.6.4). The exact configuration of the receptor array used in an analysis will depend on the topography, population distribution patterns, and other site-specific factors. All receptor locations should be identified in the HRA using actual UTM (Universal Transverse Mercator) coordinates and receptor number. The receptor numbers in the summary tables should match receptor numbers in the computer output. In addition to actual UTM coordinates, the block/street locations (i.e., north side of 3,000 block of Smith

Street) should be provided for the PMI, MEIR, and MEIW for carcinogenic and noncarcinogenic health effects. Chapter 9 provides an outline that specifies the content and recommended format of HRA results.

To evaluate localized impacts, receptor height should be taken into account at the point of maximum impact on a case-by-case basis. For example, receptor heights may have to be included to account for receptors significantly above ground level. Flagpole receptors to represent the breathing zone, or direct inhalation, of a person may need to be considered when the source to receptor distance is less than a few hundred meters. Consideration must also be given to the multipathway analysis, which requires the deposition at ground level. A health protective approach is to select a receptor height from 0 meters to 1.8 meters that will result in the highest predicted downwind concentration. Final approval lies with the District.

4.7.2 Centroid Locations

For each subarea analyzed, a centroid location (the location at which a calculated ambient concentration is assumed to represent the entire subarea) should be determined. When population is uniformly distributed within a population unit, a geographic centroid based on the shape of the population unit can be used. Where population is not uniformly distributed, a population-weighted centroid is needed. Another alternative could be to use the concentration at the point of maximum impact (PMI) within that census tract as the concentration to which the entire population of that census tract is exposed.

The centroids represent locations that should be included as receptor points in the dispersion modeling analysis. Annual average concentrations should be calculated at each centroid using the modeling procedures presented in this chapter.

For census tracts and BG/EDs, judgments can be made using census tracts maps and street maps to determine the centroid location. At the block level, a geographic centroid is sufficient.

4.8 Meteorological Data

Refined air dispersion models require hourly meteorological data. The first step in obtaining meteorological data should be to check with the District for data availability. Other sources of data include the National Weather Service (NWS); National Climatic Data Center (NCDC) in Asheville, North Carolina; military stations; and private networks. Meteorological data for a subset of NWS stations are available from the U.S. EPA Support Center for Regulatory Air Models (SCRAM). The SCRAM can be accessed at *www.epa.gov/scram001/main.htm*. All meteorological data sources should be approved by the District. Data not obtained directly from the District should be checked for quality, representativeness, and completeness. U.S. EPA provides guidance (U.S. EPA, 1995e) for these data. The HRA should indicate if the District required the use of a specified meteorological data set. All memos indicating District approval of meteorological data should be attached in an appendix. The argument that "this is the nearest available meteorological data" does not justify that the data are

representative. If no representative meteorological data are available, screening procedures should be used as indicated in Section 4.10.

The analyst should acquire enough meteorological data to ensure that the worst-case meteorological conditions are represented in the model results. The period of record, recommended for use in the air dispersion model, is five years. If it is desired to use a single year to represent long-term averages (i.e., chronic exposure), then the worst-case year should be used. The worst-case year should be the year that yields the greatest maximum chronic off-site risk. If the only adverse health effects associated with all emitted pollutants from a given facility are acute, the worst-case year should be the year that yields the greatest maximum acute off-site risk. With the increasing speeds of today's desktop computers, processing five years of data should be relatively fast. Therefore, we strongly encourage the use of five years of meteorological data when available. However, the District may determine that one year of representative meteorological data is sufficient to adequately characterize the facility's impact.

Otherwise, to determine annual average concentrations for analysis of chronic health effects, the data can be averaged, if a minimum of three years of meteorological data is available. For calculation of the one-hour maximum concentrations needed to evaluate acute effects, the worst-case year should be used in conjunction with the maximum hourly emission rate. For example, the annual average concentration and one-hour maximum concentration at a single receptor for five years of meteorological data are calculated below:

Year	Annual Average ($\mu g/m^3$)	Maximum One-Hour ($\mu g/m^3$)
1	7	100
2	5	80
3	9	90
4	8	110
5	6	90
5-year average	7	

In the above example, the long-term average concentration over five years is 7.0 $\mu g/m^3$. Therefore, 7 $\mu g/m^3$ should be used to evaluate carcinogenic and chronic effects (i.e., annual average concentration). The one-hour maximum concentration is the highest one-hour concentration in the five-year period. Therefore, 110 $\mu g/m^3$ is the peak one-hour concentration that should be used to evaluate acute effects.

During the transitional period from night to day (i.e., the first one to three hours of daylight) the meteorological processor may interpolate some very low mixing heights. This is a period of time in which the mixing height may be growing rapidly. When predicted concentrations are high and the mixing height is very low for the corresponding averaging period, the modeling results deserve additional

consideration. For receptors in the near field, it is within the model formulation to accept a very low mixing height for short durations. However, it would be unlikely that the very low mixing height would persist long enough for the pollutants to travel into the far field. In the event that the analyst identifies any of these time periods, they should be discussed with the District on a case-by-case basis.

More information on sources of meteorological data, as well as representativeness and completeness of meteorological data, can be found in Chapter 2 of the Part IV TSD.

4.9 Model Selection

There are several air dispersion models that can be used to estimate pollutant concentrations and new ones are likely to be developed. U.S. EPA is in the process of adding new models to the preferred list of models: ISC-PRIME, AERMOD, AERMOD-PRIME, and CalPuff. The latest version of the U.S. EPA recommended models can be found at the SCRAM Bulletin Board located at *www.epa.gov/scram001*. However, any model, whether a U.S. EPA guideline model or otherwise, must be approved for use by the local air district. Recommended models and guidelines for using alternative models are presented in this section. New models placed on U.S. EPA's preferred list of models (i.e., ISC-PRIME, AERMOD, AERMOD-PRIME, and CalPuff) can be considered at that time. All air dispersion models used to estimate pollutant concentrations for HRA analyses must be in the public domain. Classification according to terrain, source type, and level of analysis is necessary before selecting a model (see Section 4.4). The selection of averaging times in the modeling analysis is based on the health effects of concern. Annual average concentrations are required for an analysis of carcinogenic or other chronic effects. One-hour maximum concentrations are generally required for analysis of acute effects. There are a few pollutants that require averaging times up to 7 hours; these can be found in Table 6.1.

4.9.1 Recommended Models

Recommended air dispersion models to estimate concentrations for HRA analyses are shown in Table 4.2. Currently, SCREEN3 and ISCST3 are the two preferred models for HRAs. This could change when the U.S. EPA places ISC-PRIME, AERMOD, AERMOD-PRIME, and CalPuff on the preferred list. Some of the names of the air dispersion models reflect the version number at the time of the writing of this document. The most current version of the models should be used for the HRA analysis. More than one model may be necessary in some situations, for example, when modeling scenarios have receptors in simple and complex terrain. Some facilities may also require models capable of handling special circumstances such as building downwash, dispersion near coastal areas, etc. See Chapter 2 of the Part IV TSD for more information on modeling special cases and for specific information including inputs and default option settings for most of the models presented in Table 4.2.

To further facilitate the model selection, the District should be consulted for additional recommendations on the appropriate model(s) or a protocol can be submitted for District review and approval (see Chapter 9). A brief description of the preferred screening model, SCREEN 3, and the preferred refined model, ISCST3, are discussed below.

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4.9.2 Alternative Models

Alternative models are acceptable if applicability is demonstrated or if they produce results identical or superior to those obtained using one of the preferred models shown in Table 4.2. For more information on the applicability of alternative models refer to the following documents:

- U.S. EPA (1986) *Guideline on Air Quality Models (Revised)*
- U.S. EPA (1992a) *Protocol for Determining the Best Performing Model*
- U.S. EPA (1985a) *Interim Procedures for Evaluating Air Quality Models – Experience with Implementation*
- U.S. EPA (1984) *Interim Procedures for Evaluating Air Quality Models (Revised)*

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TABLE 4.2 Recommended Air Dispersion Models

	AVERAGING PERIOD	TERRAIN TYPE	SINGLE SOURCE		MULTIPLE SOURCE	
			RURAL	URBAN	RURAL	URBAN
REFINED MODELS	SHORT TERM (1-24 hour avg)	SIMPLE	ISCST3	RAM ISCST3	ISCST3	RAM ISCST3
		COMPLEX	CTDMPLUS	CTDMPLUS	CTDMPLUS	CTDMPLUS
	LONG TERM (Monthly-Annual)	SIMPLE	ISCST3 ISCLT3	RAM ISCST3 ISCLT3	ISCST3 ISCLT3	CDM20 / RAM ISCST3 ISCLT3
		COMPLEX	CTDMPLUS	CTDMPLUS	CTDMPLUS	CTDMPLUS
SCREENING MODELS	SHORT TERM (1-24 hour avg)	SIMPLE	SCREEN3	SCREEN3	SCREEN3	SCREEN3
		COMPLEX	ISCST3 RTDM, CTSCREEN VALLEY SCRN	SHORTZ CTSCREEN VALLEY SCRN	ISCST3 CTSCREEN* VALLEY SCRN	SHORTZ CTSCREEN* VALLEY SCRN
	LONG TERM (Monthly-Annual)	SIMPLE	SCREEN3	SCREEN3	SCREEN3	SCREEN3
		COMPLEX	ISCST3 RTDM	LONGZ	ISCST3	LONGZ
	Generally speaking, ISCST3 and SCREEN3 are the models that are used in most cases in the Hot Spots Program. Other models in this list may be considered on a case-by-case basis. Additionally, newer models (e.g., ISC-PRIME, AERMOD, AERMOD-PRIME, and/or CalPuff) may be added to this list at a future date.					

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4.10 Screening Air Dispersion Models

A screening model may be used to estimate a maximum concentration that is biased toward overestimation of public exposure. Use of screening models in place of refined modeling procedures is optional unless the District specifically requires the use of a refined model. Screening models are normally used when no representative meteorological data are available and may be used as a preliminary estimate to determine if a more detailed assessment is warranted.

Some screening models provide only 1-hour average concentration estimates. Maximum 1-hour concentration averages can be converted to other averaging periods through consultation and approval by the District. Appendix H describes the use of the conversion factors. Because of variations in local meteorology and source types, the exact factor selected may vary from one district to another. Table 4.3 provides guidance on the range and typical values applied. The conversion factors are designed to bias predicted longer-term averaging periods towards overestimation.

Table 4.3. Recommended Factors to Convert Maximum 1-hour Avg. Concentrations to Other Averaging Periods (U.S. EPA, 1995a; ARB, 1994).

Averaging Time	Range	Typical Recommended
3 hours	0.8 - 1.0	0.9
8 hours	0.5 - 0.9	0.7
24 hours	0.2 - 0.6	0.4
30 days	0.2 - 0.3	0.3
Annual	0.06 - 0.1	0.08

4.10.1 SCREEN3

The SCREEN3 model is among the most widely used model primarily because it has been periodically updated to reflect changes in air dispersion modeling practices and theories. The SCREEN3 model represents a good balance between ease of use and the capabilities and flexibility of the algorithms. In addition, the calculations performed by the model are very well documented (U.S. EPA, 1995a). The SCREEN3 User's Guide (U.S. EPA, 1995d) also presents technical information and provides references to other support documents. The dispersion algorithms used in SCREEN3 are consistent with ISCST3. (With the implementation of AERMOD, which is expected in the future, SCREEN3 may need to be superseded with a model that is compatible with AERMOD.)

The most important difference between the SCREEN3 model and refined models such as ISCST3 is the meteorological data used to estimate pollutant concentrations. The SCREEN3 model can assume worst-case meteorology, which greatly simplifies the resources and time normally

associated with obtaining meteorological data. Consequently, more conservative (higher concentration) estimates are normally obtained. Alternatively, a single stability class and wind speed may also be entered.

Number of Sources and Type

SCREEN3 was designed to simulate only a single source at a time. However, more than one source may be modeled by consolidating the emissions into one emission point or by individually running each point source and adding the results. SCREEN3 can be used to model point sources, flare releases, and simple area and volume sources. Input parameters required for various source-types are shown in Tables 4.4 (point), 4.5 (flare release), 4.6 (area), and 4.7 (volume).

Table 4.4. Required Input Parameters to Model a Point Source Using SCREEN3.

Emission Rate (g/s)	
Stack Height (m)	
Stack Inside Diameter (m)	
Stack Gas Exit Velocity (m/s) or Volumetric Flow Rate (ACFM, m^3/s)	
Stack Gas Temperature (K)	
Ambient Temperature (K)	
Receptor Height Above Ground (m)	
Receptor Distance from the Source (m)	[discrete distance or automated array]
Land Type	[urban or rural]
Meteorology	[option "1" (full meteorology) is normally selected]
In Addition, for building downwash calculations	
Building Height (m)	
Minimum Horizontal Dimension (m)	
Maximum Horizontal Dimension (m)	

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Table 4.5. Required Input Parameters to Model a Flare Using SCREEN3.

Emission Rate (g/s)	
Flare Stack Height (m)	
Total Heat Release (cal/s)	
Receptor Height Above Ground (m)	
Receptor Distance from the Source (m)	
Land Type	[urban or rural]
Meteorology	[option "1" (full meteorology) is normally selected]
In Addition, for building downwash calculations	
Building Height (m)	
Minimum Horizontal Dimension (m)	
Maximum Horizontal Dimension (m)	

Table 4.6. Required Input Parameters to Model an Area Source Using SCREEN3.

Emission Rate (g/s-m^2)	
Source Release Height (m)	
Length of Larger Side of the Rectangular Area (m)	
Length of Smaller Side of the Rectangular Area (m)	
Receptor Height Above Ground (m)	
Receptor Distance from the Source (m)	
Land Type	[urban or rural]
Meteorology	[option "1" (full meteorology) is normally selected] [wind direction optional]

Table 4.7. Required Input Parameters to Model a Volume Source Using SCREEN3.

Emission Rate (g/s)	
Source Release Height (m)	
Initial Lateral Dimension of Volume (m)	
Initial Vertical Dimension of Volume (m)	
Receptor Height Above Ground (m)	
Receptor Distance from the Source (m)	
Land Type	[urban or rural]
Meteorology	[option "1" (full meteorology) is normally selected]

Regulatory Options

SCREEN3 algorithms contain all regulatory options internally coded including stack-tip downwash and buoyancy-induced dispersion. These regulatory options are the default settings of the parameters so the user does not need to set any switches during a run.

Special Cases

SCREEN3 has the capability to model several special cases by setting switches in the input file or by responding to on-screen questions (if run interactively). The special cases include:

- simple elevated terrain
- plume impaction in complex terrain using VALLEY model 24-hr screening procedure
- building downwash (only for flat and simple elevated terrain)
- cavity region concentrations (The PRIME algorithms included with ISCST3-PRIME should be used for estimates in the cavity zone)
- inversion break-up fumigation (only for rural inland sites with stack heights greater than or equal to 10 m and flat terrain)
- shoreline fumigation (for sources within 3,000 m from a large body of water)
- plume rise for flare releases

4.11 Refined Air Dispersion Models

Refined air dispersion models are designed to provide more representative concentration estimates than screening models. In general, the algorithms of refined models are more robust and have the capability to account for site-specific meteorological conditions. For more information regarding general aspects of model selection see Section 4.9.

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4.11.1 ISCST3

The ISCST3 model (U.S. EPA, 1995b; 1995c) is a steady-state Gaussian plume model, which can be used to assess pollutant concentrations from a wide variety of sources associated with an industrial source complex. The ISCST3 model can be used for multiple sources in urban or rural terrain. The model includes the algorithms of the complex terrain model COMPLEX I. The user can specify if calculations are to be made for simple terrain, complex terrain, or both. However since COMPLEX 1 is a screening model, the ISCST3 model is only a screening tool for receptors in complex terrain. The ISCST3 model can calculate concentration averages for 1-hour or for the entire meteorological data period (e.g., annual or intermediate time periods such as 24-hour averages). A summary of basic input parameters needed to model a point source is shown in Table 4.8. Guidance on additional input requirements (e.g., for area and volume sources) may be found in the ISC Users Guide. (ISCST3 may be replaced with AERMOD in the future pending promulgation by the U.S. EPA.)

Table 4.8. Basic Input Parameters Required to Model a Point Source Using ISCST3.

Land Use	Urban or Rural
Averaging Period	
Emission Rate (g/s)	
Stack Height (m)	
Stack Gas Exit Temperature (K)	
Stack Gas Exit Velocity (m/s)	
Stack Diameter (m)	
Receptor Locations (x,y) coordinates (m)	discrete points; polar array; Cartesian array;
Meteorology	may be supplied by preprocessor, e.g., PCRAMMET
Anemometer Height (m)	

4.11.1.1 Regulatory Options

Regulatory application of the ISCST3 model requires the selection of specific switches (i.e., algorithms) during a model run. All the regulatory options can be set by selecting the DFAULT keyword. The regulatory options, automatically selected when the DFAULT keyword is used, are:

- Stack-tip downwash (except for Schulman-Scire downwash)
- Buoyancy-induced dispersion (except for Schulman-Scire downwash)
- Final plume rise (except for building downwash)
- Treatment of calms
- Default values for wind profile exponents

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- Default values for vertical potential temperature gradients
- Use upper-bound concentration estimates for sources influenced by building downwash from super-squat buildings

4.11.1.2 Special Cases

a. Building Downwash

The ISC models automatically determine if the plume is affected by the wake region of buildings when their dimensions are given. Including building dimensions in the model input does not necessarily mean that there will be downwash. See Chapter 2 of the Part IV TSD for guidance on how to determine when downwash is likely to occur.

b. Area Sources

The area source algorithms in ISCST3 use an integration technique that allows placement of receptors within the area source. Additionally, initial dispersion in the vertical can be included to simulate sources with vertical extent.

c. Volume Sources

The volume source algorithms in ISCST3 require an estimate of the initial distribution of the emission source in the horizontal and the vertical. Tables that provide information on how to estimate the initial distribution for different sources are given in the ISC3 User's Guide (U.S. EPA, 1995b; 1995c).

d. Intermediate Terrain

When simple and complex terrain algorithms are selected by the user, ISCST3 will select the higher impact from the two algorithms on an hour-by-hour, source-by-source, and receptor-by-receptor basis for all receptors located in intermediate terrain (U.S. EPA, 1995b).

Alternatively, the pollution concentrations in the receptor field may be generated separately from HARP using other approved air dispersion models. HARP has the flexibility to generate a summary of the risk data necessary for an HRA by either approach: ISCST3 internal to HARP or the use of other approved models outside of HARP.

In addition, the HARP software also incorporates the capability of using either user supplied representative meteorological data or the worst-case meteorological conditions from the SCREEN3 model as inputs to the ISCST3 air dispersion model. Information on obtaining the HARP software can be found on the ARB's web site at *www.arb.ca.gov*. Chapter 9 provides an outline that specifies the content and recommended format of HRA results.

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e. Deposition

The ISC models contain algorithms to model settling and deposition and require additional information such as the particle size distribution. For more information consult the ISC3 User's Guide (U.S. EPA, 1995b). Note that, when performing the HRA modeling, a deposition rate will be requested and used for the noninhalation pathway exposure (see Section 8.2.5.A).

4.11.1.3 HARP Dispersion Analysis

It is highly recommended that air dispersion analysis be performed using the HARP software. HARP can perform refined dispersion analysis by utilizing the U.S. EPA standard program ISCST3 (Industrial Source Complex – Short Term 3). In addition, HARP directly links the ISCST3 outputs with risk assessment modules eliminating the need for intermediate processing by the user.

4.12 Modeling Special Cases; Specialized Models

Special situations arise in modeling some sources that require considerable professional judgment; these include building down-wash effects, wet and dry deposition, short term emissions (i.e., significantly less than 1-hour), fumigation effects, rain-cap on stack, and landfill sites. Details for these special modeling situations and specific models can be found in Chapter 2 of the Part IV TSD. It is recommended that the reader consider retaining professional consultation services if the procedures are unfamiliar. Some models have been developed for application to very specific conditions. Examples include models capable of simulating sources where both land and water surfaces affect the dispersion of pollutants and models designed to simulate emissions from specific industries.

4.13 Interaction with the District

The risk assessor must contact the District to determine if there are any specific modeling requirements. Examples of such requirements may include specific receptor location guidance, specific usage of meteorological data, and specific report format (input and output). See Chapter 9 for information on the format and content of modeling protocols and HRAs.

5. Exposure Assessment - Estimation of Concentration and Dose

5.1 Introduction

This chapter provides a summary of how toxicant ground level air concentrations estimated from air dispersion modeling or monitoring results are used to determine dose at receptors of interest. This chapter includes all the algorithms and data (e.g., point-estimates, distributions, and transfer factors) that are needed to determine the substance-specific concentration in exposure media and the dose at a receptor of interest. The determination of exposure concentrations and dose precede the calculations of potential health impacts. See Chapter 8 and Appendix I for information on calculating potential health impacts.

At minimum, three receptors are evaluated in Hot Spots health risk assessments (HRA) (see Section 4.7);, these are:

1) the Point of Maximum Impact (PMI),
2) the Maximally Exposed Individual Resident (MEIR), and
3) the Maximally Exposed Individual Worker (MEIW).

The PMI is defined as the receptor point(s) with the highest acute, chronic, or cancer health impacts outside the facility boundary. The facility boundary is defined as the property line. Often the fence is on the property line. The MEIR is defined as the existing off-site residence(s) (e.g., house or apartment) with the highest acute, chronic, or cancer health impacts. The MEIW is defined as the highest acute, chronic, or cancer health impacts at an existing off-site workplace. Note, however, that occasionally some situations may require that on-site receptor (worker or residential) locations be evaluated. Some examples where the health impacts of on-site receptors may be appropriate could be military base housing, prisons, universities, or locations where the public may have regular access for the appropriate exposure period (e.g., a lunch time café or museum for acute exposures). The risk assessor should contact the Air Pollution Control or Air Quality Management District (District) for guidance if on-site exposure situations exist at the emitting facility. These on-site locations should be included in the health risk assessment (HRA).

If the facility emits multiple substances from two or more stacks, the acute, chronic, and cancer health impacts at the PMI may be located at different physical locations. The MEIR or MEIW cancer, acute, and chronic receptors may also be at different locations. In addition, it may be necessary to determine risks at sensitive receptors (e.g., schools, daycare, eldercare, and hospitals). The District or reviewing authority should be consulted in order to determine the appropriate sensitive receptors for evaluation.

The process for determining dose at the receptor location, and ultimately potential health impacts, will likely include air dispersion modeling, and, with less frequency, air monitoring data. Air dispersion modeling combines the facility emissions and release parameters and uses default or site-specific meteorological conditions to estimate downwind, ground-level concentrations at various (user-defined) receptor locations. Air dispersion modeling is described in Chapter 4 and is presented in detail in the *Air Toxics Hot Spots Program Risk Assessment*

The Air Toxics Hot Spots Program Guidance Manual for Preparation of Health Risk Assessments. August 2003.

Guidelines; Part IV; Technical Support Document for Exposure Assessment and Stochastic Analysis (OEHHA, 2000b) (Part IV TSD).

In summary, the process of using air dispersion modeling results as the basis of an HRA follows these four steps.

- Air dispersion modeling is used to estimate an annual-average and maximum one, four, six, and seven-hour ground level concentrations. The air dispersion modeling results are expressed as an air concentration or in terms of (Chi over Q) for each receptor point. (Chi over Q) is the modeled downwind air concentration based on an emission rate of one gram per second. (Chi over Q) is expressed in units of micrograms per cubic meter per gram per second, or $(\mu g/m^3)/(g/s)$. (Chi over Q) is sometimes written as (χ/Q) and is sometimes referred to as the dilution factor.

- When multiple substances are evaluated, the χ/Q is normally utilized since it is based on an emission rate of one gram per second. The χ/Q at the receptor point of interest is multiplied by the substance-specific emission rate (in g/s) to yield the substance-specific ground-level concentration (GLC) in units of $\mu g/m^3$. The following equations illustrate this point.

$$GLC = \left(\chi/Q\right)\left(Q_{\text{substance}}\right)$$

$$\chi/Q = \left(Chi \text{ over } Q\right) \text{in} \left(\frac{\mu g/m^3}{g/s}\right), \text{ from model results with unit emission rate}$$

$$Q_{\text{substance}} = \text{substance specific emission rate} \left(g/s\right)$$

- The applicable exposure pathways (e.g., inhalation, soil, fish) are identified for the emitted substances and the receptor locations are identified. This determines which exposure algorithms in this chapter are ultimately used to estimate dose. After the exposure pathways are identified, the fate and transport algorithms described in this chapter are used to estimate concentrations in the applicable exposure media (e.g., soil or water) and the exposure algorithms are used to determine the substance-specific dose.

- The dose is used with cancer and noncancer health values to calculate the potential health impacts for the receptor (Chapter 8). An example calculation using the high-end point-estimates for the inhalation (breathing) exposure pathway can be found in Appendix I.

The algorithms in this chapter are also used to calculate media concentrations and dose in the rare instance for the Hot Spots program when monitoring equipment were used rather than air dispersion modeling to obtain a receptor's substance-specific GLC. One situation that is specific to monitored data is the treatment of results below the sampling method level of detection (LOD). In short, it is standard risk assessment practice when monitoring results are reported both above and below the LOD to use one-half of the LOD for those sample

concentrations reported below the LOD. If all testing or monitoring results fall below the LOD, then assessors should contact the District for appropriate procedures. For more information about reporting emissions under the Hot Spots Program, see the ARB's *Emission Inventory Criteria and Guidelines Regulations (Title 17, California Code of Regulations, Sections 93300-93300.5),* and the *Emission Inventory Criteria and Guidelines Report* (EICG Report), which is incorporated by reference therein (ARB, 1997*)*.

The HARP software is the recommended model for calculating and presenting HRA results for the Hot Spots Program. A contractor, through consultation with OEHHA, Air Resources Board (ARB), and District representatives, developed the HARP software. Information on obtaining the HARP software can be found on the ARB's web site at *www.arb.ca.gov* under the Hot Spots Program.

5.2 Criteria for Exposure Pathway Evaluation

In order to determine total dose to the receptor the applicable pathways of exposure need to be identified. The inhalation pathway must be evaluated for all Hot Spots substances emitted by the facility. A small subset of Hot Spots substances is subject to deposition on to the soil, plants, and water bodies. These substances need to be evaluated by the appropriate noninhalation pathways, as well as by the inhalation pathway, and the results must be presented in all HRAs. These substances include semi-volatile organic chemicals and heavy metals. Such substances are referred to as multipathway substances. Two steps are used to determine if a substance should be evaluated for multipathway impacts:

- Step one is to see if the substance or its group (e.g., dioxins, PAHs) is listed in Table 5.1.

- Step two is to determine if the substance has an oral reference exposure level (REL) listed in Table 6.3, or if it has an oral cancer slope factor listed in Table 7.1. Oral or noninhalation exposure pathways include the ingestion of soil, fisher caught fish, drinking water from surface waters, mother's milk, homegrown produce, beef, pork, chicken, eggs and cow's milk. The dermal pathway is also evaluated via contact with contaminated soil.

For all multipathway substances, the minimum exposure pathways that must be evaluated at every residential site (in addition to inhalation) are soil ingestion and dermal exposure. If dioxins, furans, or PCBs are emitted, then the breast-milk consumption pathway also becomes mandatory. The other exposure pathways (e.g., the ingestion of homegrown produce or fish) are evaluated on a site-by-site basis. If the resident can be exposed through an impacted exposure pathway, then it must be included in the HRA. However, if there were no vegetable gardens or fruit trees within the zone of impact for a facility, for example, then the produce pathways would not be evaluated. Note that on-site residential receptors are potentially subject to inhalation and noninhalation exposure pathways. Table 8.2 identifies the residential and worker receptor exposure pathways that are mandatory and those that are dependent on the site-specific decisions. While residents can be exposed though several exposure pathways, worker receptors are only evaluated for inhalation, soil ingestion, and dermal exposure using single point-estimates.

Table 5.1 shows the multipathway substances that, based on available scientific data, can be considered for each noninhalation exposure pathway. The exposure pathways that are evaluated for a substance depend on two factors: 1) whether the substance is considered a multipathway substance for the Hot Spots Program (Table 5.1), and 2) what the site-specific conditions are. A multipathway substance may be excluded from a particular exposure pathway because its physical-chemical properties can preclude significant exposure via the pathway. For example, some water-soluble chemicals do not appreciably bioaccumulate in fish; therefore, the fish pathway is not appropriate. In addition, if a particular exposure pathway is not impacted by the facility or is not present at the receptor site, then the pathway is not evaluated. For example, if surface waters are not impacted by the facility, or the water source is impacted but never used for drinking water, then the drinking water pathway is not evaluated.

Table 5.1 Specific Pathways to be Analyzed for each Multipathway Substance

Substance	Soil Ingestion	Dermal	Meat, Milk & Egg Ingestion	Fish Ingestion	Exposed Vegetable Ingestion	Leafy Vegetable Ingestion	Protected Vegetable Ingestion	Root Vegetable Ingestion	Water Ingestion	Breast Milk Ingestion
4,4'-Methylene dianiline	X	X		X	X	X	X	X	X	
Creosotes	X	X	X	X	X	X			X	
Diethylhexylphthalate	X	X		X	X	X	X	X	X	
Hexachlorocyclohexanes	X	X		X	X	X			X	
PAHs	X	X	X	X	X	X			X	
PCBs	X	X	X	X	X	X			X	X
Cadmium & compounds	X	X	X	X	X	X	X	X	X	
Chromium VI & compounds	X	X	X	X	X	X	X	X	X	
Inorganic arsenic & compounds	X	X	X	X	X	X	X	X	X	
Beryllium & compounds	X	X	X	X	X	X	X	X	X	
Lead & compounds	X	X	X	X	X	X	X	X	X	
Mercury & compounds	X	X	X	X	X	X	X	X	X	
Nickel	X	X	X		X	X	X	X	X	
Fluorides (Including hydrogen fluoride)	**To be determined**									
Dioxins & furans	X	X	X	X	X	X			X	X

5.3 Estimation of Concentrations in Air, Soil, and Water

Once emissions exit the source, the substances will be dispersed in the air. The substances in the exhaust gas with high vapor pressures will remain largely in the vapor phase, and substances with lower vapor pressures will tend to adsorb to fly ash or other particulate matter. The emission plume may contain both vapor phase substances and particulates. A single semivolatile organic toxicant can partition as a vapor and into a particulate. Particulates will deposit at a rate that is dependent on the particle size. The substances will deposit on vegetation, on soil, and in water. Use the 0.02 m/s factor for emission sources that have verifiable particulate matter control devices or for emission sources that may be uncontrolled but only emit particulate matter that is less than 2.5 microns (e.g., internal combustion engines powered by compressed natural gas). The following algorithms are used to estimate concentrations in environmental media including air, soil, water, vegetation, and animal products.

5.3.1 Air

The concentration of the substance in air at ground level (GLC) is a function of the facility emission rate and the dilution factor (χ/Q) at the points under evaluation.

a. Formula 5.3.1 A: **GLC = E-rate * χ/Q (EQ 5.3.1 A)**

1> GLC = Ground-level concentration ($\mu g/m^3$)
2> E-rate = Substance emission rate (g/sec)
3> χ /Q = Dilution factor provided by dispersion modeling ($\mu g/m^3$/g/sec)

b. Recommended values for EQ 5.3.1 A:

1> E-rate = Facility specific, substance emission rate
2> χ/Q = For point of interest, site specific, from dispersion modeling

c. Assumptions for EQ 5.3.1 A:

1> No plume depletion
2> Emission rate is constant, i.e., assumes steady state

5.3.2 Soil

The average concentration of the substance in soil (Cs) is a function of the deposition, accumulation period, chemical specific soil half-life, mixing depth, and soil bulk density.

a. Formula 5.3.2 A: $C_s = Dep * X / (K_s * SD * BD * T_t)$ **(EQ 5.3.2 A)**

1> C_s = Average soil concentration over the evaluation period ($\mu g/kg$)
2> Dep = Deposition on the affected soil area per day ($\mu g/m^2/d$)

a> Formula 5.3.2 B: $$Dep = GLC * Dep\text{-}rate * 86{,}400 \quad \text{(EQ 5.3.2 B)}$$

1: GLC = Ground-level concentration ($\mu g/m^3$)
2: Dep-rate = Vertical rate of deposition (m/sec)
3: 86,400 = Seconds per day conversion factor (sec/d)

b> Recommended default values for EQ 5.3.2 B:

1: GLC = Calculated above in EQ 5.3.1 A
2: Dep-rate = Use 0.02 meters/second for controlled or
0.05 meters/second for uncontrolled sources.

c> Assumptions for EQ 5.3.2 B:

1: Deposition rate remains constant

3> **X** = Integral function

a> Formula 5.3.2 C: $$X = [\{e^{-Ks * Tf} - e^{-Ks * To}\} / K_s] + T_t \quad \text{(EQ 5.3.2 C)}$$

1: e = 2.718
2: K_s = Soil elimination constant
3: T_f = End of evaluation period (d)
4: T_o = Beginning of evaluation period (d)
5: T_t = Total days of exposure period Tf-To (d)

a: Formula 5.3.2 D: $$K_s = 0.693 / t_{1/2} \quad \text{(EQ 5.3.2 D)}$$

1) 0.693 = Natural log of 2
2) $t_{1/2}$ = Chemical specific soil half-life (d)

b: Recommended default values for EQ 5.3.2 D:

1) $t_{1/2}$ = See Table 5.3

b> Recommended default values for EQ 5.3.2 C:

1: K_s = Calculated above in EQ 5.3.2 D
2: T_f = 25,550 (d) = 70 yr (for 9, 30 and 70 years). Identifies the total number of days of soil deposition.

= 9,490 (d) = 26 years for nursing mother in mother's milk pathway
3: T_o = 0 (d) The initial time (start period) of exposure to all receptors that are impacted by the soil pathway. Used for direct soil exposure to a worker, residential adults (9, 30, and 70-years), and children. Also used as the initial time for

determining the concentration in soil that is used for estimating the dose from the ingestion of breast milk.

4> SD = Soil mixing depth (m)
5> BD = Soil bulk density (kg/m^3)

b. Recommended default values for EQ 5.3.2 A:

1> Dep = Calculated above in EQ 5.3.2 B
2> X = Calculated above in EQ 5.3.2 C
3> K_s = Calculated above in EQ 5.3.2 D
4> SD = 0.01 (m) for playground setting (soil ingestion and dermal pathways) and 0.15 (m) for agricultural setting (produce and meat pathways).
5> BD = 1,333 (kg/m^3)
6> T_t = 25,550 (d) = 70 (yr) for 9, 30 and 70 year exposure durations and mother's milk pathway
= 25,550 (d) for adult in mother's milk pathway

c. Assumptions for EQ 5.3.2 A:

1> Substances are uniformly mixed in soil.
2> Substances are not leached or washed away, except where evidence exists to the contrary.
3> For a receptor ingesting mother's milk, the mother is exposed for 26 years, the child receives milk for one year (the last year of maternal exposure), and then is exposed to all other pathways for 9, 30 or 70 years.
4> It is assumed that toxicants accumulate in the soil for 70 years from deposition.

5.3.3 In Water

The average concentration of the substance in water (C_w) is a function of direct deposition and material carried in by surface run-off. However, only the contribution from direct deposition will be considered at this time.

a. Formula 5.3.3 A:

$$C_w = C_{depw} \quad \text{(EQ 5.3.3 A)}$$

1> C_w = Average concentration in water (µg/kg)
2> C_{depw} = Contribution due to direct deposition (µg/kg)

a> Formula 5.3.3 B:

$$C_{depw} = Dep * SA * 365 / (WV * VC) \quad \text{(EQ 5.3.3 B)}$$

1: Dep = Deposition on water body per day ($\mu g/m^2/d$)
2: SA = Water surface area (m^2)
3: 365 = Days per year (d/yr)

4: WV = Water volume (kg)
5: VC = Number of volume changes per year

b> Recommended default values for EQ 5.3.3 B:

1: Dep = Calculated above in EQ 5.3.2 B
2: SA = Site specific water surface area (m^2)
3: WV = Site specific water volume in (kg)
4: VC = Site specific number of volume changes per year
(SA, WV, and VC values can be acquired from the applicable Department of Water Resources (DWR) Regional office)

c> Assumptions for EQ 5.3.3 B:

1: All material deposited into the water remains suspended or dissolved in the water column and is available for bioconcentration in fish.

5.3.4 Estimation of Concentrations in Vegetation and Animal Products

Estimates of the concentration of the substance in vegetation and animals require the use of the results of the air, water, and soil environmental fate evaluation. Plants and animals will be exposed to the substances at the concentrations previously calculated in Section 5.31 to 5.33 above.

1. **Vegetation**

The average concentration of a substance in and on vegetation (C_f) is a function of direct deposition of the substance onto the vegetation and of root translocation or uptake from soil contaminated by the substance.

a. Formula 5.3.4.1 A:

$$C_v = C_{depv} * GRAF + C_{trans} \qquad \text{(EQ 5.3.4.1 A)}$$

1> C_v = Average concentration in and on specific types of vegetation (μg/kg)
2> C_{depv} = Concentration due to direct deposition (μg/kg)
3> GRAF = Gastrointestinal Relative Absorption Fraction

a> Formula 5.3.4.1 B:

$$C_{depv} = [Dep * IF / (k * Y)] * (1 - e^{-kT})] \qquad \text{(EQ 5.3.4.1 B)}$$

1: Dep = Deposition on affected vegetation per day ($\mu g/m^2/d$)
2: IF = Interception fraction
3: k = Weathering constant (d^{-1})
4: Y = Yield (kg/m^2)
5: e = Base of natural logarithm (2.718)

6: T = Growth period (d)

b> Recommended default values for EQ 5.3.4.1 B:

1: Dep = Calculated above in EQ 5.3.2 B
2: IF = Crop specific
  a: Root crops = 0
  b: Leafy crops = 0.2
  c: Protected crops = 0
  d: Exposed crops = 0.1
3: k = 0.1 (d^{-1})
4: Y = 2 (kg/m^2) for root, leafy, protected, exposed and pasture [CA Department of Food and Agriculture dot maps]
5: T = 45 (d) for leafy crops
  T = 90 (d) for exposed crops

c> Assumptions for EQ 5.3.4.1 B:

1: No deposition on root or protected crops

3> GRAF = Gastrointestinal Relative Absorption Fraction
0.43 for dioxins; 1.0 for all other chemicals

The term **GRAF**, or gastrointestinal relative absorption factor, is defined as the fraction of contaminant absorbed by the GI tract relative to the fraction of contaminant absorbed from the matrix (feed, water, other) used in the study(ies) that is the basis of either the cancer potency factor (CPF) or the reference exposure level (REL). If no data are available to distinguish absorption in the toxicity study from absorption from the environmental matrix in question, i.e., soil, then GRAF = 1. The GRAF allows for adjustment for absorption from a soil matrix if it is known to be different from absorption across the GI tract in the study used to calculate the CPF or REL. In most instances, the GRAF will be 1 (Table 5.3).

4> C_{trans} = Concentration due to root translocation or uptake (μg/kg)

a> Formula 5.3.4.1 C: $$C_{trans} = C_s * UF_2 \qquad \text{(EQ 5.3.4.1 C)}$$

1: C_s = Average soil concentration (μg/kg)
2: UF_2 = Uptake factor based on soil concentration

b> Recommended default values for EQ 5.3.4.1 C:

1: C_s = Calculated above in EQ 5.3.2 A
2: UF_2 = Inorganic compounds--see Table 5.3

1) Formula 5.3.4.1 D: (for organic compounds)

$$UF_2 = [(0.03 * K_{ow}^{0.77}) + 0.82] / [(K_{oc})(F_{oc})] \quad \text{(EQ 5.3.4.1 D)}$$

a) 0.03 = Empirical constant
b) K_{ow} = Octanol: water partition factor
c) 0.77 = Empirical constant
d) 0.82 = Empirical constant
e) K_{oc} = Organic carbon partition coefficient
f) F_{oc} = Fraction organic carbon in soil

2) Recommended default values for EQ 5.3.4.1 D:

a) K_{ow} = Chemical specific, see Table 5.3
b) K_{oc} = Chemical specific, see Table 5.3
c) F_{oc} = 0.1

2. **Animal Products**

The average concentration of the substance in animal products (C_{fa}) depends on which routes of exposure exist for the animals. Animal exposure routes include inhalation, soil ingestion, ingestion of contaminated feed and pasture, and ingestion of contaminated water.

a. Formula EQ 5.3.4.2 E:

$$C_{fa} = (\text{Inhalation} + \text{Water ingestion} + \text{Feed ingestion} + \text{Pasture/Grazing ingestion} + \text{Soil ingestion}) * Tco \quad \text{(EQ 5.3.4.2 E)}$$

1> C_{fa} = Average concentration in farm animals and their products (µg/kg)
2> **Inhalation** = Dose through inhalation (µg/d)

a> Formula 5.3.4.2 F:

$$\text{Inhalation} = BR_A * GLC \quad \text{(EQ 5.3.4.2 F)}$$

1: BR_A = Inhalation rate for animal (m^3/d)
2: GLC = Ground-level concentration (µg/m^3)

b> Recommended default values for EQ 5.3.4.2 F:

1: BR_A = See Table 5.2
2: GLC = Calculated above in EQ 5.3.1 A

c> Assumptions for EQ 5.3.4.2 F:

1: All material inhaled is 100% absorbed

3> **Water ingestion** = Dose through water ingestion (μg/d)

a> Formula EQ 5.3.4.2 G:

$$\textbf{Water ingestion} = WIR_a * FSW * C_w \quad \textbf{(EQ 5.3.4.2 G)}$$

1: WIR_a = Water ingestion for animal (kg/d)
2: FSW = Fraction of water ingested from a contaminated body of water
3: C_w = Average concentration in water (μg/kg) For water 1 kg = 1 L

b>Recommended default values for EQ 5.3.4.2 G:

1: WIR_a = See Table 5.2
2: FSW = Site specific, need to survey, fraction of water ingestion practices in affected area

3: C_w = Calculated above in EQ 5.3.3 A

Table 5.2 Point Estimates for Animal Pathway*

Parameter	Beef Cattle	Lactating Dairy Cattle	Pigs	Poultry
BW (body weight) (kg)	500	500	60	2
BR_A (inhalation rate) (m^3/d)	100	100	7	0.4
WIR_a (water ingestion) (kg/d)**	40	80	8	0.2
FIR (feed ingestion) (kg/d)	8	16	2	0.1
FS_f (soil fraction of feed)	0.01	0.01	NA	NA
FSp (soil fraction of pasture)	0.05	0.05	0.04	0.02

Beef and dairy cattle food from pasture grazing is assumed to be leafy vegetation (grass) and account for 0.5 of the cattle's diet. For pigs, the default assumes a pig's diet consists of equal portions of all plant types exposed, leafy, protected and root. The default assumption is that 0.1 of the diet is homegrown. The default assumption for chickens is that pasture is composed of equal proportions all plant types with 0.05 homegrown.
Agricultural mixing depth should be used for calculating soil concentration for feed and pasture contamination.

NA Not applicable. Assume F S_f is equal to zero.

* See Section 7 of *Technical Support Document for Exposure Assessment and Stochastic Analysis (OEHHA, 2000b)* for source of these values.

** 1 kg=1 L for water

4> **Feed ingestion** = Dose through the ingestion of feed (μg/d) that is harvested after it is impacted by source emissions

a> Formula EQ 5.3.4.2 H:

$$\textbf{Feed ingestion} = (1 - FG) * FIR * L * C_f \quad \textbf{(EQ 5.3.4.2 H)}$$

1: FG = Fraction of Diet provided by grazing
2: FIR = Feed ingestion rate (kg/d)
3: L = fraction of locally grown (source impacted) feed that is not pasture
4: C_f = Concentration in feed (μg/kg)

b> Recommended default values EQ 5.3.4.2 H:

1: FG = Site specific fraction of diet provided by grazing (need to survey)
2: FIR = See Table 5.2
3 L = Site specific, fraction of locally grown (source impacted) feed that is not pasture
4: C_f = As calculated above in EQ 5.3.4.1 A

5> **Pasture/Grazing ingestion** = Dose through pasture/grazing (μg/d)

a> Formula EQ 5.3.4.2 I:

Pasture/Grazing ingestion = FG * C_v * FIR (EQ 5.3.4.2 I)

1: FG = Fraction of Diet provided by grazing
2: C_v = Concentration in pasture/grazing material (μg/kg)
3: FIR = Feed ingestion rate (kg/d)

b> Recommended default values EQ 5.3.4.2 J:

1: FG = Site specific fraction of diet provided by grazing (need to survey)
2: C_v = As calculated above in EQ 5.3.4.1 A
3: FIR = See Table 5.2

6> **Soil ingestion**= Dose through soil ingestion (μg/kg)

a> Formula EQ 5.3.4.2 K: **Soil ingestion = SI_a * C_s (EQ 5.3.4.2 K)**

1: SI_a = Soil ingestion rate for animal (kg/d)

a: Formula EQ 5.3.4.2 L:

SI_a = [(1 - FG) * FS_f * FIR] +[FG * FS_p * FIR] (EQ 5.3.4.2 L)

1) FG = Fraction of diet provided by grazing
2) FS_f = Soil ingested as a fraction of feed ingested
3) FIR = Feed ingestion rate (kg/d)

4) FS_p = Soil ingested as a fraction of pasture ingested

b: Recommended default values for EQ 5.3.4.2 L:

1) FG = Site specific fraction of diet provided by grazing
2) FS_f = See Table 5.2
3) FIR = See Table 5.2
4) FS_p = See Table 5.2

2: **C_s** = Average soil concentration (μg/kg)

b> Recommended default values for EQ 5.3.4.2 K:

1: SI_a = Calculated above
2: C_s = Calculated above in EQ 5.3.2 A

7> **Tco** = Transfer coefficient of contaminant from diet to animal product (d/kg)

a> Recommended default values:

1: TCO = SEE TABLE 5.3

b> Recommended default values EQ 5.3.4.2 J:

1: FG = Site specific fraction of diet provided by grazing (need to survey)
2: C_f = As calculated above in EQ 5.3.4.1 A
3: FIR = See Table 5.2

Table 5.3 Substance Specific Default Values for Multipathway Substances(1)

				Feed to meat, milk, eggs Transfer Coefficients [3][Tco (d/kg)]			Root Uptake Factors (for inorganic compounds)					
Multipathway Substance	**Log K_{oc} [2]**	**Log K_{ow} [2]**	**Fish Biocon. Factor**	**Tco Meat**	**Tco Milk**	**Tco[3] Egg**	**Root**	**Leafy**	**Exposed & Protected**	**GRAF[4]**	**Dermal[5] Absorp. Fact.(ABS)**	**Soil Half Life (days)**
Arsenic (inorganic)	NA[6]	NA	$4.0 \times 10^{+0}$	2.0×10^{-3}	6.2×10^{-5}	2.0×10^{-3}	4.0×10^{-4}	4.0×10^{-3}	9.0×10^{-4}	1.0	0.04	$1.0 \times 10^{+8}$
Beryllium & Compounds	NA	NA	$1.9 \times 10^{+1}$	1.0×10^{-3}	9.1×10^{-7}	1.0×10^{-3}	2.0×10^{-3}	1.0×10^{-3}	2.0×10^{-4}	1.0	0.01	$1.0 \times 10^{+8}$
Cadmium & Compounds	NA	NA	$3.66 \times 10^{+2}$	5.5×10^{-4}	1.0×10^{-3}	5.5×10^{-4}	4.0×10^{-2}	6.0×10^{-2}	2.0×10^{-2}	1.0	0.001	$1.0 \times 10^{+8}$
Creosotes	NA	NA	$5.83 \times 10^{+2}$	3.4×10^{-2}	1.6×10^{-2}	3.4×10^{-2}	NA	NA	NA	1.0	0.13	$5.7 \times 10^{+2}$
Chromium VI & Cmpds	NA	NA	$2.0 \times 10^{+0}$	9.2×10^{-3}	1.0×10^{-5}	9.2×10^{-3}	1.0×10^{-3}	8.0×10^{-4}	7.0×10^{-4}	1.0	0.01	$1.0 \times 10^{+8}$
Diethylhexylphthalate	4.72	5.11	$4.83 \times 10^{+2}$	NA	NA	NA	NA	NA	NA	1.0	0.10	$2.3 \times 10^{+1}$
Dioxins and Furans	NA	NA	$1.9 \times 10^{+4}$	4.0×10^{-1}	4.0×10^{-2}	4.0×10^{-1}	NA	NA	NA	0.43	0.02	$4.72 \times 10^{+3}$
Hexachlorocyclohexanes	NA	NA	$4.56 \times 10^{+2}$	NA	NA	NA	NA	NA	NA	1.0	0.10	$6.7 \times 10^{+1}$
Lead & Compounds (inorganic)	NA	NA	$1.55 \times 10^{+2}$	4.0×10^{-4}	2.6×10^{-4}	4.0×10^{-4}	2.0×10^{-3}	5.0×10^{-3}	1.0×10^{-3}	1.0	0.01	$1.0 \times 10^{+8}$
Mercury (inorganic)	NA	NA	$5.0 \times 10^{+3}$	2.7×10^{-2}	9.7×10^{-6}	2.7×10^{-2}	5.0×10^{-2}	9.0×10^{-2}	3.0×10^{-2}	1.0	0.10	$1.0 \times 10^{+8}$
Nickel and compounds	NA	NA	NA	2.0×10^{-3}	1.0×10^{-3}	2.0×10^{-3}	2.0×10^{-2}	6.0×10^{-3}	9.0×10^{-3}	1.0	0.04	$1.0 \times 10^{+8}$
4,4'-Methylene dianiline	2.24	1.59	$1.11 \times 10^{+1}$	NA	NA	NA	NA	NA	NA	1.0	0.10	$4.0 \times 10^{+0}$
PAH as Benzo(a)pyrene	NA	NA	$5.83 \times 10^{+2}$	3.4×10^{-2}	1.6×10^{-2}	3.4×10^{-2}	NA	NA	NA	1.0	0.13	$5.7 \times 10^{+2}$
Polychlorinated Biphenyls	NA	NA	$9.97 \times 10^{+4}$	5.0×10^{-2}	1.0×10^{-2}	5.0×10^{-2}	NA	NA	NA	1.0	0.14	$9.4 \times 10^{+2}$

(1) Values based on South Coast AQMD Multi-Pathway Assessment Input Parameters Guidance Document as adapted and modified by OEHHA.
(2) See Tables 5.17 and 5.18 for derivation and references for Kow and Koc values.
(3) Values for the Egg Transfer Coefficients have not been developed but are assumed to be similar to meat transfer coefficients cited in the SCAQMD document.
(4) GRAF (Gastrointestinal Relative Absorption Factor). The guidelines allow for adjusting for bioavailability where the evidence warrants. For example, there are good data which indicate that dioxin is not as available to an organism when bound to soil or fly ash matrices relative to when it is in solution or in food. Therefore, a bioavailability factor is incorporated into the model to account for this difference. When information becomes available for other chemicals of concern, this type of bioavailability will be incorporated into the model.
(5) Dermal absorption of many compounds is limited. The guidelines have incorporated dermal absorption factors to account for the decreased absorption relative to other routes of exposure, for estimates of dermal dose used to assess both cancer and noncancer health hazards. The dermal absorption values come from literature describing absorption of chemicals across the skin. In some cases, there are good data available for specific compounds. In other cases, an absorption fraction is inferred from data for similar chemicals. In a few cases the effects of adsorption to a soil or fly ash matrix on dermal bioavailability have been studied. In these rare instances, the dermal absorption factor used in the guidelines accounts for this decreased bioavailability (e.g., the dermal absorption value for dioxins/furans accounts for decreased bioavailability).
NA - Data Not Available or Not Applicable.

b> Assumptions:

1: The transfer coefficient is the same for all exposure routes.
2: The transfer coefficient for all meat is the same.
3: The transfer coefficient for eggs is the same as for meat.

3. Fish Products

The average concentration in fish (C_f) is based on the concentration in water and a bioconcentration factor.

a. Formula EQ 5.3.4.3 M: $$C_f = C_w * BCF \quad \text{(EQ 5.3.4.3 M)}$$

1> C_f = Concentration in fish (μg/kg)
2> C_w = Concentration in water (μg/kg)
3> BCF = Bioconcentration factor

b. Recommended default values for EQ 5.3.4.3 M:

1> C_w = Calculated above in EQ 5.3.3 A
2> BCF = See Table 5.3

c. Assumptions for EQ 5.3.4.3 M:

1> All contaminants in water are available for bioconcentration.
2> Contaminant is present in a soil or fly ash matrix.
Contaminant concentrations are uniform in water based on dispersion.
4> Only bioconcentration is currently considered. Bioaccumulation from the food chain is not considered.

5.4 Estimation of Dose

Once the concentrations of substances are estimated in air, soil, water, plants, and animal products, they are used to evaluate estimated exposure to people. Exposure is evaluated by calculating the lifetime average daily dose (LADD). The following algorithms calculate this dose for exposure through inhalation, dermal absorption, and ingestion pathways. This section contains average and high-end point-estimates and data distributions for adults and children for many exposure pathways. The point-estimates and data distributions that should be used for children are listed under the nine-year exposure duration. The point-estimates and data distributions that should be used for adults are listed under the 30 and 70-year exposure duration. Workers are addressed as adults using single point-estimates for three exposure pathways. Point-estimates for workers are listed under "worker (single value)."
OEHHA has not generated or endorsed distributions for worker exposure. Therefore there is no Tier 3 stochastic approach for offsite worker cancer risk assessment.

5.4.1 Estimation of Exposure Through Inhalation

Exposure through inhalation (Dose-inh) is a function of the respiration rate and the concentration of a substance in the air.

1. Formula EQ 5.4.1 A:

$$\text{Dose-inh} = \frac{C_{air} * \{DBR\} * A * EF * ED * 10^{-6}}{AT} \qquad \text{(EQ 5.4.1 A)}$$

where:

Dose-inh	=	Dose through inhalation (mg/kg/d)
10^{-6}	=	Micrograms to milligrams conversion, Liters to cubic meters conversion
C_{air}	=	Concentration in air ($\mu g/m^3$)
{DBR}	=	Daily breathing rate (L/kg body weight - day)
A	=	Inhalation absorption factor
EF	=	Exposure frequency (days/year)
ED	=	Exposure duration (years)
AT	=	Averaging time period over which exposure is averaged, in days (e.g., 25,550 d for 70 yr for cancer risk)

2. Recommended default values for EQ 5.4.1 A:

a. EF = 350 d/y
b. ED = 9; 30; or 70 yr
c. AT = 25,550 days
d. A = 1
e. {DBR} 9, 30 & 70 year exposure = see Table 5.4
f. {DBR} 30 and 70 year exposure = see Table 5. 5 for parametric models (distributions for Tier 3 stochastic risk assessment)

Table 5.4 Point Estimates for Daily Breathing Rate for 9, 30, and 70-year Exposure Durations (DBR) (L/kg BW * Day)

9-Year Exposure Duration		30 & 70-Year Exposure Duration		Off-site[1] Worker
Average	High End	Average	High End	(Single Value)
452	581	271	393	149

[1]This value corresponds to a 70 kg worker breathing 1.3 m^3/hour for an eight hour day. 1.3 m^3/hr is the breathing rate recommended by U.S.EPA, (1997a) as an hourly average for outdoor workers.

Table 5.5 Breathing Rate Distributions for 9, 30, and 70-Year Exposure Durations for Stochastic Analysis (L/kg BW * Day)

	9-Year Exposure Duration	30 & 70-Year Exposure Duration
Distribution Type	Gamma	Gamma
Location	301.67	193.99
Scale	29.59	31.27
Shape	5.06	2.46

3. Assumption for EQ 5.4.1 A:

a. The fraction of chemical absorbed (A) is the same fraction absorbed in the study on which the cancer potency or Reference Exposure Level is based.

5.4.2 Estimation of Exposure Through Dermal Absorption

Exposure through dermal absorption (Dose-dermal) is a function of the soil or dust loading of the exposed skin surface, the amount of skin surface area exposed, and the concentration and availability of the substance. Distributions are not available for stochastic analysis. Tier III stochastic risk assessments should include the dermal pathway as a high end point estimate.

1. Formula EQ 5.4.2 A:

$$\textbf{Dose-dermal} = C_s * SA * SL * Ef * ABS * 10^{-9} * ED/BW * AT \quad \textbf{(EQ 5.4.2 A)}$$

Where:

Dose-dermal	=	Exposure dose through dermal absorption (mg/kg/d)
C_s	=	Average soil concentration (µg/kg)
SA	=	Surface area of exposed skin (cm^2)
SL	=	Soil loading on skin (mg/cm^2-d)
ABS	=	Fraction absorbed across skin
BW	=	Body weight (kg)
10^{-9}	=	Micrograms to kilogram conversion factor (µg/kg)
EF	=	(EF defined in Table 5.6) (days/year)
AT	=	25,550 days (70 years)
ED	=	Exposure Duration (years)

2. Recommended default values for EQ 5.4.2 A:

a. C_s = Calculated above in EQ 5.3.2 A
b. SA = See Table 5.6
c. SL = See Table 5.6
d. ABS = See Table 5.3
e. BW = See Table 5.6
f. f = See Table 5.6

Table 5.6 Recommended Point Estimate Values for Dermal Pathway for 9, 30, and 70 Year Exposure Durations and Worker[1]

	9 Year[1] Exposure Duration		30 & 70 Year Exposure Duration		Worker[2] (Single Value)
BW Body Weight (kg)	18		63		70
	Average	High End	Average	High End	
SL Soil Loading (mg/cm^2-day)[3]	0.2	1.0	0.2	1.0	1.0
EF Exposure Frequency (d/yr)	228	350	121	350	245
SA Surface Area Exposed (cm^2)	2,778	3,044	4,700	5,500	5,800

1. OEHHA, 2000b, page 6-10 contains surface area exposed and exposure frequency recommended values for children (1- 6) and adults (>6). For the 9 year average surface area exposed, a time weighted average value for ages 0-9 was derived with following formula (5/9 x 2000) + (3/9 x 5000) = 2,778 cm^2. For the 9 year high-end surface area exposed, (5/9 x 2000) + (3/9 x 5800) = 3,044 cm^2. It is assumed that dermal exposure to outdoor soil does not occur the first year of life. For exposure frequency the same approach was used:
(5/9 x 350) + (3/9 x 100) = 228 (d/yr) for average.
2. Worker values for surface area exposed and soil loading are the high end adult values from page 6-10, OEHHA, 2000b. The exposure frequency assumes that the worker works 49 weeks per year, 5 days per week and that he or she is exposed everyday at work.
3. For Hot Spots risk assessments it is assumed that one event occurs per day.

5.4.3 Estimation of Exposure Through Ingestion

Exposure through ingestion is a function of the concentration of the substance in the substance ingested (soil, water, and food), the gastrointestinal absorption of the substance in a soil or fly ash matrix, and the amount ingested.

1. Exposure through Ingestion of Soil

There are no distributions for soil ingestion currently recommended. Tier III stochastic risk assessments should include a high-end point estimate of soil ingestion, soil loading , exposure frequency and soil area. The dose from inadvertent soil ingestion can be estimated by the point estimate approach using the following general equation:

$$\text{Dose} = \frac{C_{soil} \times GRAF \times SIR \times EF \times ED \times 10^{-9}}{AT} \qquad \text{(EQ 5.4.3.1 A)}$$

where:

Dose = dose from soil ingestion (mg/kg BW *day)
10^{-9} = conversion factor (mg/μg) (kg/mg)
C_{soil} = concentration of contaminant in soil (μg/g)

GRAF = gastrointestinal relative absorption fraction, unitless; chemical-specific (see Table 5.3)
SIR = soil ingestion rate (mg/kg BW * day) (see Table 5.7)
EF = exposure frequency (days/year)
ED = exposure duration (years)
AT = averaging time, period of time over which exposure is averaged (days); for noncancer endpoints, AT = ED x 365 d/yr; for cancer risk estimates, AT = 70 yr x 365 d/yr = 25,550 days

b. Recommended default values for EQ 5.4.3.1 A:

a. GRAF = Table 5.3
b. SIR = Table 5.7
c. EF = 350 d/year resident, 245 d/year worker
d. ED = 9, 30, or 70 yr
e. AT = 25,550 days

Table 5.7 Soil Ingestion Rates (SIR) for 9, 30 and 70-Year Exposure Durations and Off-site Worker.

	9-Year Exposure Duration	30 & 70-Year Exposure Duration	Off-site[1] Worker
Soil Ingestion Rate (mg/kg BW *Day)	8.7	1.7	1.4

1. The soil ingestion rate of 1.4 (mg/kg BW * day) corresponds to the OEHHA, 2000b recommendation of 100 mg/day for a 70 kg adult.

In this approach, it is assumed that the soil ingested contains a representative concentration of the contaminant(s) and the concentration is constant over the exposure period.

The term **GRAF**, or gastrointestinal relative absorption factor, is defined as the fraction of contaminant absorbed by the GI tract relative to the fraction of contaminant absorbed from the matrix (feed, water, other) used in the study(ies) that is the basis of either the cancer potency factor (CPF) or the Reference Exposure Level (REL). If no data are available to distinguish absorption in the toxicity study from absorption from the environmental matrix in question, i.e., soil, then GRAF = 1. The GRAF allows for adjustment for absorption from a soil matrix if it is known to be different from absorption across the GI tract in the study used to calculate the CPF or REL. In most instances, the GRAF will be 1.

2. **Exposure through Ingestion of Water**

a. Formula EQ 5.4.3.2 B:

$$\textbf{Dose-w} = C_w * \textbf{WIR} * AB_{ing} * F_{dw} * \textbf{EF} * \textbf{ED} * 10^{-6} / \textbf{AT} \quad \textbf{(EQ 5.4.3.2 B)}$$

where:

Dose-w	=	Exposure dose through ingestion of water (mg/kg/d)
C_w	=	Water concentration (μg/kg)
WIR	=	Water ingestion rate (ml/kg BW/day)
AB_{ing}	=	Gastrointestinal absorption factor
F_{dw}	=	Fraction of drinking water from contaminated source
EF	=	Exposure frequency (days/year)
ED	=	Exposure duration (years)
10^{-6}	=	Conversion factor (μg/mg)(L/ml)

b. Recommended default values for EQ 5.4.3.2 B:

1>	C_w	=	Calculated above 5.3.3 A
2>	WIR	=	See Tables 5.8 and 5.9
3>	AB_{ing}	=	Default set to 1
4>	EF	=	350 d/yr
5>	ED	=	9, 30, or 70 yrs
6>	AT	=	25,550 days

Table 5.8
Point Estimate Water Consumption Ingestion Rates (WIR) for 9, 30, and 70-Year Exposure Durations (ml/kg BW * day)

9-Year Exposure Duration		30 and 70-Year Exposure Duration	
Average	High End	Average	High End
40	81	24	54

Table 5.9
Water Ingestion Lognormal Distributions for 9, 30, and 70-Year Exposure Durations (ml/kg BW * day) (Stochastic Analysis)

Distribution Type	9-Year Exposure Duration		30 & 70-Year Exposure Duration	
Lognormal	Mean ± S.D.	μ ± σ	Mean ± S.D.	μ ± σ
Lognormal	40.03 ± 21.45	3.57 ± 0.50	24.2 ± 17.0	2.99 ± 0.63

3. Exposure through Ingestion of Food

The exposure through food ingestion can be through ingestion of plant products, animal products (including fish), and mother's milk.

a. Plant products

Exposure through ingesting plants (Dose-p) is a function of the type of plant, gastrointestinal absorption factor, bioavailability and the fraction of plants ingested that are homegrown. The calculation is done for each type of plant, then summed to get total dose for this pathway.

1> Formula EQ 5.4.3.3.a C:

$$\text{Dose-p} = (C_f * IP * GRAF * L * EF * ED * 10^{-6}) / AT \quad \text{(EQ 5.4.3.3.a C)}$$

a> Dose-p = Exposure dose through ingestion of plant products (mg/kg/d)
b> C_f = Concentration in plant type (μg/kg)
c> IP = Consumption of exposed, leafy, protected, or root produce (g/kg*day)
d> GRAF = Gastrointestinal relative absorption factor
e> L = Fraction of exposed, leafy, protected, or root produce homegrown
f> EF = Exposure frequency (days/year)
g> ED = Exposure duration (years)
h> 10^{-6} = Conversion factor (μg/kg to mg/g)
i> AT = Averaging time, period over which exposure is averaged (days)

2> Recommended default values for EQ 5.4.3.3.a C:

a> C_f = Calculated above in EQ 5.3.4.1 A
b> IP = See Tables 5.10 to 5.12
c> GRAF = See Table 5.3
d> L = Site specific fraction of produce homegrown or locally produced. For nonurban sites 0.15 may be used as a default. For urban sites 0.052 may be used (USEPA, 1997b).
e> EF = 350 d/yr
f> ED = 70 yrs
g> AT = 25,550 days

Table 5.10
Point Estimates for Per Capita Food Consumption Rates (g/Kg BW * Day)

	9-Year Exposure Duration		30 & 70-Year Exposure Durations	
	Average	High End	Average	High End
Produce				
Exposed	4.16	15.7	3.56	12.1
Leafy	2.92	10.9	2.90	10.6
Protected	1.63	6.66	1.39	4.88
Root	4.08	14.9	3.16	10.5
Meat				
Beef	2.24	7.97	2.25	6.97
Chicken	1.80	4.77	1.46	5.02
Pork	1.31	5.10	1.39	4.59
Dairy	12.0	51.9	5.46	17.4
Eggs	3.21	10.3	1.80	5.39

Table 5.11
Parametric Models for Ages 0-9 Food Consumption Distributions (g/kg BW * Day) (Stochastic Analysis)

Food Category	Distribution Type	Mean	Std. Dev.	Location	Scale	Shape	$\mu \pm \sigma$
Produce							
Exposed	Lognormal	3.93	5.49				exp(0.83±1.04)
Leafy	Lognormal	2.83	3.89				exp(0.43±1.03)
Protected	Weibull			0.13	1.21	0.71	
Root	Lognormal	4.08	5.91				exp(0.84±1.06)
Meat							
Beef	Weibull			0.24	1.72	0.77	
Chicken	Gamma			0.25	2.94	0.53	
Pork	Weibull			0.18	0.97	0.78	
Dairy	Lognormal	11.32	18.3				exp(1.78±1.13)
Eggs	Weibull			0.26	2.67	0.82	

Table 5.12
Parametric Models for Ages 0-70 Food Consumption Distributions (g/kg BW * Day) (Stochastic Analysis)

Category of Food	Mean	Standard Deviation	Distribution Type	$\mu \pm \sigma$
Produce				
Exposed	3.43	6.16	Lognormal	Exp (0.51±1.20)
Leafy	2.97	4.95	Lognormal	Exp (0.42±1.15)
Protected	1.39	2.43	Lognormal	Exp (-0.37±1.18)
Root	3.07	5.23	Lognormal	Exp (0.44±1.17)
Meat				
Beef	2.32	3.50	Lognormal	Exp (0.25±1.09)
Chicken	1.44	2.19	Lognormal	Exp (-0.23±1.09)
Pork	1.42	2.30	Lognormal	Exp (-0.29±1.13)
Dairy	5.57	10.5	Lognormal	Exp (0.96±1.23)
Eggs	1.84	2.60	Lognormal	Exp (0.061±1.05)

Table 5.13
Default Values for Fisher–caught Fish Consumption (g/kg BW * Day)

	9, 30, & 70-Year Exposure Scenario
Average	0.48
High-End	1.35

Table 5.14
Parametric Model for Fisher-caught Fish Consumption Distribution for 9, 30 and 70-Year Exposure Scenarios (g/kg BW *Day) (stochastic analysis).

Mean	Standard. Deviation	Distribution Type	$\mu \pm \sigma$
0.48	0.71	Lognormal	exp(-1.31 ± 1.08)

b. Animal Products (Including Fisher-caught Fish)

Exposure through animal product ingestion (Dose-ap) is a function of what type of meat and/or fish is ingested, as well as animal milk products and eggs. The calculation is done for each type and then summed to get the total dose for this pathway.

1> Formula 5.4.3.3.b D:

$$\textbf{Dose-ap} = C_{fa} * If * GI * L * EF * ED * 10^{-6} / AT \qquad \textbf{(EQ 5.4.3.3.b D)}$$

a> Dose-ap = Exposure dose through ingestion of animal or fish products (mg/kg BW * day)
b> C_{fa} = Concentration in animal product (μg/kg)
c> If = Consumption of animal product (g/kg BW per day), e.g, beef, chicken, pork, diary, eggs, fish
d> GI = Gastrointestinal absorption factor
e> L = Fraction of animal product homegrown
f> EF = Exposure frequency (days/year)
g> ED = Exposure duration (years)
h> AT = Averaging time (days)
i> 10^{-6} = Conversion factor (μg/kg to mg/g) for C_f term

2> Recommended default values for EQ 5.4.3.3.b D:

a> C_{fa} = Calculated above in EQ 5.3.4.2 E
b> If = See Tables 5.10, 5.11, and 5.12. For fish ingestion rates see Table 5.13. For distributions (parametric models) for Tier 3 risk assessments see Tables 5.11, 5.12, and 5.14.
c> GI = Default set to 1.
d> L = Site specific fraction of product locally produced.
e> EF = 350 d/yr
f> ED = 70 yrs
G> AT = 25,550 DAYS

c. Mother's Milk

Exposure through mother's milk ingestion (Dose-Im) is a function of the average substance concentration in mother's milk and the amount of mother's milk ingested. The minimum pathways that the nursing mother is exposed to include inhalation, soil ingestion and dermal, since the chemicals evaluated by the mother's milk pathway are multipathway chemicals. Other pathways may be appropriate depending on site conditions (e.g. presence of vegetable gardens or home grown chickens). The nursing mother in the mother's milk pathway is not herself subject to the mother's milk pathway. The summed average daily dose (mg/kg BW-day) from all pathways is calculated for the nursing mother using the equations on pages 20-26.

1> Formula 5.4.3.3.c E:

$$\text{Dose-Im} = C_m * BMI_{bw} * F * yr / 25{,}550 \quad \text{(EQ 5.4.3.3.c E)}$$

a> Dose-Im = Exposure dose through ingestion of mother's milk (mg/kg BW/d)

b> C_m = Concentration of contaminant in mother's milk is a function of the mother's exposure through all routes and the contaminant half-life in the body (mg/g milk)

1: Formula 5.4.3.3.c F:

$$Cm = E_{mi} * t_{1/2} * f_1 * f_3 * 10^{-3} / (f_2 * 0.693) \quad \text{(EQ 5.4.3.3.c F)}$$

a: E_{mi} = Average daily maternal intake of contaminant from all routes (mg/kg/d)
b: $t_{1/2}$ = Half-life of contaminant in mother (d)
c: f_1 = Fraction of contaminant that partitions to mother's fat
d: f_3 = Fraction of fat of mother's milk (kg fat/kg milk)
e: f_2 = Fraction of mother's weight that is fat(kg fat/kg bw)
f: 10^{-3} = Conversion factor (g to kg milk)
g: 0.693 = Natural log of 2

2: Recommended default values for EQ 5.4.3.3.c F:

a: E_{mi} = Sum of doses
b: $t_{1/2}$ = 2,117 (d) for PCDDs/PCDFs = 5.8 yr
1,460 (d) for both PCBs
c: f_1 = 0.8
d: f_3 = 0.04 (kg fat/kg milk)
e: f_2 = 0.33 (kg fat/kg BW)

c> BMI_{bw} = Daily breast-milk ingestion rate (g/kg BW*day)
d> F = Frequency of exposure (d/yr)
e> yr = Breast-feeding period (yr)

f> 25,550 = Exposure period (d)

2> Recommended default values for EQ 5.4.3.3.c E:

a> BMI_{bw} = see Table 5.15
For distribution (parametric model) for Tier 3 stochastic

risk assessments see Table 5.16

b> F = 365 (d)

c> yr = 1(yr)

3> Assumptions for EQ 5.4.3.3.c E:

a> For the MEIR, mother is exposed for 25 years, the child receives milk for another year, and then the nursing infant is exposed for 9, 30, or 70 years.

b> For the 9, 30, and 70 year exposure duration scenarios, the total toxicant dose from the breast-feeding in the first year of life is assumed to be spread over 70 years in order to calculate an average daily dose.

Table 5.15
Point Estimate Values for Breast Milk Consumption Rate
(g/kg BW *day)

	9, 30, and 70-Year Exposure Durations
Average	102
High End	138

Table 5.16
Parametric Model for Breast Milk Consumption Rate for
9, 30, and 70 Year Exposure Durations (Stochastic Analysis) (g/kg BW *day)

Distribution Type	Mean ± S.D.
Normal	102 ± 21.8

5.5 References for Kow and Koc Values in Table 5.3

Table 5.17 References for Kow Values

Compound	Notes	Reference
Diethylhexlyphthalate	Level 1 calculation	Mackay *et al*. (1995)
4,4'-Methylene dianiline	Measured	Hansch *et al*. (1985)

Table 5.18 References for Koc Values

Compound	Notes	Reference
Diethylhexylphthalate	Level 1 calculation	Mackay *et al*. (1995)
4,4'-Methylene dianiline	Estimated according to methodology of Lyman *et al*. (1990)	Lyman *et al*. (1990)

6. Dose-Response Assessment for Noncarcinogenic Endpoints

6.1 Derivation of Toxicity Criteria

Dose-response assessment describes the quantitative relationship between the amount of exposure to a substance (the dose) and the incidence or occurrence of an adverse health impact (the response). For noncarcinogens, dose-response information is presented in the form of Reference Exposure Levels (RELs). RELs are concentrations or doses at or below which adverse effects are not likely to occur following specified exposure conditions. The methodology for developing chronic RELs is fundamentally the same as that used by U.S. EPA in developing the inhalation Reference Concentrations (RfCs) and oral Reference Doses (RfDs).

Acute and chronic RELs are frequently calculated by dividing the no observed adverse effect level (NOAEL) or lowest observed adverse effect levels (LOAEL) in human or animal studies by uncertainty factors. Uncertainty factors are applied to account for interspecies extrapolation, intraspecies variability, the use of subchronic studies to extrapolate to chronic effects, and use of a LOAEL instead of a NOAEL. Total uncertainty factors range from one to three thousand for current RELs. Haber's equation is used, where needed, to adjust studies with different exposure times to the one-hour period needed for most acute RELs. Currently, there are eight acute RELs with reproductive health endpoints, which have exposure time periods different from one-hour; these alternative exposure periods include four, six, and seven hours. The most sensitive toxicological end point is selected as the basis for the REL when there are multiple adverse health effects. A slightly more complicated methodology, the Benchmark Concentration approach, is described in OEHHA, 1999a. The selection of the most sensitive endpoint as the basis for a REL helps ensure that the REL is protective for all health effects. The use of uncertainty factors helps ensure that the REL is protective for nearly all individuals, including sensitive subpopulations, within the limitations of current scientific knowledge.

It should be emphasized that exceeding the acute or chronic REL does not necessarily indicate that an adverse health impact will occur. However, levels of exposure above the REL have an increasing but undefined probability of resulting in an adverse health impact, particularly in sensitive individuals (e.g., depending on the toxicant, the very young, the elderly, pregnant women, and those with acute or chronic illnesses). The significance of exceeding the REL is dependent on the seriousness of the health endpoint, the strength and interpretation of the health studies, the magnitude of combined safety factors, and other considerations. In addition, there is a possibility that an REL may not be protective of certain small, unusually sensitive human subpopulations. Such subpopulations can be difficult to identify and study because of their small numbers, lack of knowledge about toxic mechanisms, and other factors. It may be useful to consult OEHHA staff when an REL is exceeded (hazard quotient or hazard index is greater than 1.0). Chapter 8 discusses the methods used for determining potential noncancer health impacts and Appendix I presents example calculations used to determine a hazard quotient (HQ) and hazard indices (HI). For detailed information on the methodology and derivations for acute RELs, see the *Air Toxics Hot Spots Program Risk Assessment Guidelines; Part I; The Determination of Acute Reference Exposure Levels for Airborne Toxicants (OEHHA 1999a)* (Part I TSD). For information on chronic RELS see the *Air Toxics Hot Spots Program*

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Risk Assessment Guidelines; Part III; Technical Support Document for the Determination of Chronic Reference Exposure Levels (OEHHA 2000a) (Part III TSD*).*

Tables 6.1 and 6.2 list the currently adopted acute and chronic inhalation RELs. Some substances that pose a chronic inhalation hazard may also present a chronic hazard via non-inhalation (oral) routes of exposure. The oral RELs for these substances are presented in Table 6.3. Appendix L provides a consolidated listing of all the acute and chronic RELs and target organs that are approved for use by OEHHA and ARB for the Hot Spots Program. Periodically, new or updated RELs are adopted by OEHHA and these guidelines will be updated to reflect those changes. See OEHHA's web site at www.oehha.ca.gov (look under "Air", then select "Hot Spots Guidelines") to determine if any new or updated RELs have been adopted since the last guideline update.

6.2 Description of Acute Reference Exposure Levels

OEHHA developed acute RELs for assessing potential noncancer health impacts for short-term, generally one-hour peak exposures to facility emissions. (A few RELs are for 4 to 7-hour peak exposures.) By definition, an acute REL is an exposure that is not likely to cause adverse health effects in a human population, including sensitive subgroups, exposed to that concentration (in units of micrograms per cubic meter or $\mu g/m^3$) for the specified exposure duration on an intermittent basis. Many acute RELs are based on mild adverse effects, such as mild irritation of the eyes, nose, or throat, or may result in other mild adverse physiological changes. For most individuals, it is expected that the mild irritation and other adverse physiological changes will not persist after exposure ceases. Some acute RELs are based on reproductive/developmental endpoints, such as teratogenicity or fetotoxicity, which are considered severe adverse effects. The RELs, target organ systems, and the averaging time for substances that can present a potential acute hazard from inhalation are presented in Table 6.1. Unlike the chronic RELs discussed in the following section, there are no acute noninhalation RELs. Chapter 8 discusses the methods used for determining noncancer acute health impacts. Appendix I presents an example calculation used to determine an HQ and HI.

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Table 6.1 Acute Reference Exposure Levels and Target Organ Systems Impacted

Substance	Chemical Abstract Service Number (CAS)	Acute Inhalation REL ($\mu g/m^3$)	Averaging [a] Time (hour)	Acute Hazard Index Target Organ Systems(s)
Acrolein	107-02-8	1.9×10^{-1}	1	Eyes; Respiratory System
Acrylic Acid	79-10-7	$6.0 \times 10^{+3}$	1	Eyes; Respiratory System
Ammonia	7664-41-7	$3.2 \times 10^{+3}$	1	Eyes; Respiratory System
Arsenic and Inorganic Arsenic Compounds	7440-38-2	1.9×10^{-1}	4	Reproductive/Developmental
Arsine	7784-42-1	$1.6 \times 10^{+2}$	1	Hematologic System
Benzene	71-43-2	$1.3 \times 10^{+3}$	6	Hematologic System; Immune System; Reproductive/Developmental
Benzyl Chloride	100-44-7	$2.4 \times 10^{+2}$	1	Eyes; Respiratory System
Carbon Disulfide	75-15-0	$6.2 \times 10^{+3}$	6	Nervous System; Reproductive/Developmental
Carbon Monoxide [b]	630-08-0	$2.3 \times 10^{+4}$	1	Cardiovascular System
Carbon Tetrachloride	56-23-5	$1.9 \times 10^{+3}$	7	Alimentary Tract; Nervous System; Reproductive/Developmental
Chlorine	7782-50-5	$2.1 \times 10^{+2}$	1	Eyes; Respiratory System
Chloroform	67-66-3	$1.5 \times 10^{+2}$	7	Nervous System; Reproductive/Developmental
Chloropicrin	76-06-2	$2.9 \times 10^{+1}$	1	Eyes; Respiratory System
Copper and Compounds	7440-50-8	$1.0 \times 10^{+2}$	1	Respiratory System
1,4-Dioxane	123-91-1	$3.0 \times 10^{+3}$	1	Eyes; Respiratory System
Epichlorohydrin	106-89-8	$1.3 \times 10^{+3}$	1	Eyes; Respiratory System
Ethylene Glycol Monobutyl Ether	111-76-2	$1.4 \times 10^{+4}$	1	Eyes; Respiratory System
Ethylene Glycol Monoethyl Ether	110-80-5	$3.7 \times 10^{+2}$	6	Reproductive/Developmental
Ethylene Glycol Monoethyl Ether Acetate	111-15-9	$1.4 \times 10^{+2}$	6	Nervous System; Reproductive/Developmental
Ethylene Glycol Monomethyl Ether	109-86-4	$9.3 \times 10^{+1}$	6	Reproductive/Developmental
Formaldehyde	50-00-0	$9.4 \times 10^{+1}$	1	Eyes; Immune System; Respiratory
Hydrogen Chloride	7647-01-0	$2.1 \times 10^{+3}$	1	Eyes; Respiratory System
Hydrogen Cyanide	74-90-8	$3.4 \times 10^{+2}$	1	Nervous System
Hydrogen Fluoride	7664-39-3	$2.4 \times 10^{+2}$	1	Eyes; Respiratory System
Hydrogen Selenide	7783-07-5	$5.0 \times 10^{+0}$	1	Eyes; Respiratory System
Hydrogen Sulfide [b]	7783-06-4	$4.2 \times 10^{+1}$	1	Nervous System
Isopropyl Alcohol	67-63-0	$3.2 \times 10^{+3}$	1	Eyes; Respiratory System
Mercury (Inorganic)	7439-97-6	$1.8 \times 10^{+0}$	1	Reproductive/Developmental
Methanol	67-56-1	$2.8 \times 10^{+4}$	1	Nervous System

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Table 6.1 Acute Reference Exposure Levels and Target Organ Systems Impacted

Substance	Chemical Abstract Service Number (CAS)	Acute Inhalation REL ($\mu g/m^3$)	Averaging Time (hour) [a]	Acute Hazard Index Target Organ Systems(s)
Methyl Bromide	74-83-9	$3.9 \times 10^{+3}$	1	Nervous System; Respiratory Irritation; Reproductive/Developmental
Methyl Chloroform	71-55-6	$6.8 \times 10^{+4}$	1	Nervous System
Methyl Ethyl Ketone	78-93-3	$1.3 \times 10^{+4}$	1	Eyes; Respiratory System
Methylene Chloride	75-09-2	$1.4 \times 10^{+4}$	1	Nervous System
Nickel and Nickel Compounds	7440-02-0	$6.0 \times 10^{+0}$	1	Immune System; Respiratory System
Nitric Acid	7697-37-2	$8.6 \times 10^{+1}$	1	Respiratory System
Nitrogen Dioxide [b]	10102-44-0	$4.7 \times 10^{+2}$	1	Respiratory System
Ozone [b]	10028-15-6	$1.8 \times 10^{+2}$	1	Eyes; Respiratory System
Perchloroethylene	127-18-4	$2.0 \times 10^{+4}$	1	Eyes; Nervous System; Respiratory System
Phenol	108-95-2	$5.8 \times 10^{+3}$	1	Eyes; Respiratory System
Phosgene	75-44-5	$4.0 \times 10^{+0}$	1	Respiratory System
Propylene Oxide	75-56-9	$3.1 \times 10^{+3}$	1	Eyes; Respiratory System; Reproductive/Developmental
Sodium Hydroxide	1310-73-2	$8.0 \times 10^{+0}$	1	Eyes; Skin; Respiratory System
Styrene	100-42-5	$2.1 \times 10^{+4}$	1	Eyes; Respiratory System
Sulfates [b]	N/A	$1.2 \times 10^{+2}$	1	Respiratory System
Sulfur Dioxide [b]	7446-09-5	$6.6 \times 10^{+2}$	1	Respiratory System
Sulfuric Acid and Oleum	7664-93-9 8014-95-7	$1.2 \times 10^{+2}$	1	Respiratory System
Toluene	108-88-3	$3.7 \times 10^{+4}$	1	Nervous System; Eyes; Respiratory System; Reproductive/Developmental
Triethylamine	121-44-8	$2.8 \times 10^{+3}$	1	Nervous System; Eyes
Vanadium Pentoxide	1314-62-1	$3.0 \times 10^{+1}$	1	Eyes; Respiratory System
Vinyl Chloride	75-01-4	$1.8 \times 10^{+5}$	1	Nervous System; Eyes; Respiratory System
Xylenes (m,o,p-isomers)	1330-20-7	$2.2 \times 10^{+4}$	1	Eyes; Respiratory System

a. The averaging period of noncancer acute RELs is generally a one-hour exposure. However, some are based on several hour exposure for reproductive/developmental endpoints (see section 1.6 of the Part I TSD). The RELs for the following substances must be compared to modeled emission concentrations of the same duration rather than maximum one-hour concentrations (e.g., a 4-hour REL should be compared to the maximum 4-hour average concentration from the air dispersion model).

b. California Ambient Air Quality Standard

6.3 Description of Chronic Reference Exposure Levels

OEHHA has developed chronic RELs for assessing noncancer health impacts from long-term exposure. (See the Part III TSD for detailed information on the development of noncancer chronic inhalation and oral RELs.) A chronic REL is a concentration level (that is expressed in units of micrograms per cubic meter ($\mu g/m^3$) for inhalation exposure and in a dose expressed in units of milligram per kilogram-day (mg/kg-day) for oral exposures), at or below which no adverse health effects are anticipated following long-term exposure. Long-term exposure for these purposes has been defined as 12% of a lifetime, or about eight years for humans. Table 6.2 lists the chronic noncancer RELs that should be used in the assessment of chronic health effects from inhalation exposure. Appendix L provides a consolidated listing of all the acute and chronic RELs and target organs that are approved for use by OEHHA and ARB for the Hot Spots Program. Periodically, new or updated RELs are adopted by OEHHA and these guidelines will be updated to reflect those changes. See OEHHA's web site at *www.oehha.ca.gov* (look under "Air", then select "Hot Spots Guidelines") to determine if any new or updated RELs have been adopted since the last guideline update.

The most sensitive organ system(s) associated with each chronic REL are also presented in Table 6.2. Chapter 8 discusses the methods used for determining potential noncancer health impacts and Appendix I presents example calculations used to determine a HQ and HI.

Table 6.2 Chronic Inhalation Reference Exposure Levels (RELs) And Chronic Hazard Index Target Organ System(s)

Substance	Chemical Abstract Service Number (CAS)	Chronic Inhalation REL ($\mu g/m^3$)	Chronic Inhalation Hazard Index Target Organ System(s)
Acetaldehyde [a]	75-07-0	$9.0 \times 10^{+0}$	Respiratory System
Acrolein	107-02-8	6.0×10^{-2}	Eyes; Respiratory System
Acrylonitrile	107-13-1	$5.0 \times 10^{+0}$	Respiratory System
Ammonia	7664-41-7	$2.0 \times 10^{+2}$	Respiratory System
Arsenic & Inorganic Arsenic Compounds	7440-38-2	3.0×10^{-2}	Cardiovascular System; Developmental; Nervous System
Benzene	71-43-2	$6.0 \times 10^{+1}$	Developmental; Hematopoietic System; Nervous System
Beryllium and Beryllium Compounds	7440-41-7	7.0×10^{-3}	Immune System; Respiratory System
Butadiene	106-99-0	$2.0 \times 10^{+1}$	Reproductive System
Cadmium and Cadmium Compounds	7440-43-9	2.0×10^{-2}	Kidney; Respiratory System
Carbon Disulfide	75-15-0	$8.0 \times 10^{+2}$	Nervous System; Reproductive System
Carbon Tetrachloride	56-23-5	$4.0 \times 10^{+1}$	Alimentary System; Developmental; Nervous System
Chlorine	7782-50-5	2.0×10^{-1}	Respiratory System
Chlorine Dioxide	10049-04-4	6.0×10^{-1}	Respiratory System
Chlorinated Dibenzo-*p*-dioxins [b]			
2,3,7,8-Tetrachlorodibenzo-*p*-dioxin [b]	1746-01-6	4.0×10^{-5}	Alimentary System; Developmental; Endocrine System; Hematopoietic System; Reproductive System; Respiratory System
1,2,3,7,8-Pentachlorodibenzo-*p*-dioxin [b]	40321-76-4	4.0×10^{-5}	
1,2,3,4,7,8-Hexachlorodibenzo-*p*-dioxin [b]	39227-28-6	4.0×10^{-4}	
1,2,3,6,7,8-Hexachlorodibenzo-*p*-dioxin [b]	57653-85-7	4.0×10^{-4}	
1,2,3,7,8,9-Hexachlorodibenzo-*p*-dioxin [b]	19408-74-3	4.0×10^{-4}	
1,2,3,4,6,7,8-Heptachlorodibenzo-*p*-dioxin [b]	35822-46-9	4.0×10^{-3}	
1,2,3,4,6,7,8,9-Octachlorodibenzo-*p*-dioxin [b]	3268-87-9	4.0×10^{-1}	
Chlorinated Dibenzofurans [b]			
2,3,7,8-Tetrachlorodibenzofuran [b]	5120-73-19	4.0×10^{-4}	Alimentary System; Developmental; Endocrine System; Hematopoietic System; Reproductive System; Respiratory System
1,2,3,7,8-Pentachlorodibenzofuran [b]	57117-41-6	8.0×10^{-4}	
2,3,4,7,8-Pentachlorodibenzofuran [b]	57117-31-4	8.0×10^{-5}	
1,2,3,4,7,8-Hexachlorodibenzofuran [b]	70648-26-9	4.0×10^{-4}	
1,2,3,6,7,8-Hexachlorodibenzofuran [b]	57117-44-9	4.0×10^{-4}	

Table 6.2 Chronic Inhalation Reference Exposure Levels (RELs) And Chronic Hazard Index Target Organ System(s)

Substance	Chemical Abstract Service Number (CAS)	Chronic Inhalation REL ($\mu g/m^3$)	Chronic Inhalation Hazard Index Target Organ System(s)
1,2,3,7,8,9-Hexachlorodibenzofuran [b]	72918-21-9	4.0×10^{-4}	Alimentary System; Developmental; Endocrine System; Hematopoietic System; Reproductive System; Respiratory System
2,3,4,6,7,8-Hexachlorodibenzofuran [b]	60851-34-5	4.0×10^{-4}	
1,2,3,4,6,7,8-Heptachlorodibenzofuran [b]	67562-39-4	4.0×10^{-3}	
1,2,3,4,7,8,9-Heptachlorodibenzofuran [b]	55673-89-7	4.0×10^{-3}	
1,2,3,4,6,7,8,9-Octachlorodibenzofuran [b]	39001-02-0	4.0×10^{-1}	
Chlorobenzene	108-90-7	$1.0 \times 10^{+3}$	Alimentary System; Kidney; Reproductive System
Chloroform	67-66-3	$3.0 \times 10^{+2}$	Alimentary System; Developmental; Kidney
Chloropicrin	76-06-2	4.0×10^{-1}	Respiratory System
Chromium VI & Soluble Chromium VI Compounds (except chromic trioxide)	18540-29-9	2.0×10^{-1}	Respiratory System
Chromic Trioxide (as chromic acid mist)	1333-82-0	2.0×10^{-3}	Respiratory System
Cresol Mixtures	1319-77-3	$6.0 \times 10^{+2}$	Nervous System
1,4-Dichlorobenzene	106-46-7	$8.0 \times 10^{+2}$	Alimentary System; Kidney; Nervous System; Respiratory System;
1,1-Dichloroethylene (Vinylidene Chloride)	75-35-4	$7.0 \times 10^{+1}$	Alimentary System
Diesel Exhaust [a]	N/A	$5.0 \times 10^{+0}$	Respiratory System
Diethanolamine	111-42-2	$3.0 \times 10^{+0}$	Cardiovascular System; Nervous System
N,N-Dimethylformamide	68-12-2	$8.0 \times 10^{+1}$	Alimentary System; Respiratory System
1,4-Dioxane	123-91-1	$3.0 \times 10^{+3}$	Alimentary System; Cardiovascular System; Kidney
Epichlorohydrin	106-89-8	$3.0 \times 10^{+0}$	Eyes; Respiratory System
1,2-Epoxybutane	106-88-7	$2.0 \times 10^{+1}$	Cardiovascular System; Respiratory System
Ethylbenzene	100-41-4	$2.0 \times 10^{+3}$	Alimentary System (Liver); Developmental; Endocrine System; Kidney
Ethyl Chloride	75-00-3	$3.0 \times 10^{+4}$	Alimentary System; Developmental
Ethylene Dibromide	106-93-4	8.0×10^{-1}	Reproductive
Ethylene Dichloride	107-06-2	$4.0 \times 10^{+2}$	Alimentary System (Liver)
Ethylene Glycol	107-21-1	$4.0 \times 10^{+2}$	Developmental; Kidney; Respiratory System
Ethylene Glycol Monoethyl Ether	110-80-5	$7.0 \times 10^{+1}$	Hematopoietic System; Reproductive System
Ethylene Glycol Monoethyl Ether Acetate	111-15-9	$3.0 \times 10^{+2}$	Developmental

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Table 6.2 Chronic Inhalation Reference Exposure Levels (RELs) And Chronic Hazard Index Target Organ System(s)

Substance	Chemical Abstract Service Number (CAS)	Chronic Inhalation REL ($\mu g/m^3$)	Chronic Inhalation Hazard Index Target Organ System(s)
Ethylene Glycol Monomethyl Ether	109-86-4	$6.0 \times 10^{+1}$	Reproductive System
Ethylene Glycol Monomethyl Ether Acetate	110-49-6	$9.0 \times 10^{+1}$	Reproductive System
Ethylene Oxide	75-21-8	$3.0 \times 10^{+1}$	Nervous System
Formaldehyde	50-00-0	$3.0 \times 10^{+0}$	Eyes; Respiratory System
Fluorides		$1.3 \times 10^{+1}$	Bone and Teeth, Respiratory System
Glutaraldehyde	111-30-8	8.0×10^{-2}	Respiratory System
Hexane (n-)	110-54-3	$7.0 \times 10^{+3}$	Nervous System
Hydrazine	302-01-2	2.0×10^{-1}	Alimentary System; Endocrine System
Hydrogen Chloride	7647-01-0	$9.0 \times 10^{+0}$	Respiratory System
Hydrogen Cyanide	74-90-8	$9.0 \times 10^{+0}$	Cardiovascular System; Endocrine System; Nervous System
Hydrogen Fluoride	7664-39-3	$1.4 \times 10^{+1}$	Bone and Teeth, Respiratory System
Hydrogen Sulfide	7783-06-4	$1.0 \times 10^{+1}$	Respiratory System
Isophorone	78-59-1	$2.0 \times 10^{+3}$	Alimentary System; Developmental
Isopropanol	67-63-0	$7.0 \times 10^{+3}$	Developmental; Kidney
Maleic Anhydride	108-31-6	7.0×10^{-1}	Respiratory System
Manganese & Manganese Compounds	7439-96-5	2.0×10^{-1}	Nervous System
Mercury & Mercury Compounds (inorganic)	7439-97-6	9.0×10^{-2}	Nervous System
Methanol	67-56-1	$4.0 \times 10^{+3}$	Developmental
Methyl Bromide	74-83-9	$5.0 \times 10^{+0}$	Developmental; Nervous System; Respiratory System
Methyl tertiary-Butyl Ether	1634-04-4	$8.0 \times 10^{+3}$	Alimentary System; Eyes; Kidney
Methyl Chloroform	71-55-6	$1.0 \times 10^{+3}$	Nervous System
Methyl Isocyanate	624-83-9	$1.0 \times 10^{+0}$	Reproductive; Respiratory System
Methylene Chloride	75-09-2	$4.0 \times 10^{+2}$	Cardiovascular System; Nervous System
4,4'-Methylene Dianiline (and its dichloride)	101-77-9	$2.0 \times 10^{+1}$	Alimentary System; Eyes
Methylene Diphenyl Isocyanate	101-68-8	7.0×10^{-1}	Respiratory System
Naphthalene	91-20-3	$9.0 \times 10^{+0}$	Respiratory System
Nickel & Nickel Compounds (except nickel oxide)	7440-02-0	5.0×10^{-2}	Hematopoietic System; Respiratory System

Table 6.2 Chronic Inhalation Reference Exposure Levels (RELs) And Chronic Hazard Index Target Organ System(s)

Substance	Chemical Abstract Service Number (CAS)	Chronic Inhalation REL ($\mu g/m^3$)	Chronic Inhalation Hazard Index Target Organ System(s)
Nickel Oxide	1313-99-1	1.0×10^{-1}	Hematopoietic System; Respiratory System
Phenol	108-95-2	$2.0 \times 10^{+2}$	Alimentary System; Cardiovascular System; Kidney; Nervous System
Phosphine	7803-51-2	8.0×10^{-1}	Alimentary System; Hematopoietic System; Kidney; Nervous System; Respiratory System
Phosphoric Acid	7664-38-2	$7.0 \times 10^{+0}$	Respiratory System
Phthalic Anhydride	85-44-9	$2.0 \times 10^{+1}$	Respiratory System
Polychlorinated biphenyls[P4] (PCBs) (speciated)[b]			
3,3',4,4'-Tetrachlorobiphenyl (77)[b]	35298-13-3	4.0×10^{-1}	Alimentary System; Developmental; Endocrine System; Hematopoietic System; Reproductive System; Respiratory System
3,4,4',5-Tetrachlorobiphenyl (81)[b]	70362-50-4	4.0×10^{-1}	
2,3,3',4,4'- Pentachlorobiphenyl (105)[b]	32598-14-4	4.0×10^{-1}	
2,3,4,4'5- Pentachlorobiphenyl (114)[b]	74472-37-0	8.0×10^{-2}	
2,3'4,4',5- Pentachlorobiphenyl (118)[b]	31508-00-6	4.0×10^{-1}	
2',3,4,4',5- Pentachlorobiphenyl (123)[b]	65510-44-3	4.0×10^{-1}	
3,3',4,4',5- Pentachlorobiphenyl (126)[b]	57465-28-8	4.0×10^{-4}	
2,3,3',4,4',5-Hexachlorobiphenyl (156)[b]	38380-08-4	8.0×10^{-2}	
2,3,3',4,4',5'-Hexachlorobiphenyl (157)[b]	69782-90-7	8.0×10^{-2}	
2,3',4,4',5,5'-Hexachlorobiphenyl (167)[b]	52663-72-6	4.0×10^{-0}	
3,3',4,4'5,5'- Hexachlorobiphenyl (169)[b]	32774-16-6	4.0×10^{-3}	
2,3,3'4,4',5,5'- Heptachlorobiphenyl (189)[b]	39635-31-9	4.0×10^{-1}	
Propylene	115-07-1	$3.0 \times 10^{+3}$	Respiratory System
Propylene Glycol Monomethyl Ether	107-98-2	$7.0 \times 10^{+3}$	Alimentary System
Propylene Oxide	75-56-9	$3.0 \times 10^{+1}$	Respiratory System
Selenium and Selenium compounds (other than Hydrogen Selenide)	7782-49-2	$2.0 \times 10^{+1}$	Alimentary System; Cardiovascular System; Nervous System
Styrene	100-42-5	$9.0 \times 10^{+2}$	Nervous System
Sulfuric Acid	7664-93-9	$1.0 \times 10^{+0}$	Respiratory System
Tetrachloroethylene [a] (Perchloroethylene)	127-18-4	$3.5 \times 10^{+1}$	Alimentary System; Kidney

Table 6.2 Chronic Inhalation Reference Exposure Levels (RELs) And Chronic Hazard Index Target Organ System(s)

Substance	Chemical Abstract Service Number (CAS)	Chronic Inhalation REL ($\mu g/m^3$)	Chronic Inhalation Hazard Index Target Organ System(s)
Toluene	108-88-3	$3.0 \times 10^{+2}$	Developmental; Nervous System; Respiratory System
2,4-Toluene Diisocyanate	584-84-9	7.0×10^{-2}	Respiratory System
2,6-Toluene Diisocyanate	91-08-7	7.0×10^{-2}	Respiratory System
Trichloroethylene [a]	79-01-6	$6.0 \times 10^{+2}$	Eyes; Nervous System
Triethylamine	121-44-8	$2.0 \times 10^{+2}$	Eyes
Vinyl Acetate	108-05-4	$2.0 \times 10^{+2}$	Respiratory System
Xylenes (m, o, p-isomers)	1330-20-7	$7.0 \times 10^{+2}$	Nervous System; Respiratory System

a These peer-reviewed values were developed under the Toxic Air Contaminant (TAC) Program mandated by AB1807 (California Health and Safety Code Sec. 39650 *et seq*.).

N/A Not Applicable

b The OEHHA has adopted the World Health Organization 1997 Toxicity Equivalency Factor (WHO_{97}-TEF) scheme for evaluating the cancer risk and noncancer risk due to exposure to samples containing mixtures of polychlorinated dibenzo-*p*-dioxins (PCDD) (also referred to as chlorinated dioxins and dibenzofurans), polychlorinated dibenzofurans (PCDF) and polychlorinated biphenyls (PCBs). See Appendix E for more information about the scheme and for the methodology for calculating 2,3,7,8-equivalents for PCDD and PCDFs. For convenience, OEHHA has calculated chronic REL values for speciated PCDDs, PCDFs and PCBs based on the WHO_{97} TEF values and the chronic REL for 2,3,7,8-tetrachlorodibenzo-*p*-dioxin using the procedure discussed in Appendix E. The chronic REL values can be used to calculate a hazard index when the mixtures are speciated from individual congener ground level concentrations.

6.4 Description of Chronic Oral (Noninhalation) Reference Exposure Levels

As specified throughout the guidelines, estimates of long-term exposure resulting from facility air emissions of specific compounds must be analyzed for both inhalation and noninhalation (multipathway) pathways of exposure for humans. Facilities often emit substances under high temperature and pressure in the presence of particulate matter. While some of these substances are expected to remain in the vapor phase, other substances such as metals and semi-volatile organics can be either emitted as particles, form particles after emission from the facility, or adhere to existing particles. Some substances will partition between vapor and particulate phases. Substances in the particulate phase can be removed from the atmosphere by settling and, thus, potentially present a significant hazard via noninhalation pathways.

Particulate-associated chemicals can be deposited directly onto soil, onto the leaves or fruits of crops, or onto surface waters. Exposure via the oral route is the predominant noninhalation pathway, resulting in the noninhalation RELs being referred to as 'oral RELs' in this document. The oral RELs are expressed as doses in milligrams of substance (consumed and dermally absorbed) per kilogram body weight per day (mg/kg-day).

Table 6.3 lists the chronic noncancer RELs to be used in the assessment of chronic health effects from noninhalation pathways of exposure. Appendix L provides a consolidated listing of all chronic RELs and target organs that are approved for use by OEHHA and ARB for the Hot Spots Program. Periodically, new or updated RELs are adopted by OEHHA and these guidelines will be updated to reflect those changes. See OEHHA's web site at *www.oehha.ca.gov* (look under "Air", then select "Hot Spots Guidelines") to determine if any new or updated RELs have been adopted since the last guideline update. Chapter 8 discusses the methods used for determining potential noncancer health impacts and Appendix I presents example calculations used to determine a HQ and HI.

Table 6.3 Chronic Noninhalation 'Oral' Reference Exposure Levels (RELs) And Chronic Hazard Index Target Organ System(s)

Substance	Chemical Abstract Service Number (CAS)	Chronic Oral REL (mg/kg-day)	Chronic Oral Hazard Index Target Organ System(s)
Arsenic & Inorganic Arsenic Compounds	7440-38-2	3.0×10^{-4}	Cardiovascular System; Skin
Beryllium and Beryllium Compounds	7440-41-7	2.0×10^{-3}	Alimentary System
Cadmium and Cadmium Compounds	7440-43-9	5.0×10^{-4}	Kidney
Chlorinated Dibenzo-*p*-dioxins [a]			
2,3,7,8-Tetrachlorodibenzo-*p*-dioxin [a]	1746-01-6	1.0×10^{-8}	Alimentary System; Developmental; Endocrine System; Hematopoietic System; Reproductive System; Respiratory System
1,2,3,7,8-Pentachlorodibenzo-*p*-dioxin [a]	40321-76-4	1.0×10^{-8}	
1,2,3,4,7,8-Hexachlorodibenzo-*p*-dioxin [a]	39227-28-6	1.0×10^{-7}	
1,2,3,6,7,8-Hexachlorodibenzo-*p*-dioxin [a]	57653-85-7	1.0×10^{-7}	
1,2,3,7,8,9-Hexachlorodibenzo-*p*-dioxin [a]	19408-74-3	1.0×10^{-7}	
1,2,3,4,6,7,8-Heptachlorodibenzo-*p*-dioxin [a]	35822-46-9	1.0×10^{-6}	
1,2,3,4,6,7,8,9-Octachlorodibenzo-*p*-dioxin [a]	3268-87-9	1.0×10^{-4}	
Chlorinated Dibenzofurans [a]			
2,3,7,8-Tetrachlorodibenzofuran [a]	5120-73-19	1.0×10^{-7}	Alimentary System; Developmental; Endocrine System; Hematopoietic System; Reproductive System; Respiratory System
1,2,3,7,8-Pentachlorodibenzofuran [a]	57117-41-6	5.0×10^{-7}	
2,3,4,7,8-Pentachlorodibenzofuran [a]	57117-31-4	5.0×10^{-8}	
1,2,3,4,7,8-Hexachlorodibenzofuran [a]	70648-26-9	1.0×10^{-7}	
1,2,3,6,7,8-Hexachlorodibenzofuran [a]	57117-44-9	1.0×10^{-7}	
1,2,3,7,8,9-Hexachlorodibenzofuran [a]	72918-21-9	1.0×10^{-7}	
2,3,4,6,7,8-Hexachlorodibenzofuran [a]	60851-34-5	1.0×10^{-7}	
1,2,3,4,6,7,8-Heptachlorodibenzofuran [a]	67562-39-4	1.0×10^{-6}	
1,2,3,4,7,8,9-Heptachlorodibenzofuran [a]	55673-89-7	1.0×10^{-6}	
1,2,3,4,6,7,8,9-Octachlorodibenzofuran [a]	39001-02-0	1.0×10^{-4}	
Chromium VI & Soluble Chromium VI Compounds (except chromic trioxide)	18540-29-9	2.0×10^{-2}	Hematologic
Fluorides (including hydrogen fluoride)		4.0×10^{-2}	Bones and Teeth
Mercury & Mercury Compounds (inorganic)	7439-97-6	3.0×10^{-4}	Immune System; Kidney
Nickel & Nickel Compounds (except nickel oxide)	7440-02-0	5.0×10^{-2}	Alimentary System
Nickel Oxide	1313-99-1	5.0×10^{-2}	Alimentary System
Polychlorinated biphenyls[P4] (PCBs) (speciated)[b]			Alimentary System; Developmental; Endocrine System; Hematopoietic System; Reproductive System; Respiratory System
3,3',4,4'-Tetrachlorobiphenyl (77)[b]	35298-13-3	1.0×10^{-4}	
3,4,4',5-Tetrachlorobiphenyl (81)[b]	70362-50-4	1.0×10^{-4}	
2,3,3',4,4'- Pentachlorobiphenyl (105)[b]	32598-14-4	1.0×10^{-4}	

Table 6.3 Chronic Noninhalation 'Oral' Reference Exposure Levels (RELs) And Chronic Hazard Index Target Organ System(s)

Substance	Chemical Abstract Service Number (CAS)	Chronic Oral REL (mg/kg-day)	Chronic Oral Hazard Index Target Organ System(s)
2,3,4,4'5- Pentachlorobiphenyl (114)[b]	74472-37-0	2.0×10^{-5}	Alimentary System; Developmental; Endocrine System; Hematopoietic System; Reproductive System; Respiratory System
2,3'4,4',5- Pentachlorobiphenyl (118)[b]	31508-00-6	1.0×10^{-4}	
2',3,4,4',5- Pentachlorobiphenyl (123)[b]	65510-44-3	1.0×10^{-4}	
3,3',4,4',5- Pentachlorobiphenyl (126)[b]	57465-28-8	1.0×10^{-7}	
2,3,3',4,4',5-Hexachlorobiphenyl (156)[b]	38380-08-4	2.0×10^{-5}	
2,3,3',4,4',5'-Hexachlorobiphenyl (157)[b]	69782-90-7	2.0×10^{-5}	
2,3',4,4',5,5'-Hexachlorobiphenyl (167)[b]	52663-72-6	1.0×10^{-3}	
3,3',4,4'5,5'- Hexachlorobiphenyl (169)[b]	32774-16-6	1.0×10^{-6}	
2,3,3'4,4',5,5'- Heptachlorobiphenyl (189)[b]	39635-31-9	1.0×10^{-4}	

a The OEHHA has adopted the World Health Organization 1997 Toxicity Equivalency Factor (WHO_{97}-TEF) scheme for evaluating the cancer risk due to exposure to samples containing mixtures of polychlorinated dibenzo-*p*-dioxins (PCDD) (also referred to as chlorinated dioxins and dibenzofurans), polychlorinated dibenzofurans (PCDF) and polychlorinated biphenyls (PCBs). For convenience, OEHHA has calculated chronic REL values for speciated PCDDs, PCDFs and PCBs based on the WHO97 TEF values and the chronic REL for 2,3,7,8-tetrachlorodibenzo-*p*-dioxin using the procedure discussed in Appendix E. See Appendix E for more information about the scheme and for the methodology for calculating 2,3,7,8-equivalents for PCDD, PCDFs and PCBs. The oral chronic RELs for these compounds may be used if the mixtures are speciated to calculate a hazard index from individual congener doses.

7. Dose-Response Assessment for Carcinogens

7.1 Introduction

Dose-response assessment describes the quantitative relationship between the amount of exposure to a substance (the dose) and the incidence or occurrence of injury (the response). The process often involves establishing a toxicity value or criterion to use in assessing potential health risk. The toxicity criterion, or health guidance value, for carcinogens is the cancer potency slope (potency factor), which describes the potential risk of developing cancer per unit of average daily dose over a 70-year lifetime. Cancer inhalation and oral potency factors have been determined by the Office of Environmental Health Hazard Assessment (OEHHA) or by the United States Environmental Protection Agency (U.S. EPA) and endorsed by OEHHA. They are available for many of the substances listed in Appendix A (List of Substances) as carcinogens. Table 7.1 and Appendix L list the inhalation and oral cancer potency factors that should be used in multipathway health risk assessments (HRAs) for the Hot Spots Program.

The details on the methodology of dose-response assessment for carcinogens are provided in the 1985 California Department of Health Services publication *Guidelines for Chemical Carcinogen Risk Assessments and their Scientific Rationale* (CDHS, 1985). Substance-by-substance information is presented in OEHHA's document entitled, *The Air Toxics Hot Spots Program Risk Assessment Guidelines; Part II; Technical Support Document for Describing Available Cancer Potency Factors (OEHHA 1999b)* (Part II TSD).

7.2 Definition of Carcinogenic Potency

Cancer potency factors are expressed as the upper bound probability of developing cancer assuming continuous lifetime exposure to a substance at a dose of one milligram per kilogram of body weight, and are expressed in units of inverse dose as a potency slope [i.e., $(mg/kg/day)^{-1}$]. Another common potency expression is in units of inverse concentration [$(\mu g/m^3)^{-1}$)] when the slope is based on exposure concentration rather than dose; this is termed the unit risk factor. It is assumed in cancer risk assessments that risk is directly proportional to dose and that there is no threshold for carcinogenesis. The derivation of carcinogenic inhalation and oral cancer potency factors takes into account the available information on pharmacokinetics and on the mechanism of carcinogenic action. These values are generally the 95% upper confidence limits (UCL) on the dose-response slope. Table 7.1 and Appendix L list inhalation and oral cancer potency factors that should be used in risk assessments for the Hot Spots Program. Chapter 8 describes procedures for use of potency factors in estimating potential cancer risk.

7.2.1 Description of the Inhalation Cancer Potency Factor

Under the new risk assessment methodology and algorithms presented in Chapters 5 and 8, inhalation cancer slope factors must be expressed in units of inverse dose (i.e., $(mg/kg/day)^{-1}$). Unit

risk factors, in the units of inverse concentration as micrograms per cubic meter (i.e., $(\mu g/m^3)^{-1}$), which have been used in previous guidelines for the Hot Spots program, can also be used for assessing cancer inhalation risk directly from air concentrations. However, breathing rates, expressed in units of liters per kilogram of body weight-day (L/kg*BW-day or L/kg-day), can be coupled with the air concentrations to estimate dose in mg/kg-day. This allows estimation of average, high-end, and distributions of cancer risk. Therefore for the Hot Spots Program, inhalation cancer potency factors are now recommended for determining cancer risk instead of unit risk factors. Unit risk factors are still listed in the Part II TSD and may prove useful in other risk assessment applications.

Multiplication of the average daily inhalation dose over 70 years (mg/kg-day) with the cancer potency factor $(mg/kg\text{-}day)^{-1}$ will give inhalation cancer risk (unitless). A more complete description of how cancer risk is calculated from the exposure dose and cancer potency factors is provided in Chapter 8. Appendix I presents an example calculation for determining potential (inhalation) cancer risk. A list of current inhalation potency factors is provided in Table 7.1. Periodically, new or revised cancer potency factors will be peer reviewed by the State's Scientific Review Panel on Toxic Air Contaminants and adopted by the Director of OEHHA. At that time, these guidelines will be updated to reflect those changes. However, in the interim between the adoption of new or updated numbers and a guideline update, consult the OEHHA web site at *www.oehha.ca.gov* (look under "Air", then select "Hot Spots Guidelines") to determine if any new or updated cancer potency factors have been adopted since the last guideline update. If so, these too should be used in the HRA.

7.2.2 Description of the Oral Cancer Potency Factor

Under the Hot Spots Program, a few substances are considered multipathway substances. Multipathway substances have the potential to impact a receptor through inhalation and noninhalation (oral) exposure routes. These substances include heavy metals and semi-volatile organic substances such as dioxins, furans, and polycyclic aromatic hydrocarbons (PAHs). These substances commonly exist in the particle phase or partially in the particle phase when emitted into the air. They can therefore be deposited onto soil, vegetation, and water. Noninhalation exposure pathways considered under the Hot Spots Program include the ingestion of soil, homegrown produce, meat, milk, surface water, breast milk, and fish as well as dermal exposure to contaminants deposited in the soil. See Table 5.1 for a list of substances that must be evaluated for multipathway exposure.

Table 7.1 and Appendix L list oral cancer potency factors in units of $(mg/kg\text{-}day)^{-1}$ that should be used for assessing the potential cancer risk for these substances through noninhalation exposure pathways. The cancer risk from these individual pathways is calculated by multiplying the dose (mg/kg-day) times the oral cancer potency factor $(mg/kg\text{-}day)^{-1}$ to yield oral potential cancer risk (unitless). Chapter 5 provides all of the algorithms to calculate exposure dose through all of the individual exposure pathways. Appendix I provides a sample calculation for dose and cancer risk using the inhalation exposure pathway.

Four carcinogens (cadmium, hexavalent chromium, beryllium, and nickel), although subject to deposition, are only treated as carcinogenic by the inhalation route and not by the oral route. Therefore,

there are no oral cancer potency factors for these substances. However, the oral doses of these substances need to be estimated because of their noncancer toxicity. See Chapters 6 and 8, and Appendices I, J, and L for dose-response factors, and calculations to address these substances.

Table 7.1 Inhalation and Oral Cancer Potency Factors

Substance	Chemical Abstract Service Number (CAS)	Inhalation Potency Factor $(mg/kg\text{-}day)^{-1}$	Oral Slope Factor $(mg/kg\text{-}day)^{-1}$
Acetaldehyde	75-07-0	1.0×10^{-2}	
Acetamide	60-35-5	7.0×10^{-2}	
Acrylamide	79-06-1	$4.5 \times 10^{+0}$	
Acrylonitrile	107-13-1	$1.0 \times 10^{+0}$	
Allyl chloride	107-05-1	2.1×10^{-2}	
2-Aminoanthraquinone	117-79-3	3.3×10^{-2}	
Aniline	62-53-3	5.7×10^{-3}	
Arsenic (inorganic)	7440-38-2	$1.2 \times 10^{+1}$	$1.5 \times 10^{+0}$
Asbestos [#]	1332-21-4	1.9×10^{-4} [#]	
Benz[*a*]anthracene [BaP]	56-55-3	3.9×10^{-1}	$1.2 \times 10^{+0}$
Benzene	71-43-2	1.0×10^{-1}	
Benzidine	92-87-5	$5.0 \times 10^{+2}$	
Benzo[*a*]pyrene	50-32-8	$3.9 \times 10^{+0}$	$1.2 \times 10^{+1}$
Benzo[*b*]fluoranthrene [BaP]	205-99-2	3.9×10^{-1}	$1.2 \times 10^{+0}$
Benzo[*j*]fluoranthrene [BaP]	205-82-3	3.9×10^{-1}	$1.2 \times 10^{+0}$
Benzo[*k*]fluoranthrene [BaP]	207-08-9	3.9×10^{-1}	$1.2 \times 10^{+0}$
Benzyl chloride	100-44-7	1.7×10^{-1}	
Beryllium	7440-41-7	$8.4 \times 10^{+0}$	
Bis(2-chloroethyl) ether	111-44-4	$2.5 \times 10^{+0}$	
Bis(chloromethyl)ether	542-88-1	$4.6 \times 10^{++1}$	
1,3-Butadiene	106-99-0	6.0×10^{-1}	
Cadmium (and compounds)	7440-43-9	$1.5 \times 10^{+1}$	
Carbon tetrachloride	56-23-5	1.5×10^{-1}	
Chlorinated Dibenzo-*p*-dioxins [A]			
2,3,7,8-Tetrachlorodibenzo-*p*-dioxin	1746-01-6	$1.3 \times 10^{+5}$	$1.3 \times 10^{+5}$
1,2,3,7,8-Pentachlorodibenzo-*p*-dioxin	40321-76-4	$1.3 \times 10^{+5}$	$1.3 \times 10^{+5}$
1,2,3,4,7,8-Hexachlorodibenzo-*p*-dioxin	39227-28-6	$1.3 \times 10^{+4}$	$1.3 \times 10^{+4}$
1,2,3,6,7,8-Hexachlorodibenzo-*p*-dioxin	57653-85-7	$1.3 \times 10^{+4}$	$1.3 \times 10^{+4}$
1,2,3,7,8,9-Hexachlorodibenzo-*p*-dioxin	19408-74-3	$1.3 \times 10^{+4}$	$1.3 \times 10^{+4}$
1,2,3,4,6,7,8-Heptachlorodibenzo-*p*-dioxin	35822-46-9	$1.3 \times 10^{+3}$	$1.3 \times 10^{+3}$
1,2,3,4,,6,7,8,9-Octachlorodibenzo-*p*-dioxin	3268-87-9	$1.3 \times 10^{+1}$	$1.3 \times 10^{+1}$
Chlorinated Dibenzofurans [A]			
2,3,7,8-Tetrachlorodibenzofuran	5120-73-19	$1.3 \times 10^{+4}$	$1.3 \times 10^{+4}$

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Table 7.1 Inhalation and Oral Cancer Potency Factors

Substance	Chemical Abstract Service Number (CAS)	Inhalation Potency Factor $(mg/kg\text{-}day)^{-1}$	Oral Slope Factor $(mg/kg\text{-}day)^{-1}$
1,2,3,7,8-Pentachlorodibenzofuran	57117-41-6	$6.5 \times 10^{+3}$	$6.5 \times 10^{+3}$
2,3,4,7,8-Pentachlorodibenzofuran	57117-31-4	$6.5 \times 10^{+4}$	$6.5 \times 10^{+4}$
1,2,3,4,7,8-Hexachlorodibenzofuran	70648-26-9	$1.3 \times 10^{+4}$	$1.3 \times 10^{+4}$
1,2,3,6,7,8-Hexachlorodibenzofuran	57117-44-9	$1.3 \times 10^{+4}$	$1.3 \times 10^{+4}$
1,2,3,7,8,9-Hexachlorodibenzofuran	72918-21-9	$1.3 \times 10^{+4}$	$1.3 \times 10^{+4}$
2,3,4,6,7,8-Hexachlorodibenzofuran	60851-34-5	$1.3 \times 10^{+4}$	$1.3 \times 10^{+4}$
1,2,3,4,6,7,8-Heptachlorodibenzofuran	67562-39-4	$1.3 \times 10^{+3}$	$1.3 \times 10^{+3}$
1,2,3,4,7,8,9-Heptachlorodibenzofuran	55673-89-7	$1.3 \times 10^{+3}$	$1.3 \times 10^{+3}$
1,2,3,4,,6,7,8,9-Octachlorodibenzofuran	39001-02-0	$1.3 \times 10^{+1}$	$1.3 \times 10^{+1}$
Chlorinated paraffins	108171-26-2	8.9×10^{-2}	
Chloroform	67-66-3	1.9×10^{-2}	
4-Chloro-*o*-phenylenediamine	95-83-0	1.6×10^{-2}	
p-Chloro-*o*-toluidine	95-69-2	2.7×10^{-1}	
Chromium (hexavalent)	18540-29-9	$5.1 \times 10^{+2}$	
Chrysene **BaP**	218-01-9	3.9×10^{-2}	1.2×10^{-1}
Creosote	8001-58-9	*	
p-Cresidine	120-71-8	1.5×10^{-1}	
Cupferron	135-20-6	2.2×10^{-1}	
2,4-Diaminoanisole	615-05-4	2.3×10^{-2}	
2,4-Diaminotoluene	95-80-7	$4.0 \times 10^{+0}$	
Dibenz[*a*,*h*]acridine **BaP**	226-36-8	3.9×10^{-1}	$1.2 \times 10^{+0}$
Dibenz[*a*,*j*]acridine **BaP**	224-42-0	3.9×10^{-1}	$1.2 \times 10^{+0}$
Dibenz[*a*,*h*]anthracene **BaP**	53-70-3	$4.1 \times 10^{+0}$	$4.1 \times 10^{+0}$
Dibenzo[*a*,*e*]pyrene **BaP**	192-65-4	$3.9 \times 10^{+0}$	$1.2 \times 10^{+1}$
Dibenzo[*a*,*h*]pyrene **BaP**	189-64-0	$3.9 \times 10^{+1}$	$1.2 \times 10^{+2}$
Dibenzo[*a*,*I*]pyrene **BaP**	189-55-9	$3.9 \times 10^{+1}$	$1.2 \times 10^{+2}$
Dibenzo[*a*,*l*]pyrene **BaP**	191-30-0	$3.9 \times 10^{+1}$	$1.2 \times 10^{+2}$
7H-Dibenzo[*c*,*g*]carbazole **BaP**	194-59-2	$3.9 \times 10^{+0}$	$1.2 \times 10^{+1}$
1,2-Dibromo-3-chloropropane	96-12-8	$7.0 \times 10^{+0}$	
1,4-Dichlorobenzene	106-46-7	4.0×10^{-2}	
3,3'-Dichlorobenzidine	91-94-1	$1.2 \times 10^{+0}$	
1,1-Dichloroethane	75-34-3	5.7×10^{-3}	
Diesel exhaust **B**	NA	$1.1 \times 10^{+0}$	
Diethylhexylphthalate	117-81-7	8.4×10^{-3}	8.4×10^{-3}
p-Dimethylaminoazobenzene	60-11-7	$4.6 \times 10^{+0}$	
7,12-Dimethylbenz[*a*]anthracene **BaP**	57-97-6	$2.5 \times 10^{+2}$	$2.5 \times 10^{+2}$

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Table 7.1 Inhalation and Oral Cancer Potency Factors

Substance	Chemical Abstract Service Number (CAS)	Inhalation Potency Factor $(mg/kg\text{-}day)^{-1}$	Oral Slope Factor $(mg/kg\text{-}day)^{-1}$
1,6-Dinitropyrene **BaP**	42397-64-8	$3.9 \times 10^{+1}$	$1.2 \times 10^{+2}$
1,8-Dinitropyrene **BaP**	42397-65-9	$3.9 \times 10^{+0}$	$1.2 \times 10^{+1}$
2,4-Dinitrotoluene	121-14-2	3.1×10^{-1}	
1,4-Dioxane	123-91-1	2.7×10^{-2}	
Epichlorohydrin	106-89-8	8.0×10^{-2}	
Ethylene dibromide	106-93-4	2.5×10^{-1}	
Ethylene dichloride	107-06-2	7.2×10^{-2}	
Ethylene oxide	75-21-8	3.1×10^{-1}	
Ethylene thiourea	96-45-7	4.5×10^{-2}	
Formaldehyde	50-00-0	2.1×10^{-2}	
Hexachlorobenzene	118-74-1	$1.8 \times 10^{+0}$	
Hexachlorocyclohexanes (technical grade)	608-73-1	$4.0 \times 10^{+0}$	$4.0 \times 10^{+0}$
Hydrazine	302-01-2	$1.7 \times 10^{+1}$	
Indeno[1,2,3-*cd*]pyrene **BaP**	193-39-5	3.9×10^{-1}	$1.2 \times 10^{+0}$
Lead and lead compounds	7439-92-1	4.2×10^{-2}	8.5×10^{-3}
Lindane	58-89-9	$1.1 \times 10^{+0}$	
Methyl tertiary-butyl ether	1634-04-4	1.8×10^{-3}	
3-Methylcholanthrene **BaP**	56-49-5	$2.2 \times 10^{+1}$	$2.2 \times 10^{+1}$
5-Methylchrysene **BaP**	3697-24-3	$3.9 \times 10^{+0}$	$1.2 \times 10^{+1}$
4, 4'-Methylene bis(2-chloroaniline) (MOCA)	101-14-4	$1.5 \times 10^{+0}$	
Methylene chloride	75-09-2	3.5×10^{-3}	
4,4'-Methylenedianiline	101-77-9	$1.6 \times 10^{+0}$	$1.6 \times 10^{+0}$
Michler's ketone	90-94-8	8.6×10^{-1}	
Nickel (and compounds)	7440-02-0	9.1×10^{-1}	
5-Nitroacenaphthene **BaP**	602-87-9	1.3×10^{-1}	1.3×10^{-1}
6-Nitrochrysene **BaP**	7496-02-8	$3.9 \times 10^{+1}$	$1.2 \times 10^{+2}$
2-Nitrofluorene **BaP**	607-57-8	3.9×10^{-2}	1.2×10^{-1}
1-Nitropyrene **BaP**	5522-43-0	3.9×10^{-1}	$1.2 \times 10^{+0}$
4-Nitropyrene **BaP**	57835-92-4	3.9×10^{-1}	$1.2 \times 10^{+0}$
N-Nitroso-n-butylamine	924-16-3	$1.1 \times 10^{+1}$	
N-Nitroso-N-methylethylamine	10595-95-6	3.7×10^{0}	
N-Nitrosodi-*n*-propylamine	621-64-7	$7.0 \times 10^{+0}$	
N-Nitrosodiethylamine	55-18-5	$3.6 \times 10^{+1}$	
N-Nitrosodimethylamine	62-75-9	$1.6 \times 10^{+1}$	
N-Nitrosodiphenylamine	86-30-6	9.0×10^{-3}	
p-Nitrosodiphenylamine	156-10-5	2.2×10^{-2}	
N-Nitrosomorpholine	59-89-2	$6.7 \times 10^{+0}$	

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Table 7.1 Inhalation and Oral Cancer Potency Factors

Substance	Chemical Abstract Service Number (CAS)	Inhalation Potency Factor $(mg/kg\text{-}day)^{-1}$	Oral Slope Factor $(mg/kg\text{-}day)^{-1}$
N-Nitrosopiperidine	100-75-4	$9.4 \times 10^{+0}$	
N-Nitrosopyrrolidine	930-55-2	$2.1 \times 10^{+0}$	
Pentachlorophenol	87-86-5	1.8×10^{-2}	
Perchloroethylene	127-18-4	2.1×10^{-2}	
Polychlorinated biphenyls (PCBs) (unspeciated mixture)	1336-36-3		
(high risk) [P1]		$2.0 \times 10^{+0}$	$2.0 \times 10^{+0}$
(mediumlow risk) [P2]		4.0×10^{-1}	4.0×10^{-1}
(lowest risk) [P3]		7.0×10^{-2}	7.0×10^{-2}
Polychlorinated biphenyls[P4] (PCBs) (speciated)			
3,3',4,4'-Tetrachlorobiphenyl (77)	35298-13-3	$1.3 \times 10^{+1}$	$1.3 \times 10^{+1}$
3,4,4',5-Tetrachlorobiphenyl (81)	70362-50-4	$1.3 \times 10^{+1}$	$1.3 \times 10^{+1}$
2,3,3',4,4'- Pentachlorobiphenyl (105)	32598-14-4	$1.3 \times 10^{+1}$	$1.3 \times 10^{+1}$
2,3,4,4'5- Pentachlorobiphenyl (114)	74472-37-0	$6.5 \times 10^{+1}$	$6.5 \times 10^{+1}$
2,3'4,4',5- Pentachlorobiphenyl (118)	31508-00-6	$1.3 \times 10^{+1}$	$1.3 \times 10^{+1}$
2',3,4,4',5- Pentachlorobiphenyl (123)	65510-44-3	$1.3 \times 10^{+1}$	$1.3 \times 10^{+1}$
3,3',4,4',5- Pentachlorobiphenyl (126)	57465-28-8	$1.3 \times 10^{+4}$	$1.3 \times 10^{+4}$
2,3,3',4,4',5-Hexachlorobiphenyl (156)	38380-08-4	$6.5 \times 10^{+1}$	$6.5 \times 10^{+1}$
2,3,3',4,4',5'-Hexachlorobiphenyl (157)	69782-90-7	$6.5 \times 10^{+1}$	$6.5 \times 10^{+1}$
2,3',4,4',5,5'-Hexachlorobiphenyl (167)	52663-72-6	$1.3 \times 10^{+0}$	$1.3 \times 10^{+0}$
3,3',4,4'5,5'- Hexachlorobiphenyl (169)	32774-16-6	$1.3 \times 10^{+3}$	$1.3 \times 10^{+3}$
2,3,3'4,4',5,5'- Heptachlorobiphenyl (189)	39635-31-9	$1.3 \times 10^{+1}$	$1.3 \times 10^{+1}$
Potassium bromate	7758-01-2	4.9×10^{-1}	
1,3-Propane sultone	1120-71-4	$2.4 \times 10^{+0}$	
Propylene oxide	75-56-9	1.3×10^{-2}	
1,1,2,2-Tetrachloroethane	79-34-5	2.0×10^{-1}	
Thioacetamide	62-55-5	$6.1 \times 10^{+0}$	
2,4-Toluene diisocyanate	584-84-9	3.9×10^{-2}	
2,6-Toluene diisocyanate	91-08-7	3.9×10^{-2}	
1,1,2-Trichloroethane (vinyl trichloride)	79-00-5	5.7×10^{-2}	
Trichloroethylene	79-01-6	7.0×10^{-3}	
2,4,6-Trichlorophenol	88-06-2	7.0×10^{-2}	
Urethane	51-79-6	$1.0 \times 10^{+0}$	
Vinyl chloride	75-01-4	2.7×10^{-1}	

#	Asbestos: [100 PCM fibers/m^3]$^{-1}$ A unit risk factor of 2.7 x 10^{-6} ($\mu g/m^3$)$^{-1}$ and an inhalation cancer potency factor of 2.2 x 10^{+2} (mg/kg BW*day)$^{-1}$ are available (see Appendix C for explanation).
BaP	PAHs and PAH Derivatives: Many have potency equivalency factors relative to benzo[*a*]pyrene (see Appendix G).
A	Polychlorinated Dibenzo-*p*-dioxins and Polychlorinated Dibenzofurans: The World Health Organization 1997 (WHO-97) Toxicity Equivalency Factors are used for polychlorinated dibenzo-*p*-dioxins, polychlorinated dibenzofurans and polychlorinated biphenyls. (see Appendix E). For convenience, OEHHA has calculated cancer potency factors for speciated poly chlorinated biphenyls congeners using the procedure in Appendix E.
B	Diesel Exhaust is listed as a Toxic Air Contaminant by the Air Resources Board as "Particulate Matter from Diesel-Fueled Engines". (See Appendix D)
*	Creosote: Can be calculated using Potency Equivalency Factors contained in the benzo[*a*]pyrene Toxic Air Contaminant document and in Appendix G of these guidelines.
P1	Polychlorinated Biphenyls (PCBs): High Risk is for use in cases where congeners with more than four chlorines do not comprise less (are greater) than one-half percent of total PCBs. The high risk number is the default for Polychlorinated Biphenyls (PCBs).
P2	The low risk number is generally not applicable to the Hot Spots program. The Hot Spots program addresses PCBs emitted by stationary facilities. It cannot be assumed that such emissions would occur by simple evaporation. There is a dermal absorption factor applied in evaluation of the dermal pathway for PCBs so the medium risk would not apply to dermal exposure. The water pathway does not include an assumption that PCB isomers are water soluble, so the medium number would not apply to the water pathway.
P3	Polychlorinated Biphenyls (PCBs): Lowest Risk is for use in cases where congeners with more than four chlorines comprise less than one-half percent of total PCBs. In order for the low number to be used, scientific justification needs to be presented.
P4	Number in parentheses is the IUPAC #, the PCB nomenclature is IUPAC.

8. Risk Characterization for Carcinogens and Noncarcinogens and the Requirements for Hot Spots Risk Assessments

8.1 Introduction

Risk characterization is the final step of the health risk assessment (HRA). In this step, information developed through the exposure assessment (e.g., monitored or modeled concentrations, inhalation or oral doses, and exposure pathway information) is combined with cancer potency factors and Reference Exposure Levels (RELs) to quantify the cancer risk and noncancer health impacts, respectively. Under the Air Toxics Hot Spots (Hot Spots) Act, comprehensive risk assessments should quantify both individual and population-wide health risks (Health and Safety Code Section (HSC) 44306). Persons preparing HRAs for the Hot Spots Program should consult the local Air Pollution Control or Air Quality Management District (District) to determine if the District has special guidelines to assist with HRA format or other requirements of the Hot Spots Program. Note that, for the Hot Spots Program, the 70-year exposure duration should continue to be used as the basis for estimating risk.

This chapter provides guidance on how to evaluate the risk characterization components required by the Hot Spots Program. A general summary of the HRA components includes the following items or information. This information should be clearly presented in cross-referenced text, tables, figures, and/or maps.

- The location and potential acute noncancer, and multipathway (inhalation and noninhalation) cancer and noncancer chronic health impacts at the point of maximum impact (PMI), at the maximum exposed individual resident (MEIR), at the maximum exposed individual worker (MEIW), and at specified (contact District or reviewing authority) sensitive receptors (e.g., schools, hospitals, daycare, or eldercare facilities).

- Estimates of population exposure for potential cancer risk and noncancer acute and chronic health impacts.

To perform the HRA and create the information listed above, OEHHA recommends using a tiered approach to risk assessment. The tiered approach provides a risk assessor with flexibility and allows consideration of site-specific differences. Furthermore, risk assessors can tailor the level of effort and refinement of an HRA by using the point-estimate exposure assumptions or the stochastic treatment of exposure factor distributions. Tier-1 evaluations are required for all HRAs prepared for the Hot Spots Program. Persons preparing an HRA using Tier-2 through Tier-4 evaluations must also include the results of a Tier-1 evaluation in the HRA. The four-tiered approach to risk assessment is intended to primarily apply to residential cancer risk assessment, both for inhalation and noninhalation pathways. OEHHA is not recommending a stochastic approach (Tier-3) for worker exposure, or noncancer inhalation chronic evaluations. A Tier-2 evaluation could be used for off-site worker risk assessments.

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There is only a Tier-1 option for determining acute noncancer risks since calculating the hazard quotient only involves the acute REL and short-term maximum ground level air concentrations. There is only a Tier-1 option for evaluating inhalation noncancer chronic risks since calculating the chronic hazard quotient only involves the chronic Reference Exposure Level and the annual average concentration (not exposure parameter distributions). Chronic noninhalation noncancer risks involve a calculation of dose from oral pathways. It is possible that site-specific intake variates (e.g., fish consumption) could be appropriate for a particular site and therefore a Tier-2 analysis could be useful. See the *Air Toxics Hot Spots Program Risk Assessment Guidelines; Part IV; Technical Support Document for Exposure Assessment and Stochastic Analysis (OEHHA, 2000b)* (Part IV TSD) for a detailed discussion of the tiered approach. Table 8.1 summarizes OEHHA's recommendations for the four Tiers.

Table 8.1 Tiers for Cancer and Noncancer Hot Spots Risk Assessments

Tier	Cancer		Chronic Non Cancer		Acute
	Inhalation	Noninhalation	Inhalation	Noninhalation	Inhalation
Tier-1	X	X	X	X	X
Tier-2	X	X		X	
Tier-3	X	X			
Tier-4	X	X			

Cancer risk assessment as currently practiced involves estimating exposure to carcinogenic chemicals and multiplying the dose times the cancer potency factor. There are often questions regarding the validity of applying the cancer potency factors to less than lifetime exposures. The cancer potency or unit risk factors are estimated from long-term animal studies approaching lifetime, or from worker epidemiological studies involving long term exposure usually over decades.

8.2 Risk Characterization for Cancer Health Effects

8.2.1 Calculating Inhalation Cancer Risk

A 70-year inhalation cancer risk evaluation is required for all carcinogenic risk assessments (see Sections 8.2.2 and 8.2.3 for exposure duration information). There are two pieces of information needed to assess inhalation cancer risk. These are the inhalation cancer potency for the substance, expressed in units of inverse dose as a potency slope (i.e., $(mg/kg/day)^{-1}$) from Table 7.1, and an estimate of average daily inhalation dose in units of milligram per kilogram-day (mg/kg-day) (see Chapters 4 and 5). Cancer risk is calculated by multiplying the inhalation dose by the inhalation cancer potency factor to yield the potential inhalation excess cancer risk. The following equation illustrates the formula for calculating cancer risk. See Appendix I for an example calculation.

(Inhalation Dose (mg/kg-day)) x (Cancer Potency $(mg/kg-day)^{-1}$) = Cancer Risk

To convert this to chances per million of developing cancer, multiply the potential cancer risk by 10^6. This result is useful as a risk communication tool.

Tier-1 is a standard point-estimate approach that uses the recommended exposure pathway (e.g., breathing rate) point-estimates presented in this document. A Tier-1 evaluation must use the high-end point-estimate for the inhalation pathway to present the inhalation cancer risk. For the Hot Spots Program, the 70-year exposure duration should be used as the basis for public notification and risk reduction audits and plans. Sections 8.2.2 and 8.2.3 describe the use of exposure duration adjustment factors for residential and worker receptors. As supplemental information, the assessor may wish to evaluate the cancer risk by using the average point-estimate to provide a range of cancer risk to the risk manager. The assessor may also decide to further supplement the HRA by performing a Tier-3 evaluation using the daily breathing rate data distribution in a stochastic analysis. See Chapter 5 for the algorithms and exposure information used for all exposure pathways for Tier-1 and Tier-3 evaluations. The HARP software will perform all of these analyses. Specifically, the required high-end, 70-year inhalation cancer risk evaluation can be performed in HARP by selecting either the high-end point-estimate/cancer risk analysis or by selecting the derived/70-year cancer risk analysis.

The risk assessment guidelines require the use of the 95th percentile (i.e., high end) breathing rate for all assessments of cancer risk by the inhalation route in Tier-1 risk assessments in order to avoid underestimating risk to the public, including children. In general, the risk management of facilities in the Air Toxics Hot Spots program is based on the 70-year risk at the highest exposed receptor point using high-end estimates of breathing rate. Some facilities subject to the Air Toxics Hot Spots Act (e.g., some in the industry-wide categories) have very small zones of impact. In some of these instances, there will be very few receptors within the zone of impact. It isn't possible to develop special recommendations for all possible exposure scenarios. Alternative breathing rates (point estimates or distributions) may be used as part of Tier-2 or Tier-4 risk assessments. Thus, the risk manager should take this into account during any risk management decisions. OEHHA is willing to work with risk managers at ARB and the Districts on this issue. Further examination of the issue is warranted.

8.2.2 Calculating Cancer Risk Using Different Exposure Durations

A. Residential

OEHHA recommends the 70-year exposure duration (ED) be used for determining residential cancer risks. For the Hot Spots Program, the 70-year exposure duration should be used as the basis for public notification and risk reduction audits and plans. This will ensure that a person residing in the vicinity of a facility for a lifetime will be included in the evaluation of risk posed by that facility. Exposure durations of 9-years and 30-years may also be evaluated as supplemental information to show the range of cancer risk based on residency periods. Lifetime or 70-year exposure is the historical benchmark for comparing facility impacts on receptors and for evaluating the effectiveness of air pollution control measures. Although it is not likely that most people will reside at a single residence for 70 years, it is

common that people will spend their entire lives in a major urban area. While residing in urban areas it is very possible to be exposed to the emissions of another facility at the next residence. In order to help ensure that people do not accumulate an excess unacceptable cancer risk from cumulative exposure to stationary facilities at multiple residences, OEHHA recommends the 70-year exposure duration for risk management decisions. However, if a facility is notifying the public regarding cancer risk, it is useful information for a person who has resided in his current residence for less than 70 years to know that the calculated estimate of his or her cancer risk is less than that calculated for a 70-year risk.

Cancer risk assessment as currently practiced involves estimating exposure to carcinogenic chemicals and multiplying the dose times the cancer potency factor. There are often questions regarding the validity of applying the cancer potency factors to less than lifetime exposures. The cancer potency or unit risk factors are estimated from long-term animal studies approaching lifetime, or from worker epidemiological studies involving long term exposure usually over decades.

OEHHA has presented in this document exposure variates for estimating 9, 30 and 70-year exposures. These exposures are chosen to coincide with U.S. EPA's estimates of the average (9 years), high-end estimates (30-years) of residence time, and a typical lifetime (70 years). We support the use of cancer potency factors for estimating cancer risk for these exposure durations. However, as the exposure duration decreases the uncertainties introduced by applying cancer potency factors derived from very long term studies increases. Short-term high exposures are not necessarily equivalent to longer-term lower exposures even when the total dose is the same. OEHHA therefore does not support the use of current cancer potency factor to evaluate cancer risk for exposures of less than 9 years. If such risk must be evaluated, we recommend assuming that average daily dose for short-term exposure is assumed to last for a minimum of 9 years. OEHHA is evaluating cancer risk assessment methodologies over the next several years to address a number of issues including methods to evaluate short-term exposures to carcinogens.
If children younger than age 9 can be exposed to the emissions of a short term project, then the point estimates for a child should be used for an exposure period of 9 years to calculate a child's potential cancer risk. OEHHA is evaluating cancer risk assessment methodologies over the next several years to address a number of issues including methods to evaluate short-term exposures to carcinogens.

As presented in Chapter 5 and explained in the Part IV TSD, the 9-year (child) exposure duration is intended to represent the first 9-years of life. Children, for physiological as well as behavioral reasons, have higher rates of exposure (mg/kg-day) than adults. Therefore, the daily point-estimate (e.g., inhalation rate, soil ingestion rates) for the 9-year exposure duration is higher than for the 30 and 70-year (adult) exposure durations. When assessing the impacts specifically for children, the 9-year point-estimates and exposure factor distributions should be used. If a 9-year adult exposure duration is desired, then the 30 and 70-year point-estimates could be used and the cancer risk is adjusted using a factor of 9/70.

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The 30 and 70-year exposure durations are intended to represent the first 30 and first 70 years of life, respectively. However, in the interest of simplicity, the 30-year exposure duration scenario uses the same exposure point-estimates and data distributions as the 70-year exposure duration scenario. This assumption to use the 70-year exposure point-estimate for both 30 and 70-year exposures probably results in a small underestimation of dose for the 30-year exposure scenario, since the exposure parameters for earlier years are higher than years spent as an adult.

The mother's milk pathway is unlike other pathways because the (entire) dose to the breastfed infant is received in the first year of life. In evaluating risk from the pathway for 9, 30 and 70 years, it is assumed that the cancer risk from the one-year exposure to contaminants in mother's milk is equally spread over 70 years to obtain a lifetime risk. If an assessor wants to calculate the multipathway risk for a 9-year exposure duration, then the cancer risk for this exposure pathway is adjusted using a $9/70^{th}$ factor.

B. Worker

The general approach for estimating the potential health impacts to an offsite worker (e.g., MEIW) includes estimating the concentration at the receptor and identifying the duration of that exposure. The best way to determine potential impacts for a worker is to use the algorithms and exposure information in Chapter 5 and the HARP software.

There are three factors that affect worker exposure for cancer risk determination. The first is the offsite worker's schedule. For example, some workers such as teachers have three months off during the summer and some workers work throughout the year except for weekends, holidays and vacation. The second factor is the operating schedule of the emitting facility under consideration. This is important because the ISCST-3 air dispersion computer model, or other models typically calculate an annual average air concentration based on actual operating conditions. For example, the facility may operate 365 days a year, 24 hours a day or may operate eight hours a day, five days a week. The third factor is the coincidence of the offsite worker's schedule with the time that the facility is emitting. For example, if the facility emits during the day, five days a week, and the offsite worker is working only at night, then no inhalation exposure would occur.

If an adjustment needs to be made for the time that the worker is present (coincident with the emissions), then the standard default assumption is the worker is present for 5 days per week, 49 weeks per year, for 40 years. The 40-year working lifetime is the same assumption used under the Proposition 65 Regulation. The worker is assumed to breath 149 L/kg BW* day for an 8-hour workday. Other adjustments may be appropriate, such as for teachers or other workers. If the offsite worker only works part time, for example 4 hours per day, a factor of 0.5 (4/8) may be used to adjust the daily inhalation exposure proportionally.

If the annual average concentration of pollutants from the emitting facility (determined by the air model) is different than the air concentration that the worker breathes when present at the site, then the

annual average concentration for the worker inhalation pathway will need to be adjusted. For example, if the offsite worker and emitting facility are on concurrent schedules (i.e., the worker has a standard working schedule of eight hours per day, 5 days a week, and the facility emits 5 days a week, 8 hours per day), then the annual average air concentrations for the worker inhalation pathway would need be approximated by adjusting it upward using a factor of 4.2 (7/5 x 24/8). The annual average determined by the air modeling program is a 24 hour per day , 7 days per week, 365 days per year regardless of the actual operating schedule of the facility. The adjustment simply reflects the air concentration that the worker breathes. If the worker is only present some of the time that the facility is operating, then the average concentration that the worker breathes over his or her working day may be used.

For the chemicals where noninhalation pathways (e.g., soil ingestion and dermal exposure) need to be evaluated for workers, the annual average concentration should not be adjusted to account for the operating schedule of the emitting facility or the worker schedule (even if the facility emits only 5 days per week 8 hours per day while the offsite worker is present). The pollutant will be deposited and accumulate in the soil in the absence or presence of the worker; therefore, the total deposition and soil concentration will be dependent on the annual average air concentration.

If the calculation for determining a MEIW inhalation risk are not able to be performed using the original algorithms or the HARP software, then the adjustment factors in Table 8.2 may be of use for inhalation assessments only. The algorithms and assumptions in Chapter 5 must be used to determine multipathway impacts to a worker receptor.

Table 8.2: Adjustment Factors to Convert Inhalation Based Cancer Risk Estimates for a Residential Receptor to a Worker Receptor

Worker Receptor Type (Hrs/Days/Weeks/Years)	Facility Operating Schedule (Hrs/Days/Weeks/Years)	Adjustment Factor	
		(High End)*	(Average)*
Worker (8/5/49/40)	Continuous (24/7/52/70)	0.1516	0.2199
Worker (8/5/49/40)	Standard (8/5/52/70)	0.6366	0.9234
Teacher (8/5/36 T/40)	Continuous (24/7/52/70)	0.1114	0.1616
Teacher (8/5/36 T/40)	Standard (8/5/52/70)	0.4679	0.6787

* High End adjustment factors convert the residential receptor risk based on the high-end breathing rate point-estimate to a worker receptor risk. Average adjustment factors convert the residential receptor risk based on the average breathing rate point-estimate to a worker receptor risk.

T Number of weeks is based on school days per year reported by school district representatives.

C. Uses of Exposure Duration Adjustments for On-site Receptors

On-site workers are protected by CAL OSHA and do not have to be evaluated under the Hot Spots program, unless the worker also lives on the facility site, or property. Occasionally, facilities like

prisons, military bases, and universities have worker housing within the facility. In these situations the evaluation of on-site cancer risks, and/or acute and chronic noncancer hazard indices is appropriate under the Hot Spots program.

If the receptor lives and works on the facility, site, or property, then they should be evaluated under both scenarios and the one that is most health protective should be used.

The cancer risk estimates for the onsite residents may be done using the 70-year exposure variates and 40-year exposure duration. The use of the 70 year exposure variates will overestimate exposure to adult workers to a small extent because higher inhalation rates, etc., during the portion of a 70 year lifetime that a person is a child are incorporated. If the on-site resident under evaluation can be exposed through an impacted exposure pathway (other than inhalation), then that exposure pathway must be included. Other situations that may require on-site receptor assessment include the presence of locations where the public may have regular access for the appropriate exposure period (e.g., a lunchtime café, store, or museum for acute exposures). No exposure adjustments apply to acute exposure analyses. The District may be consulted on the appropriate evaluations for the risk assessment.

8.2.3 Speciation for Specific Classes of Compounds: Polycyclic Aromatic Hydrocarbons (PAHs),Polychlorinated Dibenzo-p-dioxins (PCDDs) and Dibenzofurans (PCDFs), and Polychlorinated Biphenyls (PCBs)

Health values and potency equivalency factors (PEFs) have been developed for approximately 26 PAHs (see Appendix G). When speciation of PAHs has been performed on facility emissions, these health values and PEFs should be used. In those cases where speciation of PAHs has not been performed, then benzo(a)pyrene or B(a)P serves as the surrogate carcinogen for all PAH emissions. A similar method has been developed for PCDDs and PCDFs, and PCBs known as toxicity equivalency factors (WHO TEFs), based on the number of chlorines and their position on the molecule (see Appendix E). Where speciation of PCDDs and PCDFs, and PCBs has been performed on facility emissions, the WHO TEFs should be used. In those cases where speciation of PCDDs and PCDFs has not been performed, then 2,3,7,8-tetrachlorodibenzo-*p*-dioxin (TCDD) serves as the surrogate for PCDD and PCDF emissions. Similarly, where only total PCBs are available, then the cancer potency factor for PCBs should be applied.

When using the HARP software, the emission contribution of speciated PAHs and PCDDs/PCDFs that have health values can be entered into the software. Unknown contributions of the PAH or PCDD/PCDF mixtures, or PAHs without a health value, should be assigned the appropriate surrogate. If a surrogate substance is used in the report, the facility-emitted substance (PAH mixture or PCDDs/PCDF mixture) must also be clearly indicated in the risk assessment as the actual substance emitted.

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Since the surrogates for total PAH (B(a)P) and total PCDD/PCDF (2,3,7,8-tetrachlorodibenzo-*p*-dioxin) are the most or nearly-the-most potent carcinogens in the class, use of the cancer potency factors for these with total emissions will overestimate the risk.

Given that speciation data on these classes of compounds can result in significant capital investment, it may be reasonable to run a screening estimate of risk on the unknown mixture using the appropriate surrogate compound to represent the class. If the resulting risk estimate is deemed significant enough to trigger health concerns, it would then be advisable to speciate the mixture and run a screening estimate using the speciated data.

8.2.4 Determination of Noninhalation (Oral) Cancer Risk

A small subset of Hot Spots substances is subject to deposition onto the soil, plants, and water bodies. These substances need to be evaluated by the appropriate noninhalation pathways, as well as by the inhalation pathway, and the results must be presented in all HRAs. These substances include semi-volatile organic chemicals and heavy metals.

For all multipathway substances, the minimum exposure pathways that must be evaluated at every residential site (in addition to inhalation) are soil ingestion and dermal exposure. If dioxins, furans, or PCBs are emitted, then the breast-milk consumption pathway becomes mandatory. The other exposure pathways (e.g., ingestion of homegrown produce or fish) are only evaluated if the facility impacts that exposure medium and the receptor under evaluation can be exposed to that medium or pathway. For example, if the facility does not impact a fishable body of water within the isopleth of the facility, or the impacted water body does not sustain fish, then the fish pathway will not be considered for that facility or receptor. Table 5.1 lists the multipathway substances and the pathways that can be considered for each substance. Table 8.3 identifies the residential receptor exposure pathways that are mandatory and those that are dependent on the available routes of exposure. Table 8.3 also identifies the three exposure pathways that are appropriate for a worker receptor.

Table 8.3 Mandatory and Site/Route Dependant Exposure Pathways

Mandatory Exposure Pathways	Site/Route Dependent Exposure Pathways
• Inhalation[w] • Soil Ingestion[w] • Dermal Exposure[w] • Breast-Milk or Mother's Milk Consumption*	• Homegrown Produce Ingestion • Fish Ingestion • Drinking Water Ingestion • Dairy (Cow's) Milk Ingestion • Meat (Beef, Pork, Chicken, and Egg) Ingestion

(*) If dioxins, furans, or PCBs are emitted, then the breast-milk consumption pathway becomes mandatory.
(w) Identifies the only appropriate exposure pathways that should be evaluated for a worker. These pathways are

inhalation, dermal exposure, and the soil ingestion pathways.

The oral cancer risk is calculated using the same steps as inhalation cancer risk described in Section 8.2.1. The only difference is that the inhalation dose is replaced by a noninhalation pathway dose (e.g., soil ingestion) and consideration is given to determining the dominant exposure pathways for the proper use of point-estimates (see Section 8.2.5).

In summary, an oral dose (see Chapters 4 and 5) from the pathway under evaluation (e.g., soil ingestion) is multiplied by the substance-specific oral slope factor, expressed in units of inverse dose as a potency slope (i.e., $(mg/kg/day)^{-1}$) from Table 7.1 or Appendix L, to yield the soil ingestion cancer risk. The following equation illustrates the formula for calculating cancer risk. Details (data, algorithms, and guidance) for each exposure pathway are presented in Chapter 5 and the Part IV TSD. See the discussion of Tier-1 in Section 8.2.6 or the Part IV TSD for the method used to determine the multipathway cancer risk. See Appendix I for an example calculation for the inhalation exposure pathway.

$$\left(\text{Oral Dose}\ \frac{mg}{kg-day}\right)\left(\text{Oral Slope Factor}\ \frac{kg-day}{mg}\right) = \quad \text{Potential Cancer Risk}$$

To convert this to chances per million of developing cancer, multiply the cancer risk by 10^6. This result is useful as a risk communication tool.

$$\text{Cancer risk x } 10^6 = \text{ chances per million}$$

8.2.5 Evaluation of Multipathway (Inhalation and Noninhalation) Cancer Risk

A. Deposition Rate

A deposition rate must be used when determining potential noninhalation health impacts. In the absence of facility specific information on the size of the emitted particles, the default values for deposition rate should be used. Currently, the default value of 0.02 meters per second is used for emission sources that have verifiable particulate matter control devices or for emission sources that may be uncontrolled but only emit particulate matter that is less than 2.5 microns (e.g., internal combustion engines powered by compressed natural gas). The 0.05 meters per second default value is used for risk assessment if the emissions are uncontrolled. If other deposition rate factors are used, sufficient support documentation must be included with the HRA.

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B. Use of Air Dispersion Modeling Results for Pastures and Water Bodies in Risk Assessment and the HARP Software

The substance or pollutant deposition to a drinking or pasture water body source and pastureland will be evaluated if an HRA includes the drinking water, fish ingestion, and cow's milk or meat (beef) exposure pathways. Two approaches are recommended for determining the deposition impacts to water bodies and pastureland. A simple approach is to select the results from a single receptor point on the grid laid over the area covered by the water body or pasture and assume that the modeled concentration at that grid-point is uniform across the water or pasture area. To make this first approach health protective, the grid-point within the area of the water body or pastureland with the highest modeled concentration should be used. A more refined approach is to average the air dispersion modeling results for all of the grid-points covering the area of the pasture or water body.

C. Summary of the Tiered Approach to Risk Assessment

The tiered approach for risk assessment that is presented in detail in the Part IV TSD and summarized here should be reviewed prior to estimating multipathway cancer risk. The tiered approach to risk assessment and the evaluation described here are included in the HARP software. The HARP software is the recommended model for calculating HRA results for the Hot Spots Program. Information on obtaining the HARP software can be found under the Air Toxics Program on the ARB's web site at *www.arb.ca.gov*.

Tier-1 is a standard point-estimate approach that uses the recommended exposure variate (e.g., breathing or water ingestion rate) point-estimates presented in this document. If an HRA cancer risk assessment involves multipathway residential exposures, then the risk assessor needs to first calculate the cancer risk from each pathway using the high-end exposure variates for all pathways. Then a second calculation is performed in which the pathways with the two highest cancer risks are added to the cancer risks from the rest of the pathways (if any) calculated with the average exposure variates. Dominant pathways are defined as the two exposure pathways that contribute the most to the total cancer risk estimate when using high-end point-estimates for all the exposure pathways under consideration. The final cancer risk calculation using a combination of high end and average exposure variates is referred to as derived risk in the HARP software and applies only to the residential receptor. There are only single values for exposure variates for the worker for the three pathways considered.

A similar procedure is used to determine the hazard index for the noncancer noninhalation pathways. The doses from all pathways (noninhalation) are calculated using the high-end exposure variate. The dose is used to calculate the hazard quotient for all noninhalation pathways. The hazard quotient for the inhalation pathway is calculated from the ground level concentration and the chronic REL. The three pathways with the highest hazard quotient are the dominant pathways. The remaining noninhalation pathways (if any) hazard quotients may be recalculated using the average exposure variates. The total hazard quotient for the chemical may be calculated by adding the

individual hazard quotients from the dominant pathways and those calculated with the average exposure variates.

Using the derived estimate of dose and risk will lessen the issue of compounding high-end exposure estimates, while retaining a health-protective approach for the more important exposure pathway(s). It is unlikely that an individual receptor would be on the high-end of exposure for all the intake variates (exposure pathways). Usually, inhalation is the dominant pathway posing the most cancer risk and noncancer chronic health impacts in the HRAs prepared for the Hot Spots Program. Occasionally, risks from other exposure pathways may also be dominant for lipophilic (fat-loving) compounds or metals. Therefore, for many facilities emitting volatile and multipathway chemicals, the inhalation pathway will be at least one of the two exposure pathways for which cancer risks are assessed using a high-end estimate (see Section 8.2.1).

The relatively health-protective assumptions incorporated into the Tier-1 risk assessment (e.g., 70-year exposure duration (for cancer) and the high-end values for key variates in the driving pathways) make it unlikely that the risks are underestimated for the general population. If the results indicate that a facility's estimated cancer risk and noncancer hazard are below the level of regulatory concern, further analysis may not be warranted. If the results are above a regulatory level of concern, the risk assessor may want to proceed with further analysis as described in Tier-2, or use a more resource-intensive stochastic modeling effort described in Tier-3 and Tier-4. While further evaluation may provide more information to the risk manager on which to base decisions, the Tier-1 evaluation is useful in comparing risks among a large number of facilities and must be included in all HRAs.

Tier-2 analysis allows the use of available site-specific information to develop point-estimates that are more appropriate to use in the site-specific HRA than the recommended point-estimates. In Tier-3, a stochastic approach to exposure assessment is taken using the exposure factor distributions presented in the Part IV TSD and in Chapter 5. The Part IV TSD exposure factor distributions apply only to a residential receptor and are used only for the determination of cancer risk. Tier-4 is also a stochastic approach but allows for utilization of site-specific distributions if they are justifiable and more appropriate for the site under evaluation than those recommended in this document.

Tier-3 and Tier-4 analyses show a distribution of cancer risk indicating the percent of the population exposed to various levels of risk. This type of analysis provides an illustration of population risk. The results from this type of analysis can also be used to show what percentage of the population would be protected with various risk management options.

OEHHA is not recommending a stochastic approach (Tier-3) for worker exposure, or noncancer inhalation chronic evaluations. A Tier-2 evaluation could be used for off-site worker risk assessments. There is only a Tier-1 option for determining acute noncancer risks since calculating the hazard quotient only involves the acute REL and short-term maximum ground level air concentrations. In addition, no exposure duration adjustment should be made for noncancer assessments.

D. Multipathway Cancer Risk Methodology

In order to characterize total substance risk for a single multipathway substance the inhalation risk is calculated by multiplying the inhalation dose (mg/kg-day) times the inhalation cancer potency factor to give the inhalation cancer risk (Section 8.2.1). Using Tier-1, the dermal and oral dose from each relevant exposure pathway is multiplied times the substance-specific oral potency factor to give the oral (noninhalation) cancer risk (see Sections 8.2.4 and 8.2.5). The inhalation cancer risk and oral cancer risk are then summed to give the multipathway cancer risk for that substance. Many facilities will emit multiple carcinogenic substances. If multiple substances are emitted, the cancer risk from each of the individual substances (including multipathway and volatile, inhalation-only substances) is summed to give the (total) multipathway cancer risk for the entire facility at the receptor location.

Cancer risks from different substances are treated additively in the Hot Spots Program in part because many carcinogens act through the common mechanism of DNA damage. However, this assumption fails to take into account the limited information on substance interactions. However, the overall uncertainty in the cancer potency factors and the variability in the human population is probably far greater than the uncertainty from the assumption of additivity. In addition, cancers are life threatening serious diseases so it is not unreasonable to consider total additive risk. Therefore, the additive assumption is reasonable from a public health point of view. Other possible interactions of multiple carcinogens include synergism (effects are greater than additive) or antagonism (effects are less than additive). The type of interaction is substance dependent and can be dose dependent. All three types of interactions have been demonstrated scientifically.

8.2.6 Risk Characterization for Stochastic Risk Assessment.

Risk characterization for a stochastic risk assessment is similar to that described for the point-estimate approach. However, the results of the stochastic risk assessment is a distribution of risk which accounts for some of the variability in cancer risk that results from natural variability in exposure, such as breathing rates or water intake. The cancer risk distribution for inhalation cancer risk, for example, is generated by multiplying random values from the breathing rate distribution times the ground level air concentration, and the cancer potency factor. A variation of the Monte Carlo method called Latin hypercube sampling is the method by which the values from the breathing rate distribution are selected. If noninhalation pathways need to be evaluated, the same process is followed for each pathway and the risk is summed to give an overall inhalation and noninhalation cancer risk distribution. Distributions are only available for some of the exposure variates and none are currently recommended for the fate and transport algorithms. As more data become available for exposure variates and fate and transport variates, OEHHA will expand the number of distributions in our model to better capture the variability in exposure and risk.

The HARP software will perform an HRA using either OEHHA or user-provided data distributions using a Monte Carlo analysis and include the statistics on the distributions. The 70-year

exposure duration should be used as the basis for public notification and risk reduction audits and plans. If an assessor would prefer to evaluate 9 or 30-year exposure durations, then a cancer risk distribution for 9 or 30-year exposure duration would be presented in addition to the 70-year exposure duration. An adult's analysis would use the 30 and 70-year data distributions. If a stochastic analysis is performed for a child, then the child's (9-year) distribution must be used. A stochastic approach for acute and chronic health impacts and worker (MEIW) exposures are not currently recommended. Information on obtaining the HARP software can be found under the Air Toxics Program on the ARB's web site at *www.arb.ca.gov*.

8.3 Risk Characterization for Noncarcinogens

Noncancer impacts are determined for acute (inhalation) exposure and for both inhalation and oral chronic exposure. Estimates of health impacts for noncancer endpoints are expressed as a hazard quotient (for individual substances) or a hazard index (for multiple substances). In addition, all hazard quotients (HQ) and hazard indices (HI) must be determined by target organ system. An HQ of one or less indicates that adverse health effects are not expected to result from exposure to emissions of that substance. As the HQ increases above one, the probability of human health effects increases by an undefined amount. However, it should be noted that a hazard index above 1 is not necessarily indicative of health impacts due to the application of uncertainty factors in deriving the Reference Exposure Levels. There are limitations to this method of assessing cumulative noncancer chronic health impacts. The impact on organ systems may not be additive if health effects occur by different mechanisms. However, the impact on organ systems could also be synergistic. An analysis by a trained health professional familiar with the substance's toxicological literature is usually needed to determine the public health significance of an HQ or HI above one. It is recommended that the Air District contact OEHHA if this situation presents itself. For assessing the noncancer health impacts of lead, different procedures are used; please see Appendix F.

There is only one approach to calculating the acute HI because the calculation is based on the highest short-term ground level air concentrations and the acute Reference Exposure Level. Likewise the chronic inhalation HI calculation is performed using the annual average ground level concentration and the chronic REL. Therefore no Tier-2, Tier-3 or Tier-4 options are available for acute or chronic noncancer inhalation hazard evaluation. However, there may be cases in which site specific fate and transport variates or exposure variates may be more appropriate to determine dose (mg/kg-day) for the noninhalation chronic HI; therefore, in some cases a Tier-2 evaluation may be appropriate for the noninhalation pathways.

Generally, the inhalation pathway is the largest contributor to the total dose. However, there are situations where a noninhalation pathway of exposure contributes substantially to a noncancer chronic HI. In these cases, the high-end point-estimate of dose is appropriate to use for the three dominant pathways and the average point-estimate for the non-dominant pathways. Dominant pathways are defined as the three pathways that contribute the most to the total hazard quotient for a chemical noncancer HI result when using high-end point-estimates for all the exposure pathways under

consideration. Typically inhalation would be one of these three pathways. In addition, no exposure duration adjustment (e.g., 9/70 or 30/70) should be made for noncancer assessments. See the Part IV TSD for a detailed discussion of the tiered approach, or Section 8.2.5 for a short overview of each tier.

Information contained in the following locations is needed to evaluate noncancer health impacts. Chapter 4 describes air dispersion modeling and both Chapter 6 and Appendix L list all the needed dose-response information. Appendix I presents sample calculations for determining chronic multipathway noncancer HQs and HIs and acute (inhalation) HQs and HIs. Chapter 9 provides an outline of information required for risk characterization. The HARP software is the recommended model for calculating and presenting HRA results for the Hot Spots Program. Information on obtaining the HARP software can be found under the Air Toxics Program on the ARB's web site at *www.arb.ca.gov*.

A. Evaluation of Background Criteria Pollutants

The District should be contacted to determine if the contribution of background criteria pollutants to respiratory health effects is required to be included in an HRA for the Hot Spots Program. If inclusion is required, the method for calculating the health impact from both acute and chronic exposure (respiratory endpoint) is the standard HI approach (see Sections 8.3.1 and 8.3.4). The background criteria pollutant contribution should be calculated if the HI from the facility's emissions exceeds 0.5 in either the acute or chronic assessment for the respiratory endpoint.

The most recent criteria pollutant concentration data should be obtained from the ARB's ambient air monitoring network and can be found in the *California Almanac of Emissions and Air Quality* on their web site at *www.arb.ca.gov*. For determining the criteria pollutant contribution in both the chronic and acute HI calculations, annual average concentration data should be taken from a monitoring site near the facility. If background contributions are unavailable, the District may direct the risk assessor to make an alternative assumption. The criteria pollutants that should be included in both the acute and chronic assessments for the respiratory endpoint are ozone, nitrogen dioxide, sulfur dioxide, sulfates, and hydrogen sulfide.

8.3.1 Noncancer Chronic Inhalation Health Impacts

All substances in the Hot Spots Program must be evaluated through the inhalation pathway. Noncancer chronic inhalation health impacts are calculated by dividing the substance-specific annual average air concentration in micrograms per cubic meter ($\mu g/m^3$) by the chronic inhalation REL ($\mu g/m^3$) (Table 6.2). An REL is used as an indicator of potential noncancer health impacts and is defined as the concentration at which no adverse noncancer health effects are anticipated. If this calculation is performed for a single substance, then it is called the hazard quotient (HQ). The following equation illustrates how to calculate the HQ for chronic inhalation exposure.

$$\text{Hazard Quotient} = \frac{\text{Annual Average Concentration } (mg/m^3)}{\text{Chronic Reference Exposure Level } (mg/m^3)}$$

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The risk characterization of cumulative noncancer chronic health impacts from the emissions of multiple substances by the inhalation route is accomplished by determining the HI. The HI is calculated by summing the HQs from all of the substances that affect the same organ system. Note, do not add the HQs or HIs for different target organs together (e.g., do not add the impacts for the eye to the cardiovascular system). Table 6.2 and Appendix L have a list of the organ systems affected by each substance. No exposure duration adjustment (e.g., 9/70) should be made for noncancer assessments. The following equation illustrates how to calculate the HI for chronic exposure for the eye (target organ) from two substances. See Appendix I for an example calculation.

$$\text{Hazard Index } (HI_{eye}) = HQ_{\text{substance 1(eye)}} + HQ_{\text{substance 2(eye)}}$$

8.3.2 Noncancer Chronic Health Impacts from the Oral Route

Risk characterization for chronic health effects from exposure via the oral route is also conducted using the hazard index approach. The hazard quotient is obtained by dividing the oral dose (derived from the annual average concentration) in milligrams per kilogram-day (mg/kg-day) by the oral chronic REL, expressed in units of (mg/kg-day) (Table 6.3). The point-estimates and algorithms for calculating the oral dose for all applicable exposure pathways and receptors (e.g., workers or residents) are explained in Chapter 5.

The high-end point-estimates are used for all exposure pathways to determine which exposure pathways are dominant. Once the dominant exposure pathways are decided, the assessor uses the high-end point-estimates for the two dominant noninhalation pathways and the average point estimates for the rest of the non-dominant exposure pathways to determine the dose and chronic health impacts at the residential receptor. The 70-year exposure duration point-estimates are used for residential receptors and the worker (single) point-estimates are used for the MEIW in this calculation. No exposure duration adjustment (e.g., 9/70) should be made for noncancer assessments. The oral HQ is calculated by dividing the oral dose by the oral chronic REL. The significance of oral HQs greater or less than one are the same as explained for the chronic inhalation chronic HQ in Section 8.3.1. The following equation illustrates how to calculate the HQ for chronic noninhalation exposure.
To estimate the hazard index from noninhalation exposures when multiple pollutants impact the same target organ, the oral HQ's are summed (See Section 8.3.3 below).

$$\text{Hazard Quotient}_{\text{oral}} = \frac{\text{Exposure Pathway Dose (mg/kg - day)}}{\text{Chronic (oral) Reference Exposure Level (mg/kg - day)}}$$

8.3.3 Evaluation of Chronic Noncancer Multipathway Hazard Quotients and Hazard Indices

To determine multipathway chronic noncancer health impacts, it is necessary to calculate the total hazard index from both inhalation and noninhalation exposures. First, the inhalation HQ is calculated (Section 8.3.1). Second, if the substance has an oral REL, then the oral HQ is calculated (see Sections 8.2.5, 8.3, and 8.3.2). For a residential receptor, the oral HQ is calculated using the 70-year high-end point-estimates for the two dominant noninhalation pathways and the average point-estimates for the rest of the pertinent exposure pathways. If a worker is under evaluation, then the worker single point-estimates are used for the soil and dermal pathways. The third step is to add the HQs together for each exposure pathway to give the substance's total multipathway HQ by target organ. If there is only one substance, then the multipathway HQ is the same as the HI.

- If there are multiple substances emitted, then the fourth step is to total the HQs for all the individual substances by each target organ. For example, add the HQs for all substances that impact the respiratory system, then repeat this step for the next target organ system (e.g., cardiovascular system). This step is repeated until all target organs (for the substances emitted) are individually totaled. These impacts by target organ are now referred to as the HI. Note, do not add the HQs or HIs for different target organ together (e.g., do not add the impacts for the respiratory system to the cardiovascular system). No exposure duration adjustment (e.g., 9/70) should be made for noncancer assessments. See Appendix I for an example calculation.

- For respiratory irritants, do not add in an oral contribution to the HI for the respiratory system for chemicals with both inhalation and oral RELs.

8.3.4 Noncancer Acute Health Impacts

Risk characterization for acute health effects uses the same principles (HQ, for an individual substance, and HI, for multiple substances) as the chronic noncancer inhalation methodology (see Section 8.3.1). All acute substances are evaluated through the inhalation pathway only.

- Noncancer acute health impacts are calculated by dividing the substance-specific short-term maximum concentration in micrograms per cubic meter ($\mu g/m^3$) by the acute REL (also in units of $\mu g/m^3$) (Table 6.1) for each substance. If this calculation is performed for a single substance, then it is called the HQ. The HQ should be applied to all appropriate target organs for a given substance.

- If multiple substances are emitted, then the next step is to total the individual substance's HQs by each target organ. For example, add the HQs for all substances that impact the respiratory system, then repeat this step for the next target organ system. This step is repeated until all target organs (for the substances emitted) are individually totaled. These impacts by target organ are now referred to as the HI. Note, do not add the

HQs or HIs for different target organs together (e.g., do not add the impacts for the respiratory system to immune system).

There are no oral acute RELs since it is anticipated that health effects from such a brief exposure via the oral route would be insignificant relative to the inhalation route. No exposure duration adjustment should be made for noncancer assessments. See Appendix I for an example calculation. HQs calculated using one, four, six, and seven hour exposure duration RELs may be added together for calculation of an acute HI. This would only occur in evaluating reproductive and developmental toxicants, since all other endpoints have only one hour acute RELs.

The HARP software incorporates two procedures for determining an acute HI. Both procedures use the calculations for HQ and HI described above. These two procedures make a difference when a facility has two or more separated emission points or for HRAs involving multiple facilities. The first procedure is a more simplistic approach (consistent with previous CAPCOA HRA methods) where the maximum concentrations from each emission source are superimposed to impact receptors at the same time, irrespective of wind direction and/ or atmospheric stability. This procedure is a simple, health protective approach to assess acute impacts. The second procedure is more refined than the first and improves on previous HRA methods. This second procedure takes into account meteorology and relative source positions by superimposing results from multiple sources with concurrent wind direction and atmospheric conditions, thereby computing a more refined maximum impact by hour at each receptor. This refined HI procedure may decrease the concentrations at many receptor locations when compared to the simplistic approach, but should not underestimate potential health impacts (i.e., HQs or HIs). This dual procedure approach is another way the new HRA guidelines are building flexibility into the HRA methods.

8.4 Population-Level Risk Estimates

8.4.1 Carcinogenic Risk

There are basically two ways to provide population-level risk estimates, namely cancer burden estimates and estimates of the number of people exposed at specific cancer risk levels.

1. The cancer burden is calculated by multiplying the number of people exposed (census information) by the cancer risk at either the MEIR or the population centroid of each census block. The result of this calculation is an estimate of the number of cancer cases expected from a 70-year exposure to current estimated facility emissions.

2. An estimate of the number of people exposed at various cancer risk levels can provide perspective on the magnitude of the potential public health threat posed by a facility. This approach is intended as a replacement for the cancer burden calculation used by some Districts in the past. The new approach provides a much easier way to interpret results when compared to cancer burden estimates. A facility in a sparsely populated

area can have a public health impact different from the same facility in a highly populated area. Such information can be useful in risk management decisions. The level of detail required for the population analysis (e.g., screening or refined) and the procedures to be used in determining geographic resolution and exposed population require case-by-case analysis and professional judgment. Some suggested approaches and methods for handling the breakdown of population and performance of a screening or refined population exposure analyses are provided in Section 4.6.

The population estimates should be based on the latest available census results. The population of the census block may be assumed to be equally distributed over the census block, unless for some reason more refined information is available. The population in census blocks cut by two or more risk isopleths can thus be apportioned based on the area in each isopleth. The isopleths needed should be drawn using the smallest practical grid size. The Districts may ask facilities to use the new procedure or the cancer burden approach. The District or reviewing authority should be consulted before beginning the population exposure estimates and, as results are generated, further consultation may be necessary.

A fundamental first step in estimating the number of people at risk from facility emissions is to define the zones of impact (see Section 4.6.1). This zone is commonly defined as the area within the isopleth surrounding the facility where receptors have a multipathway cancer risk greater than 10^{-6}. Some Districts may prefer to use a cancer risk of 10^{-7} to define the carcinogenic zone of impact. The total number of persons exposed to a series of potential risk levels can be presented to aid risk managers in understanding the magnitude of the potential public health impacts. See Table 8.3 for an example of data summarizing population exposure estimates for cancer risk.

Table 8.3 Example of Estimates of Population Risk

Estimated Number of Persons Exposed	Cancer Risk [N] (chances per million)
X	1 to 10
Y	10 to 100
Z	>100

(N) Column would be titled to reflect acute or chronic noncancer health impacts.

The HARP software can provide population-level risk estimates as cancer burden or as the number of persons exposed to a selected (user-identified) cancer risk level at block level centroids. Information on obtaining the HARP software can be found under the Air Toxics Program on the ARB's web site at *www.arb.ca.gov*. Chapter 9 provides an outline that specifies the content and recommended format of HRA results.

8.4.2 Population Estimates of Noncancer Health Impacts

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A noncancer chronic and acute population estimate of the number of people exposed to acute and chronic HQs or HIs exceeding 0.5 or 1.0, in increments of 1.0, should also be presented. For example, a facility with a maximum chronic HI of 4.0 would present the number of people exposed to a chronic HI of 0.5, 1.0, 2.0, 3.0, and 4.0. The isopleths used in this determination should be drawn using the smallest feasible grid size. The same methods that are described in Chapter 4 and Section 8.4.1 (for the population exposure estimate for cancer risk) should be used in the chronic and acute population estimates. Population estimates for acute and chronic health impacts should be presented separately and in a format consistent with Table 8.3.

9. Summary of the Requirements for a Modeling Protocol and a Health Risk Assessment Report

The purpose of this chapter is to clarify the type of information that is expected to be included in modeling protocols and health risk assessments (HRAs). These outlines are intended to promote transparent, consistent presentation and efficient review of these products. It is possible that protocols and HRAs that do not include all the information presented in these outlines may be considered deficient by the reviewing authority. We recommend that persons preparing these products consult with the local Air Pollution Control or Air Quality Management District (District) to determine if the District has modeling or HRA guidelines that supercede these outlines. If the District does not have guidelines for these products, then we recommend Section 9.1 be used for modeling protocols and Section 9.2 be used for the presentation of HRAs. Persons preparing modeling protocols and HRAs should specify the guidelines that were used to prepare their products.

9.1 Submittal of Modeling Protocol

It is strongly recommended that a modeling protocol be submitted to the District for review and approval prior to extensive analysis with an air dispersion model. The modeling protocol is a plan of the steps to be taken during the air dispersion modeling and risk assessment process. We encourage people who are preparing protocols to take advantage of the protocol step and fully discuss anticipated methodologies for any portion of your project that may need special consideration. Below, we have provided an example of the format that may be followed in the preparation of the modeling protocol. **Consult with the District to confirm format and content requirements or to determine the availability of District modeling guidelines before submitting the protocol.**

I. Introduction

- Include the facility name, address, and a brief overview describing the facility's operations.

- Provide a description of the terrain and topography surrounding the facility and potential receptors.

- Indicate the format in which data will be provided. Ideally, the report and summary of data will be on paper and all data and model input and output files will be provided electronically (e.g., compact disk or CD).

- Identify the guidelines used to prepare the protocol.

II. Emissions

- For each pollutant and process whose emissions are required to be quantified in the HRA, list the annual average emissions (pounds/year and grams/second) and maximum one-hour emissions (pounds/hour and grams/second)*.

- Identify the reference and method(s) used to determine emissions (e.g., source tests, emission factors, etc.). Clearly indicate any emission data that are not reflected in the previously submitted emission inventory report. In this event, a revised emission inventory report will need to be submitted to the District.

III. Models / Modeling Assumptions

- Identify the model(s) to be used, including the version number.

- Identify the model options that will be used in the analysis.

- Indicate complex terrain options that may be used, if applicable.

- Identify the source type(s) that will be used to represent the facility's operations (e.g., point, area, or volume sources, flare options or other).

- Indicate the preliminary source characteristics (e.g., stack height, gas temperature, exit velocity, dimensions of volume source, etc.).

- Identify and support the use of urban or rural dispersion coefficients for those models that require dispersion coefficients. For other models, identify and support the parameters required to characterize the atmospheric dispersion due to land characteristics (e.g., surface roughness, Monin-Obukhov length).

IV. Meteorological Data

- Specify the type, source, and year(s) of hourly meteorological data (e.g., hourly surface data, upper air mixing height information).

- State how the data are representative for the facility site.

- Describe QA/QC procedures.

- Identify any gaps in the data; if gaps exist, describe how the data gaps are filled.

*Except radionuclides, for which annual and hourly emissions are reported in Curies/year and millicuries/hour, respectively.

V. Deposition

- Specify the method to calculate deposition (if applicable).

VI. Receptors

- Identify the method that will be used to determine the location of sensitive receptors, the point of maximum impact (PMI), and the maximum exposed individual residential (MEIR) and worker (MEIW) receptors (e.g., fine receptor spacing of 20 meters at the fenceline and centered on the maximum impacts; coarse receptor spacing of 100 meters out to 2,000 meters; extra coarse spacing of 1,000 meters out to 20,000 meters).

- Identify the method that will be used to evaluate potential cancer risk in the vicinity of the facility for purposes of calculating cancer burden or population impact estimates. Clarify the same information for the presentation of noncancer impacts (e.g., centroids of the census tracts in the area within the zone of impact).

- Specify that actual UTM coordinates and the block/street locations (i.e., north side of 3,000 block of Smith Street), where possible, will be provided for specified receptor locations.

- Identify and support the use of any exposure adjustments.

- Identify if sensitive receptors are present and which receptors will be evaluated in the HRA.

VII. Maps

- Indicate which cancer risk isopleths will be plotted for the cancer zone of impact (e.g., 10^{-7}, 10^{-6} see Section 4.6.1).

- Indicate the hazard quotients or hazard indices to be plotted for the noncancer acute and chronic zones of impact (e.g., 0.5, 1.0, etc.).

9.2 Outline for a Health Risk Assessment Report

The purpose of this section is to provide an outline to assist with the preparation and review of heath risk assessments (HRAs). This outline specifies the key components that should be included in HRAs. All information used for the report must be presented in the HRA. Ideally, the HRA report and

a summary of data used in the HRA will be on paper and all data and model input and output files will be provided electronically (e.g., CD). Persons preparing HRAs for the Hot Spots Program should consult the District to determine if HRA guidelines or special formats are to be followed when preparing and presenting the HRA's results. If District guidelines or formats do not exist that supersede this outline, then the HRA should follow the format presented here. If the HRA is prepared for other programs, the reviewing authority should be consulted for clarification of format and content. We recommend that those persons preparing HRAs specify the guidelines that were used to prepare their product. The HRA may be considered deficient by the reviewing authority if components that are listed here are not included.

I. Table of Contents

- Section headings with page numbers indicated.
- Tables and figures with page numbers indicated.
- Appendices with page numbers indicated.

II. Executive Summary

- Name of the facility including the complete address.
- Facility identifier number (consult the District).
- Description of facility operations and a list identifying emitted substances including table of maximum 1-hour and annual average emissions.
- Provide a brief definition of acute, chronic, and cancer health impacts and multipathway substances.
- Text presenting overview of dispersion modeling and exposure assessment.
- Text defining dose-response assessment for cancer and noncancer health impacts and a table showing target organ systems by substance for noncancer impacts.

- Summary of results, including:
    - Location block/street location; e.g., north side of 3,000 block of Smith Street) and description of the off-site point of maximum impact (PMI), maximum exposed individual resident (MEIR), and maximum exposed individual worker (MEIW).

    - Location block/street location; e.g., north side of 3,000 block of Smith Street) and description of any on-site receptors that were evaluated at the facility (consult District or agency).

    - Location (block/street location; e.g., north side of 3,000 block of Smith Street) and description of any sensitive receptors that are required by the district or reviewing authorities (consult District or agency).

NOTE: When presenting the following information, potential cancer risk should be presented for a 70-year, Tier–1 analysis. Results of other exposure assumptions or tier evaluations can be presented, but must be clearly labeled. For the Hot Spots Program, the 70-year exposure duration should be used as the basis for public notification and risk reduction audits and plans.

- Text presenting an overview of the (total) potential multipathway cancer risk at the PMI, MEIR, MEIW, and sensitive receptors. Provide a table of cancer risk by substance for the MEIR and MEIW (if applicable). Include a statement indicating which of the substances appear to contribute most to (drive) the potential health impacts. In addition, identify the exposure pathways evaluated in the HRA.

- Provide a map of the facility and surroundings and identify the location of the MEIR, MEIW, and PMI.

- Provide a map of 70-year lifetime cancer risk zone of impact, if applicable.

- Text presenting an overview of the acute and chronic noncancer hazard quotients or the (total) hazard indices for the PMI, MEIR, MEIW, and sensitive receptors. Include separate statements (for acute and chronic exposures) indicating which of the substances appear to drive the potential health impacts. In addition, clearly identify the primary target organ(s) that are impacted from acute and chronic exposures.

- Identify any subpopulations (e.g., subsistence fishers) of concern.

- Table and text presenting an overview of estimates of population exposure (e.g., cancer burden or population estimates from HARP) (consult District or agency) (see Section 8.4).

- Version of the Risk Assessment Guidelines and computer program(s) used to prepare the risk assessment.

III. Risk Assessment Procedures

A. Hazard identification

- Table and text identifying all substances emitted from the facility, plus any other substances required by the District or reviewing authority. Include the CAS number of the substance and the physical form of the substance if possible. [The Hot Spots substances are listed in Appendix A, and also in the ARB's *Emission Inventory Criteria and Guidelines Regulations (Title 17, California Code of Regulations,*

Sections 93300-93300.5), and the *Emission Inventory Criteria and Guidelines Report* (EICG Report), which is incorporated by reference therein (ARB, 1997)].

- Table and text identifying all substances that are evaluated for cancer risk and/or noncancer acute and chronic health impacts. In addition, identify any substances that present a potential cancer risk or chronic noncancer hazard via noninhalation routes of exposure.

- Describe the types and amounts of continuous or intermittent *predictable* emissions from the facility that occurred during the reporting year. As required by statute, releases from a facility include spilling, leaking, pumping, pouring, emitting, emptying, discharging, injecting, escaping (fugitive), leaching, dumping, or disposing of a substance into ambient air. Include the substance(s) released and a description of the processes that resulted in long-term and continuous releases.

B. Exposure assessment

This section describes the information related to the air dispersion modeling process that should be reported in the risk assessment. In addition, doses calculated by pathway of exposure for each substance should be included in this section. The District may have specific requirements regarding format and content (see Section 4.13). **Sample calculations may need to be provided (in an appendix) for each step to indicate how the reported emissions data were used, if software other than HARP is used. The educated reader should be able to reproduce the risk assessment without the need for clarification. The location of any information that is presented in appendices, on electronic media, or attached documents that supports information presented in this section, must be clearly identified by title and page number in this section's text and in the document's table of contents.**

1. Information on the Facility and its Surroundings

- Report the following information regarding the facility and its surroundings:
  - Facility name
  - Facility identifier number (consult the District).
  - Location (use actual UTM coordinates and street address)
  - Land use type (see Section 4.4)
    - Local topography.
    - Facility plot plan identifying†
      - emission source locations
      - property line
      - horizontal scale
      - building heights and dimensions
      - complex terrain if applicable

- Description of the site/route dependent exposure pathways. Provide a summary of the site-specific inputs used for each pathway (e.g., water or grazing intake assumptions). This information may be presented in the appendix with the information clearly presented and cross-referenced to the text.

2. Source and Emission Inventory Information†

Source Description and Release Parameters

- Report the following information for each source in table format:
  - Source identification number used by the facility
  - Source name
  - Source location using actual UTM coordinates (m)
  - Source base elevation (m)
  - Source height (m)
  - Source dimensions (e.g., stack diameter, building dimensions, area size) (m)
  - Exhaust gas exit velocity (m/s)
  - Exhaust gas volumetric flow rate (ACFM)
  - Exhaust gas exit temperature (K)

(See Appendix K for an example.)

Source Operating Schedule

- The operating schedule for each source should be reported in table form including the following information:
  - Number of operating hours per day and per year (e.g., 0800-1700, 2700 hr/yr)
  - Number of operating days per week (e.g., Mon-Sat)
  - Number of operating days or weeks per year (e.g., 52 wk/yr excluding major holidays)

(See Appendix K for an example**.)**

Emission Control Equipment and Efficiency

- Report emission control equipment and efficiency by source and by substance. The description should be brief.

Emissions Data Grouped By Source

- Report emission rates for each toxic substance, grouped by source (i.e., emitting device or process identified in Inventory Report), in table form including the following information (see Appendix K):
  - Source name
  - Source identification number
  - Substance name and CAS number (Emittent ID from Inventory Guidelines)
  - Annual average emissions for each substance (lb/yr & g/s)*
  - Maximum one-hour emissions for each substance (lb/hr & g/s)*

*Except radionuclides, for which annual and hourly emissions are reported in Curies/year and millicuries/hour, respectively.

Emissions Data Grouped by Substance

- Report facility total emission rate by substance for all emitted substances listed in the Air Toxics Hot Spots Program including the following information (see Appendix K):
  - Substance name and CAS number (Emittent ID from Inventory Guidelines)
  - Annual average emissions for each substance (lb/yr & g/s)
  - Maximum one-hour emissions for each substance (lb/hr & g/s)

Emission Estimation Methods

- Report the methods used in obtaining the emissions data indicating whether emissions were measured or estimated. Clearly indicate any emission data that are not reflected in the previously submitted emission inventory report and submit a revised emission inventory report to the District. A reader should be able to reproduce the risk assessment without the need for clarification.

3. Meteorological Data

- The HRA should indicate the source and time period of the meteorological data used. Include the meteorological data (electronically) with the HRA.

- Include proper justification for using this data including information regarding appropriateness and quality assurance/quality control.

- Identify any gaps in the data; if gaps exist, describe how the data gaps are filled.
- Provide a wind rose for a minimum of the entire time period of the meteorological data used, and time period coincident with operating schedule. (Other wind roses may be useful as well, such as a stability rose or a day/night wind rose.)

- The HRA should indicate if the District required the use of a specified representative meteorological data set or the use of default meteorological conditions from SCREEN3. All memos indicating the District's approval of meteorological data should be attached in an appendix.

4. Model Selection and Modeling Rationale

- The report should include an explanation of the model chosen to perform the analysis and any other decisions made during the modeling process. The report should clearly indicate the name of the model used, the level of detail (screening or refined analysis) and the rationale behind the selection.

- Table and text that specifies the following information for each air dispersion model used:
  - version number
  - selected options and parameters
  - receptor grid spacing

5. Air Dispersion Modeling Results

- All information used for the report must be presented in the HRA. Ideally, a summary of data used in the HRA will be on paper and all data and model input and output (e.g., the ISCST3 input file containing the regulatory options and emission parameters, receptor locations, meteorology, etc) files will be provided electronically (e.g., CD).

- For the PMI, MEIR, MEIW, and any sensitive receptors required by the District, include tables that summarize the annual average concentrations that are calculated for all the substances at each site. We recommend the use of tables to present the relative contribution of each emission point to the receptor concentration. (These tables should have clear reference to the computer model that generated the data. It should be made clear to any reader how data from the computer output was transferred to these tables).

- For the PMI, MEIR, MEIW, and any sensitive receptors required by the District, include tables that summarize the maximum one-hour; four, six, or seven-hour (for those substance with RELs based on those averaging periods); and 30-day average (lead only‡) concentrations. (These tables should have clear reference to the computer model that generated the data. It should be made clear to any reader how data from the computer output was transferred to these tables).

- If proprietary software is used, all algorithms and parameters should be included with the HRA in a clear, easy to use format.

C. Dose-Response

- Provide tables of the inhalation and oral RELs and cancer potency factors for each substance that is quantified in the HRA.

- Identify the guidelines (title and date) that were used to obtain these factors.

- Provide a table of target organ systems for each noncancer substance, including chronic inhalation, chronic oral (if applicable), and acute.

D. Risk Characterization

The Hot Spots Analysis and Reporting Program (HARP) will generate the risk characterization data needed for the outline below. Any data needed to support the risk characterization findings should be clearly presented and referenced in the text and appendices. A listing of HARP output files that meet these HRA requirements are provided in this outline under the section entitled "Appendices". **All HARP files should be included in the HRA. Ideally, the HRA report and a summary of data used in the HRA will be on paper and all data and model input and output files will be provided electronically (e.g., CD). Information on obtaining copies of HARP is available on the California Air Resources Board's Internet web site under the Air Toxics Program at *www.arb.ca.gov*.**

NOTE: The potential cancer risk for the PMI, MEIR and sensitive receptors of interest must be presented in the HRA's text, tables, and maps using a (lifetime) 70-year exposure period. MEIW location should use appropriate exposure periods. For the Hot Spots Program, the 70-year exposure duration should be used as the basis for residential public notification and risk reduction audits and plans. All HRAs must include the results of a Tier-1 exposure assessment (see Chapter 2 and 8, or Part IV TSD). If the reviewing authority specifies that additional exposure periods should be presented, or if persons preparing the HRA would like to present additional information (i.e., exposure duration adjustments or the inclusions of risk

characterizations using Tier-2 through Tier-4 exposure data), then this information should be presented in separate, clearly titled, sections, tables, and text.

The following information should be presented in this section of the HRA. If not fully presented here, then by topic, clearly identify the section(s) and pages within the HRA where this information is presented.

- Description of receptors to be quantified.

- Table and text providing the location [UTM coordinates and the block/street address (e.g., north side of 3,000 block of Smith Street)] and description of the PMI, MEIR, and MEIW for both cancer and noncancer risks.

- Table and text providing description of the PMI and MEIR for 9-and 30-year cancer risk.

- Table and text providing the location [UTM coordinates and the block/street address (e.g., north side of 3,000 block of Smith Street)] and description of any sensitive receptors that are of interest to the District or reviewing authorities (consult District or agency).

- Provide any exposure information that is used for risk characterization (e.g., concentrations at receptors, emissions information, census information, figures, zone of impact maps, etc.). Identify the site/route dependent exposure pathways (e.g., water ingestion) for the receptor(s), where appropriate (e.g., MEIR). Provide a summary of the site-specific inputs used for each exposure pathway (e.g., water or grazing intake assumptions). This information may be presented in the appendix with the information clearly presented and cross-referenced to the text. In addition, provide reference to the appendix (section and page number) that contains the modeling (i.e., HARP/dispersion modeling) files that show the same information.

- If any exposure parameters were used other than those provided in the *Air Toxics Risk Assessment Guidelines; Part IV; Technical Support Document for Exposure Assessment and Stochastic Analysis (2000b)* (Part IV TSD), they must be presented in detail. The derivation and data used must be presented so that it is clear to the reviewer. The justification for using site-specific exposure parameters must be clearly presented.

- Include tables of the estimated dose for each substance by each exposure pathway at the PMI, MEIR, MEIW, and at any sensitive receptor locations (required by the District).

- Table and text presenting the potential multipathway cancer risk by substance, by pathway, and total, at the PMI, MEIR, MEIW, and sensitive receptor locations (required by the District).

- Table and text presenting the acute (inhalation) and chronic noncancer (inhalation and oral) hazard quotients (by substance, exposure pathways, and target organs) and the (total) hazard indices by substance and target organs for the PMI, MEIR, MEIW, and sensitive receptors. Note: chronic noncancer results should be shown with inhalation and oral contributions (shown separately) and for the combined (multipathway) impact.

- Identify any subpopulations (e.g., subsistence fishers) of concern.

- Table and text presenting estimates of population exposure (e.g., population exposure estimates or cancer burden from HARP) (consult District or agency). Tables should indicate the number of persons exposed to a (total) cancer risk greater than 10^{-7}, 10^{-6}, 10^{-5}, 10^{-4}, etc., and total hazard quotient or hazard index greater than 0.5, 1.0, 2.0, and 3.0, etc. Provide a table that shows excess cancer burden for each population unit and the total excess cancer burden, if cancer burden calculation is required.

- Provide maps that illustrate the HRA results for the three bullet points below. These maps should be an actual street map of the area impacted by the facility with elevation contours and actual UTM coordinates, and the facility boundaries clearly labeled. In some cases the elevation contours will make the map too crowded and should therefore not appear. This should be a true map (one that shows roads, structures, etc.), drawn to scale, and not just a schematic drawing. USGS 7.5-minute maps are usually the most appropriate choice (see Section 4.6). Note that the HARP program contains a mapping feature.
    - The facility (emission points and boundaries), the locations of the PMI, MEIR, MEIW, and sensitive receptors.

- Maps of the cancer zone of impacts (e.g., 10^{-6} or 10^{-7} levels - consult District or Agency). The map should clearly identify the zone of impact for the minimum exposure pathways (inhalation, soil ingestion, dermal exposure, and breast-milk consumption) and the zone of impact for all the applicable exposure pathways (minimum exposure pathways plus additional site/route specific pathways). Two maps may be needed to accomplish this. The legend of these maps should state the level(s) used for the zone of impact and identify the exposure pathways that were included in the assessment.
- Maps of the noncancer hazard index (HI) zone of impacts (e.g., 0.5 or 1.0 - consult District or Agency). The noncancer maps should clearly identify the noncancer zones of impact. These include the acute (inhalation), chronic (inhalation), and chronic (multipathway) zones of impact. For clarity, presentation of the noncancer zones of impact may require two or more maps. The legend of these maps should state the level(s) used for the zone of impact and identify the exposure pathways.

- The risk assessor may want to include a discussion of the strengths and weaknesses of the risk analyses and associated uncertainty directly related to the facility HRA.

- If appropriate, comment on the possible alternatives for control or remedial measures. How do the risks compare?

- If possible, identify any community concerns that influence public perception of risk.

- Sample calculations may be needed for all analyses in the HRA if proprietary software other than HARP was used. The District should be consulted. These calculations should be clearly presented and referenced to the findings they are supporting in the HRA text.

- Version of the Risk Assessment Guidelines and computer program used to prepare the risk assessment.

- If software other than HARP is used for the heath assessment modeling, all supporting material must be included with the HRA (e.g., all algorithms and parameters used in a clear, easy to review format).

E. References

F. Appendices

The appendices should contain all data, sample calculations, assumptions, and all modeling and risk assessment files that are needed to reproduce the HRA results. Ideally, a summary of data used in the HRA will be on paper and all data and model input and output files will be provided electronically (e.g., CD), unless otherwise specified by the district or reviewing

authority. All appendices and the information they contain should be referenced, clearly titled, and paginated. The HARP program (input and output) files will include many of the items listed below.

- **Potential Appendix Topics (if not presented elsewhere in the HRA report):**
  - List of all receptors locations (UTM coordinates and the block/street address (e.g., north side of 3,000 block of Smith Street)) for the PMI, MEIR, MEIW, and sensitive receptors.
  - List of all emitted substances.
  - All emissions files.
  - List of dose-response factors.
  - All air dispersion modeling input and output files. Detailed discussions of meteorological data, regulatory options, emission parameters, receptor locations, etc.
  - Census data.
  - Maps.
  - Identify the site/route dependent exposure pathways for the receptor(s), where appropriate (e.g., MEIR). Provide a summary of the site-specific inputs used for each pathway (e.g., water or grazing intake assumptions) and the data to support them.
  - All calculations used to determine emissions, concentrations, and potential health impacts at the PMI, MEIR, MEIW, and sensitive receptors.
  - All HRA model input and output (HARP) files for receptors of concern.
  - (Total) cancer and noncancer impacts by receptor, substance, and exposure pathway (by endpoint for noncancer) at all receptors.
  - Presentation of alternate risk assessment methods (e.g., alternate exposure durations, or Tier-2 to Tier-4 evaluations with supporting information).

- **List of HARP files that meet the Submittal Requirements**
  - ISC workbook file with all ISC parameters (filename.ISC).
  - ISC input file generated by HARP when ISC is run (filename.INP)
  - ISC output file generated by HARP when ISC in run (filename.OUT)
  - ISC binary output file; holds χ/Q for data for each hour (filename.BIN)
  - List of error messages generated by ISC (filename.ERR)
  - Sources receptor file; contains list of sources and receptors for the ISC run; generated by HARP when you set up ISC (filename.SRC)
  - Point estimate risk values generated by HARP; this file is updated automatically each time you perform one of the point estimate risk analysis functions (filename.RSK)
  - Average and maximum χ/Q values for each source-receptor combination; generated by ISC (filename.XOQ)
  - Plot file generated by ISC (filename.PLT)

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- Representative meteorological data used for the facility air dispersion modeling (filename.MET)
- Site-specific parameters used for all receptor risk modeling (filename.SIT)
- Map file used to overlay facility and receptors (filename.DEB)

(†) Health and Safety Code (HSC) Section 44346 authorizes facility operators to designate certain Hot Spots information as trade secret. HSC Section 44361(a) requires Districts to make health risk assessments available for public review upon request. HSC Section 44346 specifies procedures to be followed upon receipt of a request for the release of trade secret information. See also the Inventory Guidelines Report regarding the designation of trade secret information in the Inventory Reports.

(‡) Please see Appendix F or contact the Office of Environmental Health Hazard Assessment for information on calculating and presenting chronic lead results.

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Appendix A

Air Toxics Hot Spots Program

List Of Substances*

*The List of Substances presented in Appendix A is periodically updated by the California Air Resources Board. The last update was July 1, 1997.

Appendix A-I

Substances For Which

Emissions Must Be Quantified

July 1, 1997

The Air Toxics Hot Spots Program Guidance Manual for Preparation of Health Risk Assessments. August 2003.

APPENDIX A-I
Substances For Which Emissions Must Be Quantified

Emittent ID Other (Note [1]) Notes(s)	Substance Name (Note [2])	Add Date (Note [3])	Carcinogen (Note [4])	Applicable Degree of Accuracy (lb/yr) (Note [5])	Source List(s) (Note [6])
75070	Acetaldehyde		c	20.	1 2 3 4
60355	Acetamide		c	2.	1 2 3 4
75058	Acetonitrile	06/91		200.	1 2
98862	Acetophenone	06/91		100.	1 2
53963	2-Acetylaminofluorene [PAH-Derivative, POM]		c	100.	1 2 4 5
107028	Acrolein			0.05	1 2
79061	Acrylamide		c	0.01	1 2 3 4
79107	Acrylic acid	06/91		5.	1 2
107131	Acrylonitrile		c	0.1	1 2 3 4 5
107051	Allyl chloride		c	5.	1 2 4
7429905	Aluminum	06/91		100.	1
1344281	Aluminum oxide (fibrous forms)	06/91		100.	7
117793	2-Aminoanthraquinone [PAH-Derivative, POM]		c	5.	1 2 4 5
92671	4-Aminobiphenyl [POM]		c	100.	1 2 3 4 5
61825	Amitrole		c	0.1	3 4 5
7664417	Ammonia			200.	1 2
6484522	Ammonium nitrate	06/91		100.	1
7783202	Ammonium sulfate	06/91		100.	1
62533	Aniline	09/90	c	5.	1 2 4
90040	o-Anisidine		c	100.	1 2 3 4 5
-	Anthracene [PAH, POM], (see PAH)				
7440360	Antimony	06/91		1.	7
*	Antimony compounds	06/91		1.	1 2
[7]					
	including but not limited to:				
1309644	Antimony trioxide	09/90	c	1.	1 2 3 4
[7]					
7440382	Arsenic		c	0.01	1 2 3 4 5
1016	Arsenic compounds (inorganic)		c	0.01	1 2 3 4 5
[7]					
	including but not limited to:				
7784421	Arsine			0.01	1 2 7
[7]					
1017	Arsenic compounds (other than inorganic)	06/91		0.1	1
[7]					
7440393	Barium	06/91		1.	7
*	Barium compounds	06/91		1.	1
[7]					
-	Benz[a]anthracene [PAH, POM], (see PAH)				
71432	Benzene		c	2.	1 2 3 4 5

92875	Benzidine (and its salts) [POM]		c	0.0001	1 2 3 4 5	
1020	Benzidine-based dyes [POM]		c	0.0001	1 2 3	
	including but not limited to:					
1937377	Direct Black 38 [PAH-Derivative, POM]		c	0.0001	1 2 4 5	
2602462	Direct Blue 6 [PAH-Derivative, POM]		c	0.0001	1 2 4 5	
16071866	Direct Brown 95 (technical grade) [POM]	09/89	c	0.0001	1 2 4	
-	Benzo[a]pyrene [PAH, POM], (see PAH)					
-	Benzo[b]fluoranthene [PAH, POM], (see PAH)					
271896	Benzofuran	06/91	c	100.	4	

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98077	Benzoic trichloride {Benzotrichloride}		c	10.	1 2 4 5
-	Benzo[j]fluoranthene [PAH, POM], (see PAH)				
-	Benzo[k]fluoranthene [PAH, POM], (see PAH)				
98884	Benzoyl chloride	06/91		100.	1
94360	Benzoyl peroxide	06/91		100.	7
100447	Benzyl chloride		c	50.	1 2 4
7440417	Beryllium		c	0.001	1 2 3 4 5
*	Beryllium compounds	09/89	c	0.001	1 2 3 4 5
[7]					
92524	Biphenyl [POM]	06/91		0.5	1 2
111444	Bis(2-chloroethyl) ether {DCEE}	09/89	c	0.05	1 2 4
542881	Bis(chloromethyl) ether		c	0.001	1 2 3 4 5
103231	Bis(2-ethylhexyl) adipate	06/91		100.	1
7726956	Bromine			0.5	2
*	Bromine compounds (inorganic)			100.	1 2
[7]					
	including but not limited to:				
7758012	Potassium bromate			0.1	1 3 4
[7]					
75252	Bromoform	06/91		100.	1 2 4
106990	1,3-Butadiene		c	0.1	1 2 3 4 5
141322	Butyl acrylate	06/91		100.	1
71363	n-Butyl alcohol	06/91		100.	1
78922	sec-Butyl alcohol	06/91		100.	1
75650	tert-Butyl alcohol	06/91		100.	1
85687	Butyl benzyl phthalate	06/91		100.	1
7440439	Cadmium		c	0.01	1 2 3 4 5
*	Cadmium compounds		c	0.01	1 2 3 4 5
[7]					
156627	Calcium cyanamide	06/91		100.	1 2
105602	Caprolactam	06/91		100.	1 2
2425061	Captafol	09/89	c	100.	4
133062	Captan	09/90	c	100.	1 2 4
63252	Carbaryl [PAH-Derivative, POM]	06/91		100.	1 2
1050	Carbon black extracts		c	2.	1 3 4
75150	Carbon disulfide	09/89		200.	1 2 4
56235	Carbon tetrachloride		c	1.	1 2 3 4 5
463581	Carbonyl sulfide	06/91		100.	1 2
1055	Carrageenan (degraded)		c	100.	3 4
120809	Catechol	06/91		100.	1 2

133904	Chloramben	06/91		100.	1	2						
57749	Chlordane	09/89	c	10.	1	2		4				
108171262	Chlorinated paraffins (average chain length, C12; approximately 60% chlorine by weight)	09/89	c	2.					3	4	5	
7782505	Chlorine			0.5	1	2						
10049044	Chlorine dioxide	06/91		1.	1							
79118	Chloroacetic acid	06/91		100.	1	2						
532274	2-Chloroacetophenone	06/91		0.1	1	2						
106478	p-Chloroaniline	07/96		100.				4				7

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1058	Chlorobenzenes	06/91		100.	1
	including but not limited to:				
108907	Chlorobenzene			200.	1 2
25321226	Dichlorobenzenes (mixed isomers)	06/91		100.	1 7
	including:				
95501	1,2-Dichlorobenzene	06/91		200.	1 7
541731	1,3-Dichlorobenzene	06/91		100.	1 7
106467	p-Dichlorobenzene {1,4-Dichlorobenzene}		c	5.	1 2 3 5
120821	1,2,4-Trichlorobenzene	06/91		200.	1 2
510156	Chlorobenzilate [POM] {Ethyl-4,4'-dichlorobenzilate}	09/90	c	100.	1 2 4
67663	Chloroform		c	10.	1 2 3 4 5
107302	Chloromethyl methyl ether (technical grade)		c	100.	1 2 4 5
1060	Chlorophenols		c	100.	1 3
	including but not limited to:				
120832	2,4-Dichlorophenol	06/91	c	100.	1 7
87865	Pentachlorophenol	09/90	c	10.	1 2 4
58902	2,3,4,6-Tetrachlorophenol	07/96	c	100.	1 7
95954	2,4,5-Trichlorophenol	06/91	c	100.	1 2
88062	2,4,6-Trichlorophenol		c	2.	1 2 4
95830	4-Chloro-o-phenylenediamine		c	10.	3 4 5
76062	Chloropicrin			2.	7
126998	Chloroprene			5.	1 2
95692	p-Chloro-o-toluidine		c	0.5	3 4
7440473	Chromium	06/91		0.001	7
*	Chromium compounds (other than hexavalent) [7]	06/91		0.001	1 2
18540299	Chromium, hexavalent (and compounds) [7]		c	0.0001	1 2 3 4 5
	including but not limited to:				
10294403	Barium chromate [7]	06/91	c	0.001	1 2 5
13765190	Calcium chromate [7]	06/91	c	0.001	1 2 5
1333820	Chromium trioxide [7]	06/91	c	0.0001	1 2 5
7758976	Lead chromate [7]	06/91	c	0.001	1 2 5

10588019	Sodium dichromate	06/91	c	0.0001	1 2 5	[7]
7789062	Strontium chromate	06/91	c	0.001	1 2 5	[7]
-	Chrysene [PAH, POM], (see PAH)					
7440484	Cobalt	06/91		0.5		7
*	Cobalt compounds	06/91		0.5	1 2	[7]
1066	Coke oven emissions		c	0.05	1 2 3 4 5	
7440508	Copper			0.1	2	
*	Copper compounds	09/89		0.1	1 2	[7]
1070	Creosotes		c	0.05	1 3 4	
120718	p-Cresidine		c	1.	3 4 5	
1319773	Cresols (mixtures of) {Cresylic acid} including:			5.	1 2	
108394	m-Cresol	06/91		5.	1 2	
95487	o-Cresol	06/91		5.	1 2	
106445	p-Cresol	06/91		5.	1 2	
4170303	Crotonaldehyde	07/96	c	50.		7

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98828	Cumene	06/91		200.	1 2	
80159	Cumene hydroperoxide	06/91		100.	1	
135206	Cupferron		c	0.5	4 5	
1073	Cyanide compounds	06/91		0.05	1 2	[8]
	including but not limited to:					
74908	Hydrocyanic acid			10.	2	
110827	Cyclohexane	06/91		200.	1	
108930	Cyclohexanol	07/96		200.	7	
66819	Cycloheximide			2.	6	
1163195	Decabromodiphenyl oxide [POM]	06/91		100.	1 2	
1075	Dialkylnitrosamines			0.001	1	
	including but not limited to:					
924163	N-Nitrosodi-n-butylamine		c	0.0001	1 3 4 5	
1116547	N-Nitrosodiethanolamine		c	100.	1 3 4 5	
55185	N-Nitrosodiethylamine		c	0.001	1 3 4 5	
62759	N-Nitrosodimethylamine		c	0.01	1 2 3 4 5	
621647	N-Nitrosodi-n-propylamine		c	0.01	1 3 4 5	
10595956	N-Nitrosomethylethylamine		c	0.001	1 3 4	
615054	2,4-Diaminoanisole		c	5.	3 4	
1078	Diaminotoluenes (mixed isomers)	09/90	c	100.	1 4	
	including but not limited to:					
95807	2,4-Diaminotoluene {2,4-Toluenediamine}		c	0.05	1 2 3 4 5	
334883	Diazomethane	06/91	c	5.	1 2	
226368	Dibenz[a,h]acridine [POM]		c	0.5	1 2 3 4 5	
224420	Dibenz[a,j]acridine [POM]		c	0.5	1 2 3 4 5	
-	Dibenz[a,h]anthracene [PAH, POM], (see PAH)					
194592	7H-Dibenzo[c,g]carbazole		c	0.05	1 2 3 4 5	
-	Dibenzo[a,e]pyrene [PAH, POM], (see PAH)					
-	Dibenzo[a,h]pyrene [PAH, POM], (see PAH)					
-	Dibenzo[a,i]pyrene [PAH, POM], (see PAH)					
-	Dibenzo[a,l]pyrene [PAH, POM], (see PAH)					
132649	Dibenzofuran [POM]	06/91		100.	1 2	
-	Dibenzofurans (chlorinated) (see Polychlorinated dibenzofurans) [POM]					
96128	1,2-Dibromo-3-chloropropane {DBCP}		c	0.01	1 2 3 4 5	
96139	2,3-Dibromo-1-propanol	07/96	c	50.	4	
84742	Dibutyl phthalate	06/91		100.	1 2	
-	p-Dichlorobenzene {1,4-Dichlorobenzene} (see Chlorobenzenes)					

91941	3,3'-Dichlorobenzidine [POM]		c	0.1	1 2 3 4 5
72559	Dichlorodiphenyldichloroethylene {DDE} [POM]	09/89	c	100.	1 2 4
75343	1,1-Dichloroethane {Ethylidene dichloride}	09/90	c	20.	1 2 4
94757	Dichlorophenoxyacetic acid, salts and esters {2,4-D}	06/91		100.	1 2
78875	1,2-Dichloropropane {Propylene dichloride}	09/90	c	20.	1 2 4
542756	1,3-Dichloropropene		c	10.	1 2 3 4 5
62737	Dichlorovos {DDVP}	09/89	c	0.5	1 2 4
115322	Dicofol [POM]	06/91		100.	1 2

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- - [9]	Diesel engine exhaust	09/90	c		1 3 4
9901 [9]	Diesel engine exhaust, particulate matter	09/90	c	10.	1 3 4
9902 [9]	Diesel engine exhaust, total organic gas	09/90	c	10.	1 3 4
#	Diesel fuel (marine)	06/91	c		
111422	Diethanolamine	06/91		20.	1 2
117817	Di(2-ethylhexyl) phthalate {DEHP}		c	20.	1 2 3 4 5
64675	Diethyl sulfate		c	100.	1 2 3 4 5
119904	3,3'-Dimethoxybenzidine [POM]		c	100.	1 2 3 4 5
60117	4-Dimethylaminoazobenzene [POM]		c	0.01	1 2 3 4 5
121697	N,N-Dimethylaniline	06/91		200.	1 2
57976	7,12-Dimethylbenz[a]anthracene [PAH-Derivative, POM]	09/90	c	0.0001	1 2 4
119937	3,3'-Dimethylbenzidine {o-Tolidine} [POM]		c	10.	1 2 3 4 5
79447	Dimethyl carbamoyl chloride		c	100.	1 2 3 4 5
68122	Dimethyl formamide	09/90	c	100.	1 2 3
57147	1,1-Dimethylhydrazine		c	0.1	1 2 3 4 5
131113	Dimethyl phthalate	06/91		50.	1 2
77781	Dimethyl sulfate		c	0.01	1 2 3 4 5
534521	4,6-Dinitro-o-cresol (and salts)	06/91		100.	1 2
51285	2,4-Dinitrophenol	06/91		100.	1 2
42397648	1,6-Dinitropyrene [PAH-Derivative, POM]	06/91	c	0.001	1 2 3 4
42397659	1,8-Dinitropyrene [PAH-Derivative, POM]	06/91	c	0.05	1 2 3 4
25321146	Dinitrotoluenes (mixed isomers) including but not limited to:	06/91		100.	7
121142	2,4-Dinitrotoluene	09/89	c	0.5	1 2 4
606202	2,6-Dinitrotoluene	06/91		100.	7
123911	1,4-Dioxane		c	5.	1 2 3 4 5
-	Dioxins (Chlorinated dibenzodioxins) (see Polychlorinated dibenzo-p-dioxins) [POM]				
630933	Diphenylhydantoin [POM]		c	100.	1 2 4
122667	1,2-Diphenylhydrazine {Hydrazobenzene} [POM]		c	100.	1 2 4 5
1090	Environmental Tobacco Smoke		c	2.	1 3 4
106898	Epichlorohydrin		c	2.	1 2 3 4 5
106887	1,2-Epoxybutane	06/91		100.	1 2
1091	Epoxy resins	09/89		100.	6
140885	Ethyl acrylate		c	200.	1 2 3 4 5
100414	Ethyl benzene	06/91		200.	1 2

75003	Ethyl chloride {Chloroethane}			200.	1 2 4
-	Ethyl-4,4'-dichlorobenzilate (see Chlorobenzilate)				
74851	Ethylene	06/91		200.	7
106934	Ethylene dibromide {1,2-Dibromoethane}		c	0.5	1 3 4 5 6
107062	Ethylene dichloride {1,2-Dichloroethane}		c	2.	1 2 3 4 5
107211	Ethylene glycol	06/91		200.	1 2
151564	Ethyleneimine {Aziridine}	06/91		100.	1 2
75218	Ethylene oxide		c	0.5	1 2 3 4 5 6
96457	Ethylene thiourea		c	2.	1 2 3 4 5

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1101	Fluorides and compounds	09/89		100.	2
	including but not limited to:				
7664393	Hydrogen fluoride			50.	1 2 7
1103 [10]	Fluorocarbons (brominated)			200.	6
1104 [10]	Fluorocarbons (chlorinated)			200.	1 6
	including but not limited to:				
76131	Chlorinated fluorocarbon {CFC-113} {1,1,2-Trichloro-1,2,2-trifluoroethane}			200.	1 2 6
75456	Chlorodifluoromethane {Freon 22}	07/96		200.	1 6 7
75434	Dichlorofluoromethane {Freon 12}	07/96		200.	1 6 7
75694	Trichlorofluoromethane {Freon 11}	07/96		200.	1 6 7
50000	Formaldehyde		c	5.	1 2 3 4 5 6
110009	Furan	07/96	c	5.	4
- - [9]	Gasoline engine exhaust	09/90	c		3
	including but not limited to:				
- - [9]	Gasoline engine exhaust (condensates & extracts)	06/91	c		4
9910 [9]	Gasoline engine exhaust, particulate matter	09/90	c	100.	3 4
9911 [9]	Gasoline engine exhaust, total organic gas	09/90	c	100.	3 4
1110 [11]	Gasoline vapors		c	200.	1 2 3 4
111308	Glutaraldehyde			0.1	1 6
1115	Glycol ethers and their acetates			100.	1 2 6
	including but not limited to:				
111466	Diethylene glycol	09/90		100.	1 6
111966	Diethylene glycol dimethyl ether	09/90		100.	1 2 6
112345	Diethylene glycol monobutyl ether	09/90		100.	1 2 6
111900	Diethylene glycol monoethyl ether	09/90		100.	1 2 6
111773	Diethylene glycol monomethyl ether	09/90		100.	1 2 6
25265718	Dipropylene glycol	09/90		100.	1 6
34590948	Dipropylene glycol monomethyl ether	09/90		100.	1 6
629141	Ethylene glycol diethyl ether	09/90		100.	1 2 6
110714	Ethylene glycol dimethyl ether	09/90		100.	1 2 6
111762	Ethylene glycol monobutyl ether	09/90		200.	1 2 6

110805	Ethylene glycol monoethyl ether	09/89		50.	1	2				6				
111159	Ethylene glycol monoethyl ether acetate	09/90		100.	1	2				6				
109864	Ethylene glycol monomethyl ether	09/89		10.	1	2				6				
110496	Ethylene glycol monomethyl ether acetate	09/90		200.	1	2				6				
2807309	Ethylene glycol monopropyl ether	09/90		100.	1	2				6				
107982	Propylene glycol monomethyl ether	09/90		200.	1					6				
108656	Propylene glycol monomethyl ether acetate	09/90		100.	1					6				
112492	Triethylene glycol dimethyl ether	09/90		100.	1	2				6				
76448	Heptachlor	09/89	c	100.	1	2		4						
118741	Hexachlorobenzene		c	0.1	1	2	3		5					
87683	Hexachlorobutadiene	06/91		0.1	1	2								
1120	Hexachlorocyclohexanes(mixed or technical grade) including but not limited to:		c	0.05	1		3	4	5					
319846	alpha-Hexachlorocyclohexane	07/96	c	0.1	1		3	4	5		7			
319857	beta-Hexachlorocyclohexane	07/96	c	0.1	1		3	4	5		7			
58899	Lindane {gamma-Hexachlorocyclohexane}	09/90	c	0.1	1	2		4						

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77474	Hexachlorocyclopentadiene			2.	1 2
67721	Hexachloroethane	09/90	c	200.	1 2 4
680319	Hexamethylphosphoramide		c	100.	1 2 3 4 5
110543	Hexane	06/91		200.	1 2
302012	Hydrazine		c	0.01	1 2 3 4 5
7647010	Hydrochloric acid			20.	1 2
-	Hydrocyanic acid (see Cyanide compounds)				
7783064	Hydrogen sulfide			5.	1 2
123319	Hydroquinone	06/91		100.	1 2
-	Indeno[1,2,3-cd]pyrene [PAH, POM], (see PAH)				
13463406	Iron pentacarbonyl	07/96		5.	7
1125	Isocyanates			0.05	6
	including but not limited to:				
822060	Hexamethylene-1,6-diisocyanate	06/91		0.05	1 2
101688	Methylene diphenyl diisocyanate {MDI} [POM]	06/91		0.1	1 2
624839	Methyl isocyanate			1.	1 2
-	Toluene-2,4-diisocyanate (see Toluene diisocyanates)				
-	Toluene-2,6-diisocyanate (see Toluene diisocyanates)				
78591	Isophorone	06/91		200.	1 2
78795	Isoprene, except from vegetative emission sources	07/96	c	200.	3
67630	Isopropyl alcohol	06/91		200.	1
80057	4,4'-Isopropylidenediphenol [POM]	06/91		100.	1 2
7439921	Lead		c	0.5	1 4 6
1128 [7]	Lead compounds (inorganic)		c	0.5	1 3
	including but not limited to:				
301042 [7] [12]	Lead acetate		c	1.	1 2 4 5
-	Lead chromate (see Chromium, hexavalent)				
7446277 [7]	Lead phosphate		c	2.	1 4 5
1335326 [7] [12]	Lead subacetate	09/90	c	2.	1 2 4
1129 [7]	Lead compounds (other than inorganic)	06/91		5.	1 2
108316	Maleic anhydride			0.5	1 2
7439965	Manganese			0.1	1 2

*	Manganese compounds	09/89		0.1	1 2
[7]					
7439976	Mercury			1.	1 2 4 6
*	Mercury compounds	09/89		1.	1 2 4
[7]					
	including but not limited to:				
7487947	Mercuric chloride			1.	2
[7]					
593748	Methyl mercury {Dimethylmercury}			1.	2
[7]					
67561	Methanol			200.	1 2
72435	Methoxychlor [POM]	06/91		100.	1 2
75558	2-Methylaziridine {1,2-Propyleneimine}		c	100.	1 2 3 4
74839	Methyl bromide {Bromomethane}			20.	1 2 6
74873	Methyl chloride {Chloromethane}	06/91		20.	1 2
71556	Methyl chloroform {1,1,1-Trichloroethane}			200.	1 2 6
56495	3-Methylcholanthrene [PAH-Derivative, POM]	09/90	c	0.001	1 2 4
3697243	5-Methylchrysene [PAH-Derivative, POM]		c	0.05	1 2 3 4 5

APPENDIX A-I
Substances For Which Emissions Must Be Quantified

Emittent ID Other (Note [1])	Substance Name (Note [2])	Add Date (Note [3])	Carcinogen (Note [4])	Applicable Degree of Accuracy (lb/yr) (Note [5])	Source List(s) (Note [6])	Notes(s)
101144	4,4'-Methylene bis(2-chloroaniline) {MOCA} [POM]		c	0.1	1 2 3 4 5	
75092	Methylene chloride {Dichloromethane}		c	50.	1 2 3 4 5 6	
101779	4,4'-Methylenedianiline (and its dichloride) [POM]		c	0.1	1 2 3 4 5	
78933	Methyl ethyl ketone {2-Butanone}	06/91		200.	1 2	
60344	Methyl hydrazine	06/91		100.	1 2	
74884	Methyl iodide {Iodomethane}		c	100.	1 2 4 5	
108101	Methyl isobutyl ketone {Hexone}	06/91		20.	1 2	
75865	2-Methyllactonitrile {Acetone cyanohydrin}	07/96		50.	7	
80626	Methyl methacrylate			200.	1 2 6	
109068	2-Methylpyridine	07/96		100.	7	
1634044	Methyl tert-butyl ether	06/91		200.	1 2	
90948	Michler's ketone [POM]		c	0.1	1 2 4 5	
1136	Mineral fibers (fine, manmade) (fine mineral fibers which are manmade and are airborne particles of a respirable size greater than 5 microns in length, less than or equal to 3.5 microns in diameter, with a length to diameter ratio of 3:1)	06/91	c	100.	1 2 7	
	including but not limited to:					
1056	Ceramic fibers	09/89	c	100.	1 2 3 4	
1111	Glasswool fibers	09/89	c	100.	1 2 3 4	
1168	Rockwool fibers	09/89	c	100.	1 2 3	
1181	Slagwool fibers	09/89	c	100.	1 2 3	
1135	Mineral fibers (other than manmade)			100.	2 7	
	including but not limited to:					
1332214	Asbestos		c	0.0001	1 2 3 4 5	
12510428	Erionite		c	100.	2 3 4	
1190	Talc containing asbestiform fibers		c	100.	2 3 4	
1313275	Molybdenum trioxide	06/91		100.	1	
-	Naphthalene [PAH, POM], (see PAH)					
7440020	Nickel		c	0.1	1 2 3 4 5	
*	Nickel compounds		c	1.	1 2 3 4 5	[7]
	including but not limited to:					
373024	Nickel acetate	06/91	c	0.1	1 2 5	[7]
3333393	Nickel carbonate	06/91	c	0.1	1 2 5	[7]
13463393	Nickel carbonyl		c	0.1	1 2 4 5	[7]

12054487	Nickel hydroxide	06/91	c	0.1	1 2 5 [7]
1271289	Nickelocene	06/91	c	0.1	1 2 5 [7]
1313991	Nickel oxide	06/91	c	0.1	1 2 5 [7]
12035722	Nickel subsulfide		c	0.1	1 2 4 5 [7]
1146	Nickel refinery dust from the pyrometallurgical process	09/89	c	0.1	4
7697372	Nitric acid	06/91		50.	1
139139	Nitrilotriacetic acid		c	100.	1 4 5
98953	Nitrobenzene			0.5	1 2
92933	4-Nitrobiphenyl [POM]	09/89	c	100.	1 2 4
7496028	6-Nitrochrysene [PAH-Derivative, POM]	06/91	c	0.001	1 2 3 4
607578	2-Nitrofluorene [PAH-Derivative, POM]	06/91	c	5.	1 2 3 4

APPENDIX A-I
Substances For Which Emissions Must Be Quantified

Emittent ID Other (Note [1]) Notes(s)	Substance Name (Note [2])	Add Date (Note [3])	Carcinogen (Note [4])	Applicable Degree of Accuracy (lb/yr) (Note [5])	Source List(s) (Note [6])
302705	Nitrogen mustard N-oxide		c	0.05	3 4
100027	4-Nitrophenol	06/91		100.	1 2
79469	2-Nitropropane		c	0.01	1 2 3 4 5
5522430	1-Nitropyrene [PAH-Derivative, POM]	06/91	c	0.5	1 2 3 4
156105	p-Nitrosodiphenylamine [POM]		c	5.	1 2 4 5
684935	N-Nitroso-N-methylurea		c	100.	1 2 4 5
59892	N-Nitrosomorpholine		c	0.01	1 2 3 4 5
100754	N-Nitrosopiperidine		c	200.	3 4 5
930552	N-Nitrosopyrrolidine		c	0.05	3 4 5
- - [13]	PAHs (Polycyclic aromatic hydrocarbons) [POM]				1 2
	including but not limited to:				
1151	PAHs, total, w/o individ. components reported			50.	1 2
1150	PAHs, total, with individ. components also reported			50.	1 2
83329	Acenaphthene [PAH, POM]	07/96		50.	1
208968	Acenaphthylene [PAH, POM]	07/96		50.	1
120127	Anthracene [PAH, POM]	06/91		50.	1 2 7
56553	Benz[a]anthracene [PAH, POM]		c	0.5	1 2 3 4 5
50328	Benzo[a]pyrene [PAH, POM]		c	0.05	1 2 3 4 5
205992	Benzo[b]fluoranthene [PAH, POM]		c	0.5	1 2 3 4 5
192972	Benzo[e]pyrene [PAH, POM]	07/96		0.5	1
191242	Benzo[g,h,i]perylene [PAH, POM]	07/96		0.5	1
205823	Benzo[j]fluoranthene [PAH, POM]		c	0.5	1 2 3 4 5
207089	Benzo[k]fluoranthene [PAH, POM]		c	0.5	1 2 3 4 5
218019	Chrysene [PAH, POM]	09/90	c	5.	1 2 4
53703	Dibenz[a,h]anthracene [PAH, POM]		c	0.1	1 2 3 4 5
192654	Dibenzo[a,e]pyrene [PAH, POM]		c	0.05	1 2 3 4 5
189640	Dibenzo[a,h]pyrene [PAH, POM]		c	0.001	1 2 3 4 5
189559	Dibenzo[a,i]pyrene [PAH, POM]		c	0.001	1 2 3 4 5
191300	Dibenzo[a,l]pyrene [PAH, POM]		c	0.001	1 2 3 4 5
206440	Fluoranthene [PAH, POM]	07/96		0.5	1
86737	Fluorene [PAH, POM]	07/96		0.5	1
193395	Indeno[1,2,3-cd]pyrene [PAH, POM]		c	0.5	1 2 3 4 5
91576	2-Methyl naphthalene [PAH, POM]	07/96		50.	1
91203	Naphthalene [PAH, POM]			50.	1 2
198550	Perylene [PAH, POM]	07/96		0.5	1
85018	Phenanthrene [PAH, POM]	07/96		0.5	1
129000	Pyrene [PAH, POM]	07/96		0.5	1

#	PAH-Derivatives (Polycyclic aromatic hydrocarbon derivatives) [POM] (including but not limited to those substances listed in Appendix A with the bracketed designation [PAH-Derivative, POM]) [14]	06/91			
56382	Parathion	06/91		100.	1 2
1336363	PCBs (Polychlorinated biphenyls) [POM]		c	0.01	1 2 3 4 5 6
82688	Pentachloronitrobenzene {Quintobenzene}	06/91		100.	1 2
79210	Peracetic acid	06/91		100.	1
127184	Perchloroethylene {Tetrachloroethene}		c	5.	1 2 3 4 5 6

APPENDIX A-I
Substances For Which Emissions Must Be Quantified

Emittent ID Other (Note [1]) Notes(s)	Substance Name (Note [2])	Add Date (Note [3])	Carcinogen (Note [4])	Applicable Degree of Accuracy (lb/yr) (Note [5])	Source List(s) (Note [6])
108952	Phenol			200.	1 2
106503	p-Phenylenediamine	06/91		100.	1 2
90437	2-Phenylphenol [POM]	06/91		100.	1 2
75445	Phosgene			2.	1 2
7723140	Phosphorus			0.1	1 2
- -	Phosphorus compounds:	09/89			2
7803512	Phosphine			0.01	1 2 7
7664382	Phosphoric acid	09/89		50.	1 2
10025873	Phosphorus oxychloride	09/89		0.1	2
10026138	Phosphorus pentachloride	09/89		0.1	2
1314563	Phosphorus pentoxide	09/89		0.1	2
7719122	Phosphorus trichloride	09/89		0.1	2
126738	Tributyl phosphate	09/89		100.	2
78400	Triethyl phosphine	09/89		100.	2
512561	Trimethyl phosphate	09/89		100.	2
78308	Triorthocresyl phosphate [POM]	09/89		0.5	1 2
115866	Triphenyl phosphate [POM]	09/89		100.	1 2
101020	Triphenyl phosphite [POM]	09/89		100.	1 2
85449	Phthalic anhydride			0.01	1 2
- -	Polychlorinated dibenzo-p-dioxins {PCDDs or Dioxins} [POM] including but not limited to:		c		1 2
1086	Dioxins, total, w/o individ. isomers reported {PCDDs}		c	0.00002	1 2
1085	Dioxins, total, with individ. isomers also reported {PCDDs}		c	0.00002	1 2
1746016	2,3,7,8-Tetrachlorodibenzo-p-dioxin {TCDD} [POM]		c	0.000001	1 2 3 4 5
40321764	1,2,3,7,8-Pentachlorodibenzo-p-dioxin [POM]		c	0.000001	1 2
39227286	1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin [POM]		c	0.000001	1 2 4
57653857	1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin [POM]		c	0.000001	1 2
19408743	1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin [POM]		c	0.000001	1 2
35822469	1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin [POM]		c	0.000001	1 2
3268879	1,2,3,4,5,6,7,8-Octachlorodibenzo-p-dioxin [POM]	07/96	c	0.000001	1 2
41903575	Total Tetrachlorodibenzo-p-dioxin [POM]	07/96	c	0.000001	1 2
36088229	Total Pentachlorodibenzo-p-dioxin [POM]	07/96	c	0.000001	1 2
34465468	Total Hexachlorodibenzo-p-dioxin [POM]	07/96	c	0.000001	1 2
37871004	Total Heptachlorodibenzo-p-dioxin [POM]	07/96	c	0.000001	1 2

APPENDIX A-I
Substances For Which Emissions Must Be Quantified

Emittent ID Other (Note [1])	Substance Name (Note [2])	Add Date (Note [3])	Carcinogen (Note [4])	Applicable Degree of Accuracy (lb/yr) (Note [5])	Source List(s) (Note [6])	Notes(s)
- -	Polychlorinated dibenzofurans {PCDFs or Dibenzofurans} [POM] including but not limited to:		c		1 2	
1080	Dibenzofurans (Polychlorinated dibenzofurans) {PCDFs} [POM]		c	0.00002	1 2	
51207319	2,3,7,8-Tetrachlorodibenzofuran [POM]		c	0.000001	1 2	
57117416	1,2,3,7,8-Pentachlorodibenzofuran [POM]		c	0.000001	1 2	
57117314	2,3,4,7,8-Pentachlorodibenzofuran [POM]		c	0.000001	1 2	
70648269	1,2,3,4,7,8-Hexachlorodibenzofuran [POM]		c	0.000001	1 2	
57117449	1,2,3,6,7,8-Hexachlorodibenzofuran [POM]		c	0.000001	1 2	
72918219	1,2,3,7,8,9-Hexachlorodibenzofuran [POM]		c	0.000001	1 2	
60851345	2,3,4,6,7,8-Hexachlorodibenzofuran [POM]		c	0.000001	1 2	
67562394	1,2,3,4,6,7,8-Heptachlorodibenzofuran [POM]		c	0.000001	1 2	
55673897	1,2,3,4,7,8,9-Heptachlorodibenzofuran [POM]		c	0.000001	1 2	
39001020	1,2,3,4,5,6,7,8-Octachlorodibenzofuran [POM]	07/96	c	0.000001	1 2	
55722275	Total Tetrachlorodibenzofuran [POM]	07/96	c	0.000001	1 2	
30402154	Total Pentachlorodibenzofuran [POM]	07/96	c	0.000001	1 2	
55684941	Total Hexachlorodibenzofuran [POM]	07/96	c	0.000001	1 2	
38998753	Total Heptachlorodibenzofuran [POM]	07/96	c	0.000001	1 2	
#	POM (Polycyclic organic matter) (including but not limited to those substances listed in Appendix A with the bracketed designation of [POM], [PAH, POM], or [PAH-Derivative, POM])	09/89			1 2	[15]
1120714	1,3-Propane sultone		c	0.05	1 2 3 4 5	
57578	beta-Propiolactone		c	10.	1 2 3 4 5	
123386	Propionaldehyde	06/91		200.	1 2	
114261	Propoxur {Baygon}	06/91		100.	1 2	
115071	Propylene			200.	1 2	
75569	Propylene oxide		c	10.	1 2 3 4 5	
-	1,2-Propyleneimine (see 2-Methylaziridine)					
110861	Pyridine	06/91		100.		7
91225	Quinoline	06/91		100.	1 2	
106514	Quinone	06/91		100.	1 2	
1165	Radionuclides including but not limited to:		c	100.	1 2 4	[16]
24267569	Iodine-131	09/89	c	100.	1 2 4	
1166	Radon and its decay products	09/89	c	100.	1 4	

50555	Reserpine [POM]		c	100.	1	2		4	5		
#	Residual (heavy) fuel oils	06/91	c								
7782492	Selenium			0.5		2					
*	Selenium compounds			0.5	1	2					
[7]											
	including but not limited to:										
7446346	Selenium sulfide	09/90	c	0.1		2		4	5		
[7]											
1175	Silica, crystalline		c	0.1	1		3	4			
7440224	Silver	06/91		2.							7
*	Silver compounds	06/91		2.	1						
[7]											

APPENDIX A-I
Substances For Which Emissions Must Be Quantified

Emittent ID Other (Note [1]) Notes(s)	Substance Name (Note [2])	Add Date (Note [3])	Carcinogen (Note [4])	Applicable Degree of Accuracy (lb/yr) (Note [5])	Source List(s) (Note [6])
1310732	Sodium hydroxide			2.	1 2
100425	Styrene		c	100.	1 2 3 6
96093	Styrene oxide		c	100.	1 2 3 4
7664939	Sulfuric acid	06/91		2.	1
100210	Terephthalic acid	06/91		100.	1
79345	1,1,2,2-Tetrachloroethane	09/90	c	1.	1 2 4
7440280	Thallium	06/91		100.	7
*	Thallium compounds	06/91		100.	7
[7]					
62555	Thioacetamide		c	0.01	3 4 5
62566	Thiourea		c	0.1	1 3 4 5
7550450	Titanium tetrachloride	06/91		100.	1 2
108883	Toluene			200.	1 2 4 6
-	2,4-Toluenediamine (see 2,4-Diaminotoluene)				
1204	Toluene diisocyanates including but not limited to:	06/91	c	0.1	1 3
584849	Toluene-2,4-diisocyanate		c	0.1	1 2 3 5
91087	Toluene-2,6-diisocyanate		c	0.1	1 2 3 5
95534	o-Toluidine		c	10.	1 2 3 4 5
8001352	Toxaphene {Polychlorinated camphenes}		c	100.	1 2 3 4 5
79005	1,1,2-Trichloroethane {Vinyl trichloride}	06/91	c	50.	1 2 4
-	1,1,1-Trichloroethane (see Methyl chloroform)				
79016	Trichloroethylene		c	20.	1 2 4
-	2,4,6-Trichlorophenol (see Chlorophenols)				
96184	1,2,3-Trichloropropane	07/96	c	200.	3 4 7
121448	Triethylamine	06/91		20.	1 2
1582098	Trifluralin	06/91		100.	1 2
95636	1,2,4-Trimethylbenzene	06/91		5.	1
540841	2,2,4-Trimethylpentane	06/91		100.	1 2
51796	Urethane {Ethyl carbamate}		c	0.1	1 2 3 4 5
7440622	Vanadium (fume or dust)	06/91		10.	7
[17]					
108054	Vinyl acetate	06/91		200.	1 2
593602	Vinyl bromide		c	20.	1 2 3 4
75014	Vinyl chloride		c	0.5	1 2 3 4 5
100403	4-Vinylcyclohexene	07/96	c	5.	3
75025	Vinyl fluoride	07/96	c	200.	3
75354	Vinylidene chloride			20.	1 2
1206	Wood preservatives (containing arsenic and chromate)	09/89		100.	6

1210	Xylenes (mixed xylenes)		200.	1 2	6
	including:				
108383	m-Xylene	06/91	200.	1 2	
95476	o-Xylene	06/91	200.	1 2	
106423	p-Xylene	06/91	200.	1 2	
7440666	Zinc		2.	2	
*	Zinc compounds	09/89	2.	1 2	
[7]					
	including but not limited to:				
1314132	Zinc oxide		2.	2	
[7]					

Appendix A-II

Substances For Which Production, Use,

Or Other Presence Must Be Reported

July 1, 1997

APPENDIX A-II
Substances For Which Production, Use, Or Other Presence Must Be Reported

Emittent ID (Note [1])	Substance Name (Note [2])	Add Date (Note [3])	Carcinogen (Note [4])	Source List(s) (Note [6])	Other Notes(s)
26148685	A-alpha-C {2-Amino-9H-pyrido[2,3-b]indole}	09/89	c	3 4	[18]
34256821	Acetochlor	09/89	c	4	
62476599	Acifluorfen [POM]	09/90	c	1 2 4	
3688537	AF-2		c	3 4	
1000	Aflatoxins		c	3 4 5	
15972608	Alachlor	09/89	c	4	
309002	Aldrin	09/89	c	4	
107186	Allyl alcohol	06/91		7	
60093	p-Aminoazobenzene {4-Aminoazobenzene} [POM]		c	1 2 3 4	
97563	o-Aminoazotoluene [POM]		c	1 2 3 4 5	
6109973	3-Amino-9-ethylcarbazole hydrochloride [POM]	09/89	c	1 2 4 5	
125848	Aminoglutethimide	09/90		4	
82280	1-Amino-2-methylanthraquinone [PAH-Derivative, POM]		c	1 2 4 5	
68006837	2-Amino-3-methyl-9H-pyrido(2,3-b) indole {MeA-alpha-C}	09/89	c	3 4	
712685	2-Amino-5-(5-nitro-2-furyl)-1,3,4-thiadiazole		c	3 4	
-	2-Amino-9H-pyrido(2,3-b)indole (see A-alpha-C)				
134292	o-Anisidine hydrochloride		c	4 5	
104949	p-Anisidine	06/91		7	
140578	Aramite		c	3 4	
492808	Auramine [POM]		c	1 2 3 4 5	
446866	Azathioprine		c	3 4 5	
103333	Azobenzene [POM]	09/90	c	1 2 4	
98873	Benzal chloride	06/91		7	
55210	Benzamide	06/91		7	
1694093	Benzyl violet 4B [POM]		c	1 2 3 4	
1025	Betel quid with tobacco		c	3 4	
494031	N-N-Bis(2-chloroethyl)-2-naphthylamine {Chlornaphazine} [PAH-Derivative, POM]		c	1 2 3 4 5	
108601	Bis(2-chloro-1-methylethyl) ether	06/91		7	
1030	Bitumens, extracts of steam-refined and air-refined bitumens		c	3 4	
1035	Bleomycins		c	3	
75274	Bromodichloromethane	09/90	c	4	
1689845	Bromoxynil	06/91		4	
25013165	Butylated hydroxyanisole {BHA}		c	3 4	
123728	Butyraldehyde	06/91		7	
3068880	beta-Butyrolactone		c	3 4	
630080	Carbon monoxide	09/89		4	
143500	Chlordecone {Kepone}		c	3 4	
6164983	Chlordimeform	09/89	c	4	
115286	Chlorendic acid	09/89	c	3 4 5	
124481	Chlorodibromomethane	09/90	c	4	

563473	3-Chloro-2-methylpropene	09/89	c		4 5
1065	Chlorophenoxy herbicides		c	3	
1897456	Chlorothalonil	09/89	c		4
1059	p-Chloro-o-toluidine (strong acid salts)	06/91	c	3	

APPENDIX A-II
Substances For Which Production, Use, Or Other Presence Must Be Reported

Emittent ID (Note [1])	Substance Name (Note [2])	Add Date (Note [3])	Carcinogen (Note [4])	Source List(s) (Note [6])	Other Notes(s)
4680788	C. I. Acid Green 3 [POM]	06/91		1 2 7	
569642	C. I. Basic Green 4 [POM]	06/91		1 2 7	
989388	C. I. Basic Red 1 [POM]	06/91		1 2 7	
569619	C. I. Basic Red 9 monohydrochloride [POM]	09/89	c	1 2 4 5	
2832408	C. I. Disperse Yellow 3 [POM] (NOTE: "C. I." means "color index")	06/91		1 2 7	
87296	Cinnamyl anthranilate [POM]	09/89	c	1 2 4 5	
6358538	Citrus Red No. 2 [POM]		c	1 2 3 4	
8007452	Coal tars	09/89	c	3 4 5	
21725462	Cyanazine	09/90		4	
14901087	Cycasin		c	3 4	
13121705	Cyhexatin	09/89		4	
3468631	D and C Orange No. 17 [PAH-Derivative, POM]	09/90	c	1 2 4	
81889	D and C Red No. 19 [POM]	09/90	c	1 2 4	
2092560	D and C Red No. 8 [PAH-Derivative, POM]	06/91	c	1 2 4	
5160021	D and C Red No. 9 [PAH-Derivative, POM]	09/90	c	1 2 4	
1596845	Daminozide	09/90	c	4	
50293	DDT {1,1,1-Trichloro-2,2-bis(p-chlorophenyl)ethane} [POM]		c	1 2 3 4 5	
613354	N,N'-Diacetylbenzidine [POM]		c	1 2 3 4	
2303164	Diallate	06/91		7	
39156417	2,4-Diaminoanisole sulfate		c	4 5	
101804	4,4'-Diaminodiphenyl ether [POM]		c	1 2 3 4 5	
764410	1,4-Dichloro-2-butene	09/90	c	4	
28434868	3,3'-Dichloro-4,4'-diaminodiphenyl ether [POM]	09/89	c	1 2 3 4	
72548	Dichlorodiphenyldichloroethane {DDD} [POM]	09/89	c	1 2 4	
540590	1,2-Dichloroethylene	06/91		7	
78886	2,3-Dichloropropene	06/91		7	
60571	Dieldrin	09/89	c	4	
1464535	Diepoxybutane		c	3 4 5	
1615801	1,2-Diethylhydrazine		c	3 4	
84662	Diethyl phthalate	06/91		7	
101906	Diglycidyl resorcinol ether {DGRE}		c	3 4 5	
94586	Dihydrosafrole		c	3 4	
20325400	3,3'-Dimethoxybenzidine dihydrochloride [POM]	06/91	c	1 2 4	
55738540	trans-2-[(Dimethylamino)methylimino]-5-[2-(5-nitro-2-furyl)vinyl-1,3,4-oxadiazol		c	3 4	
540738	1,2-Dimethylhydrazine		c	3 4	
105679	2,4-Dimethylphenol {2,4-Xylenol}	06/91		7	
513371	Dimethylvinylchloride {DMVC}	09/89	c	4 5	
25154545	Dinitrobenzenes (mixtures of) including:	09/90		4 7	
99650	m-Dinitrobenzene	06/91		7	
528290	o-Dinitrobenzene	06/91		7	

100254	p-Dinitrobenzene	06/91		7
39300453	Dinocap	09/90	4	
88857	Dinoseb	09/89	4	
117840	n-Dioctyl phthalate	06/91		7

APPENDIX A-II
Substances For Which Production, Use, Or Other Presence Must Be Reported

Emittent ID (Note [1])	Substance Name (Note [2])	Add Date (Note [3])	Carcinogen (Note [4])	Source List(s) (Note [6])	Other Notes(s)
2475458	Disperse Blue 1 [PAH-Derivative, POM]	06/91	c	1 2 3 4	
541413	Ethyl chloroformate	06/91		7	
62500	Ethyl methanesulfonate		c	3 4	
2164172	Fluometuron	06/91		7	
133073	Folpet	09/89	c	4	
3570750	2-(2-Formylhydrazino)-4-(5-nitro-2-furyl)thiazole		c	3 4	
60568050	Furmecyclox	09/90	c	4	
67730114	Glu-P-1 {2-Amino-6-methyldipyrido[1,2-a:3',2'-d]imidazole}		c	3 4	
67730103	Glu-P-2 {2-Aminodipyrido[1,2-a:3',2'-d]imidazole}		c	3 4	
765344	Glycidaldehyde		c	3 4	
556525	Glycidol	09/90	c	4	
16568028	Gyromitrin {Acetaldehyde methylformylhydrazone}		c	4	
2784943	HC Blue 1	09/89	c	4 5	
1024573	Heptachlor epoxide	09/89	c	4	
1335871	Hexachloronaphthalene [PAH-Derivative, POM]	06/91		1 2 7	
10034932	Hydrazine sulfate		c	4 5	
76180966	IQ {2-Amino-3-methylimidazo[4,5-f]quinoline}		c	3 4	
78842	Isobutyraldehyde	06/91		7	
120581	Isosafrole	09/90	c	4	
4759482	Isotretinoin			4	
77501634	Lactofen [POM]	09/89	c	1 2 4	
1131	Lubricant base oils and derived products, specifically vacuum distillates, acid treated oils, aromatic oils, mildly solvent-refined oils, mildly hydrotreated-oils and used engine oils.	09/89	c	3 4 5	
8018017	Mancozeb	09/90	c	4	
12427382	Maneb	09/90	c	4	
59052	Methotrexate	09/89		4	
96333	Methyl acrylate	06/91		7	
590965	Methylazoxymethanol	09/90	c	4	
592621	Methylazoxymethanol acetate	09/89	c	3 4	
101611	4,4'-Methylene bis (N,N-dimethyl) benzenamine [POM]		c	1 2 4 5	
838880	4,4'-Methylene bis(2-methylaniline) [POM]	09/89	c	1 2 3 4	
74953	Methylene bromide	06/91		7	
66273	Methyl methanesulfonate		c	3 4	
129157	2-Methyl-1-nitroanthraquinone (uncertain purity) [PAH-Derivative, POM]		c	1 2 3 4	
70257	N-Methyl-N'-nitro-N-nitrosoguanidine		c	3 4	
-	N-Methyl-N-nitrosourethane (see N-Nitroso-N-methylurethane)				
924425	N-Methyloacrylamide	09/90	c	4	

9006422	Metiram	09/90			4
1140	Mineral oils (untreated and mildly treated oils; and those used in occupations such as mulespinning, metal machining, and jute processing).		c	3	4 5

APPENDIX A-II
Substances For Which Production, Use, Or Other Presence Must Be Reported

Emittent ID (Note [1])	Substance Name (Note [2])	Add Date (Note [3])	Carcinogen (Note [4])	Source List(s) (Note [6])	Other Notes(s)
2385855	Mirex		c	3 4 5	
315220	Monocrotaline		c	3 4	
505602	Mustard gas {Sulfur mustard}		c	3 4 5	
134327	1-Naphthylamine [PAH-Derivative, POM]	09/90	c	1 2 4	
91598	2-Naphthylamine [PAH-Derivative, POM]		c	1 2 3 4 5	
54115	Nicotine	09/90		4	
1148	Nitrilotriacetic acid (salts) including but not limited to:	06/91	c	3	
18662538	Nitrilotriacetic acid, trisodium salt monohydrate	06/91	c	4	
602879	5-Nitroacenaphthene [PAH-Derivative, POM]		c	1 2 3 4	
99592	5-Nitro-o-anisidine		c	4 5	
1836755	Nitrofen (technical grade)		c	3 4 5	
51752	Nitrogen mustard {Mechlorethamine}		c	3 4 5	
55867	Nitrogen mustard hydrochloride	09/89	c	4 5	
55630	Nitroglycerin	06/91			7
88755	2-Nitrophenol	06/91			7
57835924	4-Nitropyrene [PAH-Derivative, POM]	06/91	c	1 2 3 4	
86306	N-Nitrosodiphenylamine [POM]	09/89	c	1 2 4	
759739	N-Nitroso-N-ethylurea		c	4 5	
60153493	3-(N-Nitrosomethylamino)propionitrile	09/89	c	3 4	
64091914	4-(N-Nitrosomethylamino)-1-(3-pyridyl)-1-butanone {NNK}	09/89	c	3 4	
615532	N-Nitroso-N-methylurethane {N-Methyl-N-nitrosourethane}		c	3 4	
4549400	N-Nitrosomethylvinylamine		c	3 4 5	
16543558	N-Nitrosonornicotine		c	3 4 5	
13256229	N-Nitrososarcosine		c	3 4 5	
303479	Ochratoxin A [POM]	09/90	c	1 2 4	
2234131	Octachloronaphthalene [PAH-Derivative, POM]	06/91		1 2	7
2646175	Oil Orange SS [PAH-Derivative, POM]		c	1 2 3 4	
20816120	Osmium tetroxide	06/91			7
794934	Panfuran S {Dihydroxymethylfuratrizine}		c	3 4	
122601	Phenyl glycidyl ether	09/90	c	3 4	
57410	Phenytoin [POM]		c	1 2 3 4 5	
88891	Picric acid	06/91			7
1155	Polybrominated biphenyls {PBBs} [POM]		c	1 2 3 4 5	
53973981	Polygeenan	09/89	c	4	
3761533	Ponceau MX [PAH-Derivative, POM]		c	1 2 3 4	
3564098	Ponceau 3R [PAH-Derivative, POM]		c	1 2 3 4	
36791045	Ribavirin	09/90		4	
94597	Safrole		c	3 4 5	
1180	Shale oils		c	3 4	
132274	Sodium o-phenylphenate [POM]		c	1 2 3 4	

128449	Sodium saccharin	09/89	c		4
1185	Soots		c	3	4
10048132	Sterigmatocystin [POM]		c	1 2 3	4

APPENDIX A-II

Substances For Which Production, Use, Or Other Presence Must Be Reported

Emittent ID (Note [1])	Substance Name (Note [2])	Add Date (Note [3])	Carcinogen (Note [4])	Source List(s) (Note [6])	Other Notes(s)
95067	Sulfallate		c	3 4 5	
5216251	p-alpha,alpha,alpha-Tetrachlorotoluene	09/90	c	4	
961115	Tetrachlorvinphos	06/91		7	
509148	Tetranitromethane	09/90	c	4	
139651	4,4'-Thiodianiline [POM]		c	1 2 3 4	
1314201	Thorium dioxide		c	4 5	
1200	Tobacco products, smokeless		c	3 4	
1205	alpha-chlorinated Toluenes		c	3	
636215	o-Toluidine hydrochloride		c	4 5	
106490	p-Toluidine	09/90	c	4	
52686	Trichlorfon	06/91		7	
68768	Tris(aziridinyl)-p-benzoquinone {Triaziquone}	09/90	c	4	
52244	Tris(1-aziridinyl) phosphine sulfide {Thiotepa}		c	3 4 5	
126727	Tris(2,3-dibromopropyl)phosphate	09/89	c	4	
62450060	Trp-P-1 {3-Amino-1,4-dimethyl-5H-pyrido[4,3-b]indole}		c	3 4	
62450071	Trp-P-2 {3-Amino-1-methyl-5H-pyrido[4,3-b]indole}		c	3 4	
72571	Trypan blue [PAH-Derivative, POM]		c	1 2 3 4	
106876	4-Vinyl-1-cyclohexene diepoxide {Vinyl cyclohexene dioxide}	09/90	c	4	
81812	Warfarin [POM]			1 2 4	
87627	2,6-Xylidene	06/91		4	
12122677	Zineb	09/90	c	4	

Appendix A-III

Substances Which Need Not Be Reported

Unless Manufactured By The Facility

July 1, 1997

The Air Toxics Hot Spots Program Guidance Manual for Preparation of Health Risk Assessments. September 2002.

APPENDIX A-III
Substances Which Need Not Be Reported Unless Manufactured By the Facility

Emittent ID (Note [1])	Substance Name (Note [2])	Add Date (Note [3])	Carcinogen (Note [4])	Source List(s) (Note [6])	Other Notes(s)
546883	Acetohydroxamic acid	09/90		4	
50760	Actinomycin D	09/90	c	4	
23214928	Adriamycin [PAH-Derivative, POM]		c	1 2 3 4 5	
28981977	Alprazolam [POM]	09/90		1 2 4	
39831555	Amikacin sulfate	09/90		4	
54626	Aminopterin			4	
1005	Analgesic mixtures containing phenacetin		c	3 4 5	
1010	Androgenic (anabolic) steriods		c	3 4	
	including but not limited to:				
58184	Methyltestosterone	09/90		4	
434071	Oxymetholone		c	4 5	
58220	Testosterone and its esters	09/89		4	
	including but not limited to:				
315377	Testosterone enanthate	09/90		4	
50782	Aspirin	06/91		4	
115026	Azaserine		c	3 4	
5411223	Benzphetamine hydrochloride [POM]	09/90		1 2 4	
154938	Bischloroethyl nitrosourea		c	3 4	
55981	1,4-Butanediol dimethanesulfonate {Busulfen/ Myleran}		c	3 4 5	
41575944	Carboplatin	09/90		4	
474259	Chenodiol	09/90		4	
305033	Chlorambucil		c	3 4 5	
56757	Chloramphenicol		c	3 4	
1620219	Chlorcyclizine hydrochloride [POM]			1 2 4	
13010474	1-(2-Chloroethyl)-3-cyclohexyl-1-nitrosourea {CCNU}		c	3 4 5	
13909096	1-(2-Chloroethyl)-3-(4-methylcyclohexyl)-1-nitrosourea {Methyl CCNU}		c	3	
15663271	Cisplatin		c	3 4	
50419	Clomiphene citrate [POM]	09/90		1 2 4	
50180	Cyclophosphamide		c	3 4	
147944	Cytarabine	09/89		4	
4342034	Dacarbazine		c	3 4 5	
17230885	Danazol	09/90		4	
20830813	Daunomycin [PAH-Derivative, POM]		c	1 2 3 4	
23541506	Daunorubicin hydrochloride [PAH-Derivative, POM]	09/90		1 2 4	
84173	Dienestrol [POM]	09/90	c	1 2 4	
564250	Doxycycline	09/90		4	
379793	Ergotamine tartrate [POM]	09/90		1 2 4	
1095	Estrogens, non-steroidal		c	3 5	
	including but not limited to:				
56531	Diethylstilbestrol [POM]		c	1 2 3 4 5	
1100	Estrogens, steroidal		c	3 5	

	including but not limited to:			
1068	Conjugated estrogens	09/90	c	4
50282	Estradiol 17 beta		c	4 5
53167	Estrone		c	4 5

APPENDIX A-III
Substances Which Need Not Be Reported Unless Manufactured By the Facility

Emittent ID (Note [1])	Substance Name (Note [2])	Add Date (Note [3])	Carcinogen (Note [4])	Source List(s) (Note [6])	Other Notes(s)
57636	Ethinyl estradiol		c	4 5	
72333	Mestranol		c	3 4 5	
33419420	Etoposide [POM]	09/90		2	
54350480	Etretinate			4	
51218	Fluorouracil	09/89		4	
76437	Fluoxymesterone	09/90		4	
13311847	Flutamide	09/90		4	
67458	Furazolidone	09/90	c	4	
126078	Griseofulvin		c	3 4	
23092173	Halazepam [POM]	09/90		1 2 4	
3778732	Ifosfamide	09/90		4	
9004664	Iron dextran complex		c	3 4 5	
303344	Lasiocarpine	09/89	c	3 4	
554132	Lithium carbonate	06/91		4	
919164	Lithium citrate	06/91		4	
846491	Lorazepam [POM]	09/90		1 2 4	
595335	Megestrol acetate	06/91		4	
148823	Melphalan		c	3 4 5	
9002680	Menotropins	09/90		4	
6112761	Mercaptopurine	09/90		4	
531760	Merphalan	09/89	c	4	
3963959	Methacycline hydrochloride	06/91		4	
60560	Methimazole	09/90		4	
15475566	Methotrexate sodium	09/90		4	
484208	5-Methoxypsoralen		c	3	
56042	Methylthiouracil		c	3 4	
443481	Metronidazole		c	3 4 5	
59467968	Midazolam hydrochloride [POM]	09/90		1 2 4	
62015398	Misoprostol	09/90		4	
50077	Mitomycin C		c	3 4	
70476823	Mitoxantrone hydrochloride [PAH-Derivative, POM]	09/90		1 2 4	
139913	5-(Morpholinomethyl)-3-[(5-nitrofurfurylidene)amino]-2-oxazolidinone		c	3 4	
86220420	Nafarelin acetate [PAH-Derivative, POM]	09/90		1 2 4	
3771195	Nafenopin [POM]		c	1 2 3 4	
1405103	Neomycin sulfate	09/90		4	
56391572	Netilmicin sulfate	09/90		4	
61574	Niridazole		c	3 4	
67209	Nitrofurantoin	06/91	c	4	
59870	Nitrofurazone	09/90	c	4	
555840	1-[(5-Nitrofurfurylidene)amino]-2-imidazolidinone		c	3 4	
531828	N-[4-(5-Nitro-2-furyl)-2-thiazolyl]acetamide		c	3 4	
6533002	Norgestrel	09/90		4	
79572	Oxytetracycline	06/91		4	

115673	Paramethadione	09/90	4
52675	Penicillamine	06/91	4

APPENDIX A-III
Substances Which Need Not Be Reported Unless Manufactured By the Facility

Emittent ID (Note [1])	Substance Name (Note [2])	Add Date (Note [3])	Carcinogen (Note [4])	Source List(s) (Note [6])	Other Notes(s)
57330	Pentobarbital sodium	09/90		4	
63989	Phenacemide	09/90		4	
62442	Phenacetin		c	3 4 5	
94780	Phenazopyridine hydrochloride		c	3 4 5	
3546109	Phenesterin	09/89	c	4 5	
50066	Phenobarbital		c	3 4	
59961	Phenoxybenzamine [POM]	09/89	c	1 2 4	
63923	Phenoxybenzamine hydrochloride [POM]	09/90	c	1 2 3 4 5	
54911	Pipobroman	09/90		4	
18378897	Plicamycin [PAH-Derivative, POM]	09/90		1 2 4	
366701	Procarbazine hydrochloride		c	3 4 5	
57830	Progesterone		c	3 4 5	
1160	Progestins		c	3	
	including but not limited to:				
71589	Medroxyprogesterone acetate		c	3 4	
68224	Norethisterone		c	4 5	
51525	Propylthiouracil		c	3 4 5	
302794	all-trans-Retinoic acid	09/89		4	
1167	Retinol/retinyl esters	09/89	c	4	
81072	Saccharin		c	3 4 5	
3810740	Streptomycin sulfate	06/91		4	
18883664	Streptozotocin		c	3 4 5	
54965241	Tamoxifen citrate [POM]	09/90		1 2 4	
846504	Temazepam [POM]	09/90		1 2 4	
64755	Tetracycline hydrochloride	06/91		4	
50351	Thalidomide			4	
154427	Thioguanine	09/90		4	
49842071	Tobramycin sulfate	09/90		4	
299752	Treosulfan		c	3 4	
28911015	Triazolam [POM]	09/90		1 2 4	
13647353	Trilostane	09/90		4	
127480	Trimethadione	06/91		4	
66751	Uracil mustard		c	3 4	
26995915	Urofollitropin	09/90		4	
99661	Valproate			4	
143679	Vinblastine sulfate [POM]	09/90		1 2 4	
2068782	Vincristine sulfate [POM]	09/90		1 2 4	

NOTES TO APPENDIX A

Note **Text of Note**

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[1] Emittent ID (the emittent identification number) is the Chemical Abstract Service (CAS) number where available, or an ARB-assigned 4-digit emittent ID code.

A dash ("-") is shown for the Emittent ID for substances which are alphabetized under a group header or synonym elsewhere on the list. Refer to the cross reference indicated in parenthesis, "( )".

A double dash ("- -") is shown for the Emittent ID to indicate that the entry is a non-reportable group header for the substances immediately following it.

An asterisk ("*") is shown for the Emittent ID to indicate that the emissions of unspecified metal compounds shall be reported as the metal atom equivalent. See Note [7].

A pound sign ("#") is shown for the Emittent ID to indicate that the individual, component listed substances must be reported for this mixture or group.

[2] Individual substances listed under a group heading must be reported individually. Other, unspecified substances in the group must be summed and reported using the emittent ID of the group heading.

The square bracket designation, "[ ]", indicates that the substance is a component of the chemical group heading(s) within the brackets.

The braces designation, "{ }", indicates a synonym for the substance listed.

[3] The date the Board approved addition of the substance to the original list. The original list was approved by the Board in July 1988.

[4] The letter "c" indicates that for purposes of this section the substance shall be treated as a human carcinogen or potential human carcinogen.

[5] Applicable degree of accuracy (in lbs/year except where noted). Radionuclides must be reported in Curie units, and the accuracy must be considered accordingly. Refer to Section VII.E. and Appendix B.

Note	Text of Note

[6] Substances are required to be included on the Hot Spots list based on the following lists cited in Health & Safety Code Section 44321:

1 = California Air Resources Board (44321(c));
2 = Environmental Protection Agency (44321(e));
3 = International Agency for Research on Cancer; (44321(a); Labor Code section 6382(b)(1))
4 = Governor's List of Carcinogens and Reproductive Toxicants; (44321(b); HSC Section 25249.8)
5 = National Toxicology Program (44321(a));
6 = Hazard Evaluation System and Information Service (44321(d))
7 = Added pursuant to HSC Section 44321 (f).

[7] Emissions of unspecified metal compounds shall be reported as the amount of the metal atom equivalent, using the metal emittent identification number for the metal itself (or the emittent identification number indicated on the table, such as for reporting inorganic versus other-than-inorganic arsenic compounds).

For unspecified metal compounds which contain two or more listed metals (e.g., zinc chromate), each component metal shall be reported as the amount of the appropriate metal atom equivalent (i.e., the zinc portion of the weight as zinc equivalent and the chromate portion as hexavalent chromium equivalent).

For specific, individually listed metal compounds (e.g., Lead chromate), emissions shall be reported for the compound (as pounds of whole compound), using the emittent identification number for that compound.

[8] Compounds of the form "X-CN", where formal dissociation can occur. Report as the amount of Cyanide equivalent in the compound using an emittent identification code of 1073.

[9] Emissions of these mixtures shall be reported as emissions of total particulate matter and total organic gas, using the following emittent identification numbers:

9901 Diesel exhaust, particulate matter
9902 Diesel exhaust, total organic gas
9910 Gasoline exhaust, particulate matter
9911 Gasoline exhaust, total organic gas

Individually listed substances from diesel and gasoline exhaust must also be reported.

Note	Text of Note
[10]	The emittent identification number 1105 has been discontinued for all facilities reporting for the first time and for all updates. Use the listed replacement emittent identification codes 1103 and 1104.
[11]	Emissions of the individual, component listed substances must be reported in addition to the total gasoline vapors emissions.
[12]	These lead compounds are listed here so that the inorganic lead fraction will be quantified and reported if these individual compounds cannot be quantified.
[13]	PAH: (Polycyclic Aromatic Hydrocarbon) - An organic compound consisting of a fused ring structure containing at least two (2) benzene rings, and which may also contain additional fused rings not restricted exclusively to hexagonal rings. The structure does not include any heteroatoms or substituent groups. The structure includes only carbon and hydrogen. PAHs are a subgroup of POM and have a boiling point of greater than or equal to 100 C.
[14]	PAH-DERIVATIVE: (Polycyclic Aromatic Hydrocarbon Derivative) - An organic compound consisting of a fused ring structure containing at least two (2) benzene rings, and which may also contain additional fused rings not restricted exc lusively to hexagonal rings. The fused ring structure does not contain heteroatoms. The structure does contain one or more substituent groups. PAH-Derivatives are a subgroup of POM and have a boiling point of greater than or equal to 100 C.
[15]	POM: (Polycyclic Organic Matter) - Includes organic compounds with more than one benzene ring, and which have a boiling point of greater than or equal to 100 C.
[16]	Radionuclides and other radioactive substances shall be reported in units of Curies per year (for annual average emissions) and in units of milliCuries per hour (for maximum hourly emissions).
[17]	Emissions of Vanadium (fume or dust) shall be reported as the amount of the vanadium atom equivalent, using the identification number 7440622.
[18]	The emittent identification number 1001 has been replaced with the CAS number 26148685.

Appendix B

Health And Safety Code Related to the

Air Toxics Hot Spots Program

Appendix B

Health And Safety Code Related To The Air Toxics Hot Spots Program[1]

PART 6. AIR TOXICS "HOT SPOTS" INFORMATION AND ASSESSMENT
(Part 6 added by Stats. 1987, Ch. 1252, Sec. 1. Operative July 1, 1988, pursuant to Section 44384. Note: Sections 44380 and 44384 became operative Jan. 1, 1988.)

CHAPTER 1. LEGISLATIVE FINDINGS AND DEFINITIONS
(Chapter 1 added by Stats. 1987, Ch. 1252, Sec. 1. Operative July 1, 1988, pursuant to Section 44384.)

44300. This part shall be known and may be cited as the Air Toxics "Hot Spots" Information and Assessment Act of 1987. (Added by Stats. 1987, Ch. 1252, Sec. 1. Operative July 1, 1988, pursuant to Section 44384.)

44301. The Legislature finds and declares all of the following:

(a) In the wake of recent publicity surrounding planned and unplanned releases of toxic chemicals into the atmosphere, the public has become increasingly concerned about toxics in the air.

(b) The Congressional Research Service of the Library of Congress has concluded that 75 percent of the United States population lives in proximity to at least one facility that manufactures chemicals. An incomplete 1985 survey of large chemical companies conducted by the Congressional Research Service documented that nearly every chemical plant studied routinely releases into the surrounding air significant levels of substances proven to be or potentially hazardous to public health.

(c) Generalized emissions inventories compiled by air pollution control districts and air quality management districts in California confirm the findings of the Congressional Research Service survey as well as reveal that many other facilities and businesses which do not actually manufacture chemicals do use hazardous substances in sufficient quantities to expose, or in a manner that exposes, surrounding populations to toxic air releases.

(d) These releases may create localized concentrations or air toxics "hot spots" where emissions from specific sources may expose individuals and population groups to elevated risks of adverse health effects, including, but not limited to, cancer and contribute to the cumulative health risks of emissions from other sources in the area. In some cases where large populations may not be significantly affected by adverse health risks, individuals may be exposed to significant risks.

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[1] *AB564 Passed in the 1996 legislative session. The text will be added when the code is revised.*

(e) Little data is currently available to accurately assess the amounts, types, and health impacts of routine toxic chemical releases into the air. As a result, there exists significant uncertainty about the amounts of potentially hazardous air pollutants which are released, the location of those releases, and the concentrations to which the public is exposed.
(f) The State of California has begun to implement a long-term program to identify, assess, and control ambient levels of hazardous air pollutants, but additional legislation is needed to provide for the collection and evaluation of information concerning the amounts, exposures, and short- and long-term health effects of hazardous substances regularly released to the surrounding atmosphere from specific sources of hazardous releases.
(g) In order to more effectively implement control strategies for those materials posing an unacceptable risk to the public health, additional information on the sources of potentially hazardous air pollutants is necessary.
(h) It is in the public interest to ascertain and measure the amounts and types of hazardous releases and potentially hazardous releases from specific sources that may be exposing people to those releases, and to assess the health risks to those who are exposed. (Added by Stats. 1987, Ch. 1252, Sec. 1. Operative July 1, 1988, pursuant to Section 44384.)

44302. The definitions set forth in this chapter govern the construction of this part. (Added by Stats. 1987, Ch. 1252, Sec. 1. Operative July 1, 1988, pursuant to Section 44384.)

44303. "Air release" or "release" means any activity that may cause the issuance of air contaminants, including the actual or potential spilling, leaking, pumping, pouring, emitting, emptying, discharging, injecting, escaping, leaching, dumping, or disposing of a substance into the ambient air and that results from the routine operation of a facility or that is predictable, including, but not limited to, continuous and intermittent releases and predictable process upsets or leaks. (Added by Stats. 1987, Ch. 1252, Sec. 1. Operative July 1, 1988, pursuant to Section 44384.)

44304. "Facility" means every structure, appurtenance, installation, and improvement on land which is associated with a source of air releases or potential air releases of a hazardous material. (Added by Stats. 1987, Ch. 1252, Sec. 1. Operative July 1, 1988, pursuant to Section 44384.)

44306. "Health risk assessment" means a detailed comprehensive analysis prepared pursuant to Section 44361 to evaluate and predict the dispersion of hazardous substances in the environment and the potential for exposure of human populations and to assess and quantify both the individual and population wide health risks associated with those levels of exposure. (Added by Stats. 1987, Ch. 1252, Sec. 1. Operative July 1, 1988, pursuant to Section 44384.)

44307. "Operator" means the person who owns or operates a facility or part of a facility. (Added by Stats. 1987, Ch. 1252, Sec. 1. Operative July 1, 1988, pursuant to Section 44384.)

44308. "Plan" means the emissions inventory plan which meets the conditions specified in Section 44342. (Added by Stats. 1987, Ch. 1252, Sec. 1. Operative July 1, 1988, pursuant to Section 44384.)

44309. "Report" means the emissions inventory report specified in Section 44341. (Added by Stats. 1987, Ch. 1252, Sec. 1. Operative July 1, 1988, pursuant to Section 44384.)

CHAPTER 2. FACILITIES SUBJECT TO THIS PART

(Chapter 2 added by Stats. 1987, Ch. 1252, Sec. 1. Operative July 1, 1988, pursuant to Section 44384.)

44320. This part applies to the following:

(a) Any facility which manufactures, formulates, uses, or releases any of the substances listed pursuant to Section 44321 or any other substance which reacts to form a substance listed in Section 44321 and which releases or has the potential to release total organic gases, particulates, or oxides of nitrogen or sulfur in the amounts specified in Section 44322.

(b) Except as provided in Section 44323, any facility which is listed in any current toxics use or toxics air emission survey, inventory, or report released or compiled by a district. A district may, with the concurrence of the state board, waive the application of this part pursuant to this subdivision for any facility which the district determines will not release any substance listed pursuant to Section 44321 due to a shutdown or a process change. (Amended by Stats. 1989, Ch. 1254, Sec. 7). References at the time of publication (see page iii): Regulations: 17, CCR, sections 90700-90703, 90704, 93303, 93306

44321. For the purposes of Section 44320, the state board shall compile and maintain a list of substances that contains, but is not limited to, all of the following:

(a) Substances identified by reference in paragraph (1) of subdivision (b) of Section 6382 of the Labor Code and substances placed on the list prepared by the National Toxicology Program issued by the United States Secretary of Health and Human Services pursuant to paragraph (4) of Section 262 of Public Law 95-622 of 1978. For the purposes of this subdivision, the state board may remove from the list any substance which meets both of the following criteria:
   (1) No evidence exists that it has been detected in air.
   (2) The substance is not manufactured or used in California, or, if manufactured or used in California, because of the physical or chemical characteristics of the substance or the manner in which it is manufactured or used, there is no possibility that it will become airborne.

(b) Carcinogens and reproductive toxins referenced in or compiled pursuant to Section 25249.8, except those which meet both of the criteria identified in subdivision (a).

(c) The candidate list of potential toxic air contaminants and the list of designated toxic air contaminants prepared by the state board pursuant to Article 2 (commencing with Section 39660) of Chapter 3.5 of Part 2, including, but not limited to, all substances currently under review and scheduled or nominated for review and substances identified and listed for which health effects information is limited.

(d) Substances for which an information or hazard alert has been issued by the repository of current data established pursuant to Section 147.2 of the Labor Code.
(e) Substances reviewed, under review, or scheduled for review as air toxics or potential air toxics by the Office of Air Quality Planning and Standards of the Environmental Protection Agency, including substances evaluated in all of the following categories or their equivalent: preliminary health and source screening, detailed assessment, intent to list, decision not to regulate, listed, standard proposed, and standard promulgated.
(f) Any additional substances recognized by the state board as presenting a chronic or acute threat to public health when present in the ambient air, including, but not limited to, any neurotoxins or chronic respiratory toxins not included within subdivision (a), (b), (c), (d), or (e). (Added by Stats. 1987, Ch. 1252, Sec. 1. Operative July 1, 1988, pursuant to Section 44384.)

44322. This part applies to facilities specified in subdivision (a) of Section 44320 in accordance with the following schedule:
(a) For those facilities that release, or have the potential to release, 25 tons per year or greater of total organic gases, particulates, or oxides of nitrogen or sulfur, this part becomes effective on July 1, 1988.
(b) For those facilities that release, or have the potential to release, more than 10 but less than 25 tons per year of total organic gases, particulates, or oxides of nitrogen or sulfur, this part becomes effective July 1, 1989.
(c) For those facilities that release, or have the potential to release, less than 10 tons per year of total organic gases, particulates, or oxides of nitrogen or sulfur, the state board shall, on or before July 1, 1990, prepare and submit a report to the Legislature identifying the classes of those facilities to be included in this part and specifying a timetable for their inclusion. (Amended by Stats. 1989, Ch. 1254, Sec. 8.)

44323. A district may prepare an industrywide emissions inventory and health risk assessment for facilities specified in subdivision (b) of Section 44320 and subdivisions (a) and (b) of Section 44322, and shall prepare an industrywide emissions inventory for the facilities specified in subdivision (c) of Section 44322, in compliance with this part for any class of facilities that the district finds and determines meets all of the following conditions:
(a) All facilities in the class fall within one four-digit Standard Industrial Classification Code.
(b) Individual compliance with this part would impose severe economic hardships on the majority of the facilities within the class.
(c) The majority of the class is composed of small businesses.
(d) Releases from individual facilities in the class can easily and generically be characterized and calculated. (Amended by Stats. 1989, Ch. 1254, Sec. 9.)

44324. This part does not apply to any facility where economic poisons are employed in their pesticidal use, unless that facility was subject to district permit requirements on or before August 1,1987. As used in this section, "pesticidal use" does not include the manufacture or formulation of pesticides. (Added by Stats. 1981, Ch. 1252, Sec. 1. Operative July 1, 1988, pursuant to Section 44384.)

44325. Any solid waste disposal facility in compliance with Section 41805.5 is in compliance with the emissions inventory requirements of this part. (Added by Stats. 1987, Ch. 1252, Sec. 1. Operative July 1, 1988, pursuant to Section 44384.)

CHAPTER 3. AIR TOXICS EMISSION INVENTORIES
(Chapter 3 added by Stats. 1987, Ch. 1252, Sec. 1. Operative July 1, 1988, pursuant to Section 44384.)

44340. (a) The operator of each facility subject to this part shall prepare and submit to the district a proposed comprehensive emissions inventory plan in accordance with the criteria and guidelines adopted by the state board pursuant to Section 44342.

(b) The proposed plan shall be submitted to the district on or before August 1, 1989, except that, for any facility to which subdivision (b) of Section 44322 applies, the proposed plan shall be submitted to the district on or before August 1,1990. The district shall approve, modify, and approve as modified, or return for revision and resubmission, the plan within 120 days of receipt.

(c) The district shall not approve a plan unless all of the following conditions are met:

(1) The plan meets the requirements established by the state board pursuant to Section 44342.

(2) The plan is designed to produce, from the list compiled and maintained pursuant to Section 44321, a comprehensive characterization of the full range of hazardous materials that are released, or that may be released, to the surrounding air from the facility. Air release data shall be collected at, or calculated for, the primary locations of actual and potential release for each hazardous material. Data shall be collected or calculated for all continuous, intermittent, and predictable air releases.

(3) The measurement technologies and estimation methods proposed provide state-of-the-art effectiveness and are sufficient to produce a true representation of the types and quantities of air releases from the facility.

(4) Source testing or other measurement techniques are employed wherever necessary to verify emission estimates, as determined by the state board and to the extent technologically feasible. All testing devices shall be appropriately located, as determined by the state board.

(5) Data are collected or calculated for the relevant exposure rate or rates of each hazardous material according to its characteristic toxicity and for the emission rate necessary to ensure a characterization of risk associated with exposure to releases of the hazardous material that meets the requirements of Section 44361. The source of all emissions shall be displayed or described. (Added by Stats. 1987, Ch. 1252, Sec. 1. Operative July 1, 1988, pursuant to Section 44384.)

44341. Within 180 days after approval of a plan by the district, the operator shall implement the plan and prepare and submit a report to the district in accordance with the plan. The district shall transmit all monitoring data contained in the approved report to the state board. (Added by Stats. 1987, Ch. 1252, Sec. 1. Operative July 1, 1988, pursuant to Section 44384.)

44342. The state board shall, on or before May 1, 1989, in consultation with the districts, develop criteria and guidelines for site-specific air toxics emissions inventory plans which shall be designed to comply with the conditions specified in Section 44340 and which shall include at least all of the following:

(a) For each class of facility, a designation of the hazardous materials for which emissions are to be quantified and an identification of the likely source types within that class of facility. The hazardous materials for quantification shall be chosen from among, and may include all or part of, the list specified in Section 44321.

(b) Requirements for a facility diagram identifying each actual or potential discrete emission point and the general locations where fugitive emissions may occur. The facility diagram shall include any nonpermitted and nonprocess sources of emissions and shall provide the necessary data to identify emission characteristics. An existing facility diagram which meets the requirements of this section may be submitted.

(c) Requirements for source testing and measurement. The guidelines may specify appropriate uses of estimation techniques including, but not limited to, emissions factors, modeling, mass balance analysis, and projections, except that source testing shall be required wherever necessary to verify emission estimates to the extent technologically feasible. The guidelines shall specify conditions and locations where source testing, fence-line monitoring, or other measurement techniques are to be required and the frequency of that testing and measurement.

(d) Appropriate testing methods, equipment, and procedures, including quality assurance criteria.

(e) Specifications for acceptable emissions factors, including, but not limited to, those which are acceptable for substantially similar facilities or equipment, and specification of procedures for other estimation techniques and for the appropriate use of available data.

(f) Specification of the reporting period required for each hazardous material for which emissions will be inventoried.

(g) Specifications for the collection of useful data to identify toxic air contaminants pursuant to Article 2 (commencing with Section 39660) of Chapter 3.5 of Part 2.

(h) Standardized format for preparation of reports and presentation of data.

(i) A program to coordinate and eliminate any possible overlap between the requirements of this chapter and the requirements of Section 313 of the Superfund Amendment and Reauthorization Act of 1986 (Public Law 99-499). The state board shall design the guidelines and criteria to ensure that, in collecting data to be used for emissions inventories, actual measurement is utilized whenever necessary to verify the accuracy of emission estimates, to the extent technologically feasible. (Added by Stats. 1987, Ch. 1252, Sec. 1. Operative July 1, 1988, pursuant to Section 44384.)

44343. The district shall review the reports submitted pursuant to Section 44341 and shall, within 90 days, review each report, obtain corrections and clarifications of the data, and notify the Office of Environmental Health Hazard Assessment, the Department of Industrial Relations, and the city or county health department of its findings and determinations as a result of its review of the report. (Added by Stats. 1987, Ch. 1252, Sec. 1. Operative July 1, 1988, pursuant to Section 44384. Amended by Governor's Reorganization Plan No. 1 of 1991, §142.)

44344. Except as provided in Section 44391, emissions inventories developed pursuant to this chapter shall be updated every four years, in accordance with the procedures established by the state board. Those updates shall take into consideration improvements in measurement techniques and advancing knowledge concerning the types and toxicity of hazardous material released or potentially released. (Amended by Stats. 1993, Ch. 1041, Sec. 1. Effective January 1, 1994.)

44344.3.

(a) A facility shall be granted an exemption by a district from further compliance with this part after meeting all of the following criteria:
    (1) The facility was required to comply with this part only as a result of its particulate matter emissions.
    (2) The facility has participated in, utilized data derived from, or is eligible to utilize data derived from, approved pooled source testing.
    (3) The facility has submitted an emissions inventory plan and report that was subsequently accepted and approved.
    (4) The facility has been designated by the district as a low priority facility under the guidelines set forth pursuant to this part for facility prioritization, and facility emissions do not present a significant health risk as specified in subdivision (b) of Section 44362.
    (5) The facility handles, processes, stores, or distributes bulk agricultural commodities or handles, feeds, or rears livestock. (b) Subdivision (a) does not apply to a facility that, because of information provided pursuant to Section 44344.7, is reclassified as an intermediate or high priority facility by the district.
(c) The operator of a facility that has been granted an exemption pursuant to this section shall biennially submit a statement to the district for the district's review, with a copy of the most recent emissions inventory for the facility, indicating that, except as to matters for which an emissions inventory update has been or will be submitted pursuant to Section 44344.7, there has been no significant change in facility operations or activities. The district shall not impose any fee upon the operator with regard to the submission of the statement. (Added by Stats. 1993, Ch. 1037, Sec. 1. Effective January 1, 1994.)

44344.5. The operator of any new facility that previously has not been subject to this part shall prepare and submit an emissions inventory plan and report. (Added by Stats. 1993, Ch. 1037, Sec. 2. Effective January 1, 1994.)

44344.7. The operator of a facility exempted pursuant to subdivision (a) of Section 44344.3 shall submit an emissions inventory update for those sources and substances for which a change in activities or operations has occurred, as follows:

(a) The facility emits a newly listed substance.
(b) A sensitive receptor has been established or constructed on or after January 1, 1994, within 500 meters of the facility.
(c) The facility emits a substance for which the potency factor has increased.

(d) The facility has begun emission of a listed substance not included in the previous emissions inventory. (Added by Stats. 1993, Ch. 1037, Sec. 3. Effective January 1, 1994.)

44345. (a) On or before July 1, 1989, the state board shall develop a program to compile and make available to other state and local public agencies and the public all data collected pursuant to this chapter.

(b) In addition, the state board, on or before March 1, 1990, shall compile, by district, emissions inventory data for mobile sources and area sources not subject to district permit requirements, and data on natural source emissions, and shall incorporate these data into data compiled and released pursuant to this chapter. (Added by Stats. 1987, Ch. 1252, Sec. 1. Operative July 1, 1988, pursuant to Section 44384.)

44346. (a) If an operator believes that any information required in the facility diagram specified pursuant to subdivision (b) of Section 44342 involves the release of a trade secret, the operator shall nevertheless make the disclosure to the district, and shall notify the district in writing of that belief in the report.

(b) Subject to this section, the district shall protect from disclosure any trade secret designated as such by the operator, if that trade secret is not a public record.

(c) Upon receipt of a request for the release of information to the public which includes information which the operator has notified the district is a trade secret and which is not a public record, the following procedure applies:

(1) The district shall notify the operator of the request in writing by certified mail, return receipt requested.

(2) The district shall release the information to the public, but not earlier than 30 days after the date of mailing the notice of the request for information, unless, prior to the expiration of the 30-day period, the operator obtains an action in an appropriate court for a declaratory judgment that the information is subject to protection under this section or for a preliminary injunction prohibiting disclosure of the information to the public and promptly notifies the district of that action.

(d) This section does not permit an operator to refuse to disclose the information required pursuant to this part to the district.

(e) Any information determined by a court to be a trade secret, and not a public record pursuant to this section, shall not be disclosed to anyone except an officer or employee of the district, the state, or the United States, in connection with the official duties of that officer or employee under any law for the protection of health, or to contractors with the district or the state and its employees if, in the opinion of the district or the state, disclosure is necessary and required for the satisfactory performance of a contract, for performance of work, or to protect the health and safety of the employees of the contractor.

(f) Any officer or employee of the district or former officer or employee who, by virtue of that employment or official position, has possession of, or has access to, any trade secret subject to this section, and who, knowing that disclosure of the information to the general public is prohibited by this section, knowingly and willfully discloses the information in any manner to any person not entitled to receive it is guilty of a

misdemeanor. Any contractor of the district and any employee of the contractor, who has been furnished information as authorized by this section, shall be considered an employee of the district for purposes of this section.

(g) Information certified by appropriate officials of the United States as necessary to be kept secret for national defense purposes shall be accorded the full protections against disclosure as specified by those officials or in accordance with the laws of the United States

(h) As used in this section, "trade secret" and "public record" have the meanings and protections given to them by Section 6254.7 of the Government Code and Section 1060 of the Evidence Code. All information collected pursuant to this chapter, except for data used to calculate emissions data required in the facility diagram, shall be considered "air pollution emission data," for the purposes of this section. (Added by Stats. 1987, Ch. 1252, Sec. 1. Operative July 1, 1988, pursuant to Section 44384.)

CHAPTER 4. RISK ASSESSMENT

(Chapter 4 added by Stats. 1987, Ch. 1252, Sec. 1. Operative July 1, 1988, pursuant to Section 44384.)

44360. (a) Within 90 days of completion of the review of all emissions inventory data for facilities specified in subdivision (a) of Section 44322, but not later than December 1,1990, the district shall, based on examination of the emissions inventory data and in consultation with the state board and the State Department of Health Services, prioritize and then categorize those facilities for the purposes of health risk assessment. The district shall designate high, intermediate, and low priority categories and shall include each facility within the appropriate category based on its individual priority. In establishing priorities pursuant to this section, the district shall consider the potency, toxicity, quantity, and volume of hazardous materials released from the facility, the proximity of the facility to potential receptors, including, but not limited to, hospitals, schools, day care centers, worksites, and residences, and any other factors that the district finds and determines may indicate that the facility may pose a significant risk to receptors. The district shall hold a public hearing prior to the final establishment of priorities and categories pursuant to this section.

(b) (1) Within 150 days of the designation of priorities and categories pursuant to subdivision (a), the operator of every facility that has been included within the highest priority category shall prepare and submit to the district a health risk assessment pursuant to Section 44361. The district may, at its discretion, grant a 30-day extension for submittal of the health risk assessment.

(2) Health risk assessments required by this chapter shall be prepared in accordance with guidelines established by the Office of Environmental Health Hazard Assessment. The office shall prepare draft guidelines which shall be circulated to the public and the regulated community and shall adopt risk assessment guidelines after consulting with the state board and the Risk Assessment Committee of the California Air Pollution Control Officers Association and after conducting at least two public workshops, one in the northern and one in the southern part of the state. The adoption of the guidelines is not subject to

Chapter 3.5 (commencing with Section 11340) of Part 1 of Division 3 of Title 2 of the Government Code. The scientific review panel established pursuant to Section 39670 shall evaluate the guidelines adopted under this paragraph and shall recommend changes and additional criteria to reflect new scientific data or empirical studies.

(3) The guidelines established pursuant to paragraph (2) shall impose only those requirements on facilities subject to this subdivision that are necessary to ensure that a required risk assessment is accurate and complete and shall specify the type of site-specific factors that districts may take into account in determining when a single health risk assessment may be allowed under subdivision (d). The guidelines shall, in addition, allow the operator of a facility, at the operator's option, and to the extent that valid and reliable data are available, to include for consideration by the district in the health risk assessment any or all of the following supplemental information:

(a) Information concerning the scientific basis for selecting risk parameter values that are different than those required by the guidelines and the likelihood distributions that result when alternative values are used.

(b) Data from dispersion models, microenvironment characteristics, and population distributions that may be used to estimate maximum actual exposure.

(c) Risk expressions that show the likelihood that any given risk estimate is the correct risk value.

(d) A description of the incremental reductions in risk that occur when exposure is reduced.

(4) To ensure consistency in the use of the supplemental information authorized by subparagraphs (A), (B), (C),and (D) of paragraph (3),the guidelines established pursuant to paragraph (2) shall include guidance for use by the districts in considering the supplemental information when it is included in the health risk assessment. (c) Upon submission of emissions inventory data for facilities specified in subdivisions (b) and (c) of Section 44322, the district shall designate facilities for inclusion within the highest priority category, as appropriate, and any facility so designated shall be subject to subdivision (b). In addition, the district may require the operator of any facility to prepare and submit health risk assessments, in accordance with the priorities developed pursuant to subdivision (a).

(e) The district shall, except where site specific factors may affect the results, allow the use of a single health risk assessment for two or more substantially identical facilities operated by the same person.

(f) Nothing contained in this section, Section 44380.5, or Chapter 6 (commencing with Section 44390) shall be interpreted as requiring a facility operator to prepare a new or revised health risk assessment using the guidelines established pursuant to paragraph (2) of subdivision (a) of this section if the facility operator is required by the district to begin the preparation of a health risk assessment before those guidelines are established. (Amended by Stats. 1992, Ch. 1162, Sec. 1. Effective January 1, 1993.)

44361. (a) Each health risk assessment shall be submitted to the district. The district shall make he health risk assessment available for public review, upon request. After preliminary review of the emissions impact and modeling data, the district shall submit the health risk assessment to the Office of Environmental Health Hazard Assessment for review and, within 180 days of receiving the health risk assessment, the office shall submit to the district its comments on the data and findings relating to health effects. The district shall consult with the state board as necessary to adequately evaluate the emissions impact and modeling data contained within the risk assessment.

(b) For the purposes of complying with this section, the Office of Environmental Health Hazard Assessment may select a qualified independent contractor to review the data and findings relating to health effects. The office shall not select an independent contractor to review a specific health risk assessment who may have a conflict of interest with regard to the review of that health risk assessment. Any review by an independent contractor shall comply with the following requirements:
   (1) Be performed in a manner consistent with guidelines provided by the office.
   (2) Be reviewed by the office for accuracy and completeness.
   (3) Be submitted by the office to the district in accordance with this section.

(c) The district shall reimburse the Office of Environmental Health Hazard Assessment or the qualified independent contractor designated by the office pursuant to subdivision (b), within 45 days of its request, for its actual costs incurred in reviewing a health risk assessment pursuant to this section.

(d) If a district requests the Office of Environmental Health Hazard Assessment to consult with the district concerning any requirement of this part, the district shall reimburse the office, within 45 days of its request, for the costs incurred in the consultation.

(e) Upon designation of the high priority facilities, as specified in subdivision (a) of Section 44360, the Office of Environmental Health Hazard Assessment shall evaluate the staffing requirements of this section and may submit recommendations to the Legislature, as appropriate, concerning the maximum number of health risk assessments to be reviewed each year pursuant to this section. (Added by Stats. 1987, Ch. 1252, Sec. l. Operative July 1, 1988, pursuant to Section

44384. Amended by Governor's Reorganization Plan No. l of l991, §144.)

44362. (a) Taking the comments of the Office of Environmental Health Hazard Assessment into account, the district shall approve or return for revision and resubmission and then approve, the health risk assessment within 180 days of receipt. If the health risk assessment has not been revised and resubmitted within 60 days of the district's request of the operator to do so, the district may modify the health risk assessment and approve it as modified.

(b) Upon approval of the health risk assessment, the operator of the facility shall provide notice to all exposed persons regarding the results of the health risk assessment prepared pursuant to Section 44361 if, in the judgment of the district, the health risk assessment indicates there is a significant health risk associated with emissions from the facility. If notice is required under this subdivision, the notice shall include only

information concerning significant health risks attributable to the specific facility for which the notice is required. Any notice shall be made in accordance with procedures specified by the district. (Added by Stats. 1981, Ch. 1252, Sec. 1. Operative July 1, 1988, pursuant to Section 44384. Amended by Governor's Reorganization Plan No. 1 of 1991, 145.)

44363. (a) Commencing July 1, 1991, each district shall prepare and publish an annual report which does all of the following:
(1) Describes the priorities and categories designated pursuant to Section 44360 and summarizes the results and progress of the health risk assessment program undertaken pursuant to this part.
(2) Ranks and identifies facilities according to the degree of cancer risk posed both to individuals and to the exposed population.
(3) Identifies facilities which expose individuals or populations to any noncancer health risks.
(4) Describes the status of the development of control measures to reduce emissions of toxic air contaminants, if any.
(b) The district shall disseminate the annual report to county boards of supervisors, city councils, and local health officers and the district board shall hold one or more public hearings to present the report and discuss its content and significance. (Added by Stats. 1987, Ch. 1252, Sec. l. Operative July 1, 1988, pursuant to Section 44384.)

44364. The state board shall utilize the reports and assessments developed pursuant to this part for the purposes of identifying, establishing priorities for, and controlling toxic air contaminants pursuant to Chapter 3.5 (commencing with Section 39650) of Part 2. (Added by Stats. 1987, Ch. 1252, Sec. 1. Operative July 1, 1988, pursuant to Section 44384.)

44365. (a) If the state board finds and determines that a district's actions pursuant to this part do not meet the requirements of this part, the state board may exercise the authority of the district pursuant to this part to approve emissions inventory plans and require the preparation of health risk assessments.
(b) This part does not prevent any district from establishing more stringent criteria and requirements than are specified in this part for approval of emissions inventories and requiring the preparation and submission of health risk assessments. Nothing in this part limits the authority of a district under any other provision of law to assess and regulate releases of hazardous substances. (Added by Stats. 1987, Ch. 1252, Sec. 1. Operative July 1, 1988, pursuant to Section 44384.)

44366. (a) In order to verify the accuracy of any information submitted by facilities pursuant to this part, a district or the state board may proceed in accordance with Section 41510. (Added by Stats. 1987, Ch. 1252, Sec. 1. Operative July 1, 1988, pursuant to Section 44384.)

CHAPTER 5. FEES AND REGULATIONS
(Chapter 5 added by Stats. 1987, Ch. 1252, Sec. 1. Operative July 1, 1988, pursuant to Section 44384.)

44380. (a) The state board shall adopt a regulation which does all of the following:

(1) Sets forth the amount of revenue which the district must collect to recover the reasonable anticipated cost which will be incurred by the state board and the Office of Environmental Health Hazard Assessment to implement and administer this part.

(2) Requires each district to adopt a fee schedule which recovers the costs of the district and which assesses a fee upon the operator of every facility subject to this part. A district may request the state board to adopt a fee schedule for the district if the district's program costs are approved by the district board and transmitted to the state board by April 1 of the year in which the request is made.

(3) Requires any district that has an approved toxics emissions inventory compiled pursuant to this part by August 1 of the preceding year to adopt a fee schedule, as described in paragraph (2), which imposes on facility operators fees which are, to the maximum extent practicable, proportionate to the extent of the releases identified in the toxics emissions inventory and the level of priority assigned to that source by the district pursuant to Section 44360.

(b) Commencing August 1, 1992, and annually thereafter, the state board shall review and may amend the fee regulation.

(c) The district shall notify each person who is subject to the fee of the obligation to pay the fee. If a person fails to pay the fee within 60 days after receipt of this notice, the district, unless otherwise provided by district rules, shall require the person to pay an additional administrative civil penalty. The district shall fix the penalty at not more than 100 percent of the assessed fee, but in an amount sufficient in its determination, to pay the district's additional expenses incurred by the person's noncompliance. If a person fails to pay the fee within 120 days after receipt of this notice, the district may initiate permit revocation proceedings. If any permit is revoked, it shall be reinstated only upon full payment of the overdue fee plus any late penalty, and a reinstatement fee to cover administrative costs of reinstating the permit.

(d) Each district shall collect the fees assessed pursuant to subdivision (a). After deducting the costs to the district to implement and administer this part, the district shall transmit the remainder to the Controller for deposit in the Air Toxics Inventory and Assessment Account, which is hereby created in the General Fund. The money in the account is available, upon appropriation by the Legislature, to the state board and the Office of Environmental Health Hazard Assessment for the purposes of administering this part. (Amended by Stats. 1992, Ch. 375, Sec. 1. Effective January 1, 1993.)

44380.1. A facility shall be granted an exemption by a district from paying a fee in accordance with Section 44380 if all of the following criteria are met:

(a) The facility primarily handles, processes, stores, or distributes bulk agricultural commodities or handles, feeds, or rears livestock.

(b) The facility was required to comply with this part only as a result of its particulate matter emissions.

(c) The fee schedule adopted by the district or the state board for these types of facilities is not solely based on toxic emissions weighted for potency or toxicity. (Added by Stats. 1993, Ch. 1037, Sec. 4. Effective January 1, 1994.)

44380.5. In addition to the fee assessed pursuant to Section 44380, a supplemental fee may be assessed by the district, the state board, or the Office of Environmental Health Hazard Assessment upon the operator of a facility that, at the operator's option, includes supplemental information authorized by paragraph (3) of subdivision (b) of Section 44360 in a health risk assessment, if the review of that supplemental information substantially increases the costs of reviewing the health risk assessment by the district, the state board, or the office. The supplemental fee shall be set by the state board in the regulation required by subdivision (a) of Section 44380 and shall be set in an amount sufficient to cover the direct costs to review the information supplied by an operator pursuant to paragraph (3) of subdivision (b) of Section 44360. (Added by Stats. 1992, Ch. 1162, Sec. 2. Effective January 1, 1993.)

44381. (a) Any person who fails to submit any information, reports, or statements required by this part, or who fails to comply with this part or with any permit, rule, regulation, or requirement issued or adopted pursuant to this part, is subject to a civil penalty of not less than five hundred dollars ($500) or more than ten thousand dollars ($10,000) for each day that the information, report, or statement is not submitted, or that the violation continues.

(b) Any person who knowingly submits any false statement or representation in any application, report, statement, or other document filed, maintained, or used for the purposes of compliance with this part is subject to a civil penalty of not less than one thousand dollars ($1,000) or more than twenty-five thousand dollars ($25,000) per day for each day that the information remains uncorrected. (Added by Stats. 1987, Ch. 1252, Sec. 1. Operative July 1988, pursuant to Section 44384.)

44382. Every district shall, by regulation, adopt the requirements of this part as a condition of every permit issued pursuant to Chapter 4 (commencing with Section 42300) of Part 4 for all new and modified facilities. (Added by Stats. 1987, Ch. 1252, Sec. 1. Operative July 1, 1988, pursuant to Section 44384.)

44384. Except for Section 44380 and this section, all provisions of this part shall become operative on July 1, 1988. (Added by Stats. 1987, Ch. 1252, Sec. 1. Operative January 1, 1988, by its own provisions.)

CHAPTER 6. FACILITY TOXIC AIR CONTAMINANT RISK REDUCTION AUDIT AND PLAN

(Chapter 6 added by Stats. 1992, Ch. 1162, Sec. 3. Effective January 1, 1993.)

44390. For purposes of this chapter, the following definitions apply:

(a) "Airborne toxic risk reduction measure" or "ATRRM" means those in-plant changes in production processes or feedstocks that reduce or eliminate toxic air emissions subject to this part. ATRRM's may include:

(1) Feedstock modification.

(2) Product reformulations.
(3) Production system modifications.
(4) System enclosure, emissions control, capture, or conversion.
(5) Operational standards and practices modification.

(b) Airborne toxic risk reduction measures do not include measures that will increase risk from exposure to the chemical in another media or that increase the risk to workers or consumers.

(c) "Airborne toxic risk reduction audit and plan" or "audit and plan" means the audit and plan specified in Section 44392. (Added by Stats. 1992, Ch. 1162, Sec. 3. Effective January 1, 1993.)

44391. (a) Whenever a health risk assessment approved pursuant to Chapter 4 (commencing with Section 44360) indicates, in the judgment of the district, that there is a significant risk associated with the emissions from a facility, the facility operator shall conduct an airborne toxic risk reduction audit and develop a plan to implement airborne toxic risk reduction measures that will result in the reduction of emissions from the facility to a level below the significant risk level within five years of the date the plan is submitted to the district. The facility operator shall implement measures set forth in the plan in accordance with this chapter.

(b) The period to implement the plan required by subdivision (a) may be shortened by the district if it finds that it is technically feasible and economically practicable to implement the plan to reduce emissions below the significant risk level more quickly or if it finds that the emissions from the facility pose an unreasonable health risk.

(c) A district may lengthen the period to implement the plan required by subdivision (a) by up to an additional five years if it finds that a period longer than five years will not result in an unreasonable risk to public health and that requiring implementation of the plan within five years places an unreasonable economic burden on the facility operator or is not technically feasible.

(d) (1) The state board and districts shall provide assistance to smaller businesses that have inadequate technical and financial resources for obtaining information, assessing risk reduction methods, and developing and applying risk reduction techniques.

(2) Risk reduction audits and plans for any industry subject to this chapter which is comprised mainly of small businesses using substantially similar technology may be completed by a self-conducted audit and checklist developed by the state board. The state board, in coordination with the districts, shall provide a copy of the audit and checklist to small businesses within those industries to assist them to meet the requirements of this chapter.

(e) The audit and plan shall contain all the information required by Section 44392.

(f) The plan shall be submitted to the district, within six months of a district's determination of significant risk, for review of completeness. Operators of facilities that have been notified prior to January 1, 1993, that there is a significant risk associated with emissions from the facility shall submit the plan by July 1, 1993. The district's review of completeness shall include a substantive analysis of the emission reduction measures included in the plan, and the ability of those measures to achieve

emission reduction goals as quickly as feasible as provided in subdivisions (a) and (b).

(g) The district shall find the audit and plan to be satisfactory within three months if it meets the requirements of this chapter, including, but not limited to, subdivision (f). If the district determines that the audit and plan does not meet those requirements, the district shall remand the audit and plan to the facility specifying the deficiencies identified by the district. A facility operator shall submit a revised audit and plan addressing the deficiencies identified by the district within 90 days of receipt of a deficiency notice.

(h) Progress on the emission reductions achieved by the plan shall be reported to the district in emissions inventory updates. Emissions inventory updates shall be prepared as required by the audit and plan found to be satisfactory by the district pursuant to subdivision (g).

(i) If new information becomes available after the initial risk reduction audit and plan, on air toxics risks posed by a facility, or emission reduction technologies that may be used by a facility that would significantly impact risks to exposed persons, the district may require the plan to be updated and resubmitted to the district.

(j) This section does not authorize the emission of a toxic air contaminant in violation of an airborne toxic control measure adopted pursuant to Chapter 3.5 (commencing with Section 39650) or in violation of Section 41700. (Amended by Stats. 1993, Ch. 1041, Sec. 2. Effective January 1, 1994.)

44392. A facility operator subject to this chapter shall conduct an airborne toxic risk reduction audit and develop a plan which shall include at a minimum all of the following:

(a) The name and location of the facility.

(b) The SIC code for the facility.

(c) The chemical name and the generic classification of the chemical.

(d) An evaluation of the ATRRM's available to the operator.

(e) The specification of, and rationale for, the ATRRMs that will be implemented by the operator. The audit and plan shall document the rationale for rejecting ATRRMs that are identified as infeasible or too costly.

(f) A schedule for implementing the ATRRMs. The schedule shall meet the time requirements of subdivision (a) of Section 44391 or the time period for implementing the plan set by the district pursuant to subdivision (b) or (c) of Section 44391, whichever is applicable.

(g) The audit and plan shall be reviewed and certified as meeting this chapter by an engineer who is registered as a professional engineer pursuant to Section 6762 of the Business and Professions Code, by an individual who is responsible for the processes and operations of the site, or by an environmental assessor registered pursuant to Section 25570.3. (Added by Stats. 1992, Ch. 1162, Sec. 3. Effective January 1, 1993.)

44393. The plan prepared pursuant to Section 44391 shall not be considered to be the equivalent of a pollution prevention program or a source reduction program, except insofar as the audit and plan elements are consistent with source reduction, as defined in Section 25244.14, or

subsequent statutory definitions of pollution prevention. (Added by Stats. 1992, Ch. 1162, Sec. 3. Effective January 1, 1993.)

44394. Any facility operator who does not submit a complete airborne toxic risk reduction audit and plan or fails to implement the measures set forth in the plan as set forth in this chapter is subject to the civil penalty specified in subdivision (a) of Section 44381, and any facility operator who, in connection with the audit or plan, knowingly submits any false statement or representation is subject to the civil penalty specified in subdivision (b) of Section 44381. (Added by Stats. 1992, Ch. 1162, Sec. 3. Effective January 1, 1993.)

Appendix C

Asbestos Quantity Conversion Factors

Appendix C

Asbestos Quantity Conversion Factors

A. "PCM" versus "TEM"

Two main analytical methods have been used for the analysis of asbestos samples: phase contrast microscopy (PCM), the primary method used historically to analyze asbestos samples, and transmission electron microscopy (TEM), the current state-of-the-art method.

PCM analysis has been preferred in the past over TEM because it can be done more quickly and it is less expensive. One major limitation of PCM analysis, however, especially in outdoor environments, is that the analyst cannot distinguish asbestos from non-asbestos fibers, such as cellulose, talc, or gypsum. Also, PCM cannot detect fibers that have a diameter of about 0.3 microns or less, which could substantially underestimate the asbestos fiber concentrations. These limitations make PCM impractical for the analysis of ambient asbestos samples.

Transmission electron microscopy (TEM) is the preferred analytical method for outdoor asbestos samples because of its ability to detect small fibers (greater than or equal to 0.0002 microns in diameter) and to distinguish between asbestos fibers and non-asbestos fibers. The term "TEM structures" is often used to describe asbestos fibers detected by this method. TEM is the method recommended by the Office of Environmental Health Hazard Assessment (OEHHA). TEM measurements cannot be directly related to the risk potency factors, however, because the studies upon which OEHHA's risk assessment was based used the less expensive PCM analysis. The TEM measurements must be converted to PCM-equivalent units, using the following equation (ARB, 1990):

$$1\,\text{PCM fiber} = 320\,\text{TEM structures}$$

B. Asbestos Inhalation Cancer Potency Factor

The unit risk factor for asbestos fibers is 1.9×10^{-4} in units of $(100\ \text{PCM fibers/m}^3)^{-1}$ and the unit risk factor is 6.3×10^{-2} in units of $(\mu\text{g/m}^3)^{-1}$. The unit risk factor is based on epidemiological studies in which PCM fiber measurements were used. These unit risk factors are listed in Chapter 7 and in the Asbestos Toxic Air Contaminant (TAC) identification document (CDHS, 1986) and in OEHHA, 1999b. These asbestos cancer potency factors are for mesothelioma. Since these cancer potency factors are in units of concentration or dose, complications arise when the emitted asbestos quantities are reported in mass units (pounds/year and maximum pounds/hour) for the Air Toxics Hot Spots Program (Hot Spots).

The Air Toxics Hot Spots Program Guidance Manual for Preparation of Health Risk Assessments. August 2003.

The TAC inhalation cancer potency factor has been converted from mass to concentration using a factor of 0.003 µg asbestos = 100 asbestos PCM fibers. This conversion has been derived from information published by the United States Environmental Protection Agency (U.S. EPA) (U.S. EPA, 1986). The number of asbestos PCM fibers associated with a given mass of asbestos can vary appreciably. Also, U.S. EPA has stated that this conversion factor is the geometric mean of measured relationships between optical fiber counts and mass airborne chrysotile in several published studies, that the range of the conversion factor between the different studies is large (0.0005 - 0.015 µg asbestos/100 asbestos PCM fibers), and that the factor carries with it an appreciable uncertainty.

The current recommendation for Hot Spots risk assessments uses a default breathing rate of 393 L/day-kg body weight for a 70 year exposure duration. A dose is calculated from the ground level concentration using the following equation:

$$X\ (\mu g/m^3) \times 393\ L/day\text{-}kg\ body\ weight \times 10^{-6} = dose\ (mg/kg\text{-}day)$$

The 10^{-6} term converts the L in the breathing rate to m^3 and the µg in the air concentration term to mg.

In order to obtain cancer risk the dose is subsequently multiplied times the cancer potency factor as follows:

Dose (mg/kg-body weight) x cancer potency factor (mg/kg-body weight) = Cancer risk (unitless)

For risk communication purposes cancer risk may be converted into chances per million of developing cancer. This terminology is often more clearly understood by the public than cancer risk.

Cancer risk x (1×10^6) = chances per million of developing cancer

The cancer potency factor $(mg/kg\ body\ weight)^{-1}$ may be calculated from the fiber cancer potency factor using the relationship of 0.003 µg = 100 fibers PCM, 70 kg body weight, 20 m^3 breathed per day, and a factor of 1000 to convert µg asbestos into mg:

$$1.9\times10^{-4}\left(100\ PCM\ \ fibers/m^3\right)^{-1}\times\frac{70kg}{20m^3}\times\frac{1000}{0.003mg/100\ fibers}=2.2\times10^{+2}\left(mg/kg\ body\ weight\right)^{-1}$$

The ISCST3 air dispersion modeling program estimates concentrations in units of $\mu g/m^3$ based on emission estimates in lb/yr. If the ground level concentrations are derived from PCM fiber measurements, then no additional uncertainty is introduced by the conversion to µg using the factor of 0.003. This is because the factor is effectively cancelled out by its use to derive the cancer potency factor in $(mg/kg\ body\ weight)^{-1}$. There is a slight rounding error that may be introduced.

References

ARB, 1990. Proposed Control Measure for Asbestos-Containing Serpentine Rock in Surfacing Applications, Technical Support Document, Air Resources Board, February 1990.

CDHS, (1986) California Department of Health Services (CDHS) 1986. Report to the Air Resources Board on Asbestos. Part B. Health Effects of Asbestos. Epidemiological Studies Section, Berkeley, CA.

OEHHA. (1999b). Air Toxics Hot Spots Program Risk Assessment Guidelines. Part II. Technical Support Document for Describing Available Cancer Potency Factors. Available online at http://www.oehha.ca.gov

USEPA, 1986. Airborne Asbestos Health Assessment Update. EPA/600/8-84/003F, Office of Health and Environmental Assessment, Washington, DC.

Appendix D

Risk Assessment Procedures to Evaluate Particulate Emissions from Diesel-Fueled Engines

Appendix D

Risk Assessment Procedures to Evaluate Particulate Emissions from Diesel-Fueled Engines

A. Introduction

The objective of this appendix is to discuss procedures for estimating potential cancer and noncancer health risk from exposure to particulate matter (PM) emissions from diesel-fueled engines (diesel exhaust). It will also clarify the requirements and recommendations for acute noncancer and multipathway cancer and chronic risk assessment for diesel PM. In addition to the notification and risk reduction requirements under the Hot Spots Program, this appendix should facilitate the use of the *Risk Reduction Plan to Reduce Particulate Matter Emissions from Diesel-Fueled Engines and Vehicles* (ARB, 2000) (Diesel Guidelines). The Diesel Guidelines were developed by the Air Resources Board (ARB) with assistance from the Office of Environmental Health Hazard Assessment (OEHHA) in October 2000. The Diesel Guidelines are intended to assist local Air Pollution Control and Air Quality Management Districts (Districts) and sources of diesel PM emissions in making consistent risk management decisions.

In advance of performing a health risk assessment (HRA), it is recommended that the District and the stationary source of diesel emissions reach a consensus on the HRA approach for estimating health impacts from diesel exhaust. See Chapter 9 for an outline of a modeling protocol.

B. Calculations/Risk Assessment Procedures

In August 1998, the ARB identified diesel exhaust as a toxic air contaminant (TAC) (ARB, 1998). In the identification report, OEHHA provided an inhalation noncancer chronic reference exposure level (REL) of 5 micrograms per cubic meter ($\mu g/m^3$) and a range of inhalation cancer potency factors of 1.3×10^{-4} to 2.4×10^{-3} $(\mu g/m^3)^{-1}$. The Scientific Review Panel on Toxic Air Contaminants recommended a "reasonable estimate" inhalation unit risk factor of 3.0×10^{-4} $(\mu g/m^3)^{-1}$. From the unit risk factor an inhalation cancer potency factor of 1.1 $(mg/kg\text{-}day)^{-1}$ may be calculated. These noncancer and cancer health factors were developed based on whole (gas and particulate matter) diesel exhaust. The surrogate for whole diesel exhaust is diesel PM. PM_{10} (particulate matter, ten microns or less in size) is the basis for the potential risk calculations.

Cancer

When conducting an HRA, the potential cancer risk from inhalation exposure to diesel PM will outweigh the potential noncancer health impacts. Therefore, inhalation cancer risk is required for every HRA. (The methods for calculating inhalation cancer risk can be found in Chapters 5, 7, and 8.) When comparing whole diesel exhaust to speciated diesel exhaust (e.g., PAHs, metals), potential cancer risk from inhalation exposure to whole diesel exhaust will

outweigh the multipathway cancer risk from the speciated components. For this reason, there will be few situations where an analysis of multipathway risk is necessary.

The District may elect to require a multipathway analysis if reliable data are available and the District decides that it is necessary. If the District elects to require a multipathway analysis, the components of the diesel exhaust will need to be speciated since there is not an oral cancer potency factor for diesel PM. It is recommended that the District be consulted on the procedures for conducting a multipathway analysis for diesel exhaust. The District may wish to use speciation data from the ARB. If so, a resource for speciation data is available on the ARB's website at www.arb.ca.gov/emisinv/speciate/speciate.htm.

If a multipathway analysis is required, the speciated data should be compared with the substances in Table 5.1. Any substances in the speciation profile that are listed in Table 5.1 and have an oral cancer potency factor in Table 7.1 should be included in the multipathway analysis. Potential multipathway cancer risks are estimated following the procedures in Chapters 5 and 8 of this document. These procedures require summing the potential cancer risk from each carcinogen to estimate the total facility cancer risk.

Noncancer Chronic

To determine noncancer chronic inhalation health impacts from exposure to diesel exhaust use the methods described in Chapters 6 and 8.

In most situations, noncancer health impacts from inhalation exposure to whole diesel exhaust will outweigh the noncancer multipathway health impacts to the speciated components of diesel exhaust. However, there may be situations when the multipathway impacts need to be investigated.

Therefore, the District may elect to require a multipathway analysis if reliable data is available and they feel it is necessary. If the District elects to require a multipathway analysis, the components of the diesel exhaust will need to be speciated since there is not an oral reference exposure level for diesel PM. A resource for speciation data at the ARB is identified above. It is recommended that the District be consulted on the procedures for conducting a multipathway analysis. If a multipathway analysis is required, the speciated data should be compared with the substances in Table 5.1. Any substances in the speciation profile that are listed in Table 5.1 and have an oral chronic REL in Table 6.3 should be included in the multipathway analysis. Potential multipathway chronic risks are estimated following the procedures in Chapters 5 and 8 of this document.

Noncancer Acute

As stated above, potential cancer risk is usually the driving health impact for diesel exhaust. However, there may be certain unusual situations where an evaluation of the acute health effects may be warranted. One possible situation is when a nearby receptor is located above the emission release point (e.g. on a hillside or in a multistory apartment building). Since there is no acute REL for diesel exhaust, the components of the exhaust will need to be speciated to determine the potential acute health impacts. It is recommended that the District be consulted on the procedures for conducting an acute analysis. If an acute analysis is required, the speciated

data should be compared with the substances in Table 6.1. Any substances in the speciation profile that are listed in Table 6.1 should be included in the acute analysis. A resource for speciation data at the ARB is identified above. Potential acute risks are estimated following the procedures in Chapters 6 and 8 of this document.

References:

ARB 1998. Air Resources Board, "Proposed Identification of Diesel Exhaust as a Toxic Air Contaminant, Appendix III, Part A, Exposure Assessment," April 1998.

ARB 2000. Air Resources Board, "Risk Reduction Plan to Reduce Particulate Matter Emissions from Diesel-Fueled Engines and Vehicles," October 2000.

Appendix E

Toxicity Equivalency Factors for Polychlorinated Dibenzo-*p*-Dioxins Dibenzofurans And Polychlorinated Biphenyls

Appendix E

Toxicity Equivalency Factors for Polychlorinated Dibenzo-*p*-Dioxins Dibenzofurans and Polychlorinated Biphenyls

Introduction

Dioxins and furans vary considerably in their potency for causing both cancer and noncancer health impacts. A facility may choose to speciate dioxin and furan emissions in order to obtain a more accurate picture of the risks. A scheme, based on both cancer and noncancer toxicity studies, has been developed to relate the potency of various dioxin and furan congeners to the potency of 2,3,7,8-tetrachlorodibenzo-*p*-dioxin. A detailed explanation of the World Health Organization's 1997 Toxicity Equivalents Factor (WHO_{97}-TEF) (van den Berg, 1998) scheme, the latest scheme adopted by OEHHA, is available in OEHHA (2003).

The individually calculated inhalation or oral doses of each dioxin or furan congener may be multiplied times the oral or inhalation cancer potency for each individual congener listed in Table 7.1. In order to determine the inhalation chronic hazard index, the ground level concentration of each congener may be divided by the chronic REL for each congener in Table 6.2 and the hazard quotients may be summed to give the hazard index for dioxins and furans. The oral chronic hazard quotient may be calculated by determining the oral dose of each congener and dividing by the individual chronic oral REL for each congener. The oral hazard quotients may be summed to give the hazard quotient for oral noncancer dioxin risks and may then be added to the inhalation hazard index to give the combined inhalation and oral chronic hazard quotient for dioxins.

A second equivalent procedure may also be used to calculate the cancer risk of a mixture of dioxin and furan congeners. The concentration of each congener listed in Table E-1 is multiplied by the WHO_{97}-TEF for that congener. For example, for 1,2,3,4,7,8-hexachlorodibenzodioxin the concentration ($\mu g/m^3$) may be multiplied by 0.1 to give the concentration equivalent to 2,3,7,8-tetrachlorodibenzo-*p*-dioxin. 2,4,7,8-tetrachlorodibenzodioxin would be multiplied by zero indicating no cancer or noncancer toxicity. The 2,3,7,8-tetrachlorodibenzo-*p*-dioxin equivalent concentrations may be summed and treated as if the total concentration were 2,3,7,8-tetrachlorodibenzo-*p*-dioxin for the purposes of calculating cancer and noncancer risks. Thus, the potency adjusted ground level concentration can be multiplied by the breathing rate to give dose (see equation 5.4.1), and then multiplied times the cancer potency factor for 2,3,7,8- tetrachlorodibenzo-*p*-dioxin (Table 7.1) to give cancer risk for the entire mixture. If a noncancer chronic hazard index needs to be calculated the potency adjusted ground level concentration can be divided by the chronic reference exposure level for 2,3,7,8-tetrachlorodibenzo-*p*-dioxin to give a hazard index for the entire mixture. The TEF may be multiplied times the individual congener dose calculated for the inhalation and oral cancer risk calculation, and the oral chronic hazard index determination.

The Air Toxics Hot Spots Program Guidance Manual for Preparation of Health Risk Assessments. August 2003.

The most recent TEF scheme adopted by OEHHA includes TEF for individual PCB congeners (see Table E-1) (OEHHA, 2003). These are the congeners that have dioxin-like biological effects. The same procedures as described above may be used to calculate the concentration or dose of these congeners. Where data are available on individual PCB congeners emitted by a facility, then these TEFs are to be used. If Table E1 is used to adjust the dose or concentration of the individual PCB congeners, the 2,3,7,8-tetrachlorodibenzo-*p*-dioxin oral and inhalation cancer potency factors should be used to determine cancer risk. The chronic inhalation and oral REL for 2,3,7,8-tetrachlorodibenzo-*p*-dioxin should be used to determine the noncancer chronic hazard index. If only total PCB data are available, then the PCB slope factors provided in Table 7.1 can be used for cancer risk determination.

Table E1. WHO/97 Toxic equivalency factors (TEFs)

Congener		TEF_{WHO-97}
PCDDs		
2,3,7,8-TCDD		1
1,2,3,7,8-PeCDD		1
1,2,3,4,7,8-HxCDD		0.1
1,2,3,7,8,9-HxCDD		0.1
1,2,3,6,7,8-HxCDD		0.1
1,2,3,4,6,7,8-HpCDD		0.01
1,2,3,4,6,7,8,9-OCDD		0.0001
PCDFs		
2,3,7,8-TCDF		0.1
1,2,3,7,8-PeCDF		0.05
2,3,4,7,8-PeCDF		0.5
1,2,3,4,7,8-HxCDF		0.1
1,2,3,7,8,9-HxCDF		0.1
1,2,3,6,7,8-HxCDF		0.1
2,3,4,6,7,8-HxCDF		0.1
1,2,3,4,6,7,8-HpCDF		0.01
1,2,3,4,7,8,9-HpCDF		0.01
1,2,3,4,6,7,8,9-OCDF		0.0001
PCBs (IUPAC #, Structure)		
77	3,3',4,4'-TCB	0.0001
81	3,4,4',5-TCB	0.0001
105	2,3,3',4,4'-PeCB	0.0001
114	2,3,4,4',5-PeCB	0.0005
118	2,3',4,4',5-PeCB	0.0001
123	2',3,4,4',5-PeCB	0.0001
126	3,3',4,4',5-PeCB	0.1
156	2,3,3',4,4',5-HxCB	0.0005
157	2,3,3',4,4',5'-HxCB	0.0005
167	2,3',4,4',5,5'-HxCB	0.00001
169	3,3',4,4',5,5'-HxCB	0.01
189	2,3,3',4,4',5,5'-HpCB	0.0001

The Air Toxics Hot Spots Program Guidance Manual for Preparation of Health Risk Assessments. August 2003.

References

OEHHA, 2003. Technical Support Document for Describing Available Cancer Potency Factors, Appendix A (revised August, 2003) : Use of the Revised Toxicity Equivalency Factor (TEF_{WHO-97}) Scheme for Estimating Toxicity of Mixtures of Dioxin-Like Chemicals, September 2003. Available at **www.oehha.ca.gov**.

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Appendix F

Overview of the Lead Risk Assessment Procedures

Appendix F

Overview of the Lead Risk Assessment Procedures

I. Introduction

The objective of this appendix is to provide a method for estimating potential cancer and noncancer health effects due to airborne lead exposure. This appendix should facilitate the use of the *Risk Management Guidelines for New, Modified, and Existing Sources of Lead* (Lead RM Guidelines) (ARB, 2001) for analysis of lead exposure. The Lead RM Guidelines were developed by the Air Resources Board (ARB) with assistance from Office of Environmental Health Hazard Assessment (OEHHA) and Department of Health Services (DHS) in March 2001 to assist local air districts and sources of lead in making consistent risk management decisions for new, modified, and existing sources of lead.

In April 1997, the ARB identified inorganic lead as a toxic air contaminant (TAC) (ARB, 1997). Lead is unique among other TACs identified by ARB in several ways. First, infants and children are particularly susceptible to the health effects of lead, and the risk assessment is based on health effects in children. Second, the chronic noncancer effects are related to blood lead levels (BLLs) as opposed to ambient air concentrations. These BLLs reflect current and past exposure from a number of sources; air emissions may only be a small part of the total exposure. Third, based on recommendations of the OEHHA and the Scientific Review Panel on Toxic Air Contaminants (SRP), the ARB did not identify a threshold level for chronic noncancer health effects due to lead exposure. Threshold levels are levels below which no adverse health effects are expected to occur. Since acute or chronic Reference Exposure Levels (RELs) are based on threshold levels, none were developed for lead. Thus, a hazard index approach is not used for lead. Instead, air concentrations are compared to defined air lead levels associated with specified percentages of children with BLL $\geq$ 10 μg/dL. Acceptable risk is based on minimizing the number of children at or above a BLL of 10 μg/dL.

II. Methods for Estimation of Health Risk Effects

Methods for estimating site-specific noncancer and cancer potential health impacts from exposure to lead emissions are given in the Lead RM Guidelines. The noncancer health effects pose greater public health significance than the cancer health effects. Minimizing noncancer health effects of lead will therefore also minimize cancer health effects.

Chronic noncancer health risks are estimated based on neurodevelopmental health risks to children and would also be protective of adults. These health effects can be evaluated using a tiered approach based on blood lead level distribution in the population.

Potential multipathway cancer risks are estimated following the procedures in Chapters 5 and 8 of this document. These procedures require summing individual cancer risk from each carcinogen to estimate the total facility cancer risk.

In advance of performing a health risk assessment (HRA), it is recommended that the Air Pollution Control or Air Quality Management District (District) and the stationary source of lead air emissions reach a consensus on the HRA approach for estimating chronic noncancer and cancer health risks. See Chapter 9 for an outline of a modeling protocol.

A. Tiered Approach for Estimating Noncancer Risks due to Lead Exposure

The Lead Risk Management Guidelines provide three tiers of analysis to determine baseline BLL distributions for estimating risk. Although there is a simple risk management option provided in the Lead RM Guidelines, in a risk assessment for the Air Toxics Hot Spots program one of the following tiers must be used to report estimates of the percent of children estimated to be above 10 μg/dL blood lead. The tiered approach is based on an assessment of neurodevelopmental risk, with the BLL distribution in the population as the most significant factor. The BLL distribution consists of two components: 1) the baseline BLL distribution due to all sources of exposure; and 2) the exposure due to emissions from a facility.

Tier I is a default approach that requires minimal site-specific information on concentrations of lead in environmental media other than air. Tier I uses two default BLL distributions, one for a high exposure scenario and one for an average exposure scenario. The exposure scenario is determined using the median age of the homes in the census tract and the ratio of area income to the poverty level. The default baseline BLL distribution for each of the exposure scenarios is based on a review of neighborhood and community blood lead studies. The assessor determines the 30-day average lead concentration due to the facility averaged over the 1 square kilometer area centered on the Maximum Offsite Concentration (MOC). The percentage of children with BLLs greater than or equal to 10 micrograms per deciliter (≥ 10 μg/dL) is determined using Table F-1 (also found on page 17 in the Lead RM Guidelines), the air lead concentration, and the determined exposure scenario. The 10 μg/dL threshold level has been identified by the Centers for Disease Control and Prevention (CDC) as a level where potential health effects may occur. The public health goal of management practices should be to implement procedures/practices to prevent BLLs at or above this level. The estimated percentage of children with BLLs ≥ 10 μg/dL is then used with risk management levels given in Chapter III, Section D of the Lead RM Guidelines to assist in making risk management decisions.

Table F-1 Percentage of Children with Blood Lead Levels ≥ 10 μg/dl for Various Air Lead Concentrations at Two Exposure Scenarios

Air Lead Concentration in the Maximum Exposure Area (30-day average) [μg/m^3]	Percent ≥ 10 μg/dL	
	High Exposure Scenario	Average Exposure Scenario
Baseline*	5.1	1.2
0.02	5.4	1.4
0.06	6.1	1.7
0.10	6.8	2.2
0.20	8.9	3.4
0.25	9.8	4.1
0.50	15.9	8.9
0.75	22.4	15.4
1.0	29.1	23.0
1.5	42.5	39.0

* The baseline represents BLLs due to lead in soil, dust, water, food, and background air lead concentrations.

Tier II requires the development of site-specific baseline BLL distributions within the impacted population using site-specific estimates of lead levels in environmental media, including soil, dust, water, and/or food, using the U.S. EPA Integrated Exposure Uptake Biokinetic (IEUBK) model. The IEUBK model calculates the probability of an individual exceeding a specific BLL based on site-specific information. The aggregate of the individual BLLs is used to estimate the neurodevelopmental risk in the maximum exposure area. A detailed discussion of this tier is beyond the scope of this overview; see Appendix D in the Lead RM Guidelines for a discussion of the IEUBK model and its use.

Tier III involves actual blood lead sampling of the population impacted by the facility to define the baseline BLLs. In Tier III, the facility is responsible for conducting BLL testing to establish a site-specific BLL distribution. The Lead RM Guidelines recommend the neurodevelopmental risk be calculated as the probability of children in an affected exposure area having a BLL ≥ 10 μg/dL using the results of the blood lead sampling. It is highly unlikely that this option would be used due to the cost incurred and the fact that the sampled population must consent to the sampling and an appropriate sampling strategy must be developed to adequately characterize the blood lead levels of the impacted population.

For further information on the tiered approach using the Tier I, Tier II, or Tier III, please see Chapter II of the *ARB Risk Management Guidelines for New, Modified, and Existing Sources of Lead* (ARB, 2001). This document can be downloaded from the ARB web site at *http://www.arb.ca.gov/toxics/lead/lead.htm* or can be requested by calling (916) 323-4327.

B. Methods for Estimating Potential Cancer Risks due to Lead

While lead has a unique noncancer assessment methodology, the determination of potential multipathway cancer risk is the same as other carcinogens. Chapters 5, 7, and 8, and Appendices I and L provide all the needed information for calculating potential cancer risk. The health risk assessment should report the multipathway cancer risks from lead emissions.

Chapter III in the Lead RM Guidelines provides methods for determining risk management of lead exposure, using the results from the cancer risk calculation, and the local District's defined significance levels.

III. References

ARB, 1997. Proposed Identification Inorganic Lead as a Toxic Air Contaminant, Parts A, B, C. California Air Resources Board. April, 1997.

ARB, 2001. ARB Risk Management Guidelines for New, Modified, and Existing Sources of Lead. California Air Resources Board. March 2001

APPENDIX G

PAH Potency Factors and Selection of Potency Equivalency Factors (PEF) for PAHs Based on Benzo[*A*]Pyrene Potency

Appendix G

PAH Potency Factors and Selection of Potency Equivalency Factors (PEF) for PAHs based on Benzo(*a*)pyrene Potency

Benzo(a)pyrene (BaP) was chosen as the primary representative of the class of polycyclic aromatic hydrocarbons (PAHs) because of (1) the large amount of toxicological data available on BaP (versus the relatively incomplete database for other PAHs), (2) the availability of monitoring techniques for BaP, and (3) the significant exposure expected (and found). The Office of Environmental Health Hazard Assessment (OEHHA) has developed a Potency Equivalency Factor (PEF) procedure to assess the relative potencies of PAHs and PAH derivatives as a group. This procedure can address the impact of carcinogenic PAHs in ambient air since they are usually present together. This procedure was approved by the Scientific Review Panel (SRP) on Toxic Air Contaminants (TAC) as part of the Health Effects Assessment of Benzo(a)pyrene during the TAC identification process (OEHHA, 1993).

Due to the variety of data available on the carcinogenicity and mutagenicity of PAHs, an order of preference for the use of available data in assessing relative potency was developed. If a health effects evaluation and quantitative risk assessment leading to a cancer potency value had been conducted on a specific PAH, then those values were given the highest preference. Cancer potency values for PAHs developed by this process are shown in Table G-1.

Table G-1: Potencies of PAHs and derivatives[1]

Chemicals	Cancer potency factors $(mg/kg\text{-}day)^{-1}$	Unit risks $(\mu g/m^3)^{-1}$
benzo[*a*]pyrene	11.5	1.1×10^{-3}
dibenz[*a*,*h*]anthracene	4.1	1.2×10^{-4}
7,12-dimethylbenzanthracene	250	7.1×10^{-2}
3-methylcholanthrene	22	6.3×10^{-3}
5-nitroacenaphthene	0.13	3.7×10^{-5}

1. Source: (OEHHA 1993; Collins *et al*., 1998). It is assumed that unit risks for inhalation have the same relative activities as cancer potencies for oral intake.

If potency values have not been developed for specific compounds, a carcinogenic activity relative to BaP, rather than a true potency, can be developed. These relative activity values are referred to as Potency Equivalency Factors or PEFs. For air contaminants, the relative potency to BaP based on data from inhalation studies would be optimal. Otherwise, intrapulmonary or intratracheal administration studies would be most relevant, since such studies are in the target organ of interest. Next in order of

preference is information on activity by the oral route and skin painting. Intraperitoneal and subcutaneous administration rank at the bottom of the *in vivo* tests considered useful for PEF development because of their lack of relevance to environmental exposures. Next, in decreasing order of preference, are genotoxicity data, which exist for a large number of compounds. In many cases genotoxicity information is restricted to mutagenicity data. Finally, there are data on structure-activity relationships among PAH compounds. Structure-activity considerations may help identify a PAH as carcinogenic, but at this time have not been established as predictors of carcinogenic potency.

Using this order of preference, PEFs were derived for 21 PAHs and are presented in Table G-2 (OEHHA, 1993: Collins *et al*., 1998).

Table G-2. OEHHA PEF weighting scheme for PAHs and their resulting cancer potency values.

PAH or derivative	PEF	Unit Risk $(\mu g/m^3)^{-1}$	Inhalation Slope Factor $(mg/kg\text{-}day)^{-1}$	Oral Slope Factor $(mg/kg\text{-}day)^{-1}$
benzo[*a*]pyrene (index compound)	**1.0**	**1.1E-3**	**3.9E+0**	**1.2E+1**
benz[*a*]anthracene	0.1	1.1E-4	3.9E-1	1.2E+0
benzo[b]fluoranthene	0.1	1.1E-4	3.9E-1	1.2E+0
benzo[*j*]fluoranthene	0.1	1.1E-4	3.9E-1	1.2E+0
benzo[k]fluoranthene	0.1	1.1E-4	3.9E-1	1.2E+0
dibenz[*a*,*j*]acridine	0.1	1.1E-4	3.9E-1	1.2E+0
dibenz[*a*,*h*]acridine	0.1	1.1E-4	3.9E-1	1.2E+0
7H-dibenzo[c,*g*]carbazole	1.0	1.1E-3	3.9E+0	1.2E+1
dibenzo[*a*,*e*]pyrene	1.0	1.1E-3	3.9E+0	1.2E+1
dibenzo[*a*,*h*]pyrene	10	1.1E-2	3.9E+1	1.2E+2
dibenzo[*a*,*i*]pyrene	10	1.1E-2	3.9E+1	1.2E+2
dibenzo[*a*,*l*]pyrene	10	1.1E-2	3.9E+1	1.2E+2
indeno[1,2,3-*cd*]pyrene	0.1	1.1E-4	3.9E-1	1.2E+0
5-methylchrysene	1.0	1.1E-3	3.9E+0	1.2E+1
1-nitropyrene	0.1	1.1E-4	3.9E-1	1.2E+0
4-nitropyrene	0.1	1.1E-4	3.9E-1	1.2E+0
1,6-dinitropyrene	10	1.1E-2	3.9E+1	1.2E+2
1,8-dinitropyrene	1.0	1.1E-3	3.9E+0	1.2E+1
6-nitrochrysene	10	1.1E-2	3.9E+1	1.2E+2
2-nitrofluorene	0.01	1.1E-5	3.9E-2	1.2E-1
chrysene	0.01	1.1E-5	3.9E-2	1.2E-1

1. Source: OEHHA (1993)

The cancer potency comparisons show that some PAHs are more potent than BaP, while other PAHs analyzed were less or much less potent. These comparisons indicated that considering all PAHs to be equivalent in potency to BaP would likely overestimate the cancer potency of a PAH mixture, but such an assumption would be health protective and likely to be helpful in a screening estimate of PAH risks (OEHHA, 1993). If one

assumes that PAHs are as carcinogenic as they are genotoxic, then their hazard relative to BaP would be dependent on their concentration in the environment. In light of the limited information available on other PAHs, BaP remains an important representative or surrogate for this group of air pollutants.

Detailed descriptions on the criteria used for developing individual PEFs can be found in (OEHHA, 1999b) Currently, OEHHA is undertaking a review of all recent literature pertaining to the carcinogenicity and mutagenicity of PAHs. New cancer potency values for PAHs may be developed if an adequate health effects evaluation and quantitative risk assessment can be performed. Also, some current PEFs may be modified based on new data. Any changes to the potency values and PEFs for PAHs will be reflected in the HARP program when they occur. It is incumbent on the risk assessor to access the most recent version of the HARP program to ensure that the most up-to-date PAH potency values are used.

References

Collins, J.F., Brown, J.P., Alexeeff, G.V., and Salmon, A.G. 1998. Potency equivalency factors for some polycyclic aromatic hydrocarbons and polycyclic aromatic hydrocarbon derivatives. Regul. Toxicol. Pharmacol. 28:45-54.

OEHHA, 1993. Benzo[*a*]pyrene as a Toxic Air Contaminant. Part B. Health Effects of Benzo[*a*]pyrene. Air Toxicology and Epidemiology Section, Berkeley, CA.

OEHHA, 1999b. The Air Toxics Hot Spots Program Risk Assessment Guidelines; Part II. Technical Support Document for Describing Available Cancer Potency Factors, Office of Environmental Health Hazard Assessment, April 1999.

Appendix H

Recommendations for Estimating Concentrations of Longer Averaging Periods from the Maximum One-Hour Concentration for Screening Purposes

Appendix H

Recommendations for Estimating Concentrations of Longer Averaging Periods from the Maximum One-Hour Concentration for Screening Purposes

A. Introduction

The U.S. Environmental Protection Agency (U.S. EPA) SCREEN3 air dispersion model is frequently used to estimate the maximum one-hour concentration downwind due to emissions from a point source to assess impacts from a source. The SCREEN3 model results (or ISCST3 with screening meteorological data), in conjunction with the U.S. EPA screening factors, are frequently used to estimate concentrations for longer averaging periods, such as the maximum annual average concentration. In addition, it is permissible to use the ISCST3 air dispersion model in a screening mode with identical meteorological conditions as used in the SCREEN3 model to superimpose results from multiple sources.

This method to assess short-term and long-term impacts may be used as a first-level screening indicator to determine if a more refined analysis is necessary. In the event that representative meteorological data are not available, the screening assessment may be the only computer modeling method available to assess source impacts.

In California, this standard procedure will generally bias concentrations towards over prediction in most cases when the source is a continuous release. However, in the case when a source is not continuous, these screening factors may not be biased towards over prediction. In this case, we recommend an alternative procedure for estimating screening value concentrations for longer averaging periods than one-hour for intermittent releases.

B. Current Procedures

The current screening factors used to estimate longer term averages (i.e., 3-hour, 8-hour, 24-hour, 30-day, and annual averages) from maximum one-hour concentrations in California are shown in Table H.1 and Figure H.1. The factors are U.S. EPA recommended values with the exception of the 30-day factor. The 30-day factor is an ARB recommended value (ARB, 1994). The maximum and minimum values are recommended limits to which one may diverge from the general (Rec.) case, (U.S. EPA, 1992). Diverging from the general case should only be done on a case by case basis with prior approval from the reviewing agency.

C. Non-Standard Averaging Periods with a Continuous Release

The following is the ARB recommendation for estimating screening concentrations for non-standard averaging periods that are not listed in Table H.1 or Figure H.1. Specifically, the recommendation is for estimating screening concentrations for 4-hour, 6-hour, and 7-hour averaging periods.

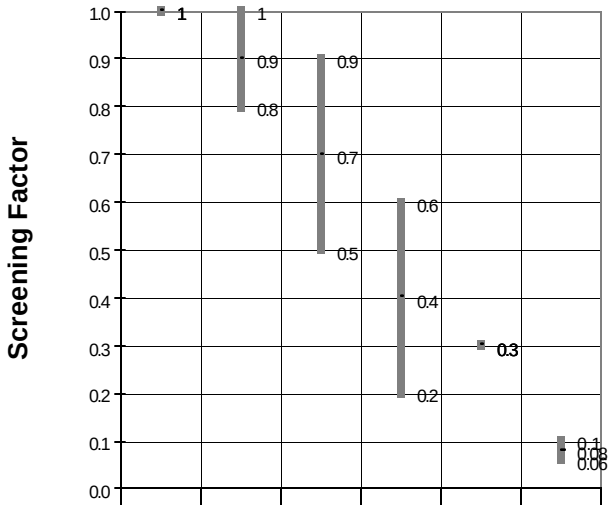
The Air Toxics Hot Spots Program Guidance Manual for Preparation of Health Risk Assessments. August 2003.

The current U.S. EPA screening factors applicable to standard averaging periods should be used for non-standard averaging periods. Specifically for the 4-hour, 6-hour, and 7-hour averaging periods, we recommend that the 3-hour screening factor of (0.9± 0.1) be used. The following illustrates the method to estimate a 6-hour average concentration from a continuous release from a single point source:

1. determine the maximum 1-hour concentration according to standard screening procedures ($C_{max1\text{-}hr}$),
2. scale the maximum 1-hour concentration by (0.9±0.1), and
3. the result is the maximum 6-hour concentration ($C_{max6\text{-}hr}=C_{max1\text{-}hr}$ *(0.9±0.1)).

In the case for the 6-hour and 7-hour average concentration estimates, the user may wish to take the lower bound of (0.9±0.1), or 0.8. For the 4-hour average estimate, we recommend the user to use the 3-hour factor as is, 0.9.

Figure H.1
Screening Factors to Convert
1-hr Max. to Longer Avg. Periods



	1-hr	3-hr	8-hr	24-hr	30-day	Annual
Max	1	1	0.9	0.6	0.3	0.1
Min	1	0.8	0.5	0.2	0.3	0.06
Rec	1	0.9	0.7	0.4	0.3	0.08

Averaging Period

Table H.1 Recommended Factors to Convert Maximum 1-hour Avg. Concentrations to Other Averaging Periods (U.S. EPA, 1992; ARB, 1994).

Averaging Time	Range	Typical Recommended
3 hours	0.8 - 1.0	0.9
8 hours	0.5 - 0.9	0.7
24 hours	0.2 - 0.6	0.4
30 days	0.2 - 0.3	0.3
Annual	0.06 - 0.1	0.08

The Air Toxics Hot Spots Program Guidance Manual for Preparation of Health Risk Assessments. August 2003.

Table H.2 summarizes these recommendations for the non-standard averaging periods.

Table H.2 Recommended Factors to Convert Maximum 1-hour Avg. Concentrations to Non-Standard Averaging Periods.

Averaging Time	Range	Typical Recommended
4 hours	0.8 - 1.0	0.9
6 hours	0.8 – 1.0	0.8
7 hours	0.8 – 1.0	0.8

D. Definitions

It is convenient to define the following terms relating to sources with respect to the duration of the release.

- Continuous Release – this is a release that is continuous over the duration of a year. An example of this type of release would be fugitive emissions from a 24-hour per day, 7-day per week operation or an operation that is nearly continuous.

- Intermittent Release – many emissions fall under this category. These are emission types that are not continuous over the year. Any operation that has normal business hours (e.g., 8 am to 6 pm) would fall into this category.

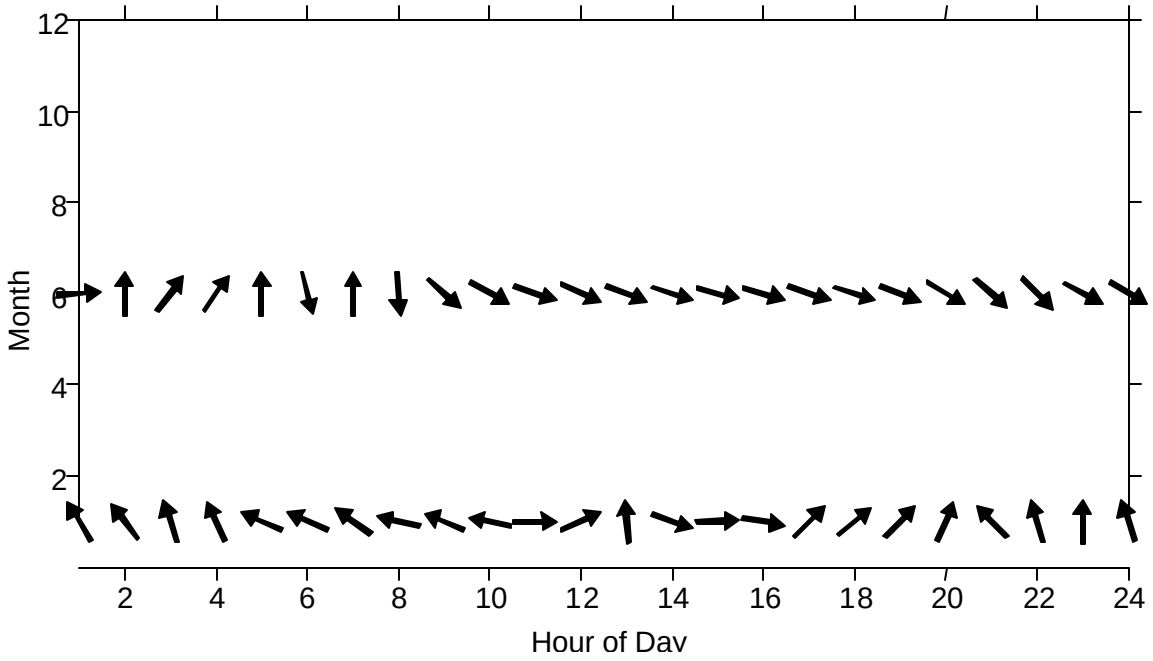
- Systematic Release – these are intermittent releases that occur at a specific time of the day. As an example, these type of releases can occur when a process requires clean out at the end of the work day. Thereby releasing emissions only at the end of the workday systematically. Systematic releases are similar to intermittent releases with a shorter duration during the normal operating schedule.

- Random Release – these are intermittent releases that can occur any time during the operating schedule. An example of this type of release would be of the type that depends on batch processing. For example, a brake shop may emit pollutants only when the brakes are cleaned which happens randomly throughout the normal business hours.

E. Screening Factors

The U.S. EPA screening factors, as shown in Table H.1, compensate for the effects of varying conditions of wind speed, wind direction, ambient temperature, atmospheric stability, and mixing height over longer averaging periods, even though it is not explicitly indicated in the U.S. EPA Guidance (U.S. EPA, 1992). Figure H.2 shows the variability in wind direction over a 24-hour period. The data are averaged for two seven-day periods from data collected at Los Angeles International Airport (LAX). Figure H.2 was compiled for data collected in 1989 for January 1 to January 7 and June1 through June 7, 1989. The ordinate in Figure H.2 shows the months of the year. Only two months are plotted. The abscissa shows the hour of the day.

Figure H.2
Hourly Wind Direction - Los Angeles
January (bottom – 1) and June (top - 6)



As seen in Figure H.2, the wind direction changes throughout all hours of the day. In addition, the wind direction for LAX, in the overnight and early morning hours, can vary from January to June. During the afternoon hours of 1400 – 1600, the wind direction is similar in both months of January and June.

The standard U.S. EPA screening factor to estimate the maximum 24-hour concentration from the maximum 1-hour concentration is 0.4, as seen in Table H.1. Figure H.2 shows that for 15 of 24 hours the wind blows from the west-northwest during June. A 24-hour screening factor could be 0.6 (0.6 ≈ 15hrs/24hrs) based on wind direction alone. This is consistent with the upper bound of the adjustment factors shown in Table H.1. Including the variability for wind speed, ambient temperature, and atmospheric stability could further reduce the estimated scaling factor of 0.6 closer towards the U.S. EPA recommended value of 0.4.

F. Intermittent Release

Support for the U.S. EPA screening factor is demonstrated for a continuous release (i.e., 24 hours per day) in the description above. It is important to be cautious when applying the U.S. EPA screening factors to an intermittent source for the purposes of estimating an annual average concentration (e.g., a business that may only emit during normal operating hours of 8 am to 6 pm).

Intermittent emissions, such as those from burning barrels, testing a standby diesel generator, or any normal business hour operation (e.g., 8am to 6pm Monday through Friday), could have the effect of eliminating some of the annual variability of meteorological conditions. For example, emissions only during the daytime could eliminate the variability of a drainage flow pattern in mountainous terrain. Guidance for estimating long-term averages for a screening approach and intermittent emissions is not available.

For a source located in the LAX meteorological domain, an emission pattern confined to the hours of 1400 to 1600 would eliminate any variability associated with the wind direction. In this case, estimating a 24-hour average with the U.S. EPA scaling factor of 0.4 would be incorrect.

In the event the emissions are intermittent but randomly distributed throughout the day, the scaling factor of 0.4 may be appropriate because the natural diurnal variability of meteorological conditions are concurrent with emissions. An additional pro-rating of the concentration, when estimating a 24-hour concentration, would be required to discount due to the intermittent nature of the emissions.

We recommend the following steps to estimate a screening based estimate of annual average concentrations from intermittent emissions.

1. Estimate the maximum one-hour concentration ($c_{1\text{-hr}}$) based on the SCREEN3 model approach (or similar, e.g., ISCST3 with screening meteorological data) for possible meteorological conditions consistent with the operating conditions and the actual hourly emission rate. It is acceptable to estimate downwind concentrations using all meteorological combinations available to SCREEN3. However, it is possible to be selective for the choices of meteorological conditions and still be conservative. For example, daytime only emissions need not be evaluated for nighttime stable atmospheric conditions (Pasquill-Gifford classes A through D are unstable and neutral atmospheric conditions applicable during the day. Classes D through F are neutral and stable atmospheric conditions applicable during the night.)

2. Estimate the concentration for the longest averaging period applicable based on the length of time of the systematic or randomly distributed emissions and the factors in Table H.1. For example, the longest averaging period concentration that may be estimated with the U.S. EPA scaling factors is an 8-hour concentration ($c_{8\text{-hr}}$) for emissions that are systematically released for 12 hours. Scaling factors between 8-hours and 12-hours are not available. In the case of the 8-hour concentration, the U.S. EPA screening factor of 0.7 ± 0.2 to estimate the maximum 8-hour concentration is appropriate.

   The U.S. EPA Screening Guidance allows for deviation from the suggested conversion factor on a case-by-case basis. We recommend the lower end of the range for the conversion factor (i.e., 0.5 for the 8-hour average) when estimating an annual average concentration. This is because variability associated with seasonal differences in wind speed, wind direction, and atmospheric stability would not be addressed otherwise. As seen in Figure H.2, there are seasonal differences in the wind direction.

For example, if X is the length of time of systematic or randomly distributed emissions, the following scalars can apply.

- $X \leq 2$ hrs; Scalar = 1.0 to estimate a 1-hour average
- 3 hrs $\leq X \leq$ 7 hrs; Scalar = 0.8 to estimate a 3-hour average
- 8 hrs $\leq X \leq$ 20 hrs; Scalar = 0.5 to estimate an 8-hour average (the selection of 20 hours is arbitrary)
- 21 hrs $\leq X \leq$ 24 hrs; this may be a continuous release, use standard screening procedures.

3. Estimate the annual average concentration (c_{annual}) by assuming the longer averaging period estimated above is persistent for the entire year. In the above example the 8-hour concentration is assumed to be persistent for an entire year to estimate an annual average concentration (i.e., the annual average concentration is assumed to be equal to the 8-hour concentration).

   In addition, the annual average concentration should be pro-rated over the final averaging period based on the pro-rated emissions (i.e., the calculation should include the fact that for some hours over the year, the emission rate is zero).

   For example, if Y is the number of operating hours in the year (e.g., Y = X * 365), the following may apply.
   $(c_{annual}) = (c_{1\text{-}hr})$ (Scalar) (Y/8760hrs/yr)

4. The hourly emission rate should be calculated based on the assumed operating schedule in the steps above. An example for a facility operating Y hours per year follows.
   $(q_{hourly}) = (Q_{yearly})/(Y$ hrs/yr)

5. The annual average concentration (or ground level concentration GLC) can be estimated as follows.
   $GLC = (c_{annual})\ (q_{hourly})$
   $= (c_{1\text{-}hr})$(Scalar) (Yhrs/8760hrs) $(Q_{yearly})/(Y$ hrs/yr)
   $= (c_{1\text{-}hr})$(Scalar) $(Q_{yearly})/(8760$ hrs/yr)

Practically speaking, the above five steps condense down to determining three values. The first value is the maximum 1-hour concentration. The second value is the Scalar (either 1.0, 0.8, or 0.5). And the third value is the hourly emission rate estimated by uniformly distributed over the entire year (8760 hours). The operating hours per year drops out of the calculations for an annual average concentration provided the emissions are based on an annual inventory (See step 5).

In the event that the acute averaging period is required and the emissions are based on an annual inventory, then the annual operating hours are required.

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Below are four examples using the steps as outlined above. In each case, the annual average concentration is the desired value for use in risk assessment calculations. A fifth example is also included to demonstrate the need for the operating hours per year for an acute analysis when the inventory is provided on an annual basis.

Example 1 - Fugitive Gasoline Station Emissions

Emissions are **continuous** for 24 hours per day and 365 days per year.

1. Estimate the maximum 1-hour concentration with the Screen3 model (or similar screening modeling approach), $c_{1\text{-}hr}$.

2. Estimate the annual average concentration, $c_{annual,}$ with the U.S. EPA screening factor of 0.08.
   $(c_{annual}) = (c_{1\text{-}hr})(0.08)$

3. The hourly emission rate, q_{hourly}, for the annual average concentration is based on 24 hours per day and 365 days per year (8760 hours per year).
   $(q_{hourly}) = (Q_{yearly})/(8760\ hrs/yr)$

4. The annual average concentration (or ground level concentration GLC) can be estimated as follows.
   $GLC = (c_{annual})\ (q_{hourly})$
   $GLC = (c_{1\text{-}hr})(0.08)\ (Q_{yearly})/(8760\ hrs/yr)$

Example 2 - Dry Cleaner Emissions

Emissions are **intermittent** over the year but **systematic** for 10 hours per day, 5 days per week and 50 weeks per year.

1. Estimate the maximum 1-hour concentration with the Screen3 model (or similar screening modeling approach), $c_{1\text{-}hr}$.

2. Estimate the maximum 8-hour average concentration, $c_{8\text{-}hr,}$ with the U.S. EPA screening factor of 0.7 ± 0.2 as the longest averaging period of continuous release. The averaging period would need to be less than 10 hours. Use the lower range of the screening factor, 0.5, because the annual average is the final product and variability due to seasonal differences are not accounted for otherwise.
   $(c_{8\text{-}hr}) = (c_{1\text{-}hr})(0.5)$

3. Assume the worst-case 8-hour concentration is persistent throughout the year and pro-rate the concentration based on emissions over the year. For this dry cleaner, there are 2500 hours of operating condition emissions. Therefore the annual average is calculated as follows.
   $(c_{annual}) = (c_{8\text{-}hr})\ (2500hrs/8760hrs)$
   $= (c_{1\text{-}hr})(0.5)\ (2500hrs/8760hrs)$

4. The hourly emission rate, q_{hourly}, for the annual average concentration is based on 2500 hours per year.
   $(q_{hourly}) = (Q_{yearly})/(2500\ hrs/yr)$

5. The annual average concentration (or ground level concentration GLC) can be estimated as follows.
   $GLC = (c_{annual})\ (q_{hourly})$
   $= (c_{1\text{-}hr})(0.5)\ (2500hrs/8760hrs)\ (Q_{yearly})/(2500\ hrs/yr)$
   $= (c_{1\text{-}hr})(0.5)\ (Q_{yearly})/(8760\ hrs/yr)$

Example 3 - Burning Barrel Emissions

Emissions are **intermittent** over the year and **random** during daylight hours for two hours per burn, two burns per week, and 52 weeks per year.

1. Estimate the maximum 1-hour concentration with the Screen3 model (or similar screening modeling approach), $c_{1\text{-}hr}$. Meteorological combinations may be restricted to daytime conditions for this screening analysis. Pasquill-Gifford stability classes A, B, C, and D are unstable and neutral conditions for daytime conditions.

2. Estimate the maximum 8-hour average concentration, $c_{8\text{-}hr,}$ with the U.S. EPA screening factor of 0.7 ± 0.2 as the longest averaging period where the emissions have the potential to be randomly distributed. Depending on the day of the year and latitude of the emissions, the daylight hours can vary. For this example, we assume the daylight hours can be as short as 10 hours per day to as long as 14 hours per day. Since the emissions are randomly distributed throughout the daylight hours, the longest averaging period we can scale with U.S. EPA scaling factors is a 10 hour average. In this case, the averaging period becomes the 8-hour average and the scaling factor becomes 0.7 ± 0.2. Again since this is for an annual average, we use the lower end of the range, 0.5.
   $(c_{8\text{-}hr}) = (c_{1\text{-}hr})(0.5)$

3. Assume the worst-case 8-hour concentration is persistent throughout the year and pro-rate the concentration based on the emissions over the year. For the burning barrels there are 208 hours of operating condition emissions (208 hrs = (2hrs/burn)(2burns/wk)(52wk/yr)). Therefore the annual average concentration is calculated as follows.
   $(c_{annual}) = (c_{8\text{-}hr})\ (208hrs/8760hrs)$
   $= (c_{1\text{-}hr})(0.5)\ (208hrs/8760hrs)$

4. The hourly emission rate, q_{hourly}, for the annual average concentration is based on 208 hours per year.
   $(q_{hourly}) = (Q_{yearly})/(208\ hrs/yr)$

5. The annual average concentration (or ground level concentration GLC) can be estimated as follows.

$GLC = (c_{annual})\ (q_{hourly})$
$= (c_{1\text{-}hr})(0.5)\ (208hrs/8760hrs)\ (Q_{yearly})/(208\ hrs/yr)$
$= (c_{1\text{-}hr})(0.5)\ (Q_{yearly})/(8760\ hrs/yr)$

Example 4 - Standby Diesel Engine Testing

Emissions are **intermittent** over the year and **systematic** for two hours per week and 50 weeks per year. The engine testing is conducted at 2 pm on Fridays.

1. Estimate the maximum 1-hour concentration with the Screen3 model (or similar screening modeling approach), $c_{1\text{-}hr}$. Meteorological combinations may be restricted to daytime conditions in this screening analysis because the engine test is conducted at 2 pm. Pasquill-Gifford stability classes A, B, C, and D are unstable and neutral conditions for daytime conditions.

2. In this case, the emission schedule is systematically fixed over a two hour period. Therefore, the longest averaging period which is applicable for the U.S. EPA screening factors is one-hour because a two-hour conversion factor is not available. Therefore, we assume the maximum 1-hour concentration is persistent for the entire year. We still prorate the concentration based on the emissions. There are 100 hours of engine testing per year. Therefore the annual average concentration becomes.
$(c_{annual}) = (c_{1\text{-}hr})\ (100hrs/8760hrs)$

3. The hourly emission rate, q_{hourly}, for the annual average concentration is based on 100 hours per year.
$(q_{hourly}) = (Q_{yearly})/(100\ hrs/yr)$

4. The annual average concentration (or ground level concentration GLC) can be estimated as follows.
$GLC = (c_{annual})\ (q_{hourly})$
$= (c_{1\text{-}hr})\ (100hrs/8760hrs)\ (Q_{yearly})/(100\ hrs/yr)$
$= (c_{1\text{-}hr})\ (Q_{yearly})/(8760\ hrs/yr)$

Below is an example using the steps above to estimate an acute concentration longer than a 1-hour averaging period. This case is similar to Example 3 above with the exception of the averaging period.

Example 5 - Burning Barrel Emissions – Acute REL

Emissions are **intermittent** over the year and **random** during daylight hours for two **continuous** hours per burn, two burns per week, and 52 weeks per year. The arsenic acute REL is for a 4-hour averaging period. The steps below are used to estimate the acute concentration, 4-hour REL, for arsenic.

1. Estimate the maximum 1-hour concentration with the Screen3 model (or similar screening modeling approach), $c_{1\text{-}hr}$. Meteorological combinations may be restricted

to daytime conditions for this screening analysis. Pasquill-Gifford stability classes A, B, C, and D are unstable and neutral conditions for daytime conditions.

2. The maximum 1-hour concentration is used as is without screening adjustment factors listed in Tables H.1 or H.2. The emissions are **continuous** through a 2-hour event within a 4-hour window. The adjustments in Table H.2 would only be used if the emissions were continuous for a 4-hour event or **randomly** distributed through a 4-hour event.

3. Assume the worst-case 1-hour concentration is persistent for the 4-hour averaging period and pro-rate the concentration based on the emissions over the 4-hour window. For the burning barrels there are 2 hours of operating condition emissions (2hrs/burn). Therefore the 4-hour average concentration is calculated as follows.
   $(c_{4\text{-hr}}) = (c_{1\text{-hr}})$ (2hrs/4hrs)

4. The hourly emission rate, q_{hourly}, for the annual average concentration is based on 208 hours per year (208 hrs = (2hrs/burn)(2burns/wk)(52wk/yr)).
   $(q_{hourly}) = (Q_{yearly})/(208$ hrs/yr)

5. The 4-hr average concentration (or ground level concentration $GLC_{4\text{-hr}}$) can be estimated as follows.
   $GLC_{4\text{-hr}} = (c_{4\text{-hr}})\ (q_{hourly})$
   $= (c_{1\text{-hr}})$ (2hrs/4hrs) $(Q_{yearly})/(208$ hrs/yr)

   This step of Example 5 differs from the previous Examples because the number of operating hours per year does not drop out of the calculation as seen above.

The above methods were used in a recent modeling evaluation for emissions from a burning barrel (example 3 above) (ARB, 2002). Table H.3, below, shows results from the modeling evaluation. Shown in Table H.3 are the maximum annual average concentration based on the screening approach outlined above as well as a refined approach with site specific meteorological data from four locations, Alturas, Bishop, San Benito, and Escondido. As seen in Table H.3, the screening evaluation as described in the example overestimates the values calculated based on the refined analysis. This is the desired outcome of a screening approach.

Table H.3
Maximum Annual Average Concentration (c/q)
Above Ambient Conditions - Burning Barrel Emissions

Met. City	Alturas	Bishop	San Benito	Escondido	*SCREENING*
D (m)	(mg/m^3)/(g/s)	(mg/m^3)/(g/s)	(mg/m^3)/(g/s)	(mg/m^3)/(g/s)	*(mg/m^3)/(g/s)*
20	44.	61.	85.	110.	*590.*
50	12.	16.	22.	30.	*230.*
100	4.	5.	7.	9.	*85.*

Notes: (a) Annual χ/q is based on 208 hours of emissions at 1 g/s.
(b) χ/q is the concentration in $\mu g/m^3$ based on an hourly emission rate of 1 g/s.

G. Implementation

The approach outlined above has been implemented in the HARP program. Appendix J provides example output files from the Hot Spot Analysis and Reporting Program (HARP). The HARP software has been developed by a contractor through consultation with OEHHA, Air Resources Board (ARB), and District representatives. The HARP software is the recommended model for calculating and presenting HRA results for the Hot Spots Program. Information on obtaining the HARP software can be found on the ARB's web site at www.arb.ca.gov. Note, since the HARP software is a tool that uses the methods specified in this document, the software will be available after these guidelines have undergone public and peer review, been endorsed by the state's Scientific Review Panel (SRP) on Toxic Air Contaminants, and adopted by OEHHA.

References

ARB (1994). ARB memorandum dated 4/11/94 from A. Ranzieri to J. Brooks on the subject, "One-hour to Thirty-day Average Screening Factor."

ARB (2002). Staff Report: Initial Statement of Reasons for the Proposed Airborne Toxic Control Measure to Reduce Emissions of Toxic Air Contaminants from Outdoor Residential Waste Burning, January 2002. California Air Resources Board.

U.S. EPA (1992). Screening Procedures for Estimating the Air Quality Impact of Stationary Sources, Revised, October 1992, EPA-454/R-92-019. U.S. Environmental Protection Agency, Research Triangle Park, NC.

Appendix I

Calculation Examples for

Estimating Potential Health Impacts

Appendix I

Calculation Examples for Estimating Potential Health Impacts

This appendix provides three example calculations to illustrate the procedures to estimate potential health impacts from a facility. The examples provided are intended to assist the risk assessor in understanding the steps associated with conducting the final step of risk assessment, risk characterization. The three examples provided in this appendix evaluate the inhalation cancer risk, the noncancer acute hazard quotient (HQ) and hazard index (HI), and the multipathway (inhalation and oral) noncancer chronic HQ and HI for seven compounds. Specific requirements for health risk assessment (HRA) under the Hot Spots Program are presented in Chapter 8. The HARP software will perform the calculations that are presented here and required in Chapters 8 and 9. See the ARB's website at *www.arb.ca.gov* for more information on HARP.

A. Sample Calculation for Inhalation Cancer Health Risk Assessment

The following example illustrates the steps for calculating cancer risk at the maximum exposed individual resident (MEIR) using the high-end point-estimate for the inhalation exposure pathway. This example does not cover the steps for completing a noninhalation or multipathway HRA. Algorithms to estimate point-estimate and stochastic multipathway exposure can be found in Chapter 5. For simplicity, it is recommended that the risk assessor use HARP to conduct a multipathway risk assessment or stochastic risk assessment.

Step one - Determine the annual average concentration at the MEIR and inhalation cancer potency factor for each emitted compound.

The risk assessor would obtain the annual average concentrations from the air dispersion modeling results. This step has been completed for this example. Table I.1 presents the annual average concentrations at our hypothetical facility. In addition, Table I.1 also presents inhalation cancer potency factors for each substance, which also can be found in Chapter 7 and Appendix L. Note that where no inhalation cancer potency has been developed for a substance, the tables in this example have been annotated with dashes, since it will not be possible to conduct a quantitative risk assessment for these compounds. As previously stated, this example does not take into account multipathway effects for the compounds listed in Table I.1. It is recommended that the risk assessor use HARP for conducting such an analysis.

Table I.1 Annual Average Concentrations at the MEIR and Inhalation Cancer Potency Factors

Substance	Annual Average Concentrations ($\mu g/m^3$)	Inhalation Cancer Potency Factor $(mg/kg\text{-}d)^{-1}$
Ammonia	--	--
Arsenic	0.0015	12
Benzene	5	0.10
Chlorine	--	--
Chlorobenzene	--	--
2,3,7,8-TCDD (dioxin)	0.000004	130,000
Nickel	0.02	0.91

Step two - Determine the inhalation dose for each compound.

Once you have determined the annual average concentration for the emitted substance, the equation below is used to calculate the inhalation dose for each substance. This equation is listed in Section 5.4.1 of this document, and is also listed in the *Air Toxics Hot Spots Risk Assessment Guidelines*; *Part IV; Exposure Assessment and Stochastic Analysis Technical Support Document (OEHHA, 2000b)* (Part IV TSD).

$$\text{dose} - \text{inh} = \frac{(\text{Cair})(\text{DBR})(\text{A})(\text{EF})(\text{ED})(1 \times 10^{-6})}{\text{AT}}$$

Where:

dose-inh	=	Dose through inhalation (mg/kg/d)
$1x10^{-6}$	=	Micrograms to milligrams conversion (10^{-3} mg/µg), liters to cubic meters conversion (10^{-3} m^3/l)
Cair	=	Concentration in air ($\mu g/m^3$)
DBR	=	Daily breathing rate (L/kg body weight-day or L/kg-day)
A	=	Inhalation absorption factor
EF	=	Exposure frequency (days/year)
ED	=	Exposure duration (years)
AT	=	Averaging time period over which exposure is averaged, in days (e.g., 25,550 days for 70 year cancer risk)

A summary of the exposure point-estimates and data distributions for use in risk assessment can be found in Chapter 5 of this document. For more detail on point-estimates and data distributions see the Part IV TSD. The recommended default values presented in Table I.2 can be used when site-specific information is not available.

Table I.2 Recommended Default Values

Variable	Recommended Default Value
EF	350 days/year
ED	9; 30; or 70 years
AT	70 years (25,550 days)
DBR (used in this example) 30 and 70 year-exposure	271 (mean); 393 (95th percentile) L/kg body weight – day (For other DBRs see Table 5.4, Chapter 5)
A	1 (currently used for all substances included in the Hot Spots program)

The following equation shows the calculation for the inhalation dose of arsenic by using the annual average concentration for arsenic (Table I.1) and the recommended default values in Table I.2. Note that the high-end (95th percentile) 70-year daily breathing rate of 393 liters/kg - day was used in this example.

$$\text{arsenic}\ (\text{dose}-\text{inh}) = \frac{\left(\frac{0.0015\,mg}{m^3}\right)\left(\frac{393\,liters}{kg-day}\right)(1)\left(\frac{350\ days}{year}\right)(70\ years)\left(\frac{1\text{x}10^{-3}\ mg}{1mg}\right)\left(\frac{1\text{x}10^{-3}\ m^3}{liters}\right)}{25{,}550\ days}$$

$$\text{arsenic}\ (\text{dose}-\text{inh}) = 5.7\times10^{-7}\,mg/kg-day$$

This calculation would be repeated for each substance under evaluation using their respective annual average concentrations. For our hypothetical facility, we have calculated each inhalation dose for each substance. Table I.3 shows the results from our analysis.

Table I.3 Calculated Doses for Substances

Compound	Calculated Dose
Ammonia	--
Arsenic	5.7 x 10^{-7}
Benzene	1.9 x 10^{-3}
Chlorine	--
Chlorobenzene	--
2,3,7,8-TCDD (dioxin)	1.5 x 10^{-9}
Nickel	7.5 x 10^{-6}

Step three – Determine potential inhalation cancer risk for the MEIR.

Once you have calculated the inhalation dose, multiply the dose by the inhalation cancer potency factor as shown below. Use a factor of $1x10^6$ to express cancer risk in chances per million.

$$\left(\text{Inhalation Dose } \frac{mg}{kg-day}\right)\left(\text{Cancer Potency } \frac{kg-day}{mg}\right)\left(1 \times 10^6\right) = \text{Cancer Risk (chances per million)}$$

For our hypothetical facility, the equation below shows the calculation for the inhalation cancer risk of arsenic. For this example, the inhalation cancer potency factor for arsenic is 12 $(mg/kg\text{-}d)^{-1}$ taken from Table I.1.

$$\left(5.7 \times 10^{-7} \frac{mg}{kg-day}\right)\left(12 \frac{kg-day}{mg}\right)\left(1 \times 10^6\right) = 6.8 \text{ chances per million}$$

Use the substance-specific inhalation dose and inhalation cancer potency factor to determine the cancer risk for each compound by repeating this step. Finally, sum the individual substance cancer risks to give you the total facility (inhalation) cancer risk. Table I.4 shows the individual substance and total facility potential (inhalation) cancer risk. In this example, our hypothetical facility poses a (inhalation) cancer risk of 399 chances per million at the MEIR. Note, although not presented here, a facility emitting arsenic or dioxins should also evaluate cancer risk from noninhalation exposure pathways.

Table I.4 Hypothetical Facility Inhalation Cancer Risk

Compound	Cancer risk (per million)
Ammonia	--
Arsenic	6.8
Benzene	190
Chlorine	--
Chlorobenzene	--
2,3,7,8-TCDD (dioxin)	195
Nickel	6.8
Total Facility Inhalation Cancer Risk	**399**

While this example illustrates the steps used to calculate cancer risk using the inhalation dose algorithm, steps one through three can also be used to calculate noninhalation cancer risk and ultimately multipathway (inhalation and noninhalation pathway) cancer risk. To determine noninhalation cancer risk, an assessor should use the appropriate exposure pathway algorithm presented in Chapter 5. For example, equation 5.4.3.1.A (Chapter 5) would be used to determine

dose for the soil ingestion pathway. Once the assessor has determined the ingestion dose, the cancer risk for that pathway is calculated using the substance-specific oral slope factor. Oral slope factors can be found in Appendix L and Chapter 7. To calculate multipathway cancer risk, the cancer risks for all substances and exposure pathways are summed. See Chapter 8 for further discussion.

B. Sample Calculation of Noncancer Acute Hazard Indices

Risk characterization for noncancer health impacts are expressed as a hazard quotient (for individual substances) or a hazard index (for multiple substances). In addition, all hazard quotients (HQ) and hazard indices (HI) must be determined by target organ system. The example below illustrates the approach for calculating a noncancer acute HQ and HI at the MEIR. As discussed in Chapter 8, the following example is provided to assist the risk assessor in understanding how to calculate an acute HQ and HI. Using HARP, both the acute HQ and HI will be automatically calculated at each receptor. No exposure duration adjustment should be made for noncancer assessments. Specific requirements for risk assessment under the Hot Spots Program can be found in Chapters 8 and 9.

Step one - Determine the 1-hour maximum concentrations at the MEIR and acute reference exposure levels (RELs) for each emitted substance.

The risk assessor would obtain the 1-hour maximum (or 4, 6, or 7-hour, if required) concentrations from the air dispersion modeling results. This step has been completed for this example. Table I.5 presents the maximum 1, 4, 6, or 7-hour concentrations, target organ systems, and acute RELs for seven substances. Note that where an acute REL has not been developed for a substance, the tables in this example have been annotated with dashes. In this

Table I.5 Concentrations, Acute RELs, and Target Organ System(s) for Substances at the MEIR

Substance	1, 4, 6 or 7-hour Maximum Concentration ($\mu g/m^3$)	Acute REL ($\mu g/m^3$)	Target Organ System(s)
Ammonia	1900	3200	Respiratory system; Eye
Arsenic	0.03	0.19	Reproductive/developmental
Benzene	20	1300	Reproductive/developmental; Immune system; Hematologic system
Chlorine	40	210	Respiratory system; Eye
Chlorobenzene	--	--	--
2,3,7,8-TCDD (dioxin)	--	--	--
Nickel	1.8	6	Respiratory system; Immune system

example, chlorobenzene and 2,3,7,8-TCDD (dioxin) do not have acute REL values. The acute RELs and their corresponding target organ system(s) can be found in Table 6.1 (Chapter 6) and also in Appendix L.

Step two - Determine the hazard quotient for each compound.

The hazard quotients for each compound are calculated by taking the acute maximum 1, 4, 6, or 7-hour concentration and dividing by the substance-specific acute REL. The following equation shows how to calculate the hazard quotient for ammonia.

$$\text{Acute Hazard Quotient} = \frac{\left(\begin{matrix}Maximum\ 1,\ 4,\ 6,\ or\ 7-hr\\ Concentration\end{matrix}\right)}{\left(\begin{matrix}Acute\\ REL\end{matrix}\right)} \Rightarrow \text{Acute Hazard Quotient}_{(\text{ammonia})} = \frac{\left(1900\ mg/m^3\right)}{\left(3200\ mg/m^3\right)} = 0.6$$

Step three – Determine the HI for all emitted substances.

The acute HI is calculated by summing each hazard quotient for each substance by target organ system(s). For example, add the HQs for all substances that impact the respiratory system, then repeat this step for the next target organ system (e.g., reproductive/developmental system). This step is repeated until all target organs (for the substances emitted) are individually totaled. See Table 6.1 for target organ system information. Note, never add together the HQs or HIs for different target organ systems (e.g., do not add the impacts for the respiratory system to the reproductive/developmental system). Table I.6 shows individual hazard quotients for each substance and total hazard index. {Bob, adding benzene (6-hr) and arsenic (4-hr) below OK?]

Table I.6 Individual Hazard Quotients and Total Hazard Index

Substance	Immune System	Reproductive/ Developmental	Hematologic System	Respiratory System	Eye
Ammonia				0.6	0.6
Arsenic		0.2			
Benzene	0.02	0.02	0.02		
Chlorine				0.2	0.2
Chlorobenzene					
2,3,7,8-TCDD (dioxin)					
Nickel	0.3			0.3	
Total Hazard Index	**0.32**	**0.22**	**0.02**	**1.1**	**0.8**

The Air Toxics Hot Spots Program Guidance Manual for Preparation of Health Risk Assessments. August 2003.

In this example, an HQ of one was not equaled or exceeded for any individual substance. However, an HI (the sum of the hazard quotients for each target organ) of one was exceeded for the respiratory system. Exceeding a hazard index of one may indicate that there is the potential for adverse acute health impacts at this receptor location. Therefore, there is increased concern that exposed individuals may experience respiratory system irritation, particularly among sensitive individuals. The District and OEHHA should be consulted when a hazard index exceeds one (see Section 8.3).

C. Sample Calculation of Noncancer Chronic Hazard Indices

The example below illustrates the approach for calculating a noncancer chronic HQ and HI at the MEIR. An HQ expresses the noncancer health impacts for an individual substance and an HI expresses the potential impacts for multiple substances. As discussed in Chapter 8, the following example is provided to assist the risk assessor in understanding the calculation of a chronic HQ and HI. Using the HARP software, both the chronic HQ and HI will be automatically calculated at each receptor. No exposure duration adjustment (e.g., 9/70) should be made for noncancer assessments. Specific requirements for risk assessment under the Hot Spots Program can be found in Chapters 8 and 9.

Step one - Determine the annual average concentrations at the MEIR and inhalation and oral chronic RELs for each emitted substance.

The risk assessor would obtain the substance-specific annual average concentrations from the air dispersion modeling results. This step has been completed for this example. Table I.7 presents the annual average concentrations, target organ systems, and chronic RELs for seven substances. All of the substances have a chronic REL value associated with them. In addition, arsenic, dioxins, and nickel are multipathway substances; therefore, oral and dermal exposure must be included as potential exposure pathways. The chronic RELs and their corresponding target organ system(s) can be found in Tables 6.2 and 6.3 (Chapter 6) and also in Appendix L.

Table I.7 Annual Average Concentrations, Chronic RELs, and Target Organ Systems for Substances at the MEIR.

Substance	Annual Average Conc. ($\mu g/m^3$)	Chronic REI (inhalation) ($\mu g/m^3$)	Target Organ System(s) (inhalation)	Chronic Oral REL (mg/kg-day)	Target Organ System(s) (oral/dermal)
Ammonia	160	200	Respiratory System	-	-
Arsenic	0.0015	0.03	Development; Cardiovascular System; Nervous System	0.0003	Cardiovascular system; skin
Benzene	5	60	Hematopoietic System; Development; Nervous System	-	-
Chlorine	0.08	0.2	Respiratory System	-	-
Chlorobenzene	20	1000	Alimentary System; Kidney; Reproductive System	-	-
2,3,7,8-TCDD (dioxin)	0.000004	0.00004	Alimentary System (Liver); Reproductive System; Development; Endocrine System; Respiratory System; Hematopoietic System	0.00000001 (10 pg/kg-day)	Alimentary System (Liver); Reproductive System; Development; Endocrine System; Respiratory System; Hematopoietic System
Nickel	0.02	0.05	Respiratory System; Hematopoietic System	0.05	Alimentary System

Step two – Determine the inhalation chronic hazard quotient for each substance.

For inhalation exposure, the individual hazard quotients for each substance are calculated by taking the annual average concentration and dividing by its corresponding chronic inhalation REL. Using the information contained in Table I.7, the equation below is used to calculate the inhalation hazard quotient for arsenic.

$$\text{Chronic Hazard Quotient} = \frac{\left(\begin{matrix}\text{Annual avg.}\\ \text{Concentration}\end{matrix}\right)}{\left(\begin{matrix}\text{Chronic}\\ \text{REL}\end{matrix}\right)} \Rightarrow \text{Chronic Hazard Quotient}_{(arsenic)} = \frac{\left(0.0015\ \mu g/m^3\right)}{\left(0.03\ \mu g/m^3\right)} = 0.05$$

Step three – Determine the noninhalation hazard quotient for each substance.

For the substances that are subject to deposition, noninhalation (i.e., oral and dermal) exposure pathways need to be considered in the chronic hazard quotient evaluation. The point-estimates and algorithms for calculating the oral dose for all of the applicable exposure

pathways and receptors (e.g., workers or residents) are explained in Chapter 5. Note, the HARP software uses the appropriate information and performs all the steps discussed in these examples.

As discussed in Sections 8.2.5 and 8.3, Tier-1 of the tiered approach to risk assessment states that the high-end point-estimates are used for the two dominant noninhalation exposure pathways and the non-dominant exposure pathways use the average point-estimates to determine the dose and chronic health impacts at a residential receptor. To determine which exposure pathways are the two dominant ones, high-end point-estimates are used for all applicable exposure pathways to see which two pathways provide the highest impacts for each substance. Once the two dominant noninhalation pathways are determined for each substance, the doses for the remaining noninhalation exposure pathway for that substance are recalculated using the average point-estimates. The 70-year exposure duration point-estimates are used for residential receptors and the worker (single) point-estimates are used for the maximum exposed worker (see Chapter 5). No exposure duration adjustment (e.g., 9/70) should be made for noncancer assessments.

This example shows how to combine the impacts from multiple exposure pathways to obtain an oral (noninhalation) hazard quotient for a single substance. For each substance, the impacts for a specific exposure pathway are assessed by dividing the oral dose (derived from the annual average concentration) in milligrams per kilogram-day (mg/kg-day) by the oral chronic REL, expressed in units of (mg/kg-day) (Table 6.3). The next equation shows the HQ calculation for arsenic through the soil ingestion (SI) exposure pathway.

Note, prior to this point in this calculation, we are assuming several steps have taken place. These steps include: 1) the completion of air dispersion modeling to obtain the ground-level annual-average air concentration; 2) identification of the existing exposure pathways at the receptor location; 3) calculation of the concentration in the exposure media (e.g., for soil - Equation 5.3.2.A); 4) determination of the dominant noninhalation exposure pathway(s) for the substance; and 5) the calculation of the substance-specific dose for that exposure pathway (e.g., Equation 5.4.3.1.A is used to calculate the dose from soil ingestion). See Chapter 5 for the algorithms for calculating the oral dose for all of the applicable exposure pathways and receptors. For this example, the calculated dose for arsenic from soil ingestion is assumed to be 0.000015 mg/kg-day.

$$\text{Chronic Oral Hazard Quotient} = \frac{SI\ dose}{\left(\frac{Chronic}{Oral\ REL}\right)} \Rightarrow \text{Chronic Oral Hazard Quotient}_{(SI\ arsenic)} = \frac{(0.000015\ mg/kg-day)}{(0.0003\ mg/kg-day)} = 0.05$$

For each substance, this step is repeated for each applicable noninhalation exposure pathway. As illustrated below, the (total) oral HQ for a substance is calculated by summing the HQs for all applicable exposure pathways. In this example, the chronic oral HQ is assumed to equal 0.1.

The Air Toxics Hot Spots Program Guidance Manual for Preparation of Health Risk Assessments. August 2003.

$$\text{Chronic Oral Hazard Quotient*}_{(\text{arsenic})} = [HQ_{(SI)} + HQ_{(D)} + HQ_{(DW)} + HQ_{(MI)} + HQ_{(FI)} + HQ_{(HV)}]$$

$$\text{Chronic Oral Hazard Quotient*}_{(\text{arsenic})} = 0.1$$

* Noninhalation pathways:

SI = soil ingestion	FI = fisher-caught fish
DW = drinking water	HV= homegrown vegetables
D = dermal absorption	BM= breast milk (not applicable for arsenic exposure)
MI = meat, milk & egg	

Step four – Determine the chronic HI

The chronic HI is calculated by summing each hazard quotient (inhalation and noninhalation) for each substance by the target organ system(s). For example, add the HQs for all substances that impact the respiratory system, then repeat this step for the next target organ

Table I.8 Substance-Specific Inhalation and Noninhalation Hazard Quotients and the Hazard Index by Target Organ System

Substance	Respiratory System	Hematopoietic System	Alimentary System	Endocrine System	Development	Reproductive System	Kidney	Nervous System	Cardiovascular System	Skin
Ammonia	0.8									
Arsenic					***0.05(i)***			***0.05(i)***	***0.05(i)*** ***0.1(ni)***	***0.1(ni)***
Benzene		0.08			0.08			0.08		
Chlorine	0.04									
Chlorobenzene			0.02			0.02	0.02			
2,3,7,8-TCDD (dioxin)	0.1(i) 0.2(ni)	0.1(i) 0.2(ni)	0.1(i) 0.2(ni)	0.1(i) 0.2(ni)	0.1(i) 0.2(ni)	0.1(i) 0.2(ni)				
Nickel	0.4(i)	0.4(i)	0.1(ni)							
Hazard Index	**1.54**	**0.78**	**0.32**	**0.3**	**0.43**	**0.32**	**0.02**	**0.13**	**0.15**	**0.1**

i = inhalation pathway contribution
ni = noninhalation pathway contribution

system (e.g., cardiovascular system). This step is repeated until all target organs (for the substances emitted) are individually totaled. See Tables 6.2 and 6.3 for target organ system information. Note, never add together the HQs or HIs for different target organ systems (e.g., do not add the impacts for the respiratory system to the cardiovascular system). No exposure duration adjustment (e.g., 9/70) should be made for noncancer assessments. Table I.8 shows individual hazard quotients (inhalation and noninhalation) for each substance and the hazard index by target organ system. In this table, arsenic is highlighted in bold to identify how the information calculated above is presented and used.

In this example, an HQ of one was not equaled or exceeded for any individual substance. However, an HI (the sum of the hazard quotients for each target organ) of one was exceeded for the respiratory system. Exceeding a hazard index of one may indicate that there is the potential for adverse chronic health impacts at this receptor location. Therefore, there is increased concern that exposed individuals may experience respiratory system irritation or injury, particularly among sensitive individuals. The District and OEHHA should be consulted when a hazard index exceeds one (see Section 8.3).

Appendix J

Glossary Of Acronyms and Definition of Selected Terms

Glossary of Acronyms and Definitions of Selected Terms

Acute Exposure: One or a series of short-term exposures generally lasting less than 24 hours.

Acute Health Effects: A health effect that occurs over a relatively short period of time (e.g., minutes or hours). The term is used to describe brief exposures and effects which appear promptly after exposure.

Adverse Health Effect: A health effect from exposure to air contaminants that may range from relatively mild temporary conditions, such as eye or throat irritation, shortness of breath, or headaches, to permanent and serious conditions, such as birth defects, cancer or damage to lungs, nerves, liver, heart, or other organs.

AERMOD: a proposed (by U.S. EPA) steady-state, plume-based air dispersion model for estimating near-field impacts from a variety of industrial source types (designed to provide reasonable concentration estimates over a wide range of conditions with minimal discontinuities, to be easily implemented with reasonable input requirements and computer resource needs, to be based on up-to-date science that captures the essential physical processes while remaining simple, and to be easily revised as the science evolves). To the extent practicable, the structure of the input or the control file for AERMOD is the same as that for ISCST3.

Air Dispersion Modeling: Algorithms, usually performed with a computer, that relate a mass emission rate, source configuration, and meteorological information to calculate ambient air concentrations.

Air District: The Air Pollution Control and Air Quality Management Districts are the political bodies responsible for managing air quality on a regional or county basis. California is currently divided into 35 air districts.

Air monitoring: The periodic or continuous sampling and analysis of air pollutants in ambient air or from individual pollutant sources.

Air Toxics Hot Spots Act Emission Inventory Reports: Documents that contain information regarding emission sources, emitted substances, emission rates and release parameters, prepared under the Emission Inventory Criteria and Guidelines (also referred to as "Inventory Reports").

Air Toxics Hot Spots Information and Assessment Act of 1987 (AB 2588): (Health and Safety Code, Section 44300-44394) - A state law which established the "Hot Spots" Program to develop a statewide inventory of site-specific air toxic emissions, to assess the risk to public health from exposure to these emissions, to notify the public of any significant health risks and to reduce emissions below the significant risk levels.

Algorithm: a set of rules for solving a problem in a finite number of steps

The Air Toxics Hot Spots Program Guidance Manual for Preparation of Health Risk Assessments. August 2003.

California Air Resources Board (ARB): The State's lead air quality management agency consisting of an eleven-member board appointed by the Governor. The ARB is responsible for attainment and maintenance of the state and federal air quality standards, and is fully responsible for motor vehicle pollution control. It oversees county and regional air pollution management programs.

Asthma: A chronic inflammatory disorder of the lungs characterized by wheezing, breathlessness, chest tightness, and cough.

Atmospheric half-life: The time required for the concentration of a pollutant or reactant to fall to one-half of its initial value.

Benchmark Dose: That dose derived from linear regression of one or more dose-response curves associated with a specific response rate (such as 1, 5, or 10%) in the test population. This is the starting dose to which uncertainty factors are applied to determine a reference exposure level (REL) using the benchmark dose approach.

Urban Block Groups (BGs): A geographical unit smaller than a census tract used for reporting census data. BGs contain roughly 1,100 persons.

Bioaccumulation: the concentration of a substance in a body or part of a body or other living tissue in a concentration higher than that of the surrounding environment

Bioconcentrate: The process of increasing contaminant concentration in biota up the food chain as contaminants are ingested and concentrated in tissues of organisms higher up in the chain.

Cancer burden: The estimated number of theoretical cancer cases in a defined population resulting from lifetime exposure to pollutants emitted from a facility.

Cancer potency factor (CPF): The theoretical upper bound probability of extra cancer cases occurring in an exposed population assuming a lifetime exposure to the chemical when the chemical dose is expressed in exposure units of milligrams/kilogram-day (mg/kg-d).

California Air Pollution Control Officers Association (CAPCOA): A non-profit association of the air pollution control officers from all 35 air quality districts throughout California. CAPCOA was formed in 1975 to promote clean air and to provide a forum for sharing knowledge, experience, and information among the air quality regulatory agencies around the state.

Cal/EPA: In July 1991, the California Environmental Protection Agency (Cal/EPA) was created to coordinate the State's environmental quality programs and assure that there is a cabinet level voice for environmental protection.

Chemical Abstract Services Registry Number (CAS): The Chemical Abstracts Service Registry Number (CAS) is a numeric designation assigned by the American Chemical Society's Chemical Abstracts Service and uniquely identifies a specific chemical compound. This entry allows one to conclusively identify a material regardless of the name or naming system used.

The Air Toxics Hot Spots Program Guidance Manual for Preparation of Health Risk Assessments. August 2003.

CCR: California Code of Regulations

CERCLA: Comprehensive Environmental Response, Compensation and Liability Act (Superfund), a federal regulation providing direction and financial support for the clean-up of major hazardous waste sites

Centroid Locations: The location at which calculated ambient concentration is assumed to represent the entire subarea, typically the geometric centroid of an area, but possibly the population-weighted centroid of the area.

Census Tract: A physical area used by the U.S. Census Bureau to compile population and other statistical data.

Chronic Exposure: Long-term exposure, usually lasting one year to a lifetime.

Chronic Health Effect: An adverse non-cancer health effect that develops and persists (e.g., months or years) over time after long-term exposure to a substance

Criteria Air Pollutant: a pollutant or precursor to a pollutant for which the U.S. Environmental Protection Agency or the Air Resources Board has established an Ambient Air Quality Standard (AAQS). Examples include ozone, carbon monoxide, nitrogen dioxide, sulfur dioxide, lead, and PM_{10} and $PM_{2.5}$.

Default: A value used when specific information that applies to a specific situation is not available.

Developmental toxicity: Adverse effects on the developing organism that may result from exposure prior to conception (either parent), during prenatal development, or postnatally to the time of sexual maturation. Adverse developmental effects may be detected at any point in the life span of the organism. Major manifestations of developmental toxicity include: death of the developing organism; induction of structural birth defects; altered growth; and functional deficiency.

Dilution factor (c/Q): a site-specific quantity defined as a ratio of the ground level concentration in $\mu g/m^3$ to the mass emission rate in g/s and represented by c/Q.

Dose: A calculated amount of a substance estimated to be received by the subject, whether human or animal, as a result of exposure. Doses are generally expressed in terms of amount of chemical per unit body weight; typical units are mg/kg-day.

Dose-response assessment: The process of characterizing the relationship between the exposure to an agent and the incidence of an adverse health effect in exposed populations.

DTSC: California Department of Toxic Substances Control

ED: Rural Enumeration District. A geographical unit smaller than a census tract used to report census data. EDs contain roughly 1,100 persons.

The Air Toxics Hot Spots Program Guidance Manual for Preparation of Health Risk Assessments. August 2003.

Emission Inventory Criteria and Guidelines: Regulation and Report adopted by the California Air Resources Board specifying criteria and procedures for the preparation of Air Toxics Hot Spots Act Emission Inventory Reports (Title 17, California Code or Regulations, Sections 93300-93300.5)

Endpoint: An observable or measurable biological or biochemical event including cancer used as an index of the effect of a chemical on a cell, tissue, organ, organism, etc.

Epidemiology: The study of the occurrence and distribution of a disease or physiological condition in human populations and of the factors that influence this distribution.

Exposure: Contact of an organism with a chemical, physical, or biological agent. Exposure is quantified as the amount of the agent available at the exchange boundaries of the organism (e.g., skin, lungs, digestive tract) and available for absorption.

Exposure Pathway: A route of exposure by which xenobiotics enter the human body, (e.g., inhalation, ingestion, dermal absorption).

Fugitive Dust: Dust particles that are introduced into the air through certain activities such as soil cultivation, or vehicles operating on open fields or dirt roadways. A subset of fugitive emissions.

Fugitive Emissions: Emissions not caught by a capture system which are often due to equipment leaks, evaporative processes, and windblown disturbances.

Gaussian Model: An air dispersion model based on the assumption that the time-averaged concentration of a species emitted from a point source has a Gaussian distribution about the mean centerline.

Genotoxic: having an adverse effect on the genetic material (DNA) resulting in a mutation or in chromosome damage

GLC: Estimated ground level concentration, usually for a specified averaging time (e.g., annual average, 1 hour, etc.)

Hot Spots Analysis and Reporting Program (HARP): A single integrated software package designed to promote statewide consistency, efficiency, and cost-effective implementation of health risk assessments and the Hot Spots Program. The HARP software package consists of three modules that include: 1) the Emissions Inventory Database Module, 2) the Air Dispersion Modeling Module, and 3) the Risk Analysis and Mapping Module.

Health Risk Assessment (HRA): the name of a computer program developed by the ARB, the OEHHA, and the University of California which was designed to aid in the computation of risk in the Hot Spots program

HSC: Health and Safety Code of the State of California

The Air Toxics Hot Spots Program Guidance Manual for Preparation of Health Risk Assessments. August 2003.

Haber's Law: The product of the concentration (C) and time of exposure (t) required to produce a specific physiologic effect is equal to a constant level or severity of response (K), or C * t = K

Hazard identification: The process of determining whether exposure to an agent can cause an increase in the incidence of an adverse health effect including cancer

Health Risk Assessment: A health risk assessment (HRA) is an evaluation or report that a risk assessor (e.g., Air Resources Board, district, consultant, or facility operator) develops to describe the potential a person or population may have of developing adverse health effects from exposure to a facility's emissions. Some health effects that are evaluated could include cancer, developmental effects, or respiratory illness. The pathways that can be included in an HRA depend on the toxic air pollutants that a person (receptor) may be exposed to, and can include breathing, the ingestion of soil, water, crops, fish, meat, milk, and eggs, and dermal exposure.

Health Risk Guidance Value (HRGV): A numerical value with which to compare an exposure level in order to determine the probability of occurrence of an adverse health effect. In the Hot Spots program the toxicity criteria or toxicity values are known as Reference Exposure Levels (RELs) for noncancer effects and as inhalation unit risk factors and cancer potency values for cancer effects.

Hazard Index (HI): The sum of individual acute or chronic hazard quotients (HQs) for each substance affecting a particular toxicological endpoint.

Hazard Quotient (HQ): The estimated ground level concentration divided by the reference exposure level for a single substance and a particular endpoint. For an acute HQ the one hour maximum concentration is divided by the acute Reference Exposure Level for the substance. For a chronic HQ, the annual concentration is divided by the chronic Reference Exposure level.

Hot Spot: A location where emissions from specific sources may expose individuals and population groups to elevated risks of adverse health effects, including but not limited to cancer, and contribute to the cumulative health risks of emissions from other sources in the area.

Individual Excess Cancer Risk: The theoretical probability of an individual person developing cancer as a result of lifetime exposure to carcinogenic substances. The Individual Excess Cancer Risk is calculated by summing the potential cancer risks due to both inhalation and noninhalation routes of exposure.

Inhalation (Breathing) Rate: The amount of air inhaled in a specified time period (e.g., per minute, per hour, per day, etc.); also called breathing rate and ventilation rate. This is an example of a variate.

Inhalation unit risk factor: The theoretical upper bound probability of extra cancer cases occurring in the exposed population assuming a lifetime exposure to the chemical when the air concentration is expressed in exposure units of per microgram/cubic meter $(\mu g/m^3)^{-1}$.

Initiator carcinogen: A substance which causes the first stage of carcinogenesis, the conversion of a normal cell to a neoplastic cell. Initiation is considered to be a rapid, irreversible change often involving a change in the DNA caused by the initiator.

Interspecies: Between different species.

Intraspecies: Within the same species.

Industrial Source Complex Dispersion model (ISC3): Air modeling software that incorporates three previous programs into a single program. These are the short-term model (ISCST), the long term model (ISCLT), and the complex terrain model (COMPLEX).

Isopleth: A line on a map connecting points of equal value (e.g., risk, concentration, etc.).

Lowest-observed adverse effect level (LOAEL): The lowest dose or exposure level of a chemical in a study at which there is a statistically or biologically significant increase in the frequency or severity of an adverse effect in the exposed population as compared with an appropriate, unexposed control group.

Margin of safety: The ratio of the no-observed-adverse-effect level (NOAEL) to the estimated human exposure.

Mean: The arithmetic average.

MEI: Maximum exposed individual (theoretical)

MEIR: Maximum exposed individual resident (actual)

MEIW: Maximum exposed individual worker (actual)

Meteorology: The science that deals with the phenomena of the atmosphere especially weather and weather conditions. In the area of air dispersion modeling, *meteorology* is used to refer to climatological data needed to run an air dispersion model including: wind speed, wind direction, stability class and ambient temperature.

Milligram: One one-thousandth (10^{-3}) of a gram.

Molecular formula: The formula which identifies the atoms and the number of each kind in the molecules of a compound. Elements in the molecular formula are listed according to the Hill convention (C, H, then other elements in alphabetical order).

Molecular weight: The sum of the atomic weights of the atoms in a molecule. For example, methane (CH_4) is 16.043, the atomic weights being carbon = 12.011, hydrogen = 1.008.

Monte Carlo simulation: Application of random sampling to obtain an approximate value of an expression.

The Air Toxics Hot Spots Program Guidance Manual for Preparation of Health Risk Assessments. August 2003.

Multipathway substance: A substance or chemical that once airborne from an emission source can, under environmental conditions, be taken into a human receptor by inhalation and by other exposure routes such as after deposition on skin or after ingestion of soil contaminated by the emission

No Observed Adverse Effect Level (NOAEL): The highest experimental dose at which there is no statistically or biologically significant increase in frequency or severity of adverse health effects in the exposed population compared with an appropriate, unexposed population. Effects may be produced at this level, but they are not considered to be adverse. Substances are generally considered to not have a NOAEL for the cancer endpoint.

Noncarcinogenic Effects: Noncancer health effects which may include birth defects, organ damage, morbidity, and death.

Office of Environmental Health Hazard Assessment (OEHHA): An office within the California Environmental Protection Agency that is responsible for evaluating chemicals for adverse health impacts and establishing safe exposure levels. OEHHA also assists in performing health risk assessments and developing risk assessment procedures for air quality management purposes.

PM_{10}, $PM_{2.5}$: PM_{10} is particulate matter less than 10 μm in diameter; $PM_{2.5}$ is particulate matter less than 2.5 μm in diameter.

PMI: Off-site point of maximum impact. A location, with or without people currently present, at which the total cancer risk, or the total noncancer risk, has the highest numerical value.

Point Estimate: A single value estimate for a given variate

Potency: Essentially the relative effectiveness, or risk, of a standard amount of a substance to cause a toxic response.

Potency Slope: Used to calculate the probability or risk of cancer associated with an estimated exposure, based on the assumption in cancer risk assessments that risk is directly proportional to dose and that there is no threshold for carcinogenesis. It is the slope of the dose-response curve estimated at low exposures.

Proposition 65: Safe Drinking Water and Toxic Enforcement Act of 1986, also known as Proposition 65. This Act is codified in California Health and Safety Code Section 25249.5, et seq. No person in the course of doing business shall knowingly discharge or release a chemical known to the state to cause cancer or reproductive toxicity into water or into land where such chemical passes or probably will pass into any source of drinking water, without first giving clear and reasonable warning to such individual.

Resource Conservation and Recovery Act (RCRA) of 1976: A federal law regulating disposal of hazardous waste

Receptor: A location with or without people present at which the ground level concentration of an emitted chemical can be estimated

The Air Toxics Hot Spots Program Guidance Manual for Preparation of Health Risk Assessments. August 2003.

Refined Models: Air dispersion models designed to provide more representative concentration estimates than screening models taking into account actual meteorological conditions.

Reference Concentration (RfC): An estimate, derived by the U.S. EPA (with an uncertainty spanning perhaps an order of magnitude) of a daily exposure to the human population, (including sensitive subgroups) that is likely to be without appreciable risk of deleterious effects during a lifetime of exposure. The RfC is derived from a no or lowest observed adverse effect level from human or animal exposures, to which uncertainty or "safety" factors are applied.

Reference Dose (RfD): An estimate delivered by the U.S. EPA (with uncertainty spanning perhaps an order of magnitude) of the daily exposure to the human population (including sensitive subpopulations) that is likely to be without deleterious effects during a lifetime. The RfD is reported in units of mg of substance/kg body weight/day for oral exposures.

Reference exposure level (REL): expressed in units of $\mu g/m^3$ for inhalation exposures and of mg/kg-d for noninhalation exposures. The REL is an exposure level at or below which no noncancer adverse health effect is anticipated to occur in a human population exposed for a specific duration. An REL is virtually the same as the terms Reference Concentration (RfC) for inhalation or Reference Dose (RFD) used by U.S. EPA, only it may be for varying amounts of time rather than lifetime only. It has been given a different name so that the values estimated by the State Office of Environmental Health Hazard Assessment can easily be distinguished from those developed by the U.S. EPA. RELs are used to evaluate toxicity endpoints other than cancer.

Reproductive toxicity: Harmful effects on fertility, gestation, or offspring, caused by exposure of either parent to a substance.

Risk: The (characterization of the) probability of potentially adverse effects to human health, in this instance from the exposure to environmental hazards.

Risk Assessment: The characterization (in the present context) of the probability of potentially adverse health effects to people from exposure to environmental chemical hazards.

Risk Management: An evaluation of the need for and feasibility of reducing risk. It includes consideration of magnitude of risk, available control technologies, and economic feasibility.

Risk Management and Prevention Program (RMPP): A program administered by the Office of Emergency Services (OES) and local agencies to reduce the frequency and severity of accidental releases of toxic materials

Scientific Review Panel on Toxic Air Contaminants or SRP: A nine-member panel appointed to advise the Air Resources Board and the Department of Pesticide Regulation in their evaluation of the adverse health effects toxicity of substances being evaluated as Toxic Air Contaminants.

Screening Models: Dispersion models used to provide a maximum concentration that is likely to overestimate public exposure.

The Air Toxics Hot Spots Program Guidance Manual for Preparation of Health Risk Assessments. August 2003.

Sensitive Receptor: A location such as a hospital or daycare center where the human occupants are considered to be more sensitive to pollutants than "average".

Severity Level: The (acute) discomfort or mild effect level; the concentration of an airborne substance at or below which exposure for one hour may result in some odors, tastes, visual cues, and sensations but which will cause no adverse health effects in essentially all of the population. Exposure to concentrations above this level, depending on the chemical, may result in minor health effects, such as mild eye and respiratory irritation, skin irritation, minor histologic effects, and headaches.

Severity Level II: The (acute) disability or serious effect level. Exposure for one hour to an airborne substance above this level may lead individuals to seek assistance. Exposures above this level, depending on the chemical, may result in serious health effects such as severe eye irritation, severe respiratory irritation, bronchospasm, shortness of breath, disorientation, blurred vision, vomiting, cardiac arrhythmia and adverse outcomes of an existing or subsequent pregnancy.

Stationary source: A non-mobile source of air pollutants which can be either a point or area source.

Stochastic: A process that involves random variation

Synergism: A pharmacologic or toxicologic interaction in which the combined effect of two or more chemicals is greater than the sum of the effects of each chemical alone.

Subcensus Tract: Smaller population unit within a census tract.

Surrogate: As used in this document refers to a single substance category used to represent a family of related chemical compounds, e.g., gasoline vapors or POM (polycyclic organic matter) in place of benzo(a)pyrene.

Threshold, Nonthreshold: A threshold dose is the minimally effective dose of any chemical that is observed to produce a response (e.g., enzyme change, liver toxicity, death). For most toxic effects, except carcinogenesis, there appear to be threshold doses. Nonthreshold substances are those substances, including nearly all carcinogens, that are known or assumed to have some risk of response at any dose above zero.

Toxic air contaminant (TAC): As defined by California Health and Safety Code, Section 39655 (a): an air pollutant which may cause or contribute to an increase in mortality or in serious illness, or which may pose a present or potential hazard to human health. Substances, which have been identified by the United States Environmental Protection Agency as hazardous air pollutants (e.g. benzene, asbestos), shall be identified by the Board as toxic air contaminants.

Toxicology: The multidisciplinary study of toxicants, their harmful effects on biological systems, and the conditions under which these harmful effects occur. The mechanisms of action, detection, and treatment of the conditions produced by toxicants are studied.

Uncertainty: True uncertainty is that which is not known about a factor that influences its value.

The Air Toxics Hot Spots Program Guidance Manual for Preparation of Health Risk Assessments. August 2003.

URF: See inhalation unit risk factor

UTM Coordinates: Universal Transfer Mercator Coordinates. Coordinates used to define a specific location by means of two values (i.e., easting and northing coordinates).

United States Environmental Protection Agency (U.S. EPA): The Federal agency charged with setting policy and guidelines, carrying out legal mandates, for the protection, and national interests in environmental resources.

Vapor: The gaseous phase of liquids or solids at atmospheric temperature and pressure.

Vapor Pressure: The pressure exerted by a chemical vapor in equilibrium with its liquid or solid phase at any given temperature, used to calculate the rate of evaporation of a substance.

Variability: Ability to have different numerical values of a parameter, such as height or weight

Variate: A variable quantity associated with a probability distribution (e.g. inhalation rate)

Volatile: Chemicals that rapidly pass off from the liquid state in the form of vapors.

Xenobiotic: A toxic agent; a relatively small (MW<1000), non-nutritive chemical that is foreign to the species being studied

Zone of impact: The area in the vicinity of the facility in which an individual is exposed to a specified cancer risk, usually one in a million or greater.

Appendix K

HRA Forms and Maps Used With Air Dispersion Modeling

- Example of Census Tract Map

- Example of 7.5 minute Series Map

- Examples of Tables for Emissions Reporting

Figure 1
Census Tracts, View 1

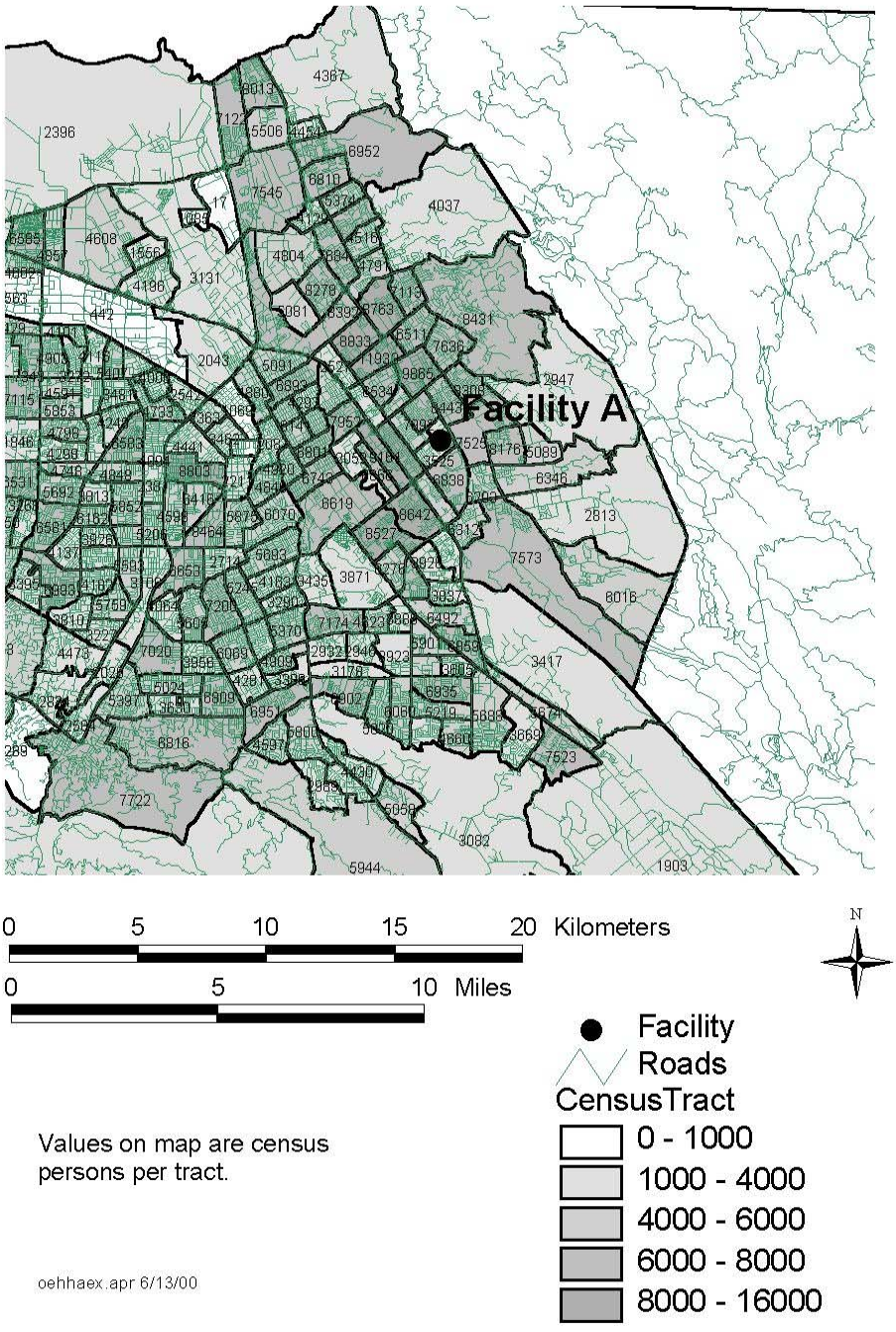


Figure 2
Census Tracts, View 2

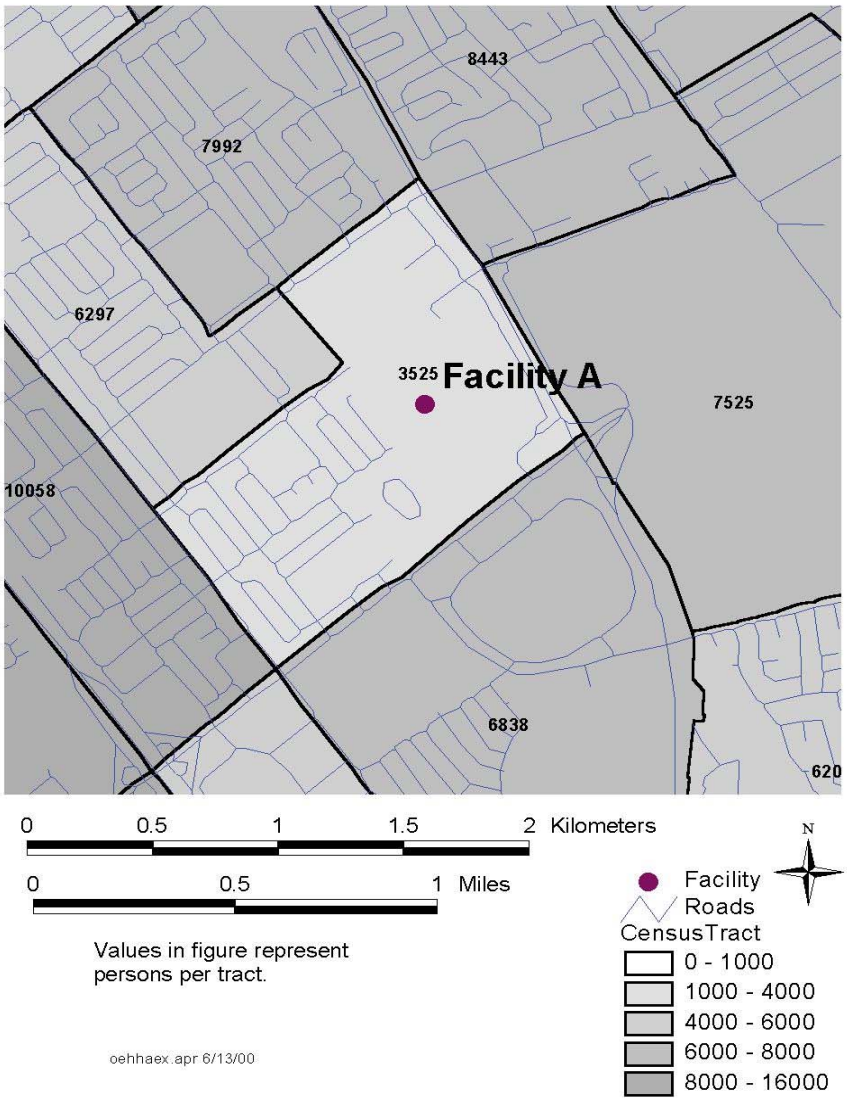
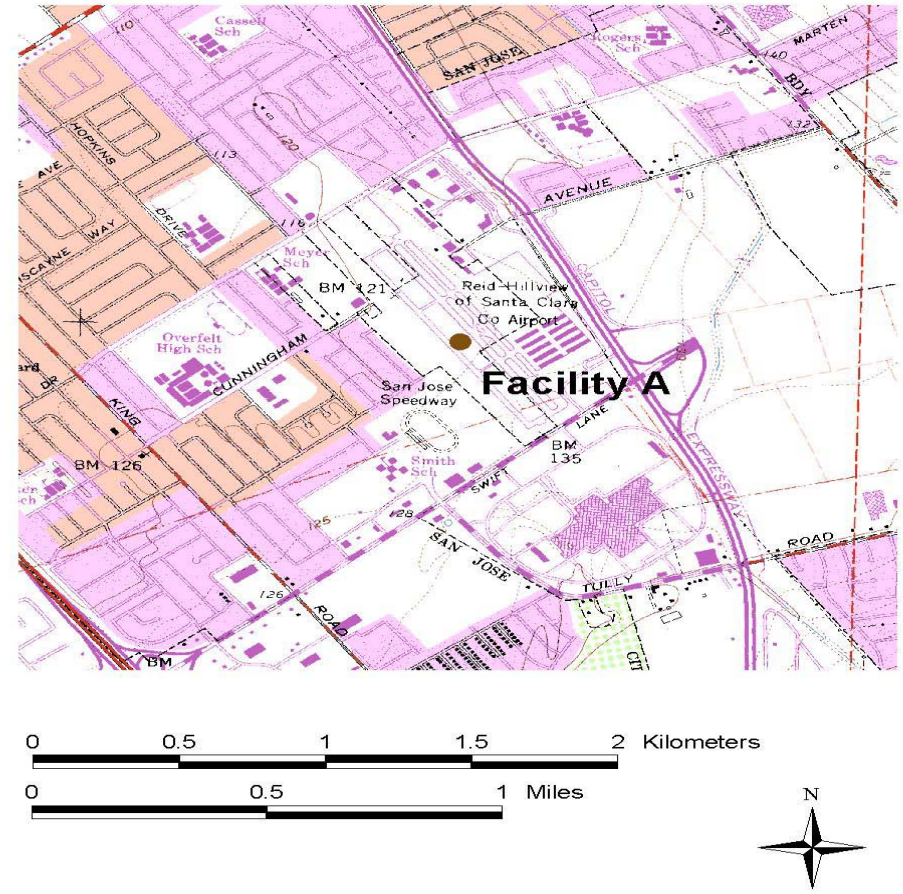


Figure 4
USGS 7.5 Minute Topographic Map



oehhaex.apr 6/13/00

HEALTH RISK ASSESSMENT

EMISSION RATE BY SUBSTANCE AND SOURCE RAG-001

FACILITY NAME / FACILITY ADDRESS / SITE ID#:

SOURCE ID No.	SOURCE NAME	SUBSTANCE NAME	CAS No.	1-HOUR MAXIMUM (lb/hr)	1-HOUR MAXIMUM (g/s)	ANNUAL AVERAGE (lb/yr)	ANNUAL AVERAGE (g/s)

HEALTH RISK ASSESSMENT

EMISSION RATE BY SUBSTANCE – TOTALS – RAG-002

FACILITY NAME / FACILITY ADDRESS / SITE ID#

SUBSTANCE NAME	CAS No.	1-HOUR MAXIMUM (lb/hr)	1-HOUR MAXIMUM (g/s)	ANNUAL AVERAGE (lb/yr)	ANNUAL AVERAGE (g/s)

HEALTH RISK ASSESSMENT

SOURCE PARAMETERS – STACKS – RAG-003

FACILITY NAME / FACILITY ADDRESS / SITE ID#

SOURCE ID No.	STACK NAME	UTM Easting	UTM Northing	HEIGHT (m)	DIAMETER (m)	TEMP. (F)	TEMP. (K)	FLOW RATE (ACFM)	EXIT VEL. (m/s)

HEALTH RISK ASSESSMENT

SOURCE OPERATING HOURS – RAG-004

FACILITY NAME / FACILITY ADDRESS / SITE ID#

SOURCE ID No.	STACK NAME	AVERAGE OPERATING HOURS		MAXIMUM OPERATING HOURS	
		(hr/day)	(days/year)	(hr/day)	(days/year)

Appendix L

OEHHA/ARB Approved Health Values
for Use in Hot Spot Facility Risk Assessments

Purpose of the Appendix L Tables:

The purpose of the following reference tables is to provide a quick list of all health values that have been approved by the Office of Environmental Health Hazard Assessment (OEHHA) and the Air Resources Board (ARB) for use in facility health risk assessments conducted for the AB 2588 Air Toxics Hot Spots Program. The OEHHA has developed and adopted new risk assessment guidelines that update and replace the California Air Pollution Control Officers Association's (CAPCOA) *Air Toxics "Hot Spots" Program Revised 1992 Risk Assessment Guidelines, October 1993*.

The following tables list the OEHHA adopted inhalation and oral cancer slope factors, noncancer acute Reference Exposure Levels (RELs), and inhalation and oral noncancer chronic RELs. In addition, these tables list the substances in Appendix A-I *(Substances For Which Emissions Must Be Quantified*) and Appendix F (*Criteria For Inputs For Risk Assessment Using Screening Air Dispersion Modeling*) of the ARB's *Hot Spots Emission Inventory Criteria and Guidelines (EICG).* OEHHA is still in the process of adopting new noncancer chronic RELs. Therefore, new health values will periodically be added to, or deleted from, these tables. Users of these tables are advised to monitor the OEHHA website (*www.oehha.ca.gov*) for any updates to the health values.

Substances written in *italics* do not have explicit OEHHA approved health values, but are included in this table to clarify applicability of OEHHA adopted heath effects values to individual or grouped substances listed in the *Hot Spots Emission Inventory Criteria and Guidelines*, Appendix A-I list of *"Substances For Which Emissions Must Be Quantified."*

The "Date Value Reviewed" column lists the date that the health value was last reviewed by OEHHA and the Scientific Review Panel, and/or approved for use in the AB 2588 Air Toxics Hot Spots Program. This information is useful to tell where the number came from. If the health value is unchanged since it was first approved for use in the Hot Spots Program, then the date that the value was first approved for use by CAPCOA is listed within the brackets [ ].

- April 1999 is listed for the cancer potency values and noncancer acute RELs, which have been adopted by the OEHHA as part of the AB 2588 "Hot Spots" Risk Assessment Guidelines.
- February 2000, April 2000, January 2001, and December 2001 are listed for the first set of 22, the second set of 16, the third set of 22, and the fourth set of 12 noncancer chronic RELs, respectively.
- October 2000 is listed for the oral chronic RELs and oral cancer slope factors. 1996 is listed for the U.S. EPA Reference Concentrations. Dates of 1990-1992 and 1996 are listed for CAPCOA chronic RELs that may eventually be dropped or replaced.
- For the substances identified as Toxic Air Contaminants, the Air Resources Board hearing date is listed. The dates for acetaldehyde, benzo[a]pyrene, and methyl tertiary-butyl ether represent the dates the values were approved by the Scientific Review Panel.

Substance ◉	Chemical▼ Abstract Service Number (CAS)	Noncancer Effects						Cancer Risk				
		Acute Inhalation REL ($\mu g/m^3$)	Date ◆ Value Reviewed [Added]	Chronic Inhalation REL ($\mu g/m^3$)	Date ◆ Value Reviewed [Added]	Chronic Oral REL (mg/kg/d)	Date ◆ Value Reviewed [Added]	Inhalation Cancer Potency Factor $(mg/kg-d)^{-1}$	Date ◆ Value Reviewed [Added]	Oral Slope Factor $(mg/kg-d)^{-1}$	Date ◆ Value Reviewed [Added]	M♣ W A F
ACETALDEHYDE	75-07-0			9.0E+00	5/93			1.0E-02	4/99 [5/93]			1
ACETAMIDE	60-35-5							7.0E-02	4/99			1
ACROLEIN	107-02-8	1.9E-01	4/99	6.0E-02	1/01							--
ACRYLAMIDE	79-06-1							4.5E+00	4/99 [7/90]			1
ACRYLIC ACID	79-10-7	6.0E+03	4/99									--
ACRYLONITRILE	107-13-1			5.0E+00	12/01			1.0E+00	4/99 [1/91]			1
ALLYL CHLORIDE	107-05-1							2.1E-02	4/99			1
2-AMINOANTHRAQUINONE	117-79-3							3.3E-02	4/99			1
AMMONIA	7664-41-7	3.2E+03	4/99	2.0E+02	2/00							--
ANILINE	62-53-3							5.7E-03	4/99			1
Antimony Compounds	*7440-36-0*											--
ANTIMONY TRIOXIDE	1309-64-4											--
ARSENIC AND COMPOUNDS (INORGANIC) TAC ♣	7440-38-2 1016 [1015]	1.9E-01 AveP	4/99	3.0E-02	1/01	3.0E-04	10/00	1.2E+01 TAC	7/90	1.5E+00	10/00	1
ARSINE	7784-42-1	1.6E+02	4/99									--
ASBESTOS TAC ¤	1332-21-4							1.9E-04 TAC¤	3/86			333.33 ¤
BENZENE TAC	71-43-2	1.3E+03 AveP	4/99	6.0E+01	2/00			1.0E-01 TAC	1/85			1
BENZIDINE (AND ITS SALTS) *values also apply to:*	92-87-5							5.0E+02	4/99 [1/91]			1
Benzidine based dyes	*1020*							*5.0E+02*	*4/99 [1/91]*			*1*
Direct Black 38	*1937-37-7*							*5.0E+02*	*4/99 [1/91]*			*1*
Direct Blue 6	*2602-46-2*							*5.0E+02*	*4/99 [1/91]*			*1*
Direct Brown 95 (technical grade)	*16071-86-6*							*5.0E+02*	*4/99 [1/91]*			*1*
BENZYL CHLORIDE	100-44-7	4E+02	4/99					1.7E-01	4/99			1
BERYLLIUM AND COMPOUNDS ♣	7440-41-7 [1021]			7.0E-03	12/01	2.0E-03	12/01	8.4E+00	4/99 [7/90]			1
BIS(2-CHLOROETHYL)ETHER (Dichloroethyl ether)	111-44-4							2.5E+00	4/99			1
BIS(CHLOROMETHYL)ETHER	542-88-1							4.6E+01	4/99 [1/91]			1
1,3-BUTADIENE TAC	106-99-0			2.0E+01	1/01			6.0E-01 TAC	7/92			1

APPENDIX L - TABLE 1
OEHHA/ARB APPROVED HEALTH VALUES FOR USE IN HOT SPOT FACILITY RISK ASSESSMENTS ◉

Substance ◉	Chemical▼ Abstract Service Number (CAS)	Noncancer Effects						Cancer Risk				
		Acute Inhalation REL ($\mu g/m^3$)	Date ◆ Value Reviewed [Added]	Chronic Inhalation REL ($\mu g/m^3$)	Date ◆ Value Reviewed [Added]	Chronic Oral REL (mg/kg/d)	Date ◆ Value Reviewed [Added]	Inhalation Cancer Potency Factor $(mg/kg-d)^{-1}$	Date ◆ Value Reviewed [Added]	Oral Slope Factor $(mg/kg-d)^{-1}$	Date ◆ Value Reviewed [Added]	M♣ W A F
CADMIUM AND COMPOUNDS TAC ♣	7440-43-9 [1045]			2.0E-02	1/01	5.0E-04	10/00	1.5E+01 TAC	1/87			1
CARBON DISULFIDE	75-15-0	6.2E+03 AveP	4/99	8.0E+02 RfC								--
CARBON MONOXIDE	630-08-0	2.3E+04	4/99									--
CARBON TETRACHLORIDE TAC (Tetrachloromethane)	56-23-5	1.9E+03 AveP	4/99	4.0E+01	1/01			1.5E-01 TAC	9/87			1
CHLORINATED PARAFFINS	108171-26-2							8.9E-02	4/99			1
CHLORINE	7782-50-5	2.1E+02	4/99	2.0E-01	2/00							--
CHLORINE DIOXIDE	10049-04-4			6.0E-01	1/01							--
4-CHLORO-O-PHENYLENEDIAMINE	95-83-0							1.6E-02	4/99			1
CHLOROBENZENE	108-90-7			1.0E+03	1/01							--
CHLORODIFLUOROMETHANE ... (see Fluorocarbons)												
CHLOROFORM TAC	67-66-3	1.5E+02 AveP	4/99	3.0E+02	4/00			1.9E-02 TAC	12/90			1
Chlorophenols	*1060*											--
PENTACHLOROPHENOL	87-86-5							1.8E-02	4/99			1
2,4,6-TRICHLOROPHENOL	88-06-2							7.0E-02	4/99 [1/91]			1
CHLOROPICRIN	76-06-2	2.9E+01	4/99	4.0E-01	12/01							--
CHLOROPRENE	126-99-8											--
p-CHLORO-o-TOLUIDINE	95-69-2							2.7E-01	4/99			1
CHROMIUM 6+ TAC ♣ *values also apply to:*	18540-29-9			2.0E-01	1/01	2.0E-02	10/00	5.1E+02 TAC	1/86			1
Barium chromate♣	*10294-40-3*			*2.0E-01*	*1/01*	*2.0E-02*	*10/00*	*5.1E+02* TAC	*1/86*			*0.2053*
Calcium chromate♣	*13765-19-0*			*2.0E-01*	*1/01*	*2.0E-02*	*10/00*	*5.1E+02* TAC	*1/86*			*0.3332*
Lead chromate♣	*7758-97-6*			*2.0E-01*	*1/01*	*2.0E-02*	*10/00*	*5.1E+02* TAC	*1/86*			*0.1609*
Sodium dichromate♣	*10588-01-9*			*2.0E-01*	*1/01*	*2.0E-02*	*10/00*	*5.1E+02* TAC	*1/86*			*0.397*
Strontium chromate♣	*7789-06-2*			*2.0E-01*	*1/01*	*2.0E-02*	*10/00*	*5.1E+02* TAC	*1/86*			*0.2554*
CHROMIUM TRIOXIDE ♣ (as chromic acid mist)	1333-82-0			2.0E-03	1/01	2.0E-02	10/00	5.1E+02 TAC	1/86			0.52
COPPER AND COMPOUNDS	7440-50-8 [1067]	1.0E+02	4/99									--
p-CRESIDINE	120-71-8							1.5E-01	4/99			1
CRESOLS (mixtures of)	1319-77-3			6.0E+02	1/01							--
m-CRESOL	108-39-4			6.0E+02	1/01							--

APPENDIX L - TABLE 1
OEHHA/ARB APPROVED HEALTH VALUES FOR USE IN HOT SPOT FACILITY RISK ASSESSMENTS ◉

Substance ◉	Chemical▼ Abstract Service Number (CAS)	Noncancer Effects						Cancer Risk				
		Acute Inhalation REL ($\mu g/m^3$)	Date ◆ Value Reviewed [Added]	Chronic Inhalation REL ($\mu g/m^3$)	Date ◆ Value Reviewed [Added]	Chronic Oral REL (mg/kg/d)	Date ◆ Value Reviewed [Added]	Inhalation Cancer Potency Factor $(mg/kg\text{-}d)^{-1}$	Date ◆ Value Reviewed [Added]	Oral Slope Factor $(mg/kg\text{-}d)^{-1}$	Date ◆ Value Reviewed [Added]	M♣ W A F
o-CRESOL	95-48-7			6.0E+02	1/01							--
p-CRESOL	106-44-5			6.0E+02	1/01							--
CUPFERRON	135-20-6							2.2E-01	4/99			1
Cyanide Compounds (inorganic)	*57-12-5 1073*	*3.4E+02*	*4/99*	*9.0E+00*	*4/00*							--
HYDROGEN CYANIDE (Hydrocyanic acid)	74-90-8	3.4E+02	4/99	9.0E+00	4/00							--
2,4-DIAMINOANISOLE	615-05-4							2.3E-02	4/99			1
2,4-DIAMINOTOLUENE	95-80-7							4.0E+00	4/99			1
1,2-DIBROMO-3-CHLOROPROPANE (DBCP)	96-12-8							7.0E+00	4/99 [1/92]			1
p-DICHLOROBENZENE	106-46-7			8.0E+02	1/01			4.0E-02	4/99 [1/91]			1
3,3-DICHLOROBENZIDINE	91-94-1							1.2E+00	4/99 [1/91]			1
1,1,-DICHLOROETHANE (Ethylidene dichloride)	75-34-3							5.7E-03	4/99			1
1,1-DICHLOROETHYLENE … (see Vinylidene Chloride)												
DI(2-ETHYLHEXYL)PHTHALATE (DEHP)	117-81-7							8.4E-03	4/99 [1/92]	8.4E-03	10/00	1
DIESEL EXHAUST … (see Particulate Emissions from Diesel-Fueled Engines)												
DIETHANOLAMINE	111-42-2			3.0E+00	12/01							--
DIMETHYLAMINE	124-40-3											--
p-DIMETHYLAMINOAZOBENZENE	60-11-7							4.6E+00	4/99			1
N,N-DIMETHYL FORMAMIDE	68-12-2			8.0E+01	1/01							--
2,4-DINITROTOLUENE	121-14-2							3.1E-01	4/99			1
1,4-DIOXANE (1,4-Diethylene dioxide)	123-91-1	3.0E+03	4/99	3.0E+03	4/00			2.7E-02	4/99 [1/91]			1
EPICHLOROHYDRIN (1-Chloro-2,3-epoxypropane)	106-89-8	1.3E+03	4/99	3.0E+00	1/01			8.0E-02	4/99 [1/92]			1
1,2-EPOXYBUTANE	106-88-7			2.0E+01	1/01							--
ETHYL ACRYLATE	140-88-5											--
ETHYL BENZENE	100-41-4			2.0E+03	2/00							--
ETHYL CHLORIDE (Chloroethane)	75-00-3			3.0E+04	4/00							--
ETHYLENE DIBROMIDE TAC (1,2-Dibromoethane)	106-93-4			8.0E-01	12/01			2.5E-01 TAC	7/85			1

APPENDIX L - TABLE 1
OEHHA/ARB APPROVED HEALTH VALUES FOR USE IN HOT SPOT FACILITY RISK ASSESSMENTS

Substance	Chemical Abstract Service Number (CAS)	Noncancer Effects						Cancer Risk				
		Acute Inhalation REL ($\mu g/m^3$)	Date Value Reviewed [Added]	Chronic Inhalation REL ($\mu g/m^3$)	Date Value Reviewed [Added]	Chronic Oral REL (mg/kg/d)	Date Value Reviewed [Added]	Inhalation Cancer Potency Factor $(mg/kg-d)^{-1}$	Date Value Reviewed [Added]	Oral Slope Factor $(mg/kg-d)^{-1}$	Date Value Reviewed [Added]	MAF
ETHYLENE DICHLORIDE TAC (1,2-Dichloroethane)	107-06-2			4.0E+02	1/01			7.2E-02 TAC	9/85			1
ETHYLENE GLYCOL	107-21-1			4.0E+02	4/00							--
ETHYLENE GLYCOL BUTYL ETHER … (see Glycol ethers)												
ETHYLENE OXIDE TAC (1,2-Epoxyethane)	75-21-8			3.0E+01	1/01			3.1E-01 TAC	11/87			1
ETHYLENE THIOUREA	96-45-7							4.5E-02	4/99			1
Fluorides	*1101*	*2.4E+02*	*4/99*	*1.3E+01*	*8/03*	4.0E-2	8/03					--
HYDROGEN FLUORIDE (Hydrofluoric acid)	7664-39-3	2.4E+02	4/99	1.4E+01	8/031	4.0E-2						--
FORMALDEHYDE TAC	50-00-0	9.4E+01	4/99	3.0E+00	2/00			2.1E-02 TAC	3/92			1
GASOLINE VAPORS	1110											--
GLUTARALDEHYDE	111-30-8			8.0E-02	1/01							--
GLYCOL ETHERS	1115											
ETHYLENE GLYCOL MONOBUTYL ETHER – EGBE	111-76-2	1.4E+04	4/99									--
ETHYLENE GLYCOL MONOETHYL ETHER – EGEE	110-80-5	3.7E+02 AveP	4/99[1/92]	7.0E+01	2/00							--
ETHYLENE GLYCOL MONOETHYL ETHER ACETATE – EGEEA	111-15-9	1.4E+02 AveP	4/99	3.0E+02	2/00							--
ETHYLENE GLYCOL MONOMETHYL ETHER – EGME	109-86-4	9.3E+01 AveP	4/99	6.0E+01	2/00							--
ETHYLENE GLYCOL MONOMETHYL ETHER ACETATE – EGMEA	110-49-6			9.0E+01	2/00							--
HEXACHLOROBENZENE	118-74-1							1.8E+00	4/99 [1/91]			1
HEXACHLOROCYCLOHEXANES (mixed or technical grade)	608-73-1 1120							4.0E+00	4/99 [1/91]	4.0E+00	10/00 [1/92]	1
Alpha-HEXACHLOROCYCLOHEXANE	319-84-6							4.0E+00	4/99 [1/91]	4.0E+00	10/00 [1/92]	1
beta- HEXACHLOROCYCLOHEXANE	319-85-7							4.0E+00	4/99 [1/91]	4.0E+00	10/00 [1/92]	1
Gamma-HEXACHLOROCYCLOHEXANE (Lindane)	58-89-9							1.1E+00	4/99	1.1E+00	10/00	1

APPENDIX L - TABLE 1
OEHHA/ARB APPROVED HEALTH VALUES FOR USE IN HOT SPOT FACILITY RISK ASSESSMENTS ◉

Substance ◉	Chemical▼ Abstract Service Number (CAS)	Noncancer Effects						Cancer Risk				
		Acute Inhalation REL ($\mu g/m^3$)	Date ◆ Value Reviewed [Added]	Chronic Inhalation REL ($\mu g/m^3$)	Date ◆ Value Reviewed [Added]	Chronic Oral REL (mg/kg/d)	Date ◆ Value Reviewed [Added]	Inhalation Cancer Potency Factor $(mg/kg\text{-}d)^{-1}$	Date ◆ Value Reviewed [Added]	Oral Slope Factor $(mg/kg\text{-}d)^{-1}$	Date ◆ Value Reviewed [Added]	M♣ W A F
n-HEXANE	110-54-3			7.0E+03	4/00							--
HYDRAZINE	302-01-2			2.0E-01	1/01			1.7E+01	4/99 [7/90]			1
HYDROCHLORIC ACID (Hydrogen chloride)	7647-01-0	2.1E+03	4/99	9.0E+00	2/00							--
HYDROGEN BROMIDE … (see Bromine & Compounds)												
HYDROGEN CYANIDE … (see Cyanide & Compounds)												
HYDROGEN FLUORIDE … (see Fluorides)												
HYDROGEN SELENIDE … (see Selenium & Compounds)												
HYDROGEN SULFIDE	7783-06-4	4.2E+01	4/99[7/90]	1.0E+01	4/00							--
ISOPHORONE	78-59-1			2.0E+03	12/01							--
ISOPROPYL ALCOHOL (Isopropanol)	67-63-0	3.2E+03	4/99	7.0E+03	2/00							--
LEAD AND COMPOUNDS[TAC ✶ ♣] (inorganic) *values also apply to:*	7439-92-1 1128 [1130]							4.2E-02 TAC	4/97	8.5E-03	10/00	1
Lead acetate♣	*301-04-2*							*4.2E-02* TAC	*4/97*	*8.5E-03*	*10/00*	*0.637*
Lead phosphate♣	*7446-27-7*							*4.2E-02* TAC	*4/97*	*8.5E-03*	*10/00*	*0.7659*
Lead subacetate♣	*1335-32-6*							*4.2E-02* TAC	*4/97*	*8.5E-03*	*10/00*	*0.7696*
LINDANE ... (see gamma-Hexachlorocyclohexane)												
MALEIC ANHYDRIDE	108-31-6			7.0E-01	12/01							--
MANGANESE AND COMPOUNDS	7439-96-5 [1132]			2.0E-01	4/00							--
MERCURY AND COMPOUNDS (INORGANIC)	7439-97-6 [1133]	1.8E+00	4/99	9.0^{E}-02	2/00	3.0E-04	10/00 [1/92]					--
Mercuric chloride	*7487-94-7*	*1.8E+00*	*4/99*	*9.0E-02*	*2/00*	*3.0E-04*	*10/00 [1/92]*					--
MERCURY AND COMPOUNDS (ORGANIC) *values also apply to:*	N/A											
METHYL MERCURY	593-74-8											--
METHANOL	67-56-1	2.8E+04	4/99	4.0E+03	4/00							--
METHYL BROMIDE (Bromomethane)	74-83-9	3.9E+03	4/99	5.0E+00	2/00							--
METHYL tertiary-BUTYL ETHER	1634-04-4			8.0E+03	2/00			9.1E-04	11/99			1
METHYL CHLOROFORM (1,1,1-Trichloroethane)	71-55-6	6.8E+04	4/99	1.0E+03	2/00							--

APPENDIX L - TABLE 1
OEHHA/ARB APPROVED HEALTH VALUES FOR USE IN HOT SPOT FACILITY RISK ASSESSMENTS ◉

Substance ◉	Chemical▼ Abstract Service Number (CAS)	Noncancer Effects						Cancer Risk				
		Acute Inhalation REL ($\mu g/m^3$)	Date ◆ Value Reviewed [Added]	Chronic Inhalation REL ($\mu g/m^3$)	Date ◆ Value Reviewed [Added]	Chronic Oral REL (mg/kg/d)	Date ◆ Value Reviewed [Added]	Inhalation Cancer Potency Factor $(mg/kg-d)^{-1}$	Date ◆ Value Reviewed [Added]	Oral Slope Factor $(mg/kg-d)^{-1}$	Date ◆ Value Reviewed [Added]	M♣ W A F
METHYL ETHYL KETONE (2-Butanone)	78-93-3	1.3E+04	4/99									--
METHYL ISOCYANATE	624-83-9			1.0E+00	12/01							--
METHYL MERCURY ... (see Mercury & Compounds)												
METHYL METHACRYLATE	80-62-6											--
4,4'-METHYLENE BIS (2-CHLOROANILINE) (MOCA)	101-14-4							1.5E+00	4/99			1
METHYLENE CHLORIDE TAC (Dichloromethane)	75-09-2	1.4E+04	4/99	4.0E+02	2/00			3.5E-03 TAC	7/89			1
4,4'-METHYLENE DIANILINE (AND ITS DICHLORIDE)	101-77-9			2.0E+01	12/01			1.6E+00	4/99	1.6E+00	10/00	1
METHYLENE DIPHENYL ISOCYANATE	101-68-8			7.0E-01	1/01							--
MICHLER'S KETONE (4,4'-Bis(dimethylamino)benzophenone)	90-94-8							8.6E-01	4/99			1
N-NITROSO-n-BUTYLAMINE	924-16-3							1.1E+01	4/99 [1/92]			1
N-NITROSODI-n-PROPYLAMINE	621-64-7							7.0E+00	4/99 [1/91]			1
N-NITROSODIETHYLAMINE	55-18-5							3.6E+01	4/99 [1/91]			1
N-NITROSODIMETHYLAMINE	62-75-9							1.6E+01	4/99 [1/91]			1
N-NITROSODIPHENYLAMINE	86-30-6							9.0E-03	4/99			1
N-NITROSO-N-METHYLETHYLAMINE	10595-95-6							2.2E+01	4/99 [7/90]			1
N-NITROSOMORPHOLINE	59-89-2							6.7E+00	4/99 [7/92]			1
N-NITROSOPIPERIDINE	100-75-4							9.4E+00	4/99 [7/92]			1
N-NITROSOPYRROLIDINE	930-55-2							2.1E+00	4/99 [7/90]			1
NAPHTHALENE ... (see Polycyclic aromatic hydrocarbons)												
NICKEL AND COMPOUNDS TAC ♣ *values also apply to:*	7440-02-0 [1145]	6.0E+00	4/99	5.0E-02	2/00	5.0E-02	10/00	9.1E-01 TAC	8/91			1
Nickel acetate♣	*373-02-4*	*6.0E+00*	*4/99*	*5.0E-02*	*2/00*	*5.0E-02*	*10/00*	*9.1E-01* TAC	*8/91*			*0.3321*
Nickel carbonate♣	*3333-39-3*	*6.0E+00*	*4/99*	*5.0E-02*	*2/00*	*5.0E-02*	*10/00*	*9.1E-01* TAC	*8/91*			*0.4945*
Nickel carbonyl♣	*13463-39-3*	*6.0E+00*	*4/99*	*5.0E-02*	*2/00*	*5.0E-02*	*10/00*	*9.1E-01* TAC	*8/91*			*0.3438*
Nickel hydroxide♣	*12054-48-7*	*6.0E+00*	*4/99*	*5.0E-02*	*2/00*	*5.0E-02*	*10/00*	*9.1E-01* TAC	*8/91*			*0.6332*

APPENDIX L - TABLE 1
OEHHA/ARB APPROVED HEALTH VALUES FOR USE IN HOT SPOT FACILITY RISK ASSESSMENTS ◉

Substance ◉	Chemical▼ Abstract Service Number (CAS)	Noncancer Effects						Cancer Risk				
		Acute Inhalation REL ($\mu g/m^3$)	Date ◆ Value Reviewed [Added]	Chronic Inhalation REL ($\mu g/m^3$)	Date ◆ Value Reviewed [Added]	Chronic Oral REL (mg/kg/d)	Date ◆ Value Reviewed [Added]	Inhalation Cancer Potency Factor $(mg/kg-d)^{-1}$	Date ◆ Value Reviewed [Added]	Oral Slope Factor $(mg/kg-d)^{-1}$	Date ◆ Value Reviewed [Added]	M♣ W A F
Nickelocene♣	*1271-28-9*	*6.0E+00*	*4/99*	*5.0E-02*	*2/00*	*5.0E-02*	*10/00*	*9.1E-01* TAC	*8/91*			*0.4937*
NICKEL OXIDE♣	1313-99-1	6.0E+00	4/99	1.0E-01	2/00	5.0E-02	10/00	9.1E-01 TAC	8/91			0.7859
Nickel refinery dust from the pyrometallurgical process	*1146*	*6.0E+00*	*4/99*	*5.0E-02*	*2/00*	*5.0E-02*	*10/00*	*9.1E-01* TAC	*8/91*			*1*
Nickel subsulfide♣	*12035-72-2*	*6.0E+00*	*4/99*	*5.0E-02*	*2/00*	*5.0E-02*	*10/00*	*9.1E-01* TAC	*8/91*			*0.2443*
NITRIC ACID	7697-37-2	8.6E+01	4/99									--
NITROGEN DIOXIDE	10102-44-0	4.7E+02	4/99[1/92]									--
2-NITROPROPANE	79-46-9											--
p-NITROSODIPHENYLAMINE	156-10-5							2.2E-02	4/99			1
OZONE	10028-15-6	1.8E+02	4/99[1/92]									--
PARTICULATE EMISSIONS FROM DIESEL-FUELED ENGINES TAC ■	9901			5.0E+00 TAC	8/98			1.1E+00 TAC	8/98			1
PENTACHLOROPHENOL ... (see Chlorophenols)												
PERCHLOROETHYLENE TAC (Tetrachloroethylene)	127-18-4	2.0E+04	4/99	3.5E+01 TAC	10/91			2.1E-02 TAC	10/91			1
PHENOL	108-95-2	5.8E+03	4/99	2.0E+02	4/00							--
PHOSGENE	75-44-5	4.0E+00	4/99									--
PHOSPHINE	7803-51-2			8.0E-01	9/02							--
PHOSPHORIC ACID	7664-38-2			7.0E+00	2/00							--
PHTHALIC ANHYDRIDE	85-44-9			2.0E+01	1/01							--
PCB (POLYCHLORINATED BIPHENYLS-unspeciated mixture) [lowest risk] ★	1336-36-3							7.0E-02	2/02	7.0E-02	2/02	1
PCB (POLYCHLORINATED BIPHENYLS-unspeciated mixture) [low risk] ★	1336-36-3							4.0E-01	2/02	4.0E-01	2/02	1
PCB (POLYCHLORINATED BIPHENYLS - unspeciated mixture) [high risk] ★	1336-36-3							2.0E+00	2/02	2.0E+00	2/02	1
PCB (POLYCHLORINATED BIPHENYLS (speciated)∇												
3,3',4,4'-TETRACHLOROBIPHENYL (77)	35298-13-3			4.0E-01	8/03	1.0E –04	8/03	1.3E +01	8/03	1.3E +01	8/03	
3,4,4',5-TETRACHLOROBIPHENYL (81)	70362-50-4			4.0E-01	8/03	1.0E –04	8/03	1.3E +01	8/03	1.3E +01	8/03	
2,3,3',4,4'- PENTACHLOROBIPHENYL (105)	32598-14-4			4.0E-01	8/03	1.0E –04	8/03	1.3E +01	8/03	1.3E +01	8/03	
2,3,4,4'5- PENTACHLOROBIPHENYL (114)	74472-37-0			8.0E-02	8/03	2.0E –05	8/03	6.5E +01	8/03	6.5E +01	8/03	
2,3'4,4',5- PENTACHLOROBIPHENYL (118)	31508-00-6			4.0E-01	8/03	1.0E –04	8/03	1.3E +01	8/03	1.3E +01	8/03	

APPENDIX L - TABLE 1
OEHHA/ARB APPROVED HEALTH VALUES FOR USE IN HOT SPOT FACILITY RISK ASSESSMENTS ◉

Substance ◉	Chemical▼ Abstract Service Number (CAS)	Noncancer Effects						Cancer Risk				
		Acute Inhalation REL ($\mu g/m^3$)	Date ◆ Value Reviewed [Added]	Chronic Inhalation REL ($\mu g/m^3$)	Date ◆ Value Reviewed [Added]	Chronic Oral REL (mg/kg/d)	Date ◆ Value Reviewed [Added]	Inhalation Cancer Potency Factor $(mg/kg-d)^{-1}$	Date ◆ Value Reviewed [Added]	Oral Slope Factor $(mg/kg-d)^{-1}$	Date ◆ Value Reviewed [Added]	M♣ W A F
2',3,4,4',5- PENTACHLOROBIPHENYL (123)	65510-44-3			4.0E-01	8/03	1.0E –04	8/03	1.3E +01	8/03	1.3E +01	8/03	
3,3',4,4',5- PENTACHLOROBIPHENYL (126)	57465-28-8			4.0E-04	8/03	1.0E –07	8/03	1.3E +04	8/03	1.3E +04	8/03	
2,3,3',4,4',5-HEXACHLOROBIPHENYL (156)	38380-08-4			8.0E-02	8/03	2.0E –05	8/03	6.5E +01	8/03	6.5E +01	8/03	
2,3,3',4,4',5'-HEXACHLOROBIPHENYL (157)	69782-90-7			8.0E-02	8/03	2.0E –05	8/03	6.5E +01	8/03	6.5E +01	8/03	
2,3',4,4',5,5'-HEXACHLOROBIPHENYL (167)	52663-72-6			4.0E-00	8/03	1.0E –03	8/03	1.3E +00	8/03	1.3E +00	8/03	
3,3',4,4'5,5' - HEXACHLOROBIPHENYL (169)	32774-16-6			4.0E-03	8/03	1.0E –06	8/03	1.3E +03	8/03	1.3E +03	8/03	
2,3,3'4,4',5,5' - HEPTACHLOROBIPHENYL (189)	39635-31-9			4.0E-01	8/03	1.0 E-04	8/03	1.3E +01	8/03	1.3E +01	8/03	
POLYCHLORINATED DIBENZO-*P*-DIOXINS (PCDD) (AS 2,3,7,8-PCDD EQUIVALENT)[TAC] ●	1085 1086											
2,3,7,8-TETRACHLORODIBENZO-*P*-DIOXIN[TAC]	1746-01-6			4.0E-05	2/00	1.0E-08	10/00	1.3E+05 TAC	8/86	1.3E+05 TAC	8/86	1
1,2,3,7,8-PENTACHLORODIBENZO-*P*-DIOXIN	40321-76-4			8.0E-05	2/00	2.0E-08	10/00	1.3E+05	4/99	1.3E+05	10/00	1
1,2,3,4,7,8-HEXACHLORODIBENZO-*P*-DIOXIN	39227-28-6			4.0E-04	2/00	1.0E-07	10/00	1.3E+04	4/99	1.3E+04	10/00	1
1,2,3,6,7,8-HEXACHLORODIBENZO-*P*-DIOXIN	57653-85-7			4.0E-04	2/00	1.0E-07	10/00	1.3E+04	4/99	1.3E+04	10/00	1
1,2,3,7,8,9-HEXACHLORODIBENZO-*P*-DIOXIN	19408-74-3			4.0E-04	2/00	1.0E-07	10/00	1.3E+04	4/99	1.3E+04	10/00	1
1,2,3,4,6,7,8-HEPTACHLORODIBENZO-*P*-DIOXIN	35822-46-9			4.0E-03	2/00	1.0E-06	10/00	1.3E+03	4/99	1.3E+03	10/00	1
1,2,3,4,6,7,8,9-OCTACHLORODIBENZO-*P*-DIOXIN	3268-87-9			4.0E-02	2/00	1.0E-05	10/00	1.3E+01	4/99	1.3E+01	10/00	1
POLYCHLORINATED DIBENZOFURANS (AS 2,3,7,8-PCDD EQUIVALENT) (PCDF) [TAC] ●	1080											
2,3,7,8-TETRACHLORODIBENZOFURAN	5120-73-19			4.0E-04	2/00	1.0E-07	10/00	1.3E+04	4/99	1.3E+04	10/00	1
1,2,3,7,8-PENTACHLORODIBENZOFURAN	57117-41-6			8.0E-04	2/00	2.0E-07	10/00	6.5E+03	4/99	6.5E+03	10/00	1
2,3,4,7,8-PENTACHLORODIBENZOFURAN	57117-31-4			8.0E-05	2/00	2.0E-08	10/00	6.5E+04	4/99	6.5E+04	10/00	1
1,2,3,4,7,8-HEXACHLORODIBENZOFURAN	70648-26-9			4.0E-04	2/00	1.0E-07	10/00	1.3E+04	4/99	1.3E+04	10/00	1

APPENDIX L - TABLE 1
OEHHA/ARB APPROVED HEALTH VALUES FOR USE IN HOT SPOT FACILITY RISK ASSESSMENTS ◉

Substance ◉	Chemical▼ Abstract Service Number (CAS)	Noncancer Effects						Cancer Risk				
		Acute Inhalation REL ($\mu g/m^3$)	Date ◆ Value Reviewed [Added]	Chronic Inhalation REL ($\mu g/m^3$)	Date ◆ Value Reviewed [Added]	Chronic Oral REL (mg/kg/d)	Date ◆ Value Reviewed [Added]	Inhalation Cancer Potency Factor $(mg/kg\text{-}d)^{-1}$	Date ◆ Value Reviewed [Added]	Oral Slope Factor $(mg/kg\text{-}d)^{-1}$	Date ◆ Value Reviewed [Added]	M♣ W A F
1,2,3,6,7,8-HEXACHLORODIBENZOFURAN	57117-44-9			4.0E-04	2/00	1.0E-07	10/00	1.3E+04	4/99	1.3E+04	10/00	1
1,2,3,7,8,9-HEXACHLORODIBENZOFURAN	72918-21-9			4.0E-04	2/00	1.0E-07	10/00	1.3E+04	4/99	1.3E+04	10/00	1
2,3,4,6,7,8-HEXACHLORODIBENZOFURAN	60851-34-5			4.0E-04	2/00	1.0E-07	10/00	1.3E+04	4/99	1.3E+04	10/00	1
1,2,3,4,6,7,8-HEPTACHLORODIBENZOFURAN	67562-39-4			4.0E-03	2/00	1.0E-06	10/00	1.3E+03	4/99	1.3E+03	10/00	1
1,2,3,4,7,8,9-HEPTACHLORODIBENZOFURAN	55673-89-7			4.0E-03	2/00	1.0E-06	10/00	1.3E+03	4/99	1.3E+03	10/00	1
1,2,3,4,6,7,8,9-OCTACHLORODIBENZOFURAN	39001-02-0			4.0E-02	2/00	1.0E-05	10/00	1.3E+01	4/99	1.3E+01	10/00	1
POLYCYCLIC AROMATIC HYDROCARBON (PAH)	1150 1151											
BENZ(A)ANTHRACENE❖	56-55-3							3.9E-01	4/99 [4/94]	1.2E+00	10/00 [4/94]	1
BENZO(A)PYRENE❖	50-32-8							3.9E+00	4/99 [4/94]	1.2E+01	10/00 [4/94]	1
BENZO(B)FLUORANTHENE❖	205-99-2							3.9E-01	4/99 [4/94]	1.2E+00	10/00 [4/94]	1
BENZO(J)FLUORANTHENE❖	205-82-3							3.9E-01	4/99 [4/94]	1.2E+00	10/00 [4/94]	1
BENZO(K)FLUORANTHENE❖	207-08-9							3.9E-01	4/99 [4/94]	1.2E+00	10/00 [4/94]	1
CHRYSENE❖	218-01-9							3.9E-02	4/99 [4/94]	1.2E-01	10/00 [4/94]	1
DIBENZ(A,H)ACRIDINE❖	226-36-8							3.9E-01	4/99 [4/94]	1.2E+00	10/00 [4/94]	1
DIBENZ(A,H)ANTHRACENE❖	53-70-3							4.1E+00	4/99 [4/94]	4.1E+00	10/00 [4/94]	1
DIBENZ(A,J)ACRIDINE❖	224-42-0							3.9E-01	4/99 [4/94]	1.2E+00	10/00 [4/94]	1
DIBENZO(A,E)PYRENE❖	192-65-4							3.9E+00	4/99 [4/94]	1.2E+01	10/00 [4/94]	1
DIBENZO(A,H)PYRENE❖	189-64-0							3.9E+01	4/99 [4/94]	1.2E+02	10/00 [4/94]	1

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OEHHA/ARB APPROVED HEALTH VALUES FOR USE IN HOT SPOT FACILITY RISK ASSESSMENTS ◉

Substance ◉	Chemical▼ Abstract Service Number (CAS)	Noncancer Effects						Cancer Risk				
		Acute Inhalation REL ($\mu g/m^3$)	Date ◆ Value Reviewed [Added]	Chronic Inhalation REL ($\mu g/m^3$)	Date ◆ Value Reviewed [Added]	Chronic Oral REL (mg/kg/d)	Date ◆ Value Reviewed [Added]	Inhalation Cancer Potency Factor $(mg/kg\text{-}d)^{-1}$	Date ◆ Value Reviewed [Added]	Oral Slope Factor $(mg/kg\text{-}d)^{-1}$	Date ◆ Value Reviewed [Added]	M♣ W A F
DIBENZO(A,I)PYRENE ❖	189-55-9							3.9E+01	4/99 [4/94]	1.2E+02	10/00 [4/94]	1
DIBENZO(A,L)PYRENE ❖	191-30-0							3.9E+01	4/99 [4/94]	1.2E+02	10/00 [4/94]	1
7H-DIBENZO(C,G)CARBAZOLE ❖	194-59-2							3.9E+00	4/99 [4/94]	1.2E+01	10/00 [4/94]	1
7,12-DIMETHYLBENZ(A)ANTHRACENE ❖	57-97-6							2.5E+02	4/99 [4/94]	2.5E+02	10/00 [4/94]	1
1,6-DINITROPYRENE ❖	42397-64-8							3.9E+01	4/99 [4/94]	1.2E+02	10/00 [4/94]	1
1,8-DINITROPYRENE ❖	42397-65-9							3.9E+00	4/99 [4/94]	1.2E+01	10/00 [4/94]	1
INDENO(1,2,3-C,D)PYRENE ❖	193-39-5							3.9E-01	4/99 [4/94]	1.2E+00	10/00 [4/94]	1
3-METHYLCHOLANTHRENE ❖	56-49-5							2.2E+01	4/99 [4/94]	2.2E+01	10/00 [4/94]	1
5-METHYLCHRYSENE ❖	3697-24-3							3.9E+00	4/99 [4/94]	1.2E+01	10/00 [4/94]	1
NAPHTHALENE	91-20-3			9.0E+00	4/00							--
5-NITROACENAPHTHENE ❖	602-87-9							1.3E-01	4/99 [4/94]	1.3E-01	10/00 [4/94]	1
6-NITROCHRYSENE ❖	7496-02-8							3.9E+01	4/99 [4/94]	1.2E+02	10/00 [4/94]	1
2-NITROFLUORENE ❖	607-57-8							3.9E-02	4/99 [4/94]	1.2E-01	10/00 [4/94]	1
1-NITROPYRENE ❖	5522-43-0							3.9E-01	4/99 [4/94]	1.2E+00	10/00 [4/94]	1
4-NITROPYRENE ❖	57835-92-4							3.9E-01	4/99 [4/94]	1.2E+00	10/00 [4/94]	1
POTASSIUM BROMATE.... ... (see Bromine & Compounds)												
1,3-PROPANE SULTONE	1120-71-4							2.4E+00	4/99			1
PROPYLENE (PROPENE)	115-07-1			3.0E+03	4/00							--
PROPYLENE GLYCOL MONOMETHYL ETHER	107-98-2			7.0E+03	2/00							--
PROPYLENE OXIDE	75-56-9	3.1E+03	4/99	3.0E+01	2/00			1.3E-02	4/99 [7/90]			1
SELENIUM AND COMPOUNDS	7782-49-2 [1170]			2.0E+01	12/01							--
HYDROGEN SELENIDE	7783-07-5	5.0E+00	4/99									--
Selenium sulfide	*7446-34-6*			*2.0E+01*	*12/01*							--
SODIUM HYDROXIDE	1310-73-2	8.0E+00	4/99	4.8E+00	7/90							--

APPENDIX L - TABLE 1
OEHHA/ARB APPROVED HEALTH VALUES FOR USE IN HOT SPOT FACILITY RISK ASSESSMENTS

Substance	Chemical Abstract Service Number (CAS)	Noncancer Effects						Cancer Risk				
		Acute Inhalation REL ($\mu g/m^3$)	Date Value Reviewed [Added]	Chronic Inhalation REL ($\mu g/m^3$)	Date Value Reviewed [Added]	Chronic Oral REL (mg/kg/d)	Date Value Reviewed [Added]	Inhalation Cancer Potency Factor $(mg/kg\text{-}d)^{-1}$	Date Value Reviewed [Added]	Oral Slope Factor $(mg/kg\text{-}d)^{-1}$	Date Value Reviewed [Added]	MWAF
STYRENE	100-42-5	2.1E+04	4/99	9.0E+02	4/00							--
SULFATES	9960	1.2E+02	4/99	2.5E+01	1/92							--
SULFUR DIOXIDE	7446-09-5	6.6E+02	4/99[1/92]	6.6E+02	1/92							--
SULFURIC ACID AND OLEUM	7664-93-9	1.2E+02	4/99	*1.0E+00*	*12/01*							--
SULFURIC ACID	*7664-93-9*	*1.2E+02*	*4/99*	1.0E+00	12/01							--
SULFUR TRIOXIDE	*7446-71-9*	*1.2E+02*	*4/99*									--
OLEUM	*8014-95-7*	*1.2E+02*	*4/99*	*1.0E+00*	*12/01*							--
1,1,2,2-TETRACHLOROETHANE	79-34-5							2.0E-01	4/99			1
TETRACHLOROPHENOLS ... (see Chlorophenols)												
2,4,5-TRICHLOROPHENOL ... (see Chlorophenols)												
2,4,6-TRICHLOROPHENOL ... (see Chlorophenols)												
THIOACETAMIDE	62-55-5							6.1E+00	4/99			1
TOLUENE	108-88-3	3.7E+04	4/99	3.0E+02	4/00							--
Toluene diisocyantates	*26471-62-5 1204*			*7.0E-02*	*1/01*			*3.9E-02*	*4/99*			*1*
TOLUENE-2,4-DIISOCYANATE	584-84-9			7.0E-02	1/01			3.9E-02	4/99			1
TOLUENE-2,6-DIISOCYANATE	91-08-7			7.0E-02	1/01			3.9E-02	4/99			1
1,1,2-TRICHLOROETHANE (Vinyl trichloride)	79-00-5							5.7E-02	4/99			1
TRICHLOROETHYLENE[TAC]	79-01-6			6.0E+02	4/00			7.0E-03 TAC	10/90			1
TRIETHYLAMINE	121-44-8	2.8E+03	4/99	2.0^{E}+02	9/02							--
URETHANE (Ethyl carbamate)	51-79-6							1.0E+00	4/99 [7/90]			1
Vanadium Compounds	*N/A*											
Vanadium (fume or dust)	*7440-62-2*	*3.0E+01*	*4/99*									--
VANADIUM PENTOXIDE	1314-62-1	3.0E+01	4/99									--
VINYL ACETATE	108-05-4			2.0E+02	12/01							--
VINYL CHLORIDE[TAC] (Chloroethylene)	75-01-4	1.8E+05	4/99					2.7E-01 TAC	12/90			1
VINYLIDENE CHLORIDE (1,1-Dichloroethylene)	75-35-4			7.0E+01	1/01							--

APPENDIX L - TABLE 1
OEHHA/ARB APPROVED HEALTH VALUES FOR USE IN HOT SPOT FACILITY RISK ASSESSMENTS ⊛

Substance ⊛	Chemical▼ Abstract Service Number (CAS)	Noncancer Effects						Cancer Risk				
		Acute Inhalation REL ($\mu g/m^3$)	Date ◆ Value Reviewed [Added]	Chronic Inhalation REL ($\mu g/m^3$)	Date ◆ Value Reviewed [Added]	Chronic Oral REL (mg/kg/d)	Date ◆ Value Reviewed [Added]	Inhalation Cancer Potency Factor $(mg/kg\text{-}d)^{-1}$	Date ◆ Value Reviewed [Added]	Oral Slope Factor $(mg/kg\text{-}d)^{-1}$	Date ◆ Value Reviewed [Added]	M♣ W A F
XYLENES (mixed isomers)	1330-20-7 1210	2.2E+04	4/99	7.0E+02	4/00							--
m-XYLENE	108-38-3	2.2E+04	4/99	7.0E+02	4/00							--
o-XYLENE	95-47-6	2.2E+04	4/99	7.0E+02	4/00							--
p-XYLENE	106-42-3	2.2E+04	4/99	7.0E+02	4/00							--

APPENDIX L - TABLE 1
OEHHA/ARB APPROVED HEALTH VALUES FOR USE IN HOT SPOT FACILITY RISK ASSESSMENTS ❁

Purpose:	The purpose of this reference table is to provide a quick list of all health values that have been approved by the Office of Environmental Health Hazard Assessment (OEHHA) and the Air Resources Board (ARB) for use in facility health risk assessments conducted for the AB 2588 Air Toxics Hot Spots Program. The OEHHA has developed and adopted new risk assessment guidelines that update and replace the California Air Pollution Control Officers Association's (CAPCOA) *Air Toxics "Hot Spots" Program Revised 1992 Risk Assessment Guidelines, October 1993.* The OEHHA has adopted five technical support documents for these guidelines. This table lists the OEHHA adopted inhalation and oral cancer slope factors, noncancer acute Reference Exposure Levels (RELs), and inhalation and oral noncancer chronic RELs. In addition, it lists the substances in Appendix A-I *(Substances For Which Emissions Must Be Quantified)* and Appendix F (*Criteria For Inputs For Risk Assessment Using Screening Air Dispersion Modeling*) of the ARB's *Air Toxics "Hot Spots" Emission Inventory Criteria and Guidelines (EICG)*. OEHHA is still in the process of adopting new noncancer chronic RELs. Therefore, new health values will periodically be added to, or deleted from, this table. Users of this table are advised to monitor the OEHHA website (*www.oehha.ca.gov*) for any updates to the health values.
❁	Substances written in *italics* do not have explicit OEHHA approved health values, but are included in this table to clarify applicability of OEHHA adopted heath effects values to individual or grouped substances listed in the *Air Toxics "Hot Spots" Emission Inventory Criteria and Guidelines*, Appendix A-I list of *"Substances For Which Emissions Must Be Quantified".*
▼	Chemical Abstract Service Number (CAS): For chemical groupings and mixtures where a CAS number is not applicable, the 4-digit code used in the *Air Toxics "Hot Spots" Emission Inventory Criteria and Guidelines (EICG) Report* is listed. The 4-digit codes enclosed in brackets [ ] are codes that have been phased out, but may still appear on previously reported Hot Spots emissions. For information on the origin and use of the 4-digit code, see the EICG report.
◆	Date Value Reviewed [Added]: These columns list the date that the health value was last reviewed by OEHHA and the Scientific Review Panel, and/or approved for use in the AB 2588 Air Toxics Hot Spots Program. If the health value is unchanged since it was first approved for use in the Hot Spots Program, then the date that the value was first approved for use by CAPCOA is listed within the brackets [ ]. • April 1999 is listed for the cancer potency values and noncancer acute RELs, which have been adopted by the OEHHA as part of the AB 2588 "Hot Spot" Risk Assessment Guidelines. • February 2000, April 2000, January 2001, and December 2001 are listed for the first set of 22, the second set of 16, the third set of 22, and the fourth set of 12 noncancer chronic RELs, respectively. • October 2000 is listed for the oral chronic RELs and oral cancer slope factors. 1996 is listed for the U.S. EPA Reference Concentrations. Dates of 1990-1992 and 1996 are listed for CAPCOA chronic RELs, which may eventually be dropped or replaced. • For the substances identified as Toxic Air Contaminants, the Air Resources Board hearing date is listed. The dates for acetaldehyde, benzo[a]pyrene, and methyl tertiary-butyl ether represent the dates the values were approved by the Scientific Review Panel.
♣	Molecular Weight Adjustment Factor: Molecular weight adjustment factors (MWAF) are only to be used when a toxic metal has a cancer potency factor. For most of the Hot Spots toxic metals, the OEHHA cancer potency factor applies to the weight of the toxic metal atom contained in the overall compound. Some of the Hot Spots compounds contain various elements along with the toxic metal atom (e.g., "Nickel hydroxide", CAS number 12054-48-7, has a formula of H_2NiO_2). Therefore, an adjustment to the reported pounds of the overall compound is needed before applying the OEHHA cancer potency factor for "Nickel and compounds" to such a compound. This ensures that the cancer potency factor is applied only to the fraction of the overall weight of the emissions that are associated with health effects of the metal. In other cases, the Hot Spots metals are already reported as the metal atom equivalent (e.g., CAS 7440-02-0, "Nickel"), and these cases do not use any further molecular weight adjustment. (Refer to Note [7] in Appendix A, List of Substances in the EICG Report for further information on how the emissions of various Hot Spots metal compounds are reported.) The appropriate molecular weight adjustment factors (MWAF) to be used along with the OEHHA cancer potency factors for Hot Spots metals can be found in the MWAF column of this table. A double dash (--) was entered into the column if the substance does not currently have a cancer potency factor. So, for example, assume 100 pounds of "Nickel hydroxide" emissions are reported under CAS number 12054-48-7. To get the Nickel atom equivalent of these emissions, multiply by the listed MWAF (0.6332) for Nickel hydroxide: • 100 pounds x 0.6332 = 63.32 pounds of Nickel atom equivalent *This step should be completed prior to applying the OEHHA cancer potency factor for "Nickel and compounds" in a calculation for a prioritization score or risk assessment calculation.* (For more information see Chapter 4 and Appendix H of OEHHA's *The Air Toxics Hot Spots Program Risk Assessment Guidelines; Part V; Technical Support Document; Guidance Manual for Preparation of Health Risk Assessments.*) Note: The value listed in the MWAF column for Asbestos is not a molecular weight adjustment. This is a conversion factor for adjusting mass to fibers or structures. See Appendix C of OEHHA's *The Air Toxics Hot Spots Program Risk Assessment Guidelines; Part V; Technical Support Document; Guidance Manual for Preparation of Health Risk Assessments* for more information on Asbestos, or see the EICG report for reporting guidance. Also see the Asbestos footnote (designated by the symbol ⌑)
N/A	Not Applicable
Ñ	Values calculated using WHO TEF procedure in OEHHA, 2003
TAC	Toxic Air Contaminant: The Air Resources Board has identified this substance as a Toxic Air Contaminant.

APPENDIX L - TABLE 1
OEHHA/ARB APPROVED HEALTH VALUES FOR USE IN HOT SPOT FACILITY RISK ASSESSMENTS ❁

AveP	The averaging period of noncancer acute RELs is generally a one-hour exposure. However, some are based on several hour exposure for reproductive/developmental endpoints (see section 1.6 of OEHHA's technical support document for *The Determination of Acute Reference Exposure Levels for Airborne Toxicants, March 1999*). Typically the RELs for the following substances are compared to modeled emission concentrations of the same duration rather than maximum one-hour concentrations (e.g., a 4-hour REL should be compared to the maximum 4-hour average concentration from the air dispersion model). 4-Hour: Arsenic and Inorganic Arsenic Compounds 6-Hour: Benzene, Carbon disulfide, Ethylene glycol monoethyl ether, Ethylene glycol monoethyl ether acetate, Ethylene glycol monomethyl ether 7-Hour: Carbon tetrachloride, Chloroform
¤	Asbestos: The units for the Inhalation Cancer Potency factor for asbestos are $(100 \text{ PCM fibers/m}^3)^{-1}$. A conversion factor of 100 fibers/0.003 µg can be multiplied by a receptor concentration of asbestos expressed in $\mu g/m^3$. Unless other information necessary to estimate the concentration (fibers/m^3) of asbestos at receptors of interest is available. A unit risk factor of $2.7E\ 10^{-6}$ $(\mu g/m^3)^{-1}$ and an inhalation cancer potency factor of $2.2E\ 10^{+2}$ $(\text{mg/kg BW} * \text{day})^{-1}$ are available. For more information on asbestos quantity conversion factors, see Appendix C of OEHHA's *The Air Toxics Hot Spots Program Risk Assessment Guidelines; Part II; Technical Support Document for Describing Available Cancer Potency Factors*, and Appendix C of OEHHA's *The Air Toxics Hot Spots Program Risk Assessment Guidelines; Part V; Technical Support Document; Guidance Manual for Preparation of Health Risk Assessments*.
✳	Inorganic Lead: Inorganic Lead was identified by the Air Resources Board as a Toxic Air Contaminant in April 1997. Since information on noncancer health effects show no identified threshold, no Reference Exposure Level has been developed. The document, *Risk Management Guidelines for New, Modified, and Existing Sources of Lead, March 2001*, has been developed by ARB and OEHHA staff for assessing noncancer health impacts from sources of lead. See Appendix F of OEHHA's *The Air Toxics Hot Spots Program Risk Assessment Guidelines; Part V; Technical Support Document; Guidance Manual for Preparation of Health Risk Assessments* for an overview of how to evaluate noncancer impacts from exposure to lead using these risk management guidelines.
❖	Polycyclic Aromatic Hydrocarbons (PAHs): These substances are PAH or PAH-derivatives that have OEHHA-developed Potency Equivalency Factors (PEFs) which were approved by the Scientific Review Panel in April 1994 (see ARB document entitled *Benzo [a]pyrene as a Toxic Air Contaminant*). PAH inhalation slope factors listed here have been adjusted by the PEFs. See Appendix G of OEHHA's *The Air Toxics Hot Spots Program Risk Assessment Guidelines; Part V; Technical Support Document; Guidance Manual for Preparation of Health Risk Assessments* for more information.
★	Polychlorinated Biphenyls: (unspeciated mixtures) Lowest Risk: For use in cases where congeners with more than four chlorines comprise less than one-half percent of total polychlorinated biphenyls. High Risk: For use in cases where congeners with more than four chlorines do not comprise less than one-half percent of total polychlorinated biphenyls. The Low Risk: This number would not ordinarly be used in the Hot Spots program.
•	Polychlorinated Dibenzo-*p*-dioxins and Polychlorinated Dibenzofurans (also referred to as chlorinated dioxins and dibenzofurans): The OEHHA has adopted the World Health Organization 1997 (WHO_{97}) Toxicity Equivalency Factor) scheme for evaluating the cancer and noncancer risk due to exposure to samples containing speciated mixtures of polychlorinated dibenzo-*p*-dioxins (PCDD) and polychlorinated dibenzofurans (PCDF). See Appendix A of OEHHA's *Technical Support Document For Describing Available Cancer Potency Factors* for more information about the scheme. See Appendix E of OEHHA's *The Air Toxics Hot Spots Program Risk Assessment Guidelines; Part V; Technical Support Document; Guidance Manual for Preparation of Health Risk Assessments* for the methodology for calculating 2,3,7,8-equivalents for PCDD and PCDFs.
■	Particulate Emissions from Diesel-Fueled Engines: The inhalation cancer potency factor and chronic REL were derived from whole diesel exhaust and should be used only for impacts from the inhalation pathway. The inhalation impacts from speciated emissions from diesel-fueled engines are already accounted for in the inhalation cancer potency factor and REL. However, at the discretion of the risk assessor, speciated emissions from diesel-fueled engines may be used to estimate acute noncancer health impacts or the contribution to cancer risk or chronic noncancer health impacts for the non-inhalation exposure pathway. See Appendix D of OEHHA's *The Air Toxics Hot Spots Program Risk Assessment Guidelines; Part V; Technical Support Document; Guidance Manual for Preparation of Health Risk Assessments* for more information.

Table last updated: August, 2003

APPENDIX L - TABLE 2 OEHHA/ARB ACUTE REFERENCE EXPOSURE LEVELS AND TARGET ORGANS ❁

Substance ❁	Chemical▼ Abstract Service Number (CAS)	Acute REL ($\mu g/m^3$)	Date ◆ Value Reviewed	Target Organs									
				Alimentary Tract	Cardiovascular	Developmental	Eye	Hematologic	Immune	Nervous	Reproductive	Respiratory	Skin
ACROLEIN	107-02-8	1.9E-01	4/99				X					X	
ACRYLIC ACID	79-10-7	6.0E+03	4/99				X					X	
AMMONIA	7664-41-7	3.2E+03	4/99				X					X	
ARSENIC AND COMPOUNDS (INORGANIC) TAC	7440-38-2 1016 [1015]	1.9E-01 AveP	4/99			X					X		
ARSINE	7784-42-1	1.6E+02	4/99					X					
BENZENE TAC	71-43-2	1.3E+03 AveP	4/99			X		X	X		X		
BENZYL CHLORIDE	100-44-7	2.4E+02	4/99				X					X	
CARBON DISULFIDE	75-15-0	6.2E+03 AveP	4/99			X				X	X		
CARBON MONOXIDE	630-08-0	2.3E+04	4/99		X								
CARBON TETRACHLORIDE TAC (Tetrachloromethane)	56-23-5	1.9E+03 AveP	4/99	X		X				X	X		
CHLORINE	7782-50-5	2.1E+02	4/99				X					X	
CHLOROFORM TAC	67-66-3	1.5E+02 AveP	4/99			X				X	X		
CHLOROPICRIN	76-06-2	2.9E+01	4/99				X					X	
COPPER AND COMPOUNDS	7440-50-8 [1067]	1.0E+02	4/99									X	
Cyanide Compounds (inorganic)	*57-12-5 1073*	*3.4E+02*	*4/99*							✓			
HYDROGEN CYANIDE (Hydrocyanic acid)	74-90-8	3.4E+02	4/99							X			
1,4-DIOXANE ✣ (1,4-Diethylene dioxide)	123-91-1	3.0E+03	4/99				X					X	
EPICHLOROHYDRIN (1-Chloro-2,3-epoxypropane)	106-89-8	1.3E+03	4/99				X					X	
Fluorides and Compounds	*1101*	*2.4E+02*	*4/99*				✓					✓	
HYDROGEN FLUORIDE (Hydrofluoric acid)	7664-39-3	2.4E+02	4/99				X					X	
FORMALDEHYDE TAC	50-00-0	9.4E+01	4/99				X		X			X	
GLYCOL ETHERS	1115												
ETHYLENE GLYCOL BUTYL ETHER – EGBE	111-76-2	1.4E+04	4/99				X					X	
ETHYLENE GLYCOL ETHYL ETHER – EGEE	110-80-5	3.7E+02 AveP	4/99 [1/92]			X					X		
ETHYLENE GLYCOL ETHYL ETHER ACETATE - EGEEA	111-15-9	1.4E+02 AveP	4/99			X				X	X		
ETHYLENE GLYCOL METHYL ETHER – EGME	109-86-4	9.3E+01 AveP	4/99			X					X		

APPENDIX L - TABLE 2 OEHHA/ARB ACUTE REFERENCE EXPOSURE LEVELS AND TARGET ORGANS ◉

Substance ◉	Chemical▼ Abstract Service Number (CAS)	Acute REL ($\mu g/m^3$)	Date ◆ Value Reviewed	Target Organs									
				Alimentary Tract	Cardiovascular	Developmental	Eye	Hematologic	Immune	Nervous	Reproductive	Respiratory	Skin
HYDROCHLORIC ACID (Hydrogen chloride)	7647-01-0	2.1E+03	4/99				X					X	
HYDROGEN CYANIDE (Hydrocyanic acid) ... (see Cyanide Compounds)													
HYDROGEN FLUORIDE (Hydrofluoric acid) ... (see Fluorides & Compounds)													
HYDROGEN SELENIDE ... (see Selenium & Compounds)													
HYDROGEN SULFIDE	7783-06-4	4.2E+01	4/99 [7/90]							X			
ISOPROPYL ALCOHOL (Isopropanol)	67-63-0	3.2E+03	4/99				X					X	
MERCURY AND COMPOUNDS (INORGANIC)	7439-97-6 [1133]	1.8E+00	4/99			X					X		
Mercuric chloride	*7487-94-7*	*1.8E+00*	*4/99*			✓					✓		
METHANOL	67-56-1	2.8E+04	4/99							X			
METHYL BROMIDE (Bromomethane)	74-83-9	3.9E+03	4/99			X				X	X	X	
METHYL CHLOROFORM (1,1,1-Trichloroethane)	71-55-6	6.8E+04	4/99							X			
METHYL ETHYL KETONE (2-Butanone)	78-93-3	1.3E+04	4/99				X					X	
METHYLENE CHLORIDE[TAC] (Dichloromethane)	75-09-2	1.4E+04	4/99							X			
NICKEL AND COMPOUNDS[TAC]	7440-02-0 [1145]	6.0E+00	4/99						X			X	
Nickel acetate,	*373-02-4*	*6.0E+00*	*4/99*						✓			✓	
Nickel carbonate	*3333-39-3*	*6.0E+00*	*4/99*						✓			✓	
Nickel carbonyl	*13463-39-3*	*6.0E+00*	*4/99*						✓			✓	
Nickel hydroxide	*12054-48-7*	*6.0E+00*	*4/99*						✓			✓	
Nickelocene	*1271-28-9*	*6.0E+00*	*4/99*						✓			✓	
NICKEL OXIDE	1313-99-1	6.0E+00	4/99						X			X	
Nickel refinery dust from the pyrometallurgical process	*1146*	*6.0E+00*	*4/99*						✓			✓	
Nickel subsulfide	*12035-72-2*	*6.0E+00*	*4/99*						✓			✓	
NITRIC ACID	7697-37-2	8.6E+01	4/99									X	
NITROGEN DIOXIDE	10102-44-0	4.7E+02	4/99 [1/92]									X	
OZONE	10028-15-6	1.8E+02	4/99 [1/92]				X					X	
PERCHLOROETHYLENE[TAC] (Tetrachloroethylene)	127-18-4	2.0E+04	4/99				X			X		X	
PHENOL	108-95-2	5.8E+03	4/99				X					X	

APPENDIX L - TABLE 2 OEHHA/ARB ACUTE REFERENCE EXPOSURE LEVELS AND TARGET ORGANS ❁

Substance ❁	Chemical▼ Abstract Service Number (CAS)	Acute REL ($\mu g/m^3$)	Date ◆ Value Reviewed	Target Organs									
				Alimentary Tract	Cardiovascular	Developmental	Eye	Hematologic	Immune	Nervous	Reproductive	Respiratory	Skin
PHOSGENE	75-44-5	4.0E+00	4/99									X	
PROPYLENE OXIDE	75-56-9	3.1E+03	4/99			X	X				X	X	
Selenium and Compounds	*7782-49-2 [1170]*												
HYDROGEN SELENIDE	7783-07-5	5.0E+00	4/99				X					X	
SODIUM HYDROXIDE	1310-73-2	8.0E+00	4/99				X					X	X
STYRENE	100-42-5	2.1E+04	4/99				X					X	
SULFATES	9960	1.2E+02	4/99									X	
SULFUR DIOXIDE	7446-09-5	6.6E+02	4/99 [1/92]									X	
SULFURIC ACID AND OLEUM	7664-93-9	1.2E+02	4/99									X	
SULFURIC ACID	*7664-93-9*	*1.2E+02*	*4/99*									✓	
SULFUR TRIOXIDE	*7446-71-9*	*1.2E+02*	*4/99*									✓	
OLEUM	*8014-95-7*	*1.2E+02*	*4/99*									✓	
TOLUENE	108-88-3	3.7E+04	4/99			X	X			X	X	X	
TRIETHYLAMINE	121-44-8	2.8E+03	4/99				X			X			
Vanadium Compounds	*N/A*												
Vanadium (fume or dust)	*7440-62-2*	*3.0E+01*	*4/99*				✓					✓	
VANADIUM PENTOXIDE	1314-62-1	3.0E+01	4/99				X					X	
VINYL CHLORIDE[TAC] (Chloroethylene)	75-01-4	1.8E+05	4/99				X			X		X	
XYLENES (mixed isomers)	1330-20-7 1210	2.2E+04	4/99				X					X	
m-Xylene	108-38-3	2.2E+04	4/99				X					X	
o-Xylene	95-47-6	2.2E+04	4/99				X					X	
p-Xylene	106-42-3	2.2E+04	4/99				X					X	

APPENDIX L - TABLE 2 OEHHA/ARB ACUTE REFERENCE EXPOSURE LEVELS AND TARGET ORGANS ❁

Purpose:	The purpose of this reference table is to provide a quick list of all health values that have been approved by the Office of Environmental Health Hazard Assessment (OEHHA) and the Air Resources Board (ARB) for use in facility health risk assessments conducted for the AB 2588 Air Toxics Hot Spots Program. The OEHHA has developed and adopted new risk assessment guidelines that update and replace the California Air Pollution Control Officers Association's (CAPCOA) *Air Toxics "Hot Spots" Program Revised 1992 Risk Assessment Guidelines, October 1993*. The OEHHA has adopted five technical support documents for these guidelines. This table lists the OEHHA adopted noncancer acute Reference Exposure Levels (RELs). In addition, it lists the substances in Appendix A-I *(Substances For Which Emissions Must Be Quantified*) and Appendix F (*Criteria For Inputs For Risk Assessment Using Screening Air Dispersion Modeling*) of the ARB's *Air Toxics "Hot Spots" Emission Inventory Criteria and Guidelines (EICG)*. Users of this table are advised to monitor the OEHHA website (*www.oehha.ca.gov*) for any updates to the health values.
❁	Substances written in *italics* and with a ✓ do not have explicit OEHHA approved health values, but are included in this table to clarify applicability of OEHHA adopted health effects values to individual or grouped substances listed in the *Air Toxics "Hot Spots" Emission Inventory Criteria and Guidelines*, Appendix A-I list of *"Substances For Which Emissions Must Be Quantified"*.
▼	Chemical Abstract Service Number (CAS): For chemical groupings and mixtures where a CAS number is not applicable, the 4-digit code used in the *Air Toxics "Hot Spots" Emission Inventory Criteria and Guidelines (EICG) Report* is listed. The 4-digit codes enclosed in brackets [ ] are codes that have been phased out, but may still appear on previously reported Hot Spots emissions. For information on the origin and use of the 4-digit code, see the EICG report.
◆	Date Value Reviewed [Added]: This column lists the date that the health value was last reviewed by OEHHA and the Scientific Review Panel, and/or approved for use in the AB 2588 Air Toxics "Hot Spots" Program. If the health value is unchanged since it was first approved for use in the "Hot Spots" Program, then the date that the value was first approved for use by CAPCOA is listed within the brackets [ ]. • April 1999 is listed for the noncancer acute RELs which have been adopted by the OEHHA as part of the AB 2588 "Hot Spot" Risk Assessment Guidelines.
TAC	Toxic Air Contaminant: The Air Resources Board has identified this substance as a Toxic Air Contaminant.
AveP	The averaging period of noncancer acute RELs is generally a one-hour exposure. However, some are based on several hour exposure for reproductive/developmental endpoints (see section 1.6 of OEHHA's technical support document for *The Determination of Acute Reference Exposure Levels for Airborne Toxicants, March 1999).* Typically the RELs for the following substances are compared to modeled emission concentrations of the same duration rather than maximum one-hour concentrations (e.g., a 4-hour REL should be compared to the maximum 4-hour average concentration from the air dispersion model). 4-Hour: Arsenic and Inorganic Arsenic Compounds 6-Hour: Benzene, Carbon disulfide, Ethylene glycol ethyl ether, Ethylene glycol ethyl ether acetate, Ethylene glycol methyl ether 7-Hour: Carbon tetrachloride, Chloroform

Table last updated: August 2003

APPENDIX L - TABLE 3 OEHHA/ARB CHRONIC INHALATION AND ORAL REFERENCE EXPOSURE LEVELS AND TARGET ORGANS ◉

Substance ◉	Chemical▼ Abstract Service Number (CAS)	Chronic Inhalation REL (µg/m^3)	Chronic Oral REL	Date ◆ Value Reviewed [Added]	Target Organs												
					Alimentary	Bone	Cardiovascular	Developmental	Endocrine	Eye	Hematologic	Immune	Kidney	Nervous	Reproductive	Respiratory	Skin
ACETALDEHYDE	75-07-0	9.0E+00		5/93												X	
ACROLEIN	107-02-8	6.0E-02		1/01						X						X	
ACRYLONITRILE	107-13-1	5.0E+00		12/01												X	
AMMONIA	7664-41-7	2.0E+02		2/00												X	
ARSENIC AND COMPOUNDS (INORGANIC) TAC	7440-38-2 1016 [1015]	3.0E-02		1/01			X	X						X			
			3.0^E-04	10/00			X										X
BENZENE TAC	71-43-2	6.0E+01		2/00				X			X			X			
BERYLLIUM AND COMPOUNDS	7440-41-7 [1021]	7.0E-03		12/01								X				X	
			2.0^E-03	12/01	X												
1,3-BUTADIENE TAC	106-99-0	2.0E+01		1/01											X		
CADMIUM AND COMPOUNDS T7AC	7440-43-9 [1045]	2.0E-02		1/01									X			X	
			5.0^E-04	10/00									X				
CARBON DISULFIDE	75-15-0	8.0E+02		11/01										X	X		
CARBON TETRACHLORIDE TAC (Tetrachloromethane)	56-23-5	4.0E+01		1/01	X			X						X			
CHLORINE	7782-50-5	2.0E-01		2/00												X	
CHLORINE DIOXIDE	10049-04-4	6.0E-01		1/01												X	
CHLOROBENZENE	108-90-7	1.0E+03		1/01	X								X		X		
CHLOROFORM TAC	67-66-3	3.0E+02		4/00	X			X					X				
CHLOROPICRIN	76-06-2	4.0E-01		12/01												X	
CHROMIUM 6+ TAC	18540-29-9	2.0E-01		1/01												X	
			2.0E-02	10/00							X						
Barium chromate	*10294-40-3*	*2.0E-01*		*1/01*												✓	
			2.0E-02	*10/00*							✓						
Calcium chromate	*13765-19-0*	*2.0E-01*		*1/01*												✓	
			2.0E-02	*10/00*							✓						
Lead chromate	*7758-97-6*	*2.0E-01*		*1/01*												✓	
			2.0E-02	*10/00*							✓						

APPENDIX L - TABLE 3 OEHHA/ARB CHRONIC INHALATION AND ORAL REFERENCE EXPOSURE LEVELS AND TARGET ORGANS ❁

Substance ❁	Chemical▼ Abstract Service Number (CAS)	Chronic Inhalation REL ($\mu g/m^3$)	Chronic Oral REL	Date ◆ Value Reviewed [Added]	Target Organs												
					Alimentary	Bone	Cardiovascular	Developmental	Endocrine	Eye	Hematologic	Immune	Kidney	Nervous	Reproductive	Respiratory	Skin
Sodium dichromate	*10588-01-9*	*2.0E-01*		*1/01*												✓	
			2.0E-02	*10/00*							✓						
Strontium chromate	*7789-06-2*	*2.0E-01*		*1/01*												✓	
			2.0E-02	*10/00*							✓						
CHROMIUM TRIOXIDE (as chromic acid mist)	1333-82-0	2.0E-03		1/01												**X**	
			2.0E-02	*10/00*							✓						
CRESOLS (mixtures of)	1319-77-3	6.0E+02		1/01										**X**			
m-CRESOL	108-39-4	6.0E+02		1/01										**X**			
o-CRESOL	95-48-7	6.0E+02		1/01										**X**			
p-CRESOL	106-44-5	6.0E+02		1/01										**X**			
Cyanide Compounds (inorganic)	*57-12-5 1073*	*9.0E+00*		*4/00*			✓		✓					✓			
HYDROGEN CYANIDE (Hydrocyanic acid)	74-90-8	9.0E+00		4/00			**X**		**X**					**X**			
p-DICHLOROBENZENE	106-46-7	8.0E+02		1/01	**X**								**X**	**X**		**X**	
1,1,-DICHLOROETHYLENE … (see Vinylidene Chloride)																	
DIESEL EXHAUST … (see Particulate Emissions from Diesel-Fueled Engines)																	
DIETHANOLAMINE	111-42-2	3.0E+00		12/01			**X**							**X**			
N,N-DIMETHYL FORMAMIDE	68-12-2	8.0E+01		1/01	**X**											**X**	
1,4-DIOXANE✣ (1,4-Diethylene dioxide)	123-91-1	3.0E+03		4/00	**X**		**X**						**X**				
EPICHLOROHYDRIN (1-Chloro-2,3-epoxypropane)	106-89-8	3.0E+00		1/01						**X**						**X**	
1,2-EPOXYBUTANE	106-88-7	2.0E+01		1/01			**X**									**X**	
ETHYL BENZENE	100-41-4	2.0E+03		2/00	**X**			**X**	**X**				**X**				
ETHYL CHLORIDE (Chlorethane)	75-00-3	3.0E+04		4/00	**X**			**X**									
ETHYLENE DIBROMIDE[TAC] (1,2-Dibromoethane)	106-93-4	8.0E-01		12/01											**X**		
ETHYLENE DICHLORIDE[TAC] (1,2-Dichloroethane)	107-06-2	4.0E+02		1/01	**X**												
ETHYLENE GLYCOL	107-21-1	4.0E+02		4/00				**X**					**X**			**X**	
ETHYLENE OXIDE[TAC] (1,2-Epoxyethane)	75-21-8	3.0E+01		1/01										**X**			

APPENDIX L - TABLE 3 OEHHA/ARB CHRONIC INHALATION AND ORAL REFERENCE EXPOSURE LEVELS AND TARGET ORGANS ◉

Substance ◉	Chemical▼ Abstract Service Number (CAS)	Chronic Inhalation REL ($\mu g/m^3$)	Chronic Oral REL	Date ◆ Value Reviewed [Added]	Target Organs													
					Alimentary	Bone	Cardiovascular	Developmental	Endocrine	Eye	Hematologic	Immune	Kidney	Nervous	Reproductive	Respiratory	Skin
Fluorides	1101	1.3E+1	4.0E-2	8/03		X				✓*						✓	✓*
HYDROGEN FLUORIDE (Hydrofluoric acid)	7664-39-3	1.4E+1	4.0E-2	8/03		X				X*						X	X*
FORMALDEHYDE TAC	50-00-0	3.0E+00		2/00						X						X	
GLUTARALDEHYDE	111-30-8	8.0E-02		1/01												X	
GLYCOL ETHERS	1115																
ETHYLENE GLYCOL ETHYL ETHER – EGEE	110-80-5	7.0E+01		2/00							X				X		
ETHYLENE GLYCOL ETHYL ETHER ACETATE - EGEEA	111-15-9	3.0E+02		2/00				X									
ETHYLENE GLYCOL METHYL ETHER – EGME	109-86-4	6.0E+01		2/00											X		
ETHYLENE GLYCOL METHYL ETHER ACETATE – EGMEA	110-49-6	9.0E+01		2/00											X		
n-HEXANE	110-54-3	7.0E+03		4/00										X			
HYDRAZINE	302-01-2	2.0E-01		1/01	X				X								
HYDROCHLORIC ACID (Hydrogen chloride)	7647-01-0	9.0E+00		2/00												X	
HYDROGEN CYANIDE (Hydrocyanic acid) (see Cyanide Compounds)																	
HYDROGEN FLUORIDE (Hydrofluoric acid) (see Fluorides & Compounds)																	
HYDROGEN SULFIDE	7783-06-4	1.0E+01		4/00												X	
ISOPHORONE	78-59-1	2.0E+03		12/01	X			X									
ISOPROPYL ALCOHOL (Isopropanol)	67-63-0	7.0E+03		2/00				X					X				
MALEIC ANHYDRIDE	108-31-6	7.0E-01		12/01												X	
MANGANESE AND COMPOUNDS	7439-96-5 [1132]	2.0E-01		4/00										X			
MERCURY AND COMPOUNDS (INORGANIC)	7439-97-6 [1133]	9.0E-02		2/00										X			
			3.0^{E}-04	10/00 [1/92]								X	X				
Mercuric chloride	*7487-94-7*	*9.0E-02*		*2/00*										✓			
			3.0E-04	*10/00 [1/92]*								✓	✓				
MERCURY AND COMPOUNDS (ORGANIC)	N/A																
METHANOL	67-56-1	4.0E+03		4/00				X									
METHYL BROMIDE (Bromomethane)	74-83-9	5.0E+00		2/00				X						X		X	
METHYL tertiary-BUTYL ETHER	1634-04-4	8.0E+03		2/00	X					X			X				

APPENDIX L - TABLE 3 OEHHA/ARB CHRONIC INHALATION AND ORAL REFERENCE EXPOSURE LEVELS AND TARGET ORGANS ❁

Substance ❁	Chemical▼ Abstract Service Number (CAS)	Chronic Inhalation REL ($\mu g/m^3$)	Chronic Oral REL	Date ◆ Value Reviewed [Added]	Target Organs												
					Alimentary	Bone	Cardiovascular	Developmental	Endocrine	Eye	Hematologic	Immune	Kidney	Nervous	Reproductive	Respiratory	Skin
METHYL CHLOROFORM (1,1,1-Trichloroethane)	71-55-6	1.0E+03		2/00										X			
METHYL ISOCYANATE	624-83-9	1.0E+00		12/01											X	X	
METHYLENE CHLORIDE[TAC] (Dichloromethane)	75-09-2	4.0E+02		2/00			X							X			
4,4'-METHYLENE DIANILINE (AND ITS DICHLORIDE)	101-77-9	2.0E+01		12/01	X					X							
METHYLENE DIPHENYL ISOCYANATE	101-68-8	7.0E-01		1/01												X	
NAPHTHALENE	91-20-3	9.0E+00		4/00												X	
NICKEL AND COMPOUNDS[TAC]	7440-02-0 [1145]	5.0E-02		2/00							X					X	
			5.0E-02	10/00	X												
Nickel acetate	*373-02-4*	*5.0E-02*		*2/00*							✓					✓	
			5.0E-02	*10/00*	✓												
Nickel carbonate	*3333-39-3*	*5.0E-02*		*2/00*							✓					✓	
			5.0E-02	*10/00*	✓												
Nickel carbonyl	*13463-39-3*	*5.0E-02*		*2/00*							✓					✓	
			5.0E-02	*10/00*	✓												
Nickel hydroxide	*12054-48-7*	*5.0E-02*		*2/00*							✓					✓	
			5.0E-02	*10/00*	✓												
Nickelocene	*1271-28-9*	*5.0E-02*		*2/00*							✓					✓	
			5.0E-02	*10/00*	✓												
NICKEL OXIDE	1313-99-1	1.0E-01		2/00							X					X	
			5.0E-02	10/00	X												
Nickel refinery dust from pyrometallurgical process	*1146*	*5.0E-02*		*2/00*							✓					✓	
			5.0E-02	*10/00*	✓												
Nickel subsulfide	*12035-72-2*	*5.0E-02*		*2/00*							✓					✓	
			5.0E-02	*10/00*	✓												
PCB (POLYCHLORINATED BIPHENYLS (speciated)∇																	
3,3',4,4'-TETRACHLOROBIPHENYL (77)	35298-13-3	4.0E-01		8/03	X			X	X		X				X	X	
			1.0E –04	8/03	X			X	X		X				X	X	
3,4,4',5-TETRACHLOROBIPHENYL (81)	70362-50-4	4.0E-01		8/03	X			X	X		X				X	X	
			1.0E –04	8/03	X			X	X		X				X	X	

APPENDIX L - TABLE 3 OEHHA/ARB CHRONIC INHALATION AND ORAL REFERENCE EXPOSURE LEVELS AND TARGET ORGANS ◉

Substance ◉	Chemical▼ Abstract Service Number (CAS)	Chronic Inhalation REL ($\mu g/m^3$)	Chronic Oral REL	Date ◆ Value Reviewed [Added]	Target Organs												
					Alimentary	Bone	Cardiovascular	Developmental	Endocrine	Eye	Hematologic	Immune	Kidney	Nervous	Reproductive	Respiratory	Skin
2,3,3',4,4' - PENTACHLOROBIPHENYL (105)	32598-14-4	4.0E-01		8/03	X			X	X		X				X	X	
			1.0E –04	8/03	X			X	X		X				X	X	
2,3,4,4'5 - PENTACHLOROBIPHENYL (114)	74472-37-0	8.0E-02		8/03	X			X	X		X				X	X	
			2.0E –05	8/03	X			X	X		X				X	X	
2,3'4,4',5- PENTACHLOROBIPHENYL (118)	31508-00-6	4.0E-01		8/03	X			X	X		X				X	X	
			1.0E –04	8/03	X			X	X		X				X	X	
2',3,4,4',5 - PENTACHLOROBIPHENYL (123)	65510-44-3	4.0E-01		8/03	X			X	X		X				X	X	
			1.0E –04	8/03	X			X	X		X				X	X	
3,3',4,4',5 - PENTACHLOROBIPHENYL (126)	57465-28-8	4.0E-04		8/03	X			X	X		X				X	X	
			1.0E –07	8/03	X			X	X		X				X	X	
2,3,3',4,4',5-HEXACHLOROBIPHENYL (156)	38380-08-4	8.0E-02		8/03	X			X	X		X				X	X	
			2.0E –05	8/03	X			X	X		X				X	X	
2,3,3',4,4',5'-HEXACHLOROBIPHENYL (157)	69782-90-7	8.0E-02		8/03	X			X	X		X				X	X	
			2.0E –05	8/03	X			X	X		X				X	X	
2,3',4,4',5,5'-HEXACHLOROBIPHENYL (167)	52663-72-6	4.0E-00		8/03	X			X	X		X				X	X	
			1.0E –03	8/03	X			X	X		X				X	X	
3,3',4,4'5,5' - HEXACHLOROBIPHENYL (169)	32774-16-6	4.0E-03		8/03	X			X	X		X				X	X	
			1.0E –06	8/03	X			X	X		X				X	X	
2,3,3'4,4',5,5' - HEPTACHLOROBIPHENYL (189)	39635-31-9	4.0E-01		8/03	X			X	X		X				X	X	
			1.0 E-04	8/03	X			X	X		X				X	X	
PARTICULATE EMISSIONS FROM DIESEL-FUELED ENGINES[TAC]■	9901	5.0E+00[TAC]		8/98												X	
PERCHLOROETHYLENE[TAC] (Tetrachloroethylene)	127-18-4	3.5E+01[TAC]		10/91	X								X				
PHENOL	108-95-2	2.0E+02		4/00	X		X						X	X			
PHOSPHINE	7803-51-2	8.0E-1		9/02	X									X		X	
PHOSPHORIC ACID	7664-38-2	7.0E+00		2/00												X	
PHTHALIC ANHYDRIDE	85-44-9	2.0E+01		1/01												X	
POLYCHLORINATED DIBENZO-P-DIOXINS (PCDD) (AS 2,3,7,8-EQUIV)[TAC]●	1085 1086																

APPENDIX L - TABLE 3 OEHHA/ARB CHRONIC INHALATION AND ORAL REFERENCE EXPOSURE LEVELS AND TARGET ORGANS ❁

Substance ❁	Chemical▼ Abstract Service Number (CAS)	Chronic Inhalation REL ($\mu g/m^3$)	Chronic Oral REL	Date ◆ Value Reviewed [Added]	Target Organs												
					Alimentary	Bone	Cardiovascular	Developmental	Endocrine	Eye	Hematologic	Immune	Kidney	Nervous	Reproductive	Respiratory	Skin
2,3,7,8-TETRACHLORODIBENZO-*P*-DIOXIN[TAC]	1746-01-6	4.0E-05		2/00	X			X	X		X				X	X	
			1.0E-08	10/00	X			X	X		X				X	X	
1,2,3,7,8-PENTACHLORODIBENZO-*P*-DIOXIN	40321-76-4	4.0E-05		2/00	X			X	X		X				X	X	
			1.0E-08	10/00	X			X	X		X				X	X	
1,2,3,4,7,8-HEXACHLORODIBENZO-*P*-DIOXIN	39227-28-6	4.0E-04		2/00	X			X	X		X				X	X	
			1.0E-07	10/00	X			X	X		X				X	X	
1,2,3,6,7,8-HEXACHLORODIBENZO-*P*-DIOXIN	57653-85-7	4.0E-04		2/00	X			X	X		X				X	X	
			1.0E-07	10/00	X			X	X		X				X	X	
1,2,3,7,8,9-HEXACHLORODIBENZO-*P*-DIOXIN	19408-74-3	4.0E-04		2/00	X			X	X		X				X	X	
			1.0E-07	10/00	X			X	X		X				X	X	
1,2,3,4,6,7,8-HEPTACHLORODIBENZO-*P*-DIOXIN	35822-46-9	4.0E-03		2/00	X			X	X		X				X	X	
			1.0E-06	10/00	X			X	X		X				X	X	
1,2,3,4,6,7,8,9-OCTACHLORODIBENZO-*P*-DIOXIN	3268-87-9	4.0E-01		2/00	X			X	X		X				X	X	
			1.0E-04	10/00	X			X	X		X				X	X	
POLYCHLORINATED DIBENZOFURANS (PCDF) (AS 2,3,7,8-EQUIV) [TAC] ●	1080																
2,3,7,8-TETRACHLORODIBENZOFURAN	5120-73-19	4.0E-04		2/00	X			X	X		X				X	X	
			1.0E-07	10/00	X			X	X		X				X	X	
1,2,3,7,8-PENTACHLORODIBENZOFURAN	57117-41-6	8.0E-04		2/00	X			X	X		X				X	X	
			2.0E-07	10/00	X			X	X		X				X	X	
2,3,4,7,8-PENTACHLORODIBENZOFURN	57117-31-4	8.0E-05		2/00	X			X	X		X				X	X	
			2.0E-08	10/00	X			X	X		X				X	X	
1,2,3,4,7,8-HEXACHLORODIBENZOFURAN	70648-26-9	4.0E-04		2/00	X			X	X		X				X	X	
			1.0E-07	10/00	X			X	X		X				X	X	
1,2,3,6,7,8-HEXACHLORODIBENZOFURAN	57117-44-9	4.0E-04		2/00	X			X	X		X				X	X	
			1.0E-07	10/00	X			X	X		X				X	X	
1,2,3,7,8,9-HEXACHLORODIBENZOFURAN	72918-21-9	4.0E-04		2/00	X			X	X		X				X	X	
			1.0E-07	10/00	X			X	X		X				X	X	
2,3,4,6,7,8-HEXACHLORODIBENZOFURAN	60851-34-5	4.0E-04		2/00	X			X	X		X				X	X	
			1.0E-07	10/00	X			X	X		X				X	X	

APPENDIX L - TABLE 3 OEHHA/ARB CHRONIC INHALATION AND ORAL REFERENCE EXPOSURE LEVELS AND TARGET ORGANS ◉

Substance ◉	Chemical▼ Abstract Service Number (CAS)	Chronic Inhalation REL ($\mu g/m^3$)	Chronic Oral REL	Date ◆ Value Reviewed [Added]	Target Organs												
					Alimentary	Bone	Cardiovascular	Developmental	Endocrine	Eye	Hematologic	Immune	Kidney	Nervous	Reproductive	Respiratory	Skin
1,2,3,4,6,7,8-HEPTACHLORODIBENZOFURAN	67562-39-4	4.0E-03		2/00	X			X	X		X				X	X	
			1.0E-06	10/00	X			X	X		X				X	X	
1,2,3,4,7,8,9-HEPTACHLORODIBENZOFURAN	55673-89-7	4.0E-03		2/00	X			X	X		X				X	X	
			1.0E-06	10/00	X			X	X		X				X	X	
1,2,3,4,6,7,8,9-OCTACHLORODIBENZOFURAN	39001-02-0	4.0E-01		2/00	X			X	X		X				X	X	
			1.0E-04	10/00	X			X	X		X				X	X	
PROPYLENE (PROPENE)	115-07-1	3.0E+03		4/00												X	
PROPYLENE GLYCOL MONOMETHYL ETHER	107-98-2	7.0E+03		2/00	X												
PROPYLENE OXIDE	75-56-9	3.0E+01		2/00												X	
SELENIUM AND COMPOUNDS (other than hydrogen selenide)	7782-49-2 [1170]	2.0E+01		12/01	X		X							X			
STYRENE	100-42-5	9.0E+02		4/00										X			
SULFURIC ACID	7664-93-9	1.0E+00		12/01												X	
Sulfuric Acid and Oleum	*7664-93-9*	*1.0E+00*		*12/01*												✓	
Sulfuric Trioxide	*7446-71-9*	*1.0E+00*		*12/01*												✓	
Oleum	*8014-95-7*	*1.0E+00*		*12/01*												✓	
TOLUENE	108-88-3	3.0E+02		4/00				X						X		X	
Toluene diisocyanates	*26471-62-5 1204*	*7.0E-02*		*1/01*												✓	
TOLUENE-2,4-DIISOCYANATE	584-84-9	7.0E-02		1/01												X	
TOLUENE-2,6-DIISOCYANATE	91-08-7	7.0E-02		1/01												X	
TRICHLOROETHYLENE[TAC]	79-01-6	6.0E+02		4/00						X				X			
TRIETHYLAMINE	121-44-8	2.0E+02		9/02						X		X				X	
VINYL ACETATE	108-05-4	2.0E+02		12/01												X	
VINYLIDENE CHLORIDE (1,1,-Dichloroethylene)	75-35-4	7.0E+01		1/01	X												
XYLENES (mixed isomers)	1330-20-7 1210	7.0E+02		4/00										X		X	
m-XYLENE	108-38-3	7.0E+02		4/00										X		X	
o-XYLENE	95-47-6	7.0E+02		4/00										X		X	
p-XYLENE	106-42-3	7.0E+02		4/00										X		X	

Purpose:	The purpose of this reference table is to provide a quick list of all health values that have been approved by the Office of Environmental Health Hazard Assessment (OEHHA) and the Air Resources Board (ARB) for use in facility health risk assessments conducted for the AB 2588 Air Toxics Hot Spots Program. The OEHHA has developed and adopted new risk assessment guidelines that update and replace the California Air Pollution Control Officers Association's (CAPCOA) *Air Toxics "Hot Spots" Program Revised 1992 Risk Assessment Guidelines, October 1993*. The OEHHA has adopted five technical support documents for these guidelines. This table lists the OEHHA adopted inhalation and oral noncancer chronic RELs. In addition, it lists the substances in Appendix A-I *(Substances For Which Emissions Must Be Quantified*) and Appendix F (*Criteria For Inputs For Risk Assessment Using Screening Air Dispersion Modeling*) of the ARB's *Air Toxics "Hot Spots" Emission Inventory Criteria and Guidelines (EICG)*. OEHHA is still in the process of adopting new noncancer chronic RELs. Therefore, new health values will periodically be added to, or deleted from, this table. Users of this table are advised to monitor the OEHHA website (*www.oehha.ca.gov*) for any updates to the health values.
❁	Substances written in *italics* and with a ✓ do not have explicit OEHHA approved health values, but are included in this table to clarify applicability of OEHHA adopted heath effects values to individual or grouped substances listed in the *Air Toxics "Hot Spots" Emission Inventory Criteria and Guidelines*, Appendix A-I list of *"Substances For Which Emissions Must Be Quantified"*.
▼	Chemical Abstract Service Number (CAS): For chemical groupings and mixtures where a CAS number is not applicable, the 4-digit code used in the *Air Toxics "Hot Spots" Emission Inventory Criteria and Guidelines (EICG) Report* is listed. The 4-digit codes enclosed in brackets [ ] are codes that have been phased out, but may still appear on previously reported Hot Spots emissions. For information on the origin and use of the 4-digit code, see the EICG report.
◆	Date Value Reviewed [Added]: This column lists the date that the health value was last reviewed by OEHHA and the Scientific Review Panel, and/or approved for use in the AB 2588 Air Toxics "Hot Spots" Program. If the health value is unchanged since it was first approved for use in the "Hot Spots" Program, then the date that the value was first approved for use by CAPCOA is listed within the brackets [ ]. • February 2000, April 2000, January 2001, and December 2001 are listed for the first set of 22, the second set of 16, the third set of 22, and the fourth set of 12 noncancer chronic RELs, respectively. • October 2000 is listed for the oral chronic RELs. The chronic REL for carbon disulfide was adopted in May 2002. Chronic RELS for phosphine and triethylamine were adopted in September 2002. Chronic RELs for fluorides including hydrogen fluoride were adopted August 2003. • For the substances identified as Toxic Air Contaminants, the Air Resources Board hearing date is listed. The date for acetaldehyde represents the date the value was approved by the Scientific Review Panel.
TAC	Toxic Air Contaminant: The Air Resources Board has identified this substance as a Toxic Air Contaminant.
★	Polychlorinated Biphenyls: Chronic Oral: The chronic oral value is U.S. EPA's 1996 oral Reference Dose for Aroclor-1254.
•	Polychlorinated Dibenzo-*p*-dioxins and Polychlorinated Dibenzofurans (also referred to as chlorinated dioxins and dibenzofurans): The OEHHA has adopted the World Health Organization 1997 (WHO-$_{97}$) Toxicity Equivalency Factor scheme for evaluating the cancer risk due to exposure to samples containing mixtures of polychlorinated dibenzo-*p*-dioxins (PCDD) and polychlorinated dibenzofurans (PCDF) and determining cancer risks for a number of specific PCB congeners. See Appendix A of OEHHA's *Technical Support Document For Describing Available Cancer Potency Factors* for more information about the scheme. See Appendix E of OEHHA's *The Air Toxics Hot Spots Program Risk Assessment Guidelines; Part V; Technical Support Document; Guidance Manual for Preparation of Health Risk Assessments* for the methodology for calculating 2,3,7,8-equivalents for PCDD, PCDFs and a number of specific PCB congeners.
■	Particulate Emissions from Diesel-Fueled Engines: The unit risk factor and chronic REL were derived from whole diesel exhaust and should be used only for impacts from the inhalation pathway. The inhalation impacts from speciated emissions from diesel-fueled engines are already accounted for in the unit risk factor and REL. However, at the discretion of the risk assessor, speciated emissions from diesel-fueled engines may be used to estimate acute noncancer health impacts or the contribution to cancer risk or chronic noncancer health impacts for the non-inhalation exposure pathway. See Appendix D of OEHHA's *The Air Toxics Hot Spots Program Risk Assessment Guidelines; Part V; Technical Support Document; Guidance Manual for Preparation of Health Risk Assessments* for more information.

Table last updated: August 2003

Health Risk Assessments for Proposed Land Use Projects



CAPCOA Guidance Document

CAPCOA
CALIFORNIA AIR POLLUTION CONTROL OFFICERS ASSOCIATION

Prepared by:
CAPCOA Planning Managers

Approved for Release
July 2009

CAPCOA Planning Managers HRA Committee Members

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Dan O'Brien – YSAQMD

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Glossary

Acute Hazard Index	Acute Hazard Index is the ratio of the average short term (generally one hour) ambient concentration of an acutely toxic substance(s) divided by the acute reference exposure level set by the Office of Environmental Health Hazard Assessment. If this ratio is above one, then adverse health effects may occur.
Background Risk	Background risk is the risk level found throughout an area. This risk is not caused by a particular facility; it is the cumulative risk and may be partly due to air pollution from vehicle traffic.
Cancer Risk	Cancer risk is defined as the probability that an individual will contract cancer usually expressed as so many chances per million persons exposed to a specified concentration of carcinogenic substance(s).
Chronic Hazard Index	Chronic Hazard Index is the ratio of the average annual ambient concentration of a chronically toxic substance(s) divided by the chronic reference exposure level set by the Office of Environmental Health Hazard Assessment. If this ratio is above one, then adverse health effects may occur.
Commenting Agency	A commenting agency is any public agency that comments on a CEQA document, but is neither a lead agency nor a responsible agency. For example, a local air district, as the agency with the responsibility for air pollution control, could review and comment on an air quality analysis in a CEQA document, even though the project was not subject to an air permit or other air pollution control requirements.
Cumulative impact	Cumulative impacts represent the risks from all onsite sources and from sources near enough to the project to significantly contribute to the total risk levels.
Hot Spots Program	Health and Safety Code §44300-44394, Program which requires existing sources to inventory toxic emissions, prepare risk assessments, notify significantly exposed receptors, and prepare and implement risk reduction plans.
Lead Agency	A lead agency is the public agency that has the principal responsibility for carrying out or approving a project that is subject to CEQA. In general, the land use agency is the preferred public agency serving as lead agency, because it has jurisdiction over general land uses. The lead agency is responsible for determining the appropriate environmental document, as well as its preparation.

Receptors	Receptors include sensitive receptors and worker receptors. Sensitive receptors refer to those segments of the population most susceptible to poor air quality (i.e., children, the elderly, and those with pre-existing serious health problems affected by air quality). Land uses where sensitive individuals are most likely to spend time include schools and schoolyards, parks and playgrounds, daycare centers, nursing homes, hospitals, and residential communities (these sensitive land uses may also be referred to as sensitive receptors). Worker receptors refer to employees and locations where people work.
Responsible Agency	A responsible agency is a public agency, other than the lead agency, with discretionary approval authority over a project that is subject to CEQA (i.e., project requires a subsequent permit).
Risk Assessment	An evaluation that assesses the impact of toxic substances affecting receptors. A risk assessment can include minimal input parameters resulting in conservative results (screening risk assessment) or include increasingly detailed input parameters (refined risk assessment).
Source	A source is referred to as the locality where toxic emissions originate and are released into the atmosphere. Sources of emissions are categorized into groups such as point source (e.g., refinery) or line source (e.g., roadway).
Type A Project	Land use project that impacts receptors near the project.
Type B Project	Land use project with receptors that are impacted by nearby, existing toxics sources.

Acronyms

ARB:	California Air Resources Board
ATCM:	Air Toxic Control Measure
CAPCOA:	California Air Pollution Control Officers Association
CEQA:	California Environmental Quality Act
DPM:	Diesel Particulate Matter
EIR:	Environmental Impact Report
EPA:	U.S. Environmental Protection Agency
HRA:	Health Risk Assessment
OEHHA:	California Office of Environmental Health Hazard Assessment
PM:	Particulate Matter
REL:	Reference Exposure Level
TAC:	Toxic Air Contaminant
TBACT:	Toxic Best Available Control Technology

Executive Summary

This guidance was prepared to assist Lead Agencies in complying with the requirements of the California Environmental Quality Act (CEQA)[1]. CEQA requires environmental impacts of a proposed project be identified, assessed, and avoided or mitigated (as possible) if these impacts are significant. To determine the impact of airborne toxic emissions [i.e., toxic air contaminants (TACs)] for CEQA purposes, health risk assessments must be prepared. This document describes when and how a health risk assessment should be prepared and what to do with the results.

In 2005, the California Air Resources Board (ARB) prepared the ***Air Quality and Land Use Handbook: a Community Health Perspective*** **(ARB Handbook)**[2], to help readers understand the potential cancer risks from some common sources of toxic emissions such as:

- Freeways and High Traffic Volume Roads,
- Goods Distribution Centers,
- Rail Yards,
- Ports,
- Refineries,
- Chrome Platers,
- Dry Cleaners using Perchloroethylene, and
- Gasoline Dispensing Facilities.

The ARB Handbook identified the potential cancer risks at various distances from these sources and recommended buffer distances between those sources and receptors.

Recent air pollution studies have shown an association between respiratory and other non-cancer health effects and proximity to high traffic roadways. Other studies have shown that diesel exhaust and other cancer-causing chemicals emitted from cars and trucks are responsible for much of the overall cancer risk from airborne toxics in California.

While local air districts have ample experience evaluating and mitigating toxic emissions from permitted stationary sources, most have limited experience preparing or reviewing risk assessments associated with multiple toxic sources or assessments for exhaust from mobile sources that are typically found when evaluating health risks to proposed land use projects.

In order to provide consistency to lead agencies, project proponents and the general public throughout the state, the California Air Pollution Control Officers Association (CAPCOA) formed a subcommittee composed of representatives from the Planning Managers Committee and the Toxic Risk Managers Committee to develop guidance on assessing the health risk impacts from and to proposed land use projects. This CAPCOA guidance document focuses on the acute, chronic, and cancer impacts of sources affected by CEQA. It also outlines the

[1] Title 14 California Code of Regulations, Chapter 3. Guidelines for Implementation of the California Environmental Quality Act.

[2] Air Quality and Land Use Handbook: a Community Health Perspective, CARB, April 2005, http://www.arb.ca.gov/ch/handbook.pdf

recommended procedures to identify when a project should undergo further risk evaluation, how to conduct the health risk assessment (HRA), how to engage the public, what to do with the results from the HRA, and what mitigation measures may be appropriate for various land use projects. With respect to health risks associated with locating sensitive land uses in proximity to freeways and other high traffic roadways, HRA modeling may not thoroughly characterize all the health risk associated with nearby exposure to traffic generated pollutants.

This guidance does not include how risk assessments for construction projects should be addressed in CEQA. As this is intended to be a "living document", the risks near construction projects are expected to be included at a later time as the toxic emissions from construction activities are better quantified. State risk assessment policy is likely to change to reflect current science, and therefore this document will need modification as this occurs.

1.0 Requirements to Evaluate Health Risks in CEQA

This guidance was prepared to assist Lead Agencies in complying with the requirements of the California Environmental Quality Act (CEQA)[3]. CEQA requires that environmental impacts of proposed projects be identified, assessed, avoided and/or mitigated (as possible) if the environmental impacts are significant.

Section 15126.2(a) requires the following: *"An Environmental Impact Report (EIR) shall identify and focus on the significant environmental effects of the proposed project. In assessing the impact of a proposed project on the environment, the lead agency should normally limit its examination to changes in the existing physical conditions in the affected area as they exist at the time the notice of preparation is published, or where no notice of preparation is published, at the time environmental analysis is commenced. Direct and indirect significant effects of the project on the environment shall be clearly identified and described, giving due consideration to both the short-term and long-term effects. The discussion should include relevant specifics of the area, the resources involved, physical changes, alterations to ecological systems, and changes induced in population distribution, population concentration, the human use of the land (including commercial and residential development), health and safety problems caused by the physical changes, and other aspects of the resource base such as water, historical resources, scenic quality, and public services. The EIR shall also analyze any significant environmental effects the project might cause by bringing development and people into the area affected. For example, an EIR on a subdivision astride an active fault line should identify as a significant effect the seismic hazard to future occupants of the subdivision. The subdivision would have the effect of attracting people to the location and exposing them to the hazards found there."*

This language is included here to clearly show that risk assessments can be required for both projects that will impact nearby receptors (Type A), and projects that will be impacted by nearby sources (Type B).

[3] Pub. Resources Code § 21067; 14 Cal. Code Regs., §§ 15150, 15367.

2.0 Overview of the Process

Figure 1 shows an overview of the proposed Health risk Assessment (HRA) process. There are basically two types of land use projects that have the potential to cause long-term public health risk impacts:

Type A - Land use projects with toxic emissions that impact receptors, and
Type B - Land use project that will place receptors in the vicinity of existing toxics sources.

Type A project examples (project impacts receptors):

- combustion related power plants,
- gasoline dispensing facilities,
- asphalt batch plants,
- warehouse distribution centers,
- quarry operations, and
- other stationary sources that emit toxic substances.

Type B project examples (project impacted by existing nearby toxic sources):

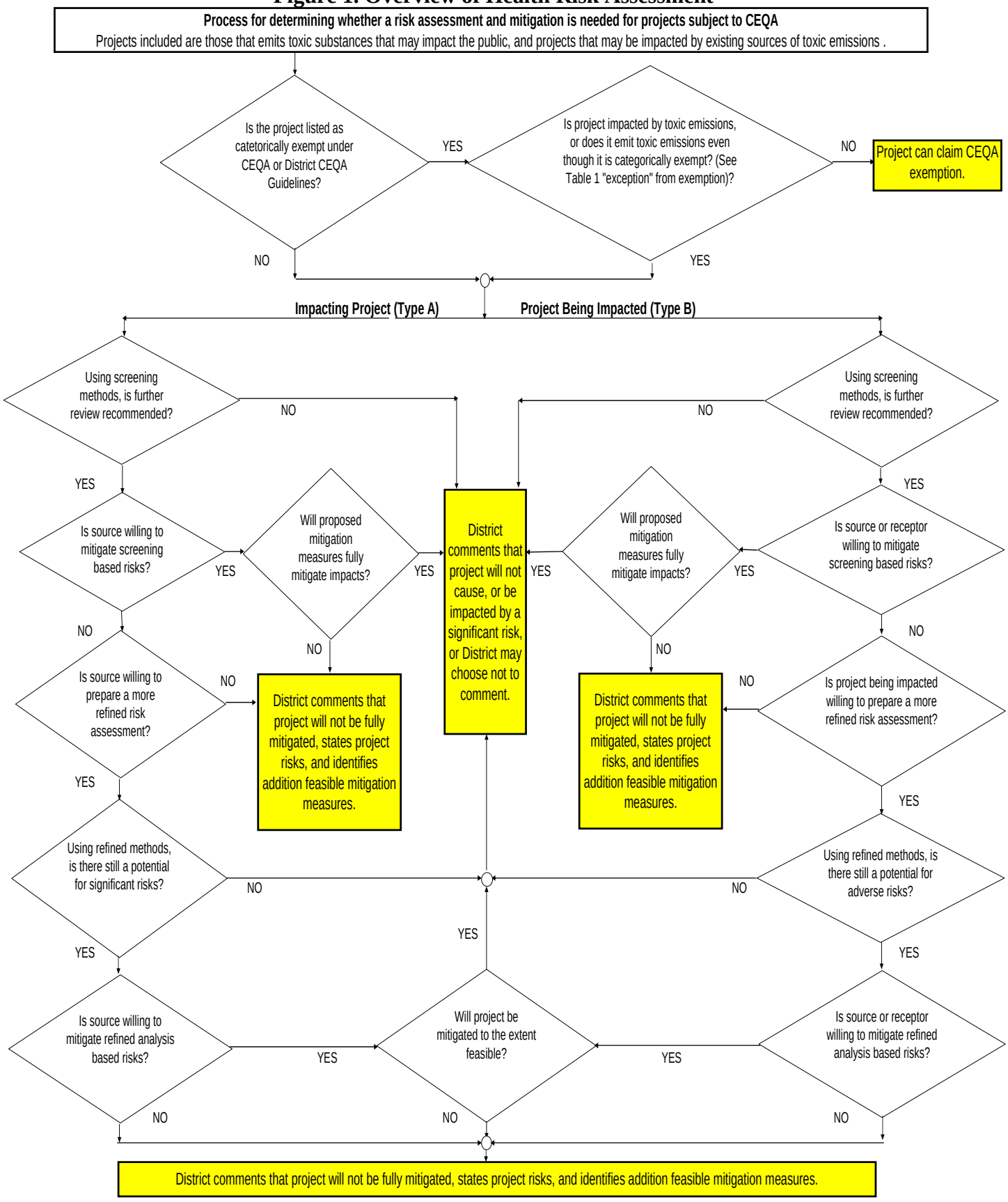
- residential, commercial, and institutional developments proposed to be located in the vicinity of existing toxic emission sources such as:
  - stationary sources,
  - high traffic roads
  - freeways,
  - rail yards, and
  - ports.

The flowchart (Figure 1) shows how to proceed with the CEQA process when either a Type A or Type B related project is proposed. The following summarizes the process for proceeding through the flowchart:

- First determine if the project is categorically exempt from CEQA;
- Next, determine if the project is impacting, or being impacted (Type A or B);
- Using screening methods, calculate acute, chronic, and cancer risk;
- If the screening analysis indicates significant health risk as defined by the lead agency, demonstrate that risks will be mitigated with all feasible measures even though a refined risk assessment may show that less mitigation is needed;
- Or, conduct a refined screening risk assessment; and,
- If the risk continues to be deemed significant by the lead agency even with the refined screening, demonstrate that the risks will be adequately mitigated with feasible measures.

Air districts, in their role as either a responsible agency or a commenting agency, should review the HRA and communicate to the lead agency their evaluation of the risk assessment and whether it is fully described (e.g., methodology, assumptions and resulting risk values) and mitigated with all feasible measures.

Figure 1. Overview of Health Risk Assessment



3.0 Overview of Risk Assessment Methodology and Guidance Documents

This document bases the risk assessment methodology on the procedures developed by the California Office of Environmental Health Hazard Assessment (OEHHA) to meet the mandates of the Air Toxics "Hot Spots" Information and Assessment Act (AB 2588). The Hot Spots program applies to stationary sources and requires affected facilities to prepare a toxic emissions inventory, and if the emissions are significant, that a risk assessment be prepared. The OEHHA procedures can be found at http://www.oehha.ca.gov/air/hot_spots/index.html and describe:

- The toxicity factors associated with various substances,
- How these toxicity factor are to be used to determine the acute, chronic, and cancer risks associated with downwind concentrations of chemicals in the air at various receptors, and
- Dispersion modeling procedures.

4.0 CEQA Exemptions

The first step in a risk analysis is to determine if the project is statutorily or categorically exempt from CEQA. There are no exceptions to statutorily exempt projects, however, certain projects that are categorically exempt under the state or air district guidelines, may emit toxic emissions or may be impacted by existing toxic sources. Table 1 shows the exceptions from categorical exemptions where an HRA evaluation is needed. These are situations where a project proponent or lead agency may not rely on a categorical exemption because the health risk may trigger an exception (CEQA §15300.2), preventing their use. In such cases, a negative declaration or environmental impact report should be prepared.

Table 1
Categorical Exemptions Requiring HRA Evaluation[4]

Categorical Exemption	Exempt Activity with *Possible Impact*
15301. Existing Facilities	This exemption also allows use of a single-family residence as a day care facility without CEQA review. *However, such uses near existing TAC emissions may warrant further review.*
15302. Replacement or Reconstruction	This exemption allows the replacement or construction of existing schools and hospitals in certain cases without CEQA review. *However, locating new facilities near existing TAC emissions may warrant further review.*
15303. New Construction or Conversion of Small Structures	This exemption class allows small new construction projects to proceed without CEQA review. *However, projects claiming this exemption should be reviewed for possible TAC impacts from ongoing nearby sources.*
15314. Minor Additions to Schools	This exemption class allows small school addition projects to proceed without CEQA review. *However, projects claiming this exemption should be reviewed for possible TAC impacts from ongoing nearby sources.*
15316. Transfer of Ownership of Land in Order to Create Parks	Exemptions in this class should be reviewed for *possible impacts from locating near ongoing sources of TAC.*
15332. In-Fill Development Projects.	This exemption class allows certain in-fill development projects to proceed without CEQA review. *However, projects claiming this exemption should be reviewed for possible TAC impacts from ongoing nearby sources such as high volume roadways and freeways.*

[4] Although methodology for assessing health risk for construction projects is not included in this document, lead agencies under CEQA are required to identify health risk from construction activities or projects and mitigate if they are deemed significant.

5.0 Screening Risk Assessments

Various tools already exist to perform a screening analysis from stationary sources impacting receptors (Type A projects) as developed for the AB2588 Hot Spots and air district permitting programs. Local air districts should be contacted for appropriate screening tools for proposed projects. Screening tools may include: prioritization charts, SCREEN3 and various spreadsheets.

For projects being impacted by existing sources (Type B projects), one screening tool is contained in the ARB Handbook[4]. The handbook includes a table (reproduced in these guidance documents as Table 2) with recommended buffer distances associated with various types of common sources. ARB's Handbook focuses on community health and provides important public health information to land use decision makers. In this document, ARB's primary goal is to provide information that will help keep California's children and other vulnerable populations out of harm's way with respect to nearby sources of air pollution.

For example, as shown in Table 2, ARB recommends avoiding siting new sensitive land uses such as residences, schools, daycare centers, playgrounds, or medical facilities within 500 feet of a freeway, urban roads with traffic volumes exceeding 100,000 vehicles/day, or rural roads with volumes greater than 50,000 vehicles/ day. Therefore, siting a residential project within 500 feet of a freeway, and the associated public health risks, should be disclosed as such in a CEQA document. Re-designing the project so that sensitive receptors are moved greater than 500 feet away from such roadways may mitigate the risk. Other non-sensitive land uses such as commercial uses may be sited in this area. ARB recommends that their guidelines be considered by the decision makers along with housing needs, economic development priorities, and other quality of life issues. It should also be noted that health risk assessments conducted on sensitive land uses in close proximity to freeways and other high traffic roadways may not thoroughly characterize all the health risk associated with nearby exposure to traffic generated pollutants.

Table 2
Recommendations on Siting New Sensitive Land Uses Such As Residences, Schools, Daycare Centers, Playgrounds, or Medical Facilities [5]

Source Category	Advisory Recommendations
Freeways and high-traffic roads	• Avoid siting new sensitive land uses within 500 feet of a freeway, urban roads with 100,000 vehicles/day, or rural roads with 50,000 vehicles per day.
Distribution centers	• Avoid siting new sensitive land uses within 1,000 feet of a distribution center (that accommodates more than 100 trucks per day, more than 40 trucks with operating transport refrigeration units (TRUs) per day, or where TRU unit operations exceed 300 hours per week). • Take into account the configuration of existing distribution centers and avoid locating residences and other new sensitive land uses near entry and exit points.
Rail yards	• Avoid siting new sensitive land uses within 1,000 feet of a major service and maintenance rail yard. • Within one mile of a rail yard, consider possible siting limitations and mitigation approaches.
Ports	• Avoid siting of new sensitive land uses immediately downwind of ports in the most heavily impacted zones. Consult local air districts or the ARB on the status of pending analyses of health risks.
Refineries	• Avoid siting new sensitive land uses immediately downwind of petroleum refineries. Consult with local air districts and other local agencies to determine an appropriate separation.
Chrome platers	• Avoid siting new sensitive land uses within 1,000 feet of a chrome plater.
Dry cleaners using perchloroethylene	• Avoid siting new sensitive land uses within 300 feet of any dry cleaning operation. For operations with two or more machines, provide 500 feet. For operations with 3 or more machines, consult with the local air district. • Do not site new sensitive land uses in the same building with perc dry cleaning operations.
Gasoline dispensing facilities	• Avoid siting new sensitive land uses within 300 feet of a large gas station (defined as a facility with a throughput of 3.6 million gallons per year or greater). A 50 foot separation is recommended for typical gas dispensing facilities.

5

- These recommendations are advisory. Land use agencies have to balance other considerations, including housing and transportation needs, economic development priorities, and other quality of life issues.
- Recommendations are based primarily on data showing that the air pollution exposures addressed here (i.e., localized) can be reduced as much as 80% with the recommended separation.
- The relative risk for these categories varies greatly. To determine the actual risk near a particular facility, a site-specific analysis would be required. Risk from diesel PM will decrease over time as cleaner technology phases in.
- These recommendations are designed to fill a gap where information about existing facilities may not be readily available and are not designed to substitute for more specific information if it exists. The recommended distances take into account other factors in addition to available health risk data (see individual category descriptions).
- Site-specific project design improvements may help reduce air pollution exposures and should also be considered when siting new sensitive land uses.
- This table does not imply that mixed residential and commercial development in general is incompatible. Rather it focuses on known problems like dry cleaners using Perchloroethylene that can be addressed with reasonable preventative actions.
- A summary of the basis for the distance recommendations can be found in the ARB Handbook.

6.0 Refined Risk Assessments

If a screening risk assessment shows that a risk is a concern, then a more refined analysis may be prepared. The refined analysis for the project may show lower risks, and provide more accurate information for decision makers. The screening assessment uses more conservative assumptions and thus gives higher risk than refined assessment. Risk assessments are normally prepared in a tiered manner, where progressively more input data is collected to refine the results. These guidelines include the evaluation of both mobile and stationary sources.

Attachment 1 to this document consists of the ***Technical Modeling and Risk Assessment Guidance*** which address various air quality dispersion modeling issues pertinent to California and is based primarily on information found in ARB, EPA and OEHHA guidance.

Appendix A, ***Meteorological Data,*** provides information on preparing meteorological data, mixing height and upper air data and land use characterization.

Appendix B, ***Modeling and Exposure Assessment Input and Output Data,*** is a checklist of parameters designed to provide an overview of all information that should be submitted for a refined air dispersion modeling assessment.

7.0 Risk Thresholds

An air district can set CEQA significant risk thresholds (e.g. the excess cancer risk shall be less than ten per million, the acute or chronic hazard index shall be less than one, or other significance levels as arrived at through a public process) that are used on a per-project basis. If the air district's governing board has adopted specific risk thresholds, the lead agency may choose to use them to determine acceptable risk levels. Additionally, clear risk thresholds are helpful when mitigation measures are necessary. The degree of mitigation can be clearly defined when a risk threshold has been determined before a project is proposed.

The absence of a risk threshold does not relieve an agency of its obligation to address toxic emissions from projects under CEQA. The implications of not having a threshold are different depending on the role the agency has under CEQA – whether it is acting as a commenting agency, as a responsible agency, or as a lead agency.

7.1 Significant Risk Thresholds - Type A (Impacting Sources)

For Type A projects, those that generate toxic air contaminants (such as gasoline stations, distribution facilities or asphalt batch plants), air districts are uniform in their recommendation to use the significance thresholds that have been established under each district's "Hot Spots" and permitting programs. For the majority of the air districts the **excess cancer risk** significance threshold is set at **10 in a million**. For toxic air contaminants with acute and chronic, non-carcinogenic health effect, a **hazard index of one** must not be exceeded. Depending on the substances being emitted, a project with a hazard index greater than one could result in adverse health effects of various sorts. It should be noted that a hazard index exceeding one may need additional analysis to determine whether the acceptable level of acute or chronic risk could be higher depending upon the safety factors that were incorporated into the reference exposure levels (RELs) associated with the hazard index results. This additional analysis could be considered an additional refinement tier.

It should be noted that these thresholds may be applied differently for air district permitting, the Hot Spots program, and CEQA. For air district permitting, the thresholds apply only to individual permit units. For the Hot Spots program, the thresholds apply to the entire facility excluding vehicle emissions. Neither the permitting programs nor the Hot Spots program apply to vehicle emissions. For CEQA, the thresholds apply to <u>all</u> facilities including vehicle emissions, and road related emissions.

7.2 Significant Risk Thresholds - Type B (Projects Impacted by Existing Sources)

For Type B projects, those that are impacted by existing sources, air districts are not uniform in their recommendation on what significance threshold should be adopted or what processes should be undertaken when disclosing potential risks.

The CEQA statutes encourage an air district or any lead agency to establish significance thresholds under CEQA for any pollutant. While there are considerations that support the establishment of thresholds, there is no obligation to do so. The absence of a threshold does not relieve agencies of their obligations to address toxic emissions from projects under CEQA. The implications of not having a threshold are different depending on the role the agency has under CEQA – whether it is acting in commenting agency, as a responsible agency, or as a lead agency.

An air district or other lead agency may elect not to establish significance thresholds for a number of reasons.

A lead agency or air district may also determine there is insufficient information to support selecting one specific threshold over another. Air districts have historically recommended CEQA thresholds for air pollutants in the context of the air district's clean air attainment plan, or (in the case of toxic air pollutants) within the framework of a rule or policy that manages risks and exposures due to toxic pollutants.

Significance levels have been approached differently by air districts as enumerated below:

- Thresholds can be based on a specific risk level such that a 10 per million excess cancer risk and an acute and chronic hazard index of one should not be exceeded. These thresholds tend to be consistent with the Hot Spot Program thresholds.
- Thresholds can also be based on the region's existing background cancer risk value if one exists.
    - One option is to establish a risk level equal to a region's background risk level.
    - Another option is to establish a risk level equal to twice a region's background risk level.
    - Still another option is to look at the ambient risk in the immediate vicinity of the project area rather than the regional risk level.
- Case by case thresholds may also be defined.

8.0 Mitigation Measures

CEQA requires that adverse environmental impacts of a proposed project be identified, assessed, avoided, and, if deemed significant, mitigated (as feasible) to a level that is considered less than significant. "'Feasible' means capable of being accomplished in a successful manner within a reasonable period of time, taking into account economic, environmental, legal, social, and technological factors" (CEQA Guidelines §15364).

In cases where significant adverse impacts are not avoided or substantially lessened, the public agency may approve the project if it first adopts a "statement of overriding considerations." The statement of overriding considerations sets forth the specific reasons why the public agency found the project's benefits outweigh its unavoidable adverse environmental effects (CEQA Guidelines§15043).

In addition to being a CEQA requirement, mitigating public exposure to toxic air pollution is needed to achieve air district goals. All potentially significant emission sources must be mitigated to the greatest extent feasible, including placing people out of harm's way.

Table 3 presents mitigation measures that are currently considered to be feasible to reduce health risk from both Type A and Type B projects. The mitigation measures included in the table are not considered to be exhaustive. The lead agency and project proponents are encouraged to think creatively in devising measures to mitigate air quality impacts. However, the air districts recognize that the final determination of feasibility for a project will be determined by the lead agency. Aside from the mitigation measures shown below, knowing about the regulatory programs to reduce air pollutant emissions through statewide strategies provide information to local air districts and lead agencies to help assess and mitigate cumulative air pollution impacts as well.

8.1 Mitigations due to Air Toxic Control Measures

ARB has been developing Air Toxic Control Measures (ATCMs) for many years. Many of these measures have a phase-in schedule. Implementation of others has already been completed. While cancer and non-cancer risks from the air toxic sources implementing ATCMs are expected to decrease with time, the Office of Environmental Health Hazard Assessment (OEHHA) recommends that it is inappropriate to assume these yet-to-be realized emissions reductions in a health-risk assessment. However, the project proponent is encouraged to become familiar with existing and proposed ATCMs in order to determine if any of the ATCMs affect project-specific emissions.

8.2 Mitigating Through Land Use and Design

To a certain extent, the long-term air quality impact of a project is a function of its design. The layout of streets, the mix of land uses, and the placement of homes and businesses can all affect overall project emissions. Yet in many instances, the air quality impacts of a project are not considered until well after a project has been designed. At such a late stage, it can be very difficult to make any substantial changes to the project to reduce the project's air quality impact.

As indicated throughout the ARB Handbook, land use agencies are strongly encouraged to consult early and often with local air districts. Including air quality considerations during the initial design phase can help an applicant to implement design features that will reduce its air quality impact.

In addition to considering the suitability of the project location, opportunities for mitigation of air pollution impacts through design should be considered. In some cases, control devices and changes in processes may be implemented at the source in order to reduce the risk from toxic air contaminant emissions. Examples of land-use based air quality specific performance standards include the following:

- Placing a process vent away from the direction of nearby receptors, or increasing the stack height so that emissions are dispersed to reduce the emissions impact on the immediate surroundings.
- Limiting the hours of operation of a facility to avoid excess emissions exposure to nearby individuals.
- An ordinance that requires fleet operators to use cleaner vehicles before project approval (if a new business), or when expanding the fleet (if an existing business).
- Providing alternate routes for truck operations that discourage detours into sensitive receptor neighborhoods.

While such measures may reduce the dimensions of a buffer zone, they do not obviate the need to maintain buffer zones to protect public health and safety. This is particularly true in situations where a sensitive receptor is encroaching on an existing source of toxic air contaminant. Also note disclosure statements, community alert procedures, etc., that are targeted at potential receptors are not appropriate mitigations to be used in lieu of buffer zones or technical controls.

Table 3 below contains examples of both project and program-level mitigation measures.

- Project-level mitigation measures are applicable to development which results in the implementation or modification of a land use which creates unacceptable levels of risk. Examples include redesigning the project to locate receptors away from TAC sources, the installation of barriers and/or vegetation and indoor air filtration.

- Program-level mitigation measures, on the other hand, are applicable to long-range community planning such as General Plans, and address land use incompatibility at a much earlier stage. Examples of program-level mitigation measures include rezoning vacant land adjacent to high-volume roadways, ports, railroads or heavy industry to avoid future proposed siting of residential and/or sensitive receptors.

8.3 Mitigation Effectiveness

The mitigation measures identified in Table 3 include both quantifiable and unquantifiable measures.

8.3.1 Quantifiable Mitigation Measures

The effect of quantifiable mitigation measures can be modeled or calculated beyond a reasonable doubt. As pertaining to health risk impacts, quantifiable mitigation measures generally result in a measurable reduction of toxic air contaminant emissions (such as DPM), or a measurable decrease in exposure to such emissions through increased buffer distances, reduced exposure durations or control devices having a certified control effectiveness.

Examples of quantifiable mitigation measures include:

- Diesel particulate filters: as of 2008, DPFs reduce the emissions of diesel particulate matter up to 85% as verified by the CARB.
- Increasing the distance between a TAC source and receptor may reduce the receptor's level of exposure to TACs; the effect of this mitigation measure can be estimated through dispersion modeling;
- Idling restrictions can greatly reduce or completely eliminate DPM emissions from stationary trucks; if such restrictions are quantitative and include a concrete limit on the number of minutes a truck (or similar) is allowed to idle, the benefits of this mitigation measure can be modeled.

Several cautionary notes regarding estimating the effectiveness of mitigation measures are warranted:

- Clearly explain the assumptions underlying the environmental document's analysis of mitigation measure effectiveness. The analysis should specifically describe the mitigation measure, identify the source(s) of air pollutants that are expected to be affected by the measure, clearly explain how and to what extent the measure will affect the source(s), and identify the basis for the estimate (empirical observations, computer modeling, case studies, etc.). Critical assumptions should be linked to the mitigation monitoring and reporting program.

- Be specific regarding implementation of mitigation measures. The environmental document should describe each mitigation measure in detail, identify who is responsible for implementing the measure, and clearly explain how and when the measure will be implemented. Methods for assessing the measure's effectiveness once it is in place, and possible triggers for additional mitigation if necessary, may be needed. This level of detail regarding mitigation measure implementation frequently is not addressed until the preparation of the mitigation monitoring and reporting program, which often takes place very late in the environmental review process. In order to reliably assess the effectiveness and feasibility of mitigation

measures, however, air agencies believe it is necessary to consider the specifics of mitigation measure implementation as early in the environmental review process as possible.

- Be sure not to double count the effect of proposed mitigation measures. The project description and assumptions underlying the analysis of project impacts should be carefully considered when estimating the effect of mitigation measures. If certain conditions or behavior are assumed in the impact analysis, then credit may not be claimed when proposing mitigation measures.

- Health risk assessments discussed in this document estimate outdoor risk. While some mitigation measures may reduce risks by filtering outdoor air to be used indoors, they do nothing to reduce the risk assessment values for outdoor air.

8.3.2 Unquantifiable Mitigation Measures

In some cases, it simply may not be possible to quantify the effect of proposed mitigation measures. It may be that the specific conditions surrounding a particular project are so unique as to render extrapolation from other examples unreliable. A proposed measure may be innovative, with little precedent. The combined effects of a package of measures may be too difficult to quantify. While a certain degree of professional judgment is usually involved in estimating the effectiveness of mitigation measures, speculative estimates should be avoided. If the project proponent cannot quantify mitigation effectiveness with a reasonable degree of certainty, the environmental document should at least address effectiveness qualitatively. If the lead-agency makes a finding that non-quantified mitigation measures reduce an impact to a level of insignificance, the document should provide a detailed justification of that conclusion.

8.3.2.1 Effects of Vegetation Next to Roadways

The Sacramento Air District funded a study to measure the removal rates of particulate matter passing through leaves and needles of vegetation. Particles were generated in a wind tunnel and a static chamber and passed through vegetative layers at low wind velocities. Redwood, deodar cedar, live oak, and oleander were tested. The results from this study indicate that all forms of vegetation able to remove 65-85 percent of very fine particles at wind velocities below 1.5 meters per second (roughly 3 miles per hour) with redwood and deodar cedar being the most effective.

This study supports the effectiveness of planting finely needled trees along sources of toxic particulate matter as an air toxics mitigation measure. Though further studies that reflect actual roadway conditions are needed to better quantify the real-world effectiveness of this mitigation measure, projects that propose sensitive receptors adjacent to sources of particulate matter such as freeways, major roadways, rail lines, and rail

yards should consider tiered plantings of redwood and/or deodar cedar in order to reduce toxic exposures.

8.3.2.2 No Idle Zone

California law currently places restrictions on idling of heavy-duty diesel motor vehicles to reduce health risk impacts from diesel emissions. The 2003 school bus idling airborne toxic control measure (ATCM) requires a driver of a school bus or vehicle, transit bus, or other commercial motor vehicle to manually turn off the bus or vehicle engine upon arriving at a school and to restart no more than 30 seconds before departing. A driver of a school bus or vehicle is subject to the same requirement when operating within 100 feet of a school and is prohibited from idling more than five minutes at each stop beyond schools, such as parking or maintenance facilities, school bus stops, or school activity destinations.

California's more recent anti-idling regulations (with some exemptions) require that drivers of diesel-fueled commercial vehicles weighing more than 10,000 pounds:

- Shall not idle the vehicle's primary diesel engine for greater than 5 minutes at any location,
- Shall not use diesel-fueled auxiliary power units for more than 5 minutes to power a heater, air conditioner, or any ancillary equipment on the vehicle equipped with a sleeper berth, at any location.

Lead agencies may place additional requirements on heavy duty diesel delivery and haul trucks less than 10,000 pounds, and create "no idle" zones at locations where there is a potential for significant health risk. It may not be possible to quantify the emission reductions associated with the creation of a no idling zone. However, this feasible mitigation measure may eliminate idling emissions and may avoid potentially significant health risk impacts.

Table 3
Mitigation Measures

Source Category	Mitigation Measure (listed in order of effectiveness by category)
Stationary Sources Type A (Sources Impacting receptors) (e.g., Auto body shops, Gas Stations, Manufacturers, Metal Platers, Chemical Producers, Rock Quarries, Incinerators, Power Plants, Diesel Engines)	1. Move source location to provide effective buffer zone. 2. Reduce throughput. 3. Install Toxic Best Available Control Technology (TBACT) to reduce the risks to below significance. 4. Install other than TBACT air pollution control devices or process operation modifications. 5. Address Diesel vehicle engines as listed below.

Source Category	Mitigation Measure (listed in order of effectiveness by category)
Onsite Diesel Truck Activities (including transport refrigeration units)	Idling Mitigation Measures: 1. Move source location to provide effective buffer zone. 2. Establish truck parking restrictions. 3. Provide utility hook-ups for trucks that need to cool their load. 4. Limit truck idling to <5 minutes (State law limits to 5 minutes of idling, and includes various exemptions). 5. Require Trucks to operate an Auxiliary Power Unit. 6. Require the installation of electrical hookups at loading docks and the connection of trucks equipped with electrical hookups to eliminate the need to operate diesel-powered TRUs at the loading docks. Onsite Truck Traveling Emissions: 1. Move source location to provide effective buffer zone. 2. Restrict operation to 2007 model year or newer trucks. 3. Require or provide incentives to use Diesel Particulate Filters for truck engines. 4. Re-route truck traffic by adding alternate access for truck traffic or by restricting truck traffic on certain sensitive routes. 5. Improve traffic flow by signal synchronization. 6. Implement incentive for improved communications of fluctuating demand forecasts for labor and equipment among carriers and operators.
High-traffic road vehicle emissions impacting adjacent receptors	1. Move receptors or source to provide effective buffer zone between the source and the receptor. 2. Improve traffic flow by signal synchronization. 3. Plant vegetation between receptor and roadway. 4. Construct wall barriers between receptor and roadway. 5. Install newer electrostatic filters in adjacent receptor buildings. 6. Fund “clean” street sweepers. 7. Improve road infrastructure to facilitate improved traffic flow without inducing capacity. 8. Improve alternative transportation options
Freeway vehicle emissions impacting adjacent receptors	1. Move receptors or source to provide effective buffer zone between the source and the receptor. 2. Plant vegetation between receptor and roadway. 3. Construct wall barriers between receptor and roadway. 4. Install newer electrostatic filters in adjacent receptor buildings. 5. Improve road infrastructure to facilitate improved traffic flow.
Marine Vehicles (e.g., recreational boating, commercial marine operations, hoteling operations, loading and unloading services)	1. Move receptors or source to provide effective buffer zone between the source and the receptor. 2. Require or provide incentives to install add-on Diesel Particulate Matter control devices or cleaner engines or boilers. 3. Require use of electric power when berthed. 4. Require cleaner fuels. 5. Limit vessel speed.

Source Category	Mitigation Measure (listed in order of effectiveness by category)
Railroad (i.e., switch yards, maintenance yards, intermodal centers)	1. Move receptors or source to provide effective buffer zone between the source and the receptor. 2. When ambient temperatures are above 50 deg F, minimize locomotive engine idling by shutting down and re-starting engines. 3. Require Idle Reduction Technologies - The rail industry has developed and designed a new Auxiliary Power Unit (APU) system that provides power during idling conditions and shuts down the main locomotive engine. Installing APU system reduces locomotive PM emissions by 84 percent. 4. Require new engine technologies be applied to the engines - Modifying fuel injectors, which includes fuel injection pressure, fuel spray pattern, injection rate and timing, has been found to reduce emissions from locomotive diesel engines. 5. Require hybrid switcher locomotives. 6. Require use of locomotive technology that meets or exceeds the latest EPA emission regulations for locomotives. 7. Apply the 1998 Railroad MOU for South Coast Air Basin. 8. Apply the 2005 Statewide MOU for Rail Yard Risk Reduction.

8.4 Mitigation Monitoring and Reporting

8.4.1 Primary Mitigation Measures

As part of CEQA environmental review procedures, Pubic Resources Code Section 21081.6 requires a public agency to adopt a monitoring and reporting program for assessing and ensuring efficacy of mitigation measures applied to the proposed project. Specifically, the lead or responsible agency must adopt a reporting or monitoring program for mitigation measures incorporated into a project or imposed as conditions of approval. The program must be designed to ensure compliance during project implementation. As stated in Public Resources Code, Section 21081.6 (a) (1):

"The public agency shall adopt a reporting or monitoring program for the changes made to the project or conditions of project approval, adopted in order to mitigate or avoid significant effects on the environment. The reporting or monitoring program shall be designed to ensure compliance during project implementation. For those changes which have been required or incorporated into the project at the request of a responsible agency or a public agency having jurisdiction by law over natural resources affected by the project, that agency shall, if so requested by the lead agency or a responsible agency, prepare and submit a proposed reporting or monitoring program."

This requirement is intended to assure that mitigation measures included as conditions of project approval are indeed implemented. A mitigation monitoring and reporting program should include the following components:

- A description of each mitigation measure adopted by the Lead Agency.
- The party responsible for implementing each mitigation measure.
- A schedule for the implementation of each mitigation measure.
- The agency or entity responsible for monitoring mitigation measure implementation.
- Criteria for assessing whether each measure has been implemented.
- Enforcement mechanism(s).

The mitigation monitoring and reporting program is not required to be included in the environmental document, but its inclusion will encourage the Lead Agency and other entities to specifically consider the feasibility and effectiveness of each mitigation measure while the environmental analysis is still underway. If a responsible agency or any agency having jurisdiction over natural resources affected by the project proposes mitigation measures, the Lead Agency may require that agency to prepare a monitoring and reporting program for those mitigation measures.

8.4.2 Contingency Mitigation Measure

A mitigation implemented to reduce health risk for a particular project may degrade or fail over time. Continuous monitoring and enforcement programs are recommended to ensure the ongoing effectiveness of all mitigation measures over the project life. In the instance that one or more mitigation measures fail or become ineffective, they should be replaced with mitigation measures of equal or greater effectiveness.

Examples of health risk mitigation measures subject to degradation and/or failure include:

- Vegetation barriers, which may die due to natural causes or lack of upkeep;
- Particulate filters, which may become clogged, mechanically damaged or simply reach the end of their design life; and,
- Indoor air filtration systems, which may become clogged or fail completely due to lack of regular maintenance.

9.0 Public Participation

As emphasized in the ARB Handbook, community involvement is an important part of the overall land use approval process. Public participation is critical when proposed projects could create increased health risk to the individuals or the community. To that extent, engaging community members during the initial phase of the project evaluation process provides a communication conduit between impacted individuals, project proponents and the decision makers. This dialog aims to expand the community's overall understanding of the risk assessment process and the resulting health impact values. While the air district is not typically the lead agency for a project undergoing health risk evaluation, it plays a critical role in working with the impacted community to explain the technical modeling tools and assumptions used to calculate the overall risk values that are ultimately provided to local decision makers for approval action.

Active public participation requires engaging individuals in ways that do not require prior knowledge of air pollution issues impacting their communities. Information should be provided to illustrate how a land use decision can affect the health of the community due to emission impacts from Type A or to Type B projects. Due to the overly technical nature of health risk assessments, air districts need to take specific efforts to develop messages and outreach tools that will assist to convey complex issues to a non-technical community. The outreach process needed to build effective community participation requires data, methodologies and formats customized to the needs of the specific community. Depending on the community characteristics cultural barriers, such as translation to another language, need to be assessed prior to conducting community outreach. More importantly, it requires the strong collaboration of community members and agencies that review and approve projects and land uses of the local community.

The ARB Handbook's Table 7-1, Public Participation Approaches includes some general outreach strategies that air districts might consider in designing an outreach program to increase understanding of the air pollution impacts to specific land use projects. Such a program could consider the preparation and presentation of information in a way that supports sensible decision-making and public involvement. In order to build community trust in the health risk assessments being conducted for proposed development, public participation should occur at the initial phases of project evaluation and continue throughout the approval process.

10.0 HRA Issues in the CEQA Process

There are number of issues that have been encountered at the local decision making level that present challenges during the evaluation of health risk impacts from proposed land use projects. To provide more assistance to air districts, lead agencies and community members on how to overcome these challenges, this chapter outlines a few issues that have been encountered during the project evaluation phase, as well as potential solutions to reduce health risk, minimize errors and assist decision makers in their final action.

10.1 Smart Growth

Land use planners, developers, public health agencies and environmentalists alike all struggle with the apparent dichotomy between the public health benefits of limiting development adjacent to freeways and major roadways, and the public health benefits of smart growth strategies which call for development closer in to the urban core, often adjacent to major travel corridors, as a way to reduce overall emissions. Guidance that helps local planners disclose potential risk, and/or seeks to limit development adjacent to freeways and major roadways appears to conflict with smart growth policies, especially when the guidance affects small projects.

A potential solution to this dilemma is the identification and implementation of effective mitigation measures that will help reduce impacts to sensitive receptors, thereby supporting smart growth policies. Table 3 contains program-level TAC mitigation measures. Such measures are applicable to long-range community planning programs such as General Plans and address land use incompatibility at an early stage. These measures are particularly effective in that they can prevent many high-risk projects from being considered or proposed in the first place, thereby eliminating the necessity for project-level mitigation which may not always be feasible or sufficiently effective. Examples of program-level mitigation measures include rezoning vacant land adjacent to freeways, high-volume roadways, ports, railroads or heavy industry to avoid future proposed siting of residential and/or sensitive receptors.

10.2 Less than Lifetime Cancer Risk Exposures

The standard OEHHA 70 year exposure timeframe for HRAs is often vigorously challenged as to whether it is reasonable to base residential cancer risk on a 70 year, 24 hour per day, seven day per week exposure. A 70-year lifetime exposure is a worst-case assumption. Shorter exposure periods can be appropriate depending on the situation. The cancer risks caused by projects impacting offsite workers can be factored in accordance with guidance provide in the State Office of Environmental Health Hazard Assessment provided a document called the *Air Toxic Hot Spots Program Guidance Manual for the Preparation of Health Risk Assessments*, August 2003. This guidance document also describes how the exposure period can be reduced from 70 year to shorter periods for Type A projects that will operate for periods less than 70 years. This information is also included in the ***Technical Modeling and Risk Assessment Guidance*** component of this document in Attachment 1.

10.3 Mitigating Roadway Toxics

As discussed above, lead agencies often struggle with requiring mitigation when, due to a lack of a threshold, the roadway toxics impacts are not considered "significant." At other times, lead agencies are eager to require mitigation, but feel most comfortable being able to point to studies that quantify the actual mitigation levels before asking project proponents to bear the additional costs of the mitigation. In addition, lead agencies often do not feel comfortable asking a project to make changes via implementing mitigation when the project complies with existing zoning requirements and does not request exemptions. While this is a contentious issue, districts may choose to suggest mitigation measures regardless of whether a health risk determination was made by the lead agency.

10.4 Existing Background Risk

Often, environmental documents with site specific HRAs contain lengthy discussions comparing a project's health risk to the existing background health risk levels, and often, potential project-specific cancer risk levels are expressed as a percentage of the existing background risk without disclosure of the actual additional risk due to the project. It is the actual additional risk due to the project (Type A), or the risk to the project (Type B) that must be disclosed and compared to CEQA significance thresholds.

10.5 Inappropriate Discounting of Risks

Standardized health risk assessment methodologies have been developed to reduce inconsistencies between HRAs and aid in comparing impacts on receptors. However, in practice inappropriate HRA calculations are still carried out and presented as the basis for public disclosure and notification. Such inappropriate HRA calculations are most often made in an attempt to present reduced risk values compared to the higher results produced by standard methodologies. This is a significant concern, especially with respect to health risks associated with locating sensitive land uses in proximity to freeways and other high traffic roadways, where even the standardized HRA modeling methods may not thoroughly characterize all the health risk associated with nearby exposure to traffic generated pollutants.

Inappropriate HRA methodologies often result in protracted controversy, which is sometimes played out in the public arena - for example, at project approval hearings. To minimize these situations, the HRA preparer should adhere to the standard risk calculation methodologies set forth by OEHHA, the Air Resources Board, and the local air district, and as described in this document.

Examples of some mistakes to avoid are described in the following paragraphs.

- One inappropriate calculation is to calculate the cancer risk using the 70-year exposure timeframe, but then reduce the risk values by dividing the risk values by the number of receptors in the subdivision. Doing so is misleading and not scientifically supported. Potential cancer risk should be expressed as probability per million, based upon OEHHA recommendations.

- For Type A projects, it is also inappropriate to present risk values as a percentage of some existing risk value, such as the existing background risk. Often this is done in an attempt to persuade readers that the project specific risk is of little consequence because the increased risk is small compared to the background risk. In cases where project specific risk is compared to other risks or expressed as a percentage of the existing background, it should be made clear that the project specific risk is in addition to the existing background risk.

- Another inappropriate calculation sometimes included in risk assessments is to base emissions on emission factors that may result from future actions, such as emission reduction rules that have not yet gone into effect, or expected emission reductions due to expected market forces.

10.6 Misleading Comparison of Cancer Risks

Comparing cancer risks can be misleading in a CEQA document. Some CEQA documents discuss a variety of cancers and the prevalence of it in our population. It's sometimes stated, for example, that currently throughout the United States, one in three or four persons will experience cancer sometime during their lifetime. This can be a misleading statistic if it is used to imply that the incremental probability of increased cancer cases due to toxic airborne emissions are very small compared to the overall probability of cancer. For example, a Health Risk Assessment may find that the increased probability of cancer cases is 200 in one million for certain sensitive receptors located near a busy freeway. To compare that HRA result with the overall population's cancer incidence would discount the risk unfairly. The CEQA document should disclose the risk without any such comparisons.

10.7 "Experts Disagree"

When project proponents submit HRAs and related materials that are developed via methodologies not supported by the air district or OEHHA, protracted controversy can result. One air district noted that, despite comment from OEHHA and ongoing district comments on the inappropriate discounting of a project's HRA results, those results remained unchanged in the Final EIR. The Final EIR discussed the nature of the disagreement, citing Section 15151 of the CEQA Guidelines which states that disagreement among experts "does not make an EIR inadequate, but the EIR should summarize the main points of disagreement among experts." Ultimately, the lead agency will make a land use decision based on their understanding. But for sources that need an air district permit, the applicable air district's risk assessment procedures will apply.

11.0 Conclusion

The study of the impact of toxic air emissions on sensitive receptors is an evolving one. Air districts in the state of California generally have had a consistent way of performing health risk assessments of stationary sources on nearby sensitive receptors (Type A projects). However, with the publication in 2005 of ARB's Handbook, the issue of the effect of mobile sources on sensitive receptors (Type B projects) required air districts to augment their guidance. This CAPCOA guidance reflects the fact that currently, the various air districts in the state have different approaches to the topic. For example, some districts have developed a threshold of significance for these projects and some have not. Despite these differences, this document offers some common guidance about the need to analyze the impacts, to disclose the risk to decision makers and to mitigate it. As health risk analysis tools, methodology, and protocol as developed, the document will be revised.

Attachment 1

Technical Modeling and Risk Assessment Guidance

Prepared by
CAPCOA Planning Managers
HRA Subcommittee

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Preface

The document shows how to model emissions of toxic substances from various source types to determine the cancer risk, acute risk, and noncancer chronic risk impacting nearby receptors. It can also be used to determine the impacts to new receptors (such as housing projects) proposed to be built next to existing sources that emit toxic substances. These guidelines were prepared to assist in complying with the requirements of the California Environmental Quality Act (CEQA). CEQA requires that environmental impacts of a proposed project be identified, assessed, and mitigated (as possible) if the environmental impacts are significant.

This document consists of three components:

- Modeling Guidelines,
- Exposure Assessment Guidelines, and
- Appendices describing how to determine the emissions and risks from common source categories. Examples of these sources categories include:
  - Roadways,
  - Facilities with onsite truck travel and idling,
  - Stationary diesel engines, and
  - Fast food and other restaurants.

The modeling guidelines are based on a document entitled "Provision of Services to Develop Guidance for Air Dispersion Modeling," developed by Dr. Jesse Thé of Lakes Environmental Software. They have been modified to include various air quality dispersion modeling issues pertinent to California, and are based primarily on information found in EPA's Guideline on Air Quality Models (Appendix W of Part 51 of Title 40 of the Code of Federal Regulations). The modeling components are intended to provide insight into recommended modeling approaches and provide consistency in the modeling methods used.

The Exposure Assessment components are based on the procedures developed by the California Office of Environmental Health Hazard Assessment (OEHHA). These calculation methodologies may change over time as the OEHHA refines the methodologies. **It is important that the air district be contacted before any risk assessment calculations are prepared, so that the most current methodologies are applied.**

This document is not designed to provide theoretical background on the models it discusses. Technical documents covering these topics can be easily obtained from several U.S. EPA sources and are listed as references in this document. This document does provide details on performing a successful modeling study including:

- Model Backgrounds and Applicability,
- Model Selection and Study Approach,
- Tiered Approach to Assessing Compliance,
- Model Input Data Requirements,
- Geographical Information,
- Meteorological Data Requirements and Acquisition, and
- Information/Parameters for Inclusion in an Assessment.

Glossary of Terms

AERMAP:	The terrain preprocessor for AERMOD, AERMAP allows the use of digital terrain data in AERMOD.
AERMET:	The meteorological preprocessor for AERMOD.
AERMIC:	American Meteorological Society/Environmental Protection Agency Regulatory Model Improvement Committee.
AERMOD:	A new air dispersion model developed by AERMIC. It is intended to replace the ISCST model.
Air Emissions:	Release of pollutants into the air from a source.
Albedo:	Portion of the incoming solar radiation reflected and scattered back to space.
Ambient Air:	Air that is accessible to the public.
AMS:	American Meteorological Society.
CAL3QHCR:	CAL3QHCR is derived from CAL3QHC which is also derived from CALINE3. CALINE3 is a Carbon Monoxide (CO) model with queuing, hot spot calculations, and a traffic model to calculate delays and queues that occur at signalized intersections. CAL3QHCR is a more refined version requiring local meteorological data.
Calm:	Cessation of horizontal wind.
Complex Terrain:	Terrain exceeding the height of the stack being modeled.
DEM:	Digital Elevation Model. Digital files that contain terrain elevations typically at a consistent interval across a standard region of the Earth's surface.
Dispersion Model:	A group of related mathematical algorithms used to estimate (model) the dispersion of pollutants in the atmosphere due to transport by the mean (average) wind and small scale turbulence.
Emission Factor:	An estimate of the rate at which a pollutant is released to the atmosphere
Flagpole Receptor:	Any receptor located above ground level.

Inversion:	An increase in ambient air temperature with height. This is the opposite of the usual case.
ISCST:	Industrial Source Complex – Short Term Dispersion Model.
Lee side:	The lee side of a building is the side that is sheltered from the wind.
Mixing Height:	Top of the neutral or unstable layer and also the depth through which atmospheric pollutants are typically mixed by dispersive processes.
Monin-Obukhov Length:	A constant, characteristic length scale for any particular example of flow. It is negative in unstable conditions (upward heat flux), positive for stable conditions, and approach infinity as the actual lapse rate for ambient air reaches the dry adiabatic lapse rate.
NWS:	National Weather Service. A U.S. government organization associated with the National Oceanic and Atmosphere Administration.
PCRAMMET:	Meteorological program used for regulatory applications capable of processing twice-daily mixing heights (TD-9689 FORMAT) and hourly surface weather observations (CD-144 format) for use in dispersion models such as ISCST, CRSTER, MPTER and RAM.
Preferred Model:	A refined model that is recommended for a specific type of regulatory application.
Primary Pollutant:	Substance emitted from the source.
Regulatory Model:	A dispersion model that has been approved for use by the regulatory offices of the U.S. EPA, specifically one that is included in Appendix A of the Guideline on Air Quality Models (Revised), such as the ISC model.
Screening Technique:	A relatively simple analysis technique to determine if a given source is likely to pose a threat to air quality. Concentration estimates from screening techniques are conservative.
Simple Terrain:	An area where terrain features are all lower in elevation than the top of the stack of the source.
Upper Air Data (soundings):	Meteorological data obtained from balloon-borne instrumentation that provides information on pressure, temperature, humidity and wind away from the surface of the earth.

U.S. EPA:	United States Environmental Protection Agency.
Worst Case:	The maximum exposure, dose, or risk that can conceivably happen to specific receptors.

Chapter 1. A Tiered Approach to Risk

1.0 Modeling and Exposure Assessment Tiers Overview

Risk assessments are normally prepared in a tiered manner, where progressively more input data is collected to refine the results. Both the modeling component and the exposure assessment component are based on a tiered method. This document shows how to:

- Model the downwind concentrations of pollutants using each of the four modeling tiers (levels), then
- Use tiers to prepare the exposure assessment part of the risk assessment.

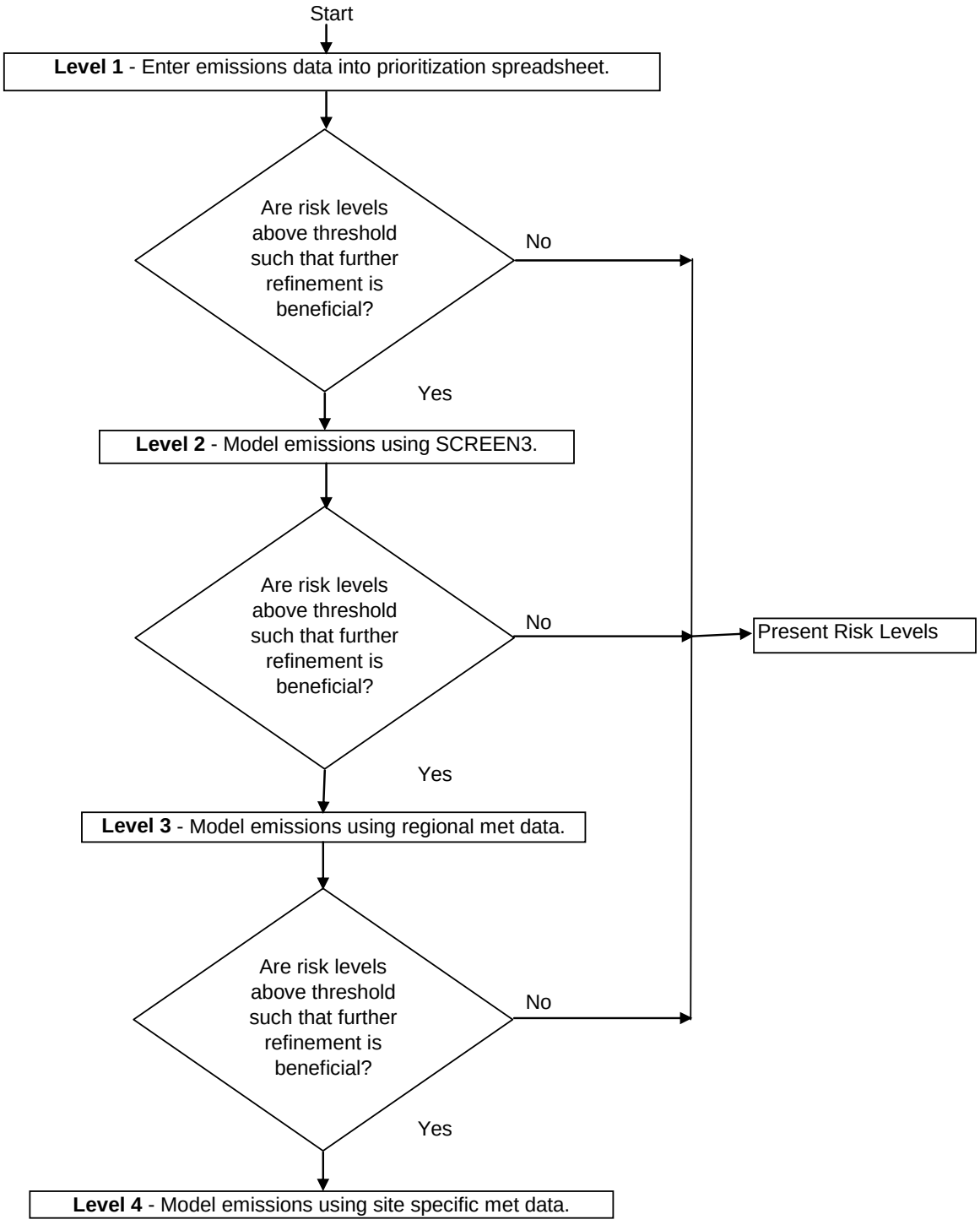
The models described in the document include:

- Screening models:
  - SCREEN3, and
  - AERSCREEN

- Refined models:
  - ISCST3,
  - ISC-PRIME, and
  - AERMOD
  - CAL3QHCR

A tiered approach to air dispersion modeling is presented in Figure 1. The level of effort generally increases with level number. It should be noted that any of the tiers or levels can provide risk assessment results, although the higher the tier or level the more accurate the results. Linear progression through each tier or level is not necessary. For example, a refined modeling analysis can be prepared without first preparing a screening analysis.

Figure 1 - Tiered approach to modeling for risk assessments:



1.1 Dispersion Models used for each TIER:

1.1.1 Level 1 – Prioritization Screening

A Level 1 analysis utilizes the CAPCOA prioritization methodology (http://www.arb.ca.gov/ab2588/RRAP-IWRA/priguide.pdf), or an air district's prioritization procedure to determine the potential impact from a facility's operation based on the quantity of emissions emitted and proximity to a receptor(s) and release height. But before preparing a Level 1 analysis, the air district should be consulted. A prioritization calculation is a screening tool that identifies whether a source has the possibility to exceed a prioritization score that represents the need for further analysis, usually this level is a score of ten

The following input data must be included in a prioritization calculation:

- The nearest receptor (residential or offsite worksite) must be used to represent all other receptors; regardless of the location of the receptor to the proposed project.
- Emissions should represent the "worst case" emissions estimate. Worst case for cancer risk is based on 70 years of exposure. Worst case for acute adverse health effects is based on the hour with the highest emissions. Worst case for chronic adverse health effects is based on the annual average emissions. These emissions should be based on actual expected worst case emissions, rather than a theoretical potential to emit estimate. The emissions should be routine and predictable.
- The prioritization calculations must follow those in the CAPCOA Prioritization Guidelines or the district's prioritization guidelines.

1.1.2 Level 2 - SCREEN3 Modeling

A Level 2 analysis is a screening level analysis using the U.S. EPA's SCREEN3 model, which includes all potential worst-case meteorological conditions. If a risk assessment based on SCREEN3 modeling shows risks below significance thresholds, then there is no need for additional modeling.

Note: At the time of writing this document, AERSCREEN remains unavailable and is currently in development. When AERSCREEN becomes available, it may be substituted for SCREEN3 in the multi-tier approach.

1.1.3 Level 3 – CAL3QHCR, ISCST3, or AERMOD modeling using Regional Met Data

A Level 3 analysis is a more refined analysis using CAL3QHCR, ISCST3, or AERMOD and regional hourly meteorological data. Contact the District regarding the availability of preprocessed meteorological data sets.

1.1.4 Level 4 - CAL3QHCR, ISCST3 or AERMOD Modeling using Site Specific Met Data

A Level 4 analysis is a more refined analysis using CAL3QHCR, ISCST3, or AERMOD and site specific hourly meteorological data. Contact the District regarding the availability of preprocessed meteorological data sets. This data typically must be pre-processed by the modeler or a meteorological data provider such as the National Weather Service (NWS). Local meteorological data sets include site-specific parameters and meteorological characteristics that directly represent the site of consideration with a greater level of detail than most regional data sets. A Level 4 analysis also encompasses modeling analyses that make use of any alternative models.

1.2 Exposure Assessment Tiers

When substances are emitted that can affect intake pathways other than inhalation, the use of the latest version of the Hot Spots Analysis and Reporting Program (HARP) modeling and risk assessment software is recommended. The latest version of HARP can be downloaded at http://www.arb.ca.gov/toxics/harp/harp.htm. If the emissions consist of only substances that enter the body through the inhalation pathway, other risk assessment methodologies consistent with the methodologies approved for the Air Toxics "Hot Spots" Emissions Inventory and Risk Assessment Program can be used. Most substances enter the body only through the inhalation pathway. Ingestion, dermal absorption, and other pathways are not usually significant pathways for emitted gases. Therefore, if all the substances impacting receptors only enter the body through inhalation, then the risk assessment preparation effort can be minimized. If just one substance can enter the body through another pathway, then a multipathway analysis must be prepared. An exception to this is diesel particulate, which is modeled only through the inhalation pathway.

The toxicity values that are used must be those that the California Office of Environmental Health Hazard Assessment (OEHHA) has identified. These toxicity values can be found at (http://www.arb.ca.gov/toxics/healthval/healthval.htm). If a substance is emitted and toxicity values have not been identified by OEHHA, other sources of data can be applied.

Although more detailed information can be found by directly reviewing the latest OEHHA risk assessment procedures, what follows is a description of the tiers associated with a multipathway exposure assessment. Additional information can be found at ARB's HARP websites and OEHHA's websites.

There are four basic tiers or levels that can be applied in the exposure assessment portion of the risk assessment:

Tier 1 -Point Estimate, Default Intake Values
The easiest tier to complete assumes various intake default values, and calculates the risk as a single value rather than a distribution curve.

Tier 2 -Point Estimate, Site Specific Intake Values
The next tier requires site specific information to determine intake values, but continues to apply single intake values to the risk values.

Tier 3 -Distribution Curve Risk Estimate, Default Distribution Curve Intake Values
The third tier applies default distribution curve values to determine a distribution curve risk result.

Tier 4 -Distribution Curve Risk Estimate, Site Specific Distribution Curve Intake Values

The fourth tier applies site specific distribution curve values to determine a distribution curve risk result.

1.3 Exposure Duration Adjustment (Cancer Only)

Cancer risk calculations are based on a 70 year lifetime exposure. In some limited cases, it may be appropriate to also use either 9 or 40 years exposure in the calculation. The 9 year exposure scenario is based on exposure to children during the first 9 years of life. Some districts use the 9 year exposure scenario to model short term projects The 40 year exposure scenario can be used to represent the risk to nearby workers. The local district should be contacted before using any exposure duration less than 70 years. In no case should an exposure period of less than 9 years be used.

Chapter 2. Application of Models

2.0 Modeling Overview

Air dispersion modeling is the mathematical estimation of pollutant impacts from emissions sources within a study area. Several factors impact the fate and transport of pollutants in the atmosphere including, but not limited to meteorological conditions, site configuration, emission release characteristics, and surrounding terrain.

2.1 Preferred Models

Preferred Models are defined as standard models that are expected to be used for air quality studies. Alternative models may be used if conditions warrant their use. These are outlined in Section 2.3. The U.S. EPA's preferred models include SCREEN3 for screening analyses and AERMOD for refined modeling analyses. For CEQA, CAL3QHCR, ISCST, and ISC-PRIME may also be used.

For efficient risk assessment processing, the district should be consulted to determine the appropriateness of the model proposed for use. A brief overview of each of these models can be found below. For appropriate model selection, please review the section that outlines:

2.1.1 AERMOD

The American Meteorological Society/EPA Regulatory Model Improvement Committee (AERMIC) Regulatory Model, AERMOD[1,2,3] was specially designed to support the U.S. EPA's

[1] U.S. Environmental Protection Agency, 1998. Revised Draft - User's Guide for the AMS/EPA Regulatory Model – AERMOD. Office of Air Quality Planning and Standards, Research Triangle Park, NC.

[2] Paine, R.J., R.W. Brode, R.B. Wilson, A.J. Cimorelli, S.G. Perry, J.C. Weil, A. Venkatram, W.D. Peters and R.F. Lee, 2003. AERMOD: The Latest Features and Evaluation Results. Paper # 69878 presented at the Air and Waste Management Association 96th Annual Conference and Exhibition, June 22-26, 2003. Air and Waste Management Association, Pittsburgh, PA 15222.

[3] Cimorelli, A.J., S.G. Perry, A. Venkatram, J.C. Weil, R.J. Paine, R.B. Wilson, R.F. Lee, W.D. Peters, R.W. Brode, J.O. Paumier, 2002: AERMOD: Description of Model Formulation. U.S. Environmental Protection Agency, EPA-454/R-02-002d (draft dated October 31, 2002). Available from http://www.epa.gov/scram001.

regulatory modeling programs. AERMOD is the next-generation air dispersion model that incorporates concepts such as planetary boundary layer theory and advanced methods for handling complex terrain. AERMOD was developed to replace the Industrial Source Complex Model-Short Term (ISCST3) as U.S. EPA's preferred model for most small-scale regulatory applications.[4,5] The latest versions of AERMOD also incorporate the Plume Rise Model Enhancements (PRIME) building downwash algorithms, which provide a more realistic handling of downwash effects than previous approaches.

The PRIME model was designed to incorporate two fundamental features associated with building downwash:

- Enhanced plume dispersion coefficients due to the turbulent wake.
- Reduced plume rise caused by a combination of the descending streamlines in the lee of the building and the increased entrainment in the wake.

AERMOD contains basically the same options as the ISCST3 model with a few exceptions, which are described below:

- Currently, the model only calculates concentration values. Dry and wet deposition algorithms were not implemented at the time this document was written.
- AERMOD requires two types of meteorological data files, a file containing surface scalar parameters and a file containing vertical profiles. These two files are produced by the U.S. EPA AERMET meteorological preprocessor program[4].
- For applications involving elevated terrain, the user must also input a hill height scale along with the receptor elevation. The U.S. EPA AERMAP terrain-preprocessing program[6] can be used to generate hill height scales as well as terrain elevations for all receptor locations.

The options AERMOD has in common with ISCST3 and ISC-PRIME are described in the next section.

2.1.2 ISCST3 & ISC-PRIME Overview

The ISCST3 dispersion model is a steady-state Gaussian plume model, which can be used to assess pollutant concentrations and/or deposition fluxes from a wide variety of sources associated with an industrial source complex. The ISCST3 dispersion model from the U.S. EPA was designed to support the EPA's regulatory modeling options, as specified in the Guidelines on Air Quality Models (Revised)[7].

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[4] U.S. Environmental Protection Agency, 1995. User's Guide for the Industrial Source Complex (ISC3) Dispersion Models (Revised), Volume 1. EPA-454/B-95-003a. Office of Air Quality Planning and Standards, Research Triangle Park, NC.

[5] U.S. Environmental Protection Agency, 1995. User's Guide for the Industrial Source Complex (ISC3) Dispersion Models, Volume II – Description of Algorithms. U.S. Environmental Protection Agency, Research Triangle Park, NC 27711. Available from website http://www.epa.gov/scram001 as of January 2003.

[6] U.S. Environmental Protection Agency, 1998. Revised Draft - User's Guide for the AERMOD Terrain Preprocessor (AERMAP). Office of Air Quality Planning and Standards, Research Triangle Park, NC.

[7] U.S. Environmental Protection Agency, 1986. Guidelines on Air Quality Models (Revised) and Supplement A. EPA-450/2-78-027R. U.S. Environmental Protection Agency, Research Triangle Park, NC.

The PRIME algorithms have been integrated into the ISCST3 (Version 96113) model. This integrated model is called ISC-PRIME[8]. The ISC-PRIME model uses the standard ISCST3 input file with a few modifications in the Source Pathway section. These modifications include three new inputs that which are used to describe the building/stack configuration.

To be able to run the ISC-PRIME model, you must first perform building downwash analysis using the Building Profile Input Program (BPIP). For more information on building downwash please refer to Section 3.8 - Building Impacts.

Some of the ISCST3/ISC-PRIME modeling capabilities are:

- ISC-PRIME model may be used to model primary pollutants and continuous releases of toxic and hazardous pollutants.
- ISC-PRIME model can handle multiple sources, including point, volume, area, and open pit source types. Line sources may also be modeled as a string of volume sources or as elongated area sources.
- Source emission rates can be treated as constant or may be varied by month, season, hour-of-day, or other periods of variation. These variable emission rate factors may be specified for a single source or for a group of sources.
- The model can account for the effects of aerodynamic downwash due to nearby buildings on point source emissions.
- The model contains algorithms for modeling the effects of settling and removal (through dry deposition) of large particulates and for modeling the effects of precipitation scavenging for gases or particulates.
- Receptor locations can be specified as gridded and/or discrete receptors in a Cartesian or polar coordinate system.
- ISC-PRIME incorporates the COMPLEX1 screening model dispersion algorithms for receptors in complex terrain.
- ISC-PRIME model uses real hourly meteorological data to account for the atmospheric conditions that affect the distribution of air pollution impacts on the modeling area.
- Results can be output for concentration, total deposition flux, dry deposition flux, and/or wet deposition flux. Until AERMOD has incorporated deposition, ISC-PRIME would be the preferred model for applications such as risk assessment where deposition estimates are required.

Unlike AERMOD, the ISC models do not contain a terrain pre-processor. As a result, receptor elevation data must be obtained through alternative means. The use of an inverse distance algorithm for interpolating representative receptor elevations is an effective method.

[8] U.S. Environmental Protection Agency, 1997. Addendum to ISC3 User's Guide – The Prime Plume Rise and Building Downwash Model. Submitted by Electric Power Research Institute. Prepared by Earth Tech, Inc., Concord, MA.

2.1.3 SCREEN3 Overview

The SCREEN3 model was developed to provide an easy-to-use method of obtaining pollutant concentration estimates. These estimates are based on the document "Screening Procedures for Estimating the Air Quality Impact of Stationary Sources"[9].

SCREEN3, version 3.0 of the SCREEN3 model, can perform all the single source short-term calculations in the EPA screening procedures document, including:

- Estimating maximum ground-level concentrations and the distance to the maximum.
- Incorporating the effects of building downwash on the maximum concentrations for both the near wake and far wake regions.
- Estimating concentrations in the cavity recirculation zone.
- Estimating concentrations due to inversion break-up and shoreline fumigation.
- Determining plume rise for flare releases.

EPA's SCREEN3[10] model can also:

- Incorporate the effects of simple elevated terrain (i.e., terrain not above stack top) on maximum concentrations.
- Estimate 24-hour average concentrations due to plume impaction in complex terrain (i.e., terrain above stack top) using the VALLEY model 24-hour screening procedure.
- Model simple area sources using a numerical integration approach.
- Calculate the maximum concentration at any number of user-specified distances in flat or elevated simple terrain, including distances out to 100 km for long-range transport.
- Examine a full range of meteorological conditions, including all stability classes and wind speeds to find maximum impacts.
- Include the effects of buoyancy-induced dispersion (BID).
- Explicitly calculate the effects of multiple reflections of the plume off the elevated inversion and off the ground when calculating concentrations under limited mixing conditions.

2.1.4 CAL3QHCR Overview

"CAL3QHCR is a refined version of the original CALINE (California Line Source Dispersion Model) that was developed as a modeling tool to predict roadside CO concentrations. CAL3QHCR can be used to estimate ambient PM concentrations and to process hourly meteorological data over a year, hourly emissions, traffic volume, and signal data. The model can be obtained from EPA at http://www.epa.gov/scram001/dispersion_prefrec.htm.

[9] U.S. Environmental Protection Agency, 1992: Screening Procedures for Estimating the Air Quality Impact of Stationary Sources, Revised, October 1992 (EPA-450/R-92-019),
User's Guide for the Industrial Source Complex (ISC2) Dispersion Models: Volume II—Description of Model Algorithms. U.S. Environmental Protection Agency, OAQPS, Research Triangle Park, NC 27711. Publication No. EPA-450/4-92-008b.

[10] U.S. Environmental Protection Agency, 1995. SCREEN3 Model User's Guide. EPA-454/B-95-004. Office of Air Quality Planning and Standards, Research Triangle Park, NC.

2.2 ISC and AERMOD Model Comparison

The ISC and AERMOD models share several similarities:

- Both are steady state plume models
- AERMOD input and output are intentionally similar to ISC for ease of use

AERMOD is a next-generation model, and while input and output may share similarities in format, there are several differences as detailed in the table below.

Table 2 – Differences between ISCST3 and AERMOD

ISCST3	AERMOD
Plume is always Gaussian	Plume is non-Gaussian when appropriate
Dispersion is function of six stability classes only	Dispersion is function of continuous stability parameters and height
Measured turbulence cannot be used	Measured turbulence can be used
Wind speed is scaled to stack height	Calculates effective speed through the plume
Mixing height is interpolated	Mixing height is calculated from met data
Plume either totally penetrates the inversion, or not at all	Plume may partially penetrate the inversion at the mixing height
Terrain is treated very simplistically	More realistic terrain treatment, using dividing streamline concept
Uses single dispersion for all urban areas	Adjusts dispersion to size of urban area
Cannot mix urban and rural sources	Can mix urban and rural sources

2.3 Alternative Models

Alternative models may also be accepted to determine health risks for CEQA projects. Please see the Guideline on Air Quality Models (published as Appendix W of 40 CFR Part 51) for terms of appropriate use and required supporting explanations. **Please note,** pre-approval is normally sought from the district before using alternative models.

2.4 Model Validations

The U.S. EPA ISCST3 / ISC-PRIME and AERMOD models are some of the most studied and validated models in the world. Studies have typically demonstrated good correlation with real-world values. AERMOD particularly handles complex terrain very well, closely matching the trends of field observations from validation studies.

ISC-PRIME differs from ISCST3 primarily in its use of the PRIME downwash algorithm. A model evaluation study was carried out under the auspices of the Electric Power Research Institute

(EPRI). The report[11] is available from EPRI and from the U.S. EPA SCRAM website http://www.epa.gov/scram001. The report analyzed comparisons between model predictions and measured data from four databases involving significant building downwash. This is in addition to 10 additional databases that were used during the development of ISC-PRIME. The study found that ISC-PRIME performed much better than ISCST3 under stable conditions, where ISCST3 predictions were very conservative (high). In general, ISC-PRIME was unbiased or somewhat over predicting. Also, ISC-PRIME showed a statistically better performance result than ISCST3 for each database in the study.

The U.S. EPA performed the evaluation of AERMOD. A summary of the evaluation studies was prepared by Paine, et al[12]. This and more detailed reports can be found at the U.S. EPA SCRAM website. Five databases were used during the development of the model. Five additional non-downwash databases were used in the final evaluation. For cases involving building downwash, four developmental databases were used to check the implementation of PRIME into AERMOD as it was accomplished. Three additional databases were reserved for the final evaluation. AERMOD remained unbiased for complex terrain databases as well as flat terrain, while ISCST3 severely over-predicted for complex terrain databases.

Chapter 3. MODEL INPUT DATA

3.0 Comparison of Screening and Refined Model Requirements

The use of the screen model requires the least amount of effort to calculate risks but produces the most conservative results. The SCREEN3 model input requirements are described in the next section.

Refined air dispersion modeling using the U.S. EPA AERMOD or ISCST3 / ISC-PRIME models can be broken down into a series of steps. These are outlined in Sections 3.2 and 3.3.

A general overview of the process typically followed for performing an air dispersion modeling assessment is present in Figure 3.1 below. The figure is not meant to be exhaustive in all data elements, but rather provides a picture of the major steps involved in an assessment.

[11] Paine, R.J. and F. Lew, 1997. Results of the Independent Evaluation of ISCST3 and ISC-PRIME. EPRI Paper No. TR2460026, WO3527-02, Final Report. Electric Power Research Institute, Palo Alto, CA 94304.

[12] Paine, R.J., R.W. Brode, R.B. Wilson, A.J. Cimorelli, S.G. Perry, J.C. Weil, A. Venkatram, W.D. Peters and R.F. Lee, 2003. AERMOD: The Latest Features and Evaluation Results. Paper # 69878 presented at the Air and Waste Management Association 96th Annual Conference and Exhibition, June 22-26, 2003. Air and Waste Management Association, Pittsburgh, PA 15222.

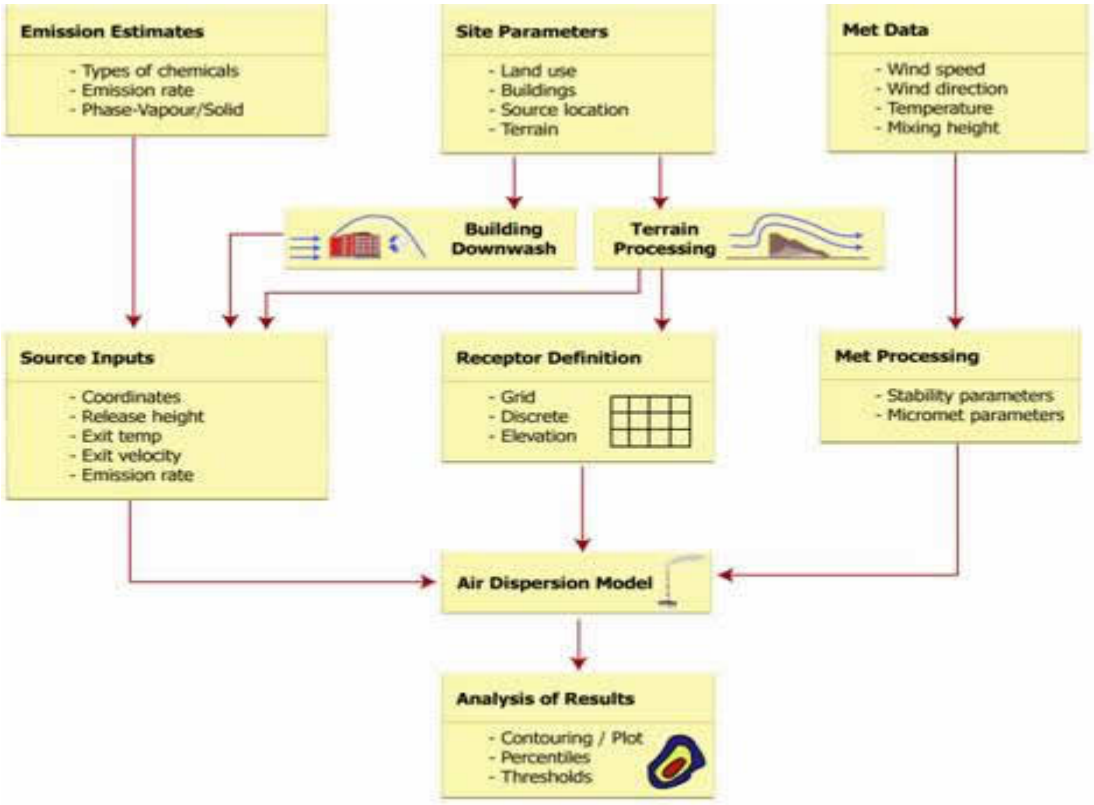


Figure 3.1 - Generalized process for performing a refined air dispersion modeling assessment.

3.1 SCREEN3

The SCREEN model[13] was developed to provide an easy-to-use method of obtaining pollutant concentration estimates. This model is normally used as an initial screening tool to assess **single sources** of emissions. SCREEN3 can be applied to multi-source facilities by conservatively summing the maximum concentrations for the individual emissions sources.

To perform a modeling study using SCREEN3, data for the following input requirements must be supplied:

- Source Type (Point, Flare, Area or Volume)
- Physical Source and Emissions Characteristics.
  (For example, a point source requires:
  - Emission Rate
  - Stack Height
  - Stack Inside Diameter
  - Stack Gas Exit Velocity
  - Stack Gas Exit Temperature
  - Ambient Air Temperature

[13] U.S. Environmental Protection Agency, 1995. SCREEN3 Model User's Guide. EPA-454/B-95-004. Office of Air Quality Planning and Standards, Research Triangle Park, NC.

    - Receptor Height Above Ground
- Meteorology: SCREEN3 can consider all conditions, or a specific stability class and wind speed can be provided.
    - If a single wind speed/stability combination is used, the predicted concentration should only be used to determine hourly concentration, as the factors used to convert hourly concentration to annual concentrations are only valid when SCREEN3 is ran with full meteorological data selected.
- Building Downwash: If this option is used then building dimensions (height, length and width) must be specified.
- Terrain: SCREEN3 supports flat, elevated and complex terrain. If elevated or complex terrain is used, distance and terrain heights must be provided.
- Fumigation: SCREEN3 supports shoreline fumigation. If used, distance to shoreline must be provided.

As can be seen above, the input requirements are minimal to perform a screening analysis using SCREEN3. The refined models discussed in the next sections, have much more detailed options allowing for greater characterization and more representative results.

3.2 AERMOD

The supported refined models have many input options, and are described further throughout this document as well as in their own respective technical documents[14,15,16,17]. An overview of the modeling approach and general steps for using each refined model are provided below. The general process for performing an air dispersion study using AERMOD includes:

- Meteorological Data Processing (AERMET is used for this)
- Obtain Digital Terrain Elevation Data (If terrain is being considered)
- Building Downwash Analysis (BPIP-PRIME is used for this) – Project requires source and building information
- Final site characterization – complete source and receptor information
- AERMAP – Perform terrain data pre-processing for AERMOD air dispersion model if required.
- AERMOD – Run the model.
- Visualize and analyze results.

[14] Cimorelli, A.J., S.G. Perry, A. Venkatram, J.C. Weil, R.J. Paine, R.B. Wilson, R.F. Lee, W.D. Peters, R.W. Brode, J.O. Paumier, 2002: AERMOD: Description of Model Formulation. U.S. Environmental Protection Agency, EPA-454/R-02-002d (draft dated October 31, 2002). Available from http://www.epa.gov/scram001.

[15] U.S. Environmental Protection Agency, 1995. User's Guide for the Industrial Source Complex (ISC3) Dispersion Models (Revised), Volume 1. EPA-454/B-95-003a. Office of Air Quality Planning and Standards, Research Triangle Park, NC.

[16] U.S. Environmental Protection Agency, 1995. User's Guide for the Industrial Source Complex (ISC3) Dispersion Models, Volume II – Description of Algorithms. U.S. Environmental Protection Agency, Research Triangle Park, NC 27711. Available from website http://www.epa.gov/scram001 as of January 2003.

[17] U.S. Environmental Protection Agency, 1997. Addendum to ISC3 User's Guide – The Prime Plume Rise and Building Downwash Model. Submitted by Electric Power Research Institute. Prepared by Earth Tech, Inc., Concord, MA.

As can be seen above, the AERMOD modeling system is comprised of 3 primary components as outlined below and illustrated in Figure 3.2:

- AERMET – Meteorological Data Preprocessor
- AERMAP – Digital Terrain Preprocessor
- AERMOD – Air dispersion model

To successfully perform a complex terrain air dispersion modeling analysis-using AERMOD, you must complete the processing steps required by AERMET and AERMAP. See Appendix A for more information on meteorological data.

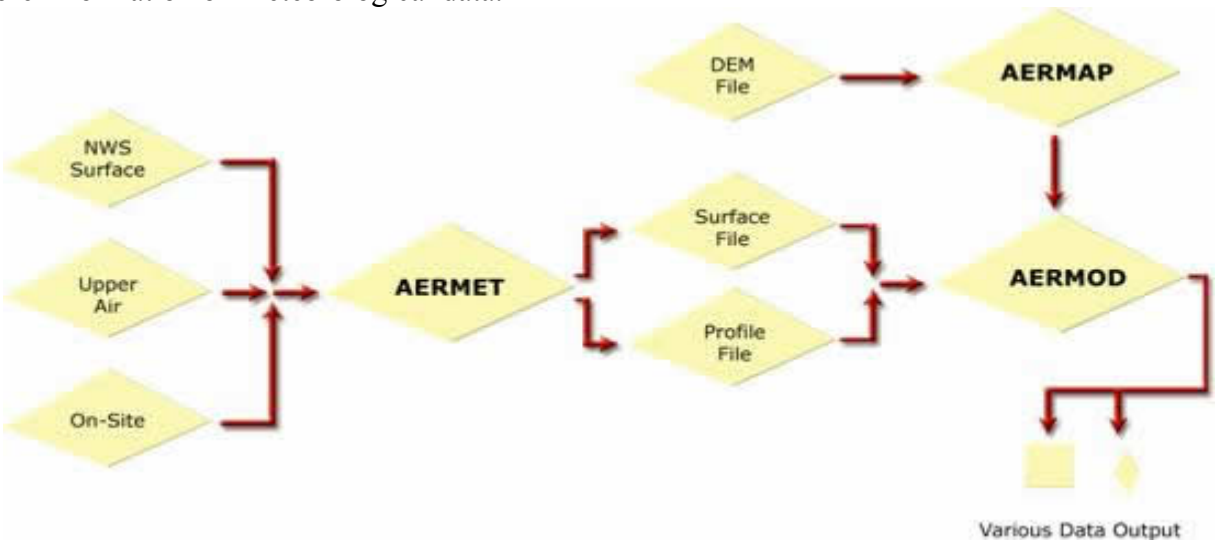


Figure 3.2 - The AERMOD air dispersion modeling system.

3.3 ISC-PRIME

The ISC-PRIME model has very similar input requirements when compared with AERMOD. These include:

- Meteorological Data Processing - PCRAMMET
- Obtain Digital Terrain Elevation Data (If terrain is being considered)
- Building Downwash Analysis (BPIP-PRIME) – Project requires source and building information
- Final site characterization – complete source and receptor information
- ISC-PRIME – Run the ISC-PRIME model.
- Visualize and analyze results.

As can be seen above, the ISC and AERMOD models follow a very similar approach to perform an air dispersion modeling project. The primary difference between running the ISC and AERMOD models is that ISC does not require a terrain preprocessor, such as AERMAP. Furthermore, ISC relies on a different meteorological preprocessor known as PCRAMMET. The components of meteorological data pre-processing using PCRAMMET are illustrated in Figure 3.3 below. For a complete outline on how to obtain meteorological data, please see Appendix A.

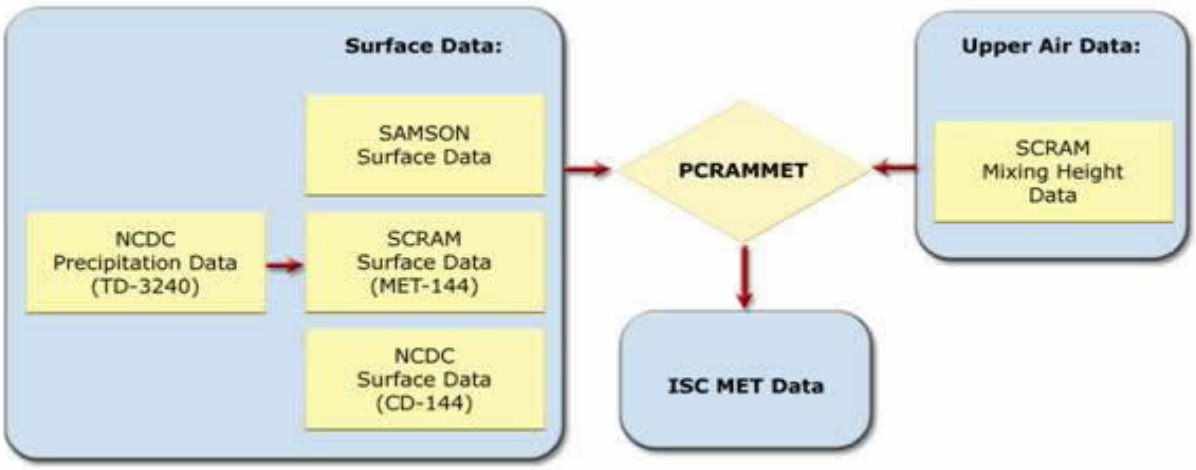


Figure 3.3 - Meteorological data pre-processing flow diagram for the U.S. EPA ISC models

3.4 Regulatory and Non-Regulatory Option Use

The ISC-PRIME and AERMOD models contain several regulatory options, which are set by default, as well as non-regulatory options. Depending on the model, the non-regulatory options can include:

- No stack-tip downwash (NOSTD)
- Missing data processing routine (MSGPRO)
- Bypass the calms processing routine (NOCALM)
- Gradual plume rise (GRDRISM)
- No buoyancy-induced dispersion (NOBID)
- Air Toxics Options (TOXICS)
- By-pass date checking for non-sequential met data file (**AERMOD**)
- Flat terrain (FLAT) (**AERMOD**)

The use of any non-regulatory default option(s) must be justified through a discussion in the modeling report and approved by the district before performing any modeling runs. Regulatory models that account for elevated terrain should be used when appropriate.

3.5 Coordinate System

Any modeling assessment will require a coordinate system to be defined in order to assess the relative distances from sources and receptors and, where necessary, to consider other geographical features. Employing a standard coordinate system for all projects increases the efficiency of the review process while providing real-world information about the site location. The AERMOD model's terrain pre-processor, AERMAP, requires digital terrain in Universal Transverse Mercator (UTM) coordinates. The UTM system uses meters as its basic unit of measurement and allows for more precise definition of specific locations than latitude/longitude.

For more information on coordinate systems and geographical information inputs, see Section 6.

3.6 Averaging Times

A key advantage to the more refined air dispersion models is the ability to compare effects-based standards with appropriate averaging times. OEHHA assigns different exposure periods to different health effects. For example, cancer risks are assessed for "lifetime" exposure. Chronic noncancer health effects are calculated for long-term, but not necessarily lifetime exposures. Acute noncancer health effects are usually based on a maximum 1-hour exposure, but there are some exceptions, such as benzene which is based on a maximum 6 hour exposure. Use of effects-based averaging times enables a contaminant to be assessed using modeled exposure concentrations for the appropriate averaging period for that contaminant and endpoint.

In addition to enabling the use of appropriate model averaging times, refined models allow the input of variable emission rates, where appropriate, for assessing concentrations over different averaging times. That is, a source that operates only during certain hours of the day can be modeled using only those hours of meteorology data.

The ability to assess air quality using the most appropriate effects-based averaging time means the refined air dispersion models provide a more representative assessment of health and environmental impacts of air emissions from a facility.

3.7 Defining Sources

3.7.1 Point, Area, Volume, and Flare Emissions Release Parameters Required for each Model

The U.S. EPA SCREEN3, ISCST3, ISC-PRIME and AERMOD models support a variety of source types that can be used to characterize most emissions within a study area. The following sections outline the primary source types and their input requirements for both screening and refined models. Detailed descriptions on the input fields for these models can be found for SCREEN3 in U.S. EPA[18], for ISC-PRIME in U.S. EPA[19,20], and for AERMOD in U.S. EPA[21].

[18] U.S. Environmental Protection Agency, 1995. SCREEN3 Model User's Guide. EPA-454/B-95-004. Office of Air Quality Planning and Standards, Research Triangle Park, NC.

[19] U.S. Environmental Protection Agency, 1995. User's Guide for the Industrial Source Complex (ISC3) Dispersion Models (Revised), Volume 1. EPA-454/B-95-003a. Office of Air Quality Planning and Standards, Research Triangle Park, NC.

[20] U.S. Environmental Protection Agency, 1997. Addendum to ISC3 User's Guide – The Prime Plume Rise and Building Downwash Model. Submitted by Electric Power Research Institute. Prepared by Earth Tech, Inc., Concord, MA.

[21] Cimorelli, A.J., S.G. Perry, A. Venkatram, J.C. Weil, R.J. Paine, R.B. Wilson, R.F. Lee, W.D. Peters, R.W. Brode, J.O. Paumier, 2002: AERMOD: Description of Model Formulation. U.S. Environmental Protection Agency, EPA-454/R-02-002d (draft dated October 31, 2002). Available from http://www.epa.gov/scram001.

3.7.1.1 Point Sources

Point sources are typically used when modeling releases from sources like stacks and isolated vents. Input requirements for point sources include:

SCREEN3

- **Emission Rate** [g/sec]: The emission rate of the pollutant.
- **Stack Height** [m]: The stack height above ground.
- **Stack Inside Diameter** [m]: The inner diameter of the stack.
- **Stack Gas Exit Velocity** [m/s] or Stack Gas Exit Flow Rate [m3/s]: Either the stack gas exit velocity or the stack gas exit flow rate should be given. The exit velocity can be determined from the following formula:

  $V_s = 4*V/(\pi*(d_s\text{^}2))$

  Where,

  V_s = Exit Velocity
  V = Flow Rate
  d_s = Stack Inside Diameter

- **Stack Gas Temperature** [K]: The temperature of the released gas in degrees Kelvin.
- **Ambient Air Temperature** [K]: The average atmospheric temperature (K) in the vicinity of the source. If no ambient temperature data are available, assume a default value of 293 degrees Kelvin (K). For non-buoyant releases, the user should input the same value for the stack temperature and ambient temperature.

AERMOD/ISCST/ISC-PRIME

- **Source ID**: An identification name for the source being defined, up to 8 characters in length.
- **X Coordinate**: The x (east-west) coordinate for the source location in meters (center of the point source).
- **Y Coordinate**: Enter here the y (north-south) coordinate for the source location in meters (center of the point source).
- **Base Elevation** [m]: The source base elevation. The model only uses the source base elevation if Elevated terrain is being used.
- **Release Height above Ground** [m]: The source release height above the ground in meters.
- **Emission Rate** [g/sec]: The emission rate of the pollutant in grams per second. Stack Gas Exit Temperature [K]: The temperature of the released gas in degrees Kelvin.
- **Stack Gas Exit Velocity** [g/sec]: The stack gas exit velocity in meters per second or the stack gas flow rate (see above section on SCREEN3).
- **Stack Inside Diameter** [m]: The inner diameter of the stack.

3.7.1.2 Area Sources

Area sources are used to model releases that occur over an area (e.g., landfills, storage piles, slag dumps, and lagoons). SCREEN3 allows definition of a rectangular area, aligned with the north-

south axes, while the ISC-PRIME and AERMOD models accept rectangular areas that may also have a rotational angle specified relative to a north-south orientation, as well as a variety of other shapes.

SCREEN3

- **Emission Rate** [g/(s-m^2)]: The emission rate of the pollutant. The emission rate for area sources is input as an emission rate per unit area (g/(s-m^2)).
- **Source Release Height** [m]: The source release height above ground.
- **Longer Side Length of Rectangular Area** [m]: The longer side of the rectangular source in meters.
- **Shorter Side Length of Rectangular Area** [m]: The shorter side of the rectangular source in meters.
- **Wind Direction Search Option**: Since the concentration at a particular distance downwind from a rectangular area is dependent on the orientation of the area relative to the wind direction, the SCREEN model provides the user with two options for treating wind direction. The regulatory default option is "yes" which results in a search of a range of wind directions. See U.S. EPA[22] for more detailed information.

AERMOD/ISC-PRIME

- **Source ID**: An identification name for the source being defined, up to 8 characters in length.
- **X Coordinate**: The x (east-west) coordinate for the vertex (corner) of the area source that occurs in the southwest quadrant of the source. Units are in meters.
- **Y Coordinate**: The y (north-south) coordinate for the vertex (corner) of the area source that occurs in the southwest quadrant of the source. Units are in meters.
- **Base Elevation** [m]: The source base elevation. The model only uses the source base elevation if elevated terrain is being used. The default unit is meters.
- **Release Height above Ground** [m]: The release height above ground in meters.
- **Emission Rate** [g/(s-m^2)]: Enter the emission rate of the pollutant. The emission rate for Area sources is input as an emission rate per unit area. The same emission rate is used for both concentration and deposition calculations.
- Options for Defining Area: In ISC-PRIME the only option for defining the area is a rectangle or square. The maximum length/width aspect ratio for area sources is 10 to 1. If this is exceeded, then the area should be divided to achieve a 10 to 1 aspect ratio (or less) for all sub-areas. See U.S. EPA[23] for more details on inputting area data. In addition to the rectangular area, AERMOD can have circular or polygon areas defined (see U.S. EPA[24] for details).

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[22] U.S. Environmental Protection Agency, 1995. Quality Assurance Handbook for Air Pollution Measurement Systems. Vol. IV, Meteorological Measurements. EPA/600/R-94/038d, U.S. Environmental Protection Agency, Research Triangle Park, NC 27711. Also available from the following website as of February 2003: http://www.epa.gov/scram001.

[23] U.S. Environmental Protection Agency, 1995. User's Guide for the Industrial Source Complex (ISC3) Dispersion Models (Revised), Volume 1. EPA-454/B-95-003a. Office of Air Quality Planning and Standards, Research Triangle Park, NC.

[24] Cimorelli, A.J., S.G. Perry, A. Venkatram, J.C. Weil, R.J. Paine, R.B. Wilson, R.F. Lee, W.D. Peters, R.W. Brode, J.O. Paumier, 2002: AERMOD: Description of Model Formulation. U.S. Environmental Protection Agency, EPA-454/R-02-002d (draft dated October 31, 2002). Available from http://www.epa.gov/scram001.

Note: There are no restrictions on the location of receptors relative to area sources. Receptors may be placed within the area and at the edge of an area. The U.S. EPA models (ISCST3, ISC-PRIME, and AERMOD) will integrate over the portion of the area that is upwind of the receptor. The numerical integration is not performed for portions of the area that are closer than 1.0 meter upwind of the receptor. Therefore, caution should be used when placing receptors within or adjacent to areas that are less than a few meters wide.

3.7.1.3 Volume Sources

Volume sources are used to model releases from a variety of industrial sources, such as building roof monitors, fugitive leaks from an industrial facility, multiple vents, and conveyor belts.

SCREEN3

- **Emission Rate** [g/sec]: The emission rate of the pollutant in grams per second (g/s).
- **Source Release Height** [m]: The source release height above ground surface at the center of the volume.
- **Initial Lateral Dimension** [m]: See Table 3.1 below for guidance on determining initial dimensions. Units are meters.
- **Initial Vertical Dimension** [m]: See Table 3.1 below for guidance on determining initial dimensions. Units are meters.

Table 3.1 Summary of Suggested Procedures for Estimating Initial Lateral Dimension ($_{yo}$) and Initial Vertical Dimension ($_{zo}$) for Volume and Line Sources.

Type of Source	Procedure for Obtaining Initial Dimension
Initial Lateral Dimension	
Single Volume Source	S_{yo} = (side length)/4.3
Line Source (Represented by Adjacent Volume Sources)	S_{yo} = (side length)/2.15
Line Source (Represented by Separated Volume Sources)	S_{yo} = (center to center distance)/2.15
Initial Vertical Dimension	
Surface-Based Source ($h_e \sim 0$)	S_{zo} = (vertical dimension of source)/2.15
Elevated Source ($h_e > 0$) on or Adjacent to a Building	S_{zo} = (building height)/2.15
Elevated Source ($h_e > 0$) not on or Adjacent to a Building	S_{zo} = (vertical dimension of source)/4.3

AERMOD/ISCST3/ISC-PRIME

- **Source ID**: An identification name for the source being defined, up to 8 characters in length.
- **X Coordinate**: The x (east-west) coordinate for the source location in meters. This location is the center of the volume source.
- **Y Coordinate**: The y (north-south) coordinate for the source location in meters. This location is the center of the volume source.
- **Base Elevation** [m]: The source base elevation. The model only uses the source base elevation if elevated terrain is being used. The default unit is meters.
- **Release Height above Ground** [m]: The release height above ground surface in meters (center of volume).
- **Emission Rate** [g/s]: The emission rate of the pollutant in grams per second. The same emission rate is used for both concentration and deposition calculations.
- **Length of Side** [m]: The length of the side of the volume source in meters. The volume source cannot be rotated and has the X side equal to the Y side (square).
- **Building Height** (If On or Adjacent to a Building) [m]: If your volume source is elevated and is on or adjacent to a building, then you need to specify the building height. The building height can be used to calculate the Initial Vertical Dimension of the source. Note that if the source is surface-based, then this is not applicable.
- **Initial Lateral Dimension** [m]: This parameter is calculated by choosing the appropriate condition in Table 3.1 above. This table provides guidance on determining initial dimensions. Units are in meters.
- **Initial Vertical Dimension** [m]: This parameter is calculated by choosing the appropriate condition in Table 3.1 above. This table provides guidance on determining initial dimensions. Units are in meters.

3.7.2 Source Grouping

Source groups enable modeling results for specific groups of one or more sources. The default in AERMOD and ISCST3/ISC-PRIME is the creations of a source group “ALL” that considers all the sources at the same time.

Analysis of individual groups of sources can be performed by using the SRCGROUP option. One example may be assigning each source to a separate source group to determine the maximum concentration generated by each individual source.

3.7.3 Special Considerations

During some air quality studies, modelers may encounter certain source configurations that require special attention. Some examples include horizontal sources or emissions from storage tanks. The following sections outline modeling techniques to account for the special characteristics of such scenarios.

3.7.3.1 Multiple Stacks

When the plumes from multiple closely spaced stacks or flues merge, the plume rise can be enhanced. Briggs[25] has proposed equations to account for this. The reader is referred to that document for further details. Most models do not explicitly account for enhanced plume rise from this cause, and most regulatory agencies do not permit it to be accounted for in regulatory applications of modeling, with one exception. That exception is the case of a single stack with multiple flues/multiple stacks very close together (less than one stack diameter apart). In these cases, the multiple plumes may be treated as a single plume. To do this, a pseudo stack diameter is used in the calculations, such that the total volume flow rate of the stack gases is correctly represented.

3.7.3.2 Horizontal Sources and Rain Caps

This section is intended to provide guidance for modeling a stack with a rain cap that is located on top of a building.

When emissions are released through a stack with a rain cap, the rain cap redirects the vertical release into a horizontal release, as shown in Figure 3.4.

The presence of a rain cap or any obstacle at the top of the stack hinders the momentum of the exiting gas. Therefore, assuming that the gas exit velocity would be the same as the velocity in a stack without an obstacle is an improper assumption. The extent of the effect is a function of the distance from the stack exit to the obstruction and of the dimensions and shape of the obstruction.

On the conservative side, the stack could be modeled as having a non-zero, but negligible exiting velocity, effectively eliminating any momentum rise. Such an approach would result in final plume heights closer to the ground and therefore higher concentrations nearby.

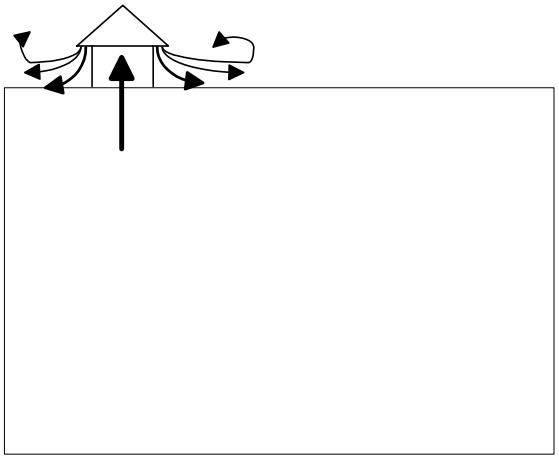


Figure 3.4

Plume buoyancy is not strongly reduced by the occurrence of a rain cap. Therefore if the plume rise is dominated by buoyancy, it is not necessary to adjust the stack conditions. (The air dispersion models determine plume rise by either buoyancy or momentum, whichever is greater.)

The stack conditions should be modified when the plume rise is dominated by momentum and in the presence of a rain cap or a horizontal stack. Sensitivity studies with the SCREEN3 model, on a case-by-case basis, can be used to determine whether plume rise is dominated by buoyancy or momentum. The District should be consulted before applying these procedures.

[25] Briggs, G.A., 1974. Diffusion Estimation for Small Emissions. In ERL, ARL USAEC Report ATDL-106. U.S. Atomic Energy Commission, Oak Ridge, TN.

- Set exit velocity to 0.001 m/sec
- Turn stack tip downwash off
- Reduce stack height by 3 times the stack diameter

Stack tip downwash is a function of stack diameter, exit velocity, and wind speed. The maximum stack tip downwash is limited to three times the stack diameter in the ISC3 air dispersion model. In the event of a horizontal stack, stack tip downwash should be turned off and no stack height adjustments should be made.

Note: This approach may not be valid for large (several meter) diameter stacks.

An alternative, more refined, approach could be considered for stack gas temperatures which are slightly above ambient (e.g., ten to twenty degrees Fahrenheit above ambient). In this approach, the buoyancy and the volume of the plume remains constant and the momentum is minimized.

- Turn stack tip downwash off
- Reduce stack height by 3 times the stack diameter ($3D_o$)
- Set the stack diameter (D_b) to a large value (e.g., 10 meters)
- Set the stack velocity to $V_b = V_o (D_o/D_b)^2$

Where:

V_o and D_o are the original stack velocity and diameter, and
V_b and D_b are the alternative stack velocity and diameter for constant buoyancy.

This approach is advantageous when $D_b >> D_o$ and $V_b << V_o$ and should only be used with District approval.

Reference: Technical Support Document for Exposure and Stochastic Analysis, Office of Environmental Health Hazard Assessment, September 2000, p. 2-39 and p. 2-40.

3.7.3.3 Modeling Bay Door or Window Openings (Volume Source)

This section is intended to provide guidance for modeling openings such as doors and windows as a volume source. When determining how to model an opening, first determine how the emissions are being released from the opening. If a profile of the emissions (% of substance and heat at different levels) is not provided, then assume that emissions are being released at all levels of the opening, and that the emissions are going out some distance from the opening before they are mixed with the outside air. Thus the release from the opening resembles a volume source where the height is the height of the opening, and the width is the width of the opening, and length is also the width of the opening. Volume source modeling requires the width and length to be equal.

Based on these assumptions, the height of the volume is equal to the height of the opening, the width of the volume is equal to the width of the opening, and the length of the volume is equal to the distance from the opening to the nearest edge of the building, see Figure 3.5.

Volume Source: (Open Door)

Height = H (V) - Height of the Door
Length = L(V) - Distance from the door to the nearest building edge.
Width = W(V) - Width of the door

Note: The above values need to be adjusted as instructed by the Modeling Guidelines.

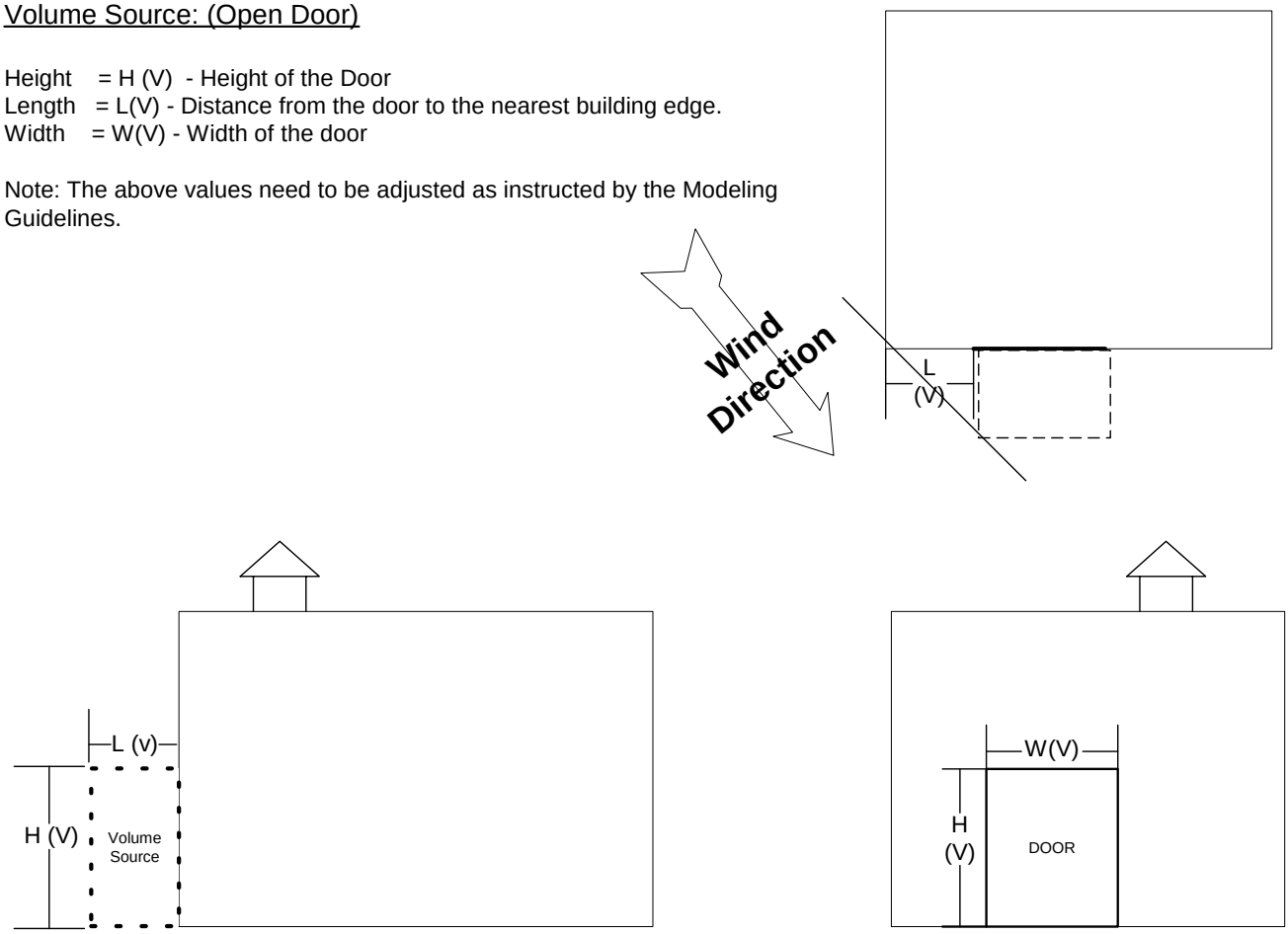


Figure 3.5

3.7.3.4 Liquid Storage Tanks

Storage tanks are generally of two types—fixed roof tanks and floating roof tanks. In the case of fixed roof tanks, most of the pollutant emissions occur from a vent, with some additional contribution from hatches and other fittings. In the case of floating roof tanks, most of the pollutant emissions occur through the seals between the roof and the wall and between the deck and the wall, with some additional emissions from fittings such as ports and hatches.

Approaches for modeling impacts from emissions from various types of storage tanks are outlined below.

Fixed roof tanks:
Model fixed roof tanks as a point (stack) source (representing the vent), which is usually in the center of the tank, and representing the tank itself as a building for downwash calculations.

Floating roof tanks:
Model floating roof tanks as a circle of eight (or more) point sources, representing the tank itself as a building for downwash calculations. Distribute the total emissions equally among the circle of

point sources. Additionally, a floating roof tanks can be modeled as a circle (polygon) area source representing the diameter of the tank with a height of the tank.

All tanks:
There is virtually no plume rise from tanks. Therefore, the stack parameters for the stack gas exit velocity and stack diameter should be set to near zero for the stacks representing the emissions. In addition, stack temperature should be set equal to the ambient temperature. This is done in ISCST3 and AERMOD by inputting a value of 0.0 for the stack gas temperature.

Note that it is very important for the diameter to be at or near zero. With low exit velocities and larger diameters, stack tip downwash will be calculated. Since all downwash effects are being calculated as building downwash, the additional stack tip downwash calculations would be inappropriate. Since the maximum stack tip downwash effect is to lower plume height by three stack diameters, a very small stack diameter effectively eliminates the stack tip downwash.

Table 3.2 - Stack parameter values for modeling tanks

Velocity	Diameter	Temperature
Near zero i.e. 0.001 m/s	Near zero i.e. 0.001m	Ambient – 0.0 sets models to use ambient temperature

3.7.4 Variable Emissions

The ISCST3 and AERMOD models both contain support for variable emission rates. This allows for modeling of source emissions that may fluctuate over time. Emission variations can be characterized across many different periods including hourly, daily, monthly and seasonally. For risk assessments, only the annual average or the maximum hourly emission rates are to be modeled. If a variable emission rate is to be used, the District must be consulted.

3.7.4.1 Wind Erosion

Modeling of emissions from sources susceptible to wind erosion, such as coal piles, can be accomplished using variable emissions.

The ISCST3 and AERMOD models allow for emission rates to be varied by wind speed. This allows for more representative emissions from sources that are susceptible to wind erosion, particularly waste piles that can contribute to particulate emissions. Once a correlation between emissions and wind speed categories is established, the models will then vary the emissions based on the wind conditions in the meteorological data.

3.7.4.2 Non-Continuous Emissions

Sources of emissions at some locations may emit only during certain periods of time. Emissions can be varied within the ISCST3 and AERMOD models by applying factors to different time periods.

For example, for a source that is non-continuous, a factor of 0 is entered for the periods when the source is not operating or is inactive. Model inputs for variable emissions rates can include the following time periods:

- Seasonally
- Monthly
- Hourly
- By Season and hour-of-day
- By Season, hour-of-day, and day-of-week
- By Season, hour, and week

3.7.4.3 Plant Shutdowns and Start-Ups

Plant start-ups and shutdowns can occur due to maintenance, designated vacation periods, or upset conditions. Emissions during shutdown and startup are usually higher than during normal operation. Process upsets or control equipment breakdowns can also increase emissions. Such upsets can result in the release of uncontrolled emissions. The ISC and AERMOD models allow the use of variable emission rates for hours of the day, day of the week, and season of the year. The example below illustrates the use of this feature to model emissions that vary by the time of the day.

Example:
Assume that a gas turbine operates 14 hours per day (1 startup, 1 shutdown, and 12 hours of normal operation

Given:
Emission Rate = 1 g/s (emissions rate during normal operation)
Operation Schedule = 6 AM – 8PM
Startup/Shutdown Emissions are twice that of normal operating emissions

The model will adjust the emissions rate using the data found in the table below:

Calculation:
Modeled Emissions Rate * Emission Rate Adjustment Factor

Emissions Rate for 1 AM – 6 AM = 1 g/s * 0 = 0 g/s
Emissions Rate for 6 AM – 7 AM = 1 g/s * 2 = 2 g/s
Emissions Rate for 7 AM – 7 PM = 1 g/s * 1 = 1 g/s
Emissions Rate for 7 PM – 8 PM = 1 g/s * 2 = 2 g/s

Non-Continuous Emissions (Hours of Day):

Morning Hours		Afternoon Hours	
Hour of the Day	**Emissions Rate Adjustment Factor**	**Hour of the Day**	**Emissions Rate Adjustment Factor**
1:00 am	0	1:00 pm	1
2:00 am	0	2:00 pm	1
3:00 am	0	3:00 pm	1
4:00 am	0	4:00 pm	1
5:00 am	0	5:00 pm	1
6:00 am	2	6:00 pm	1
7:00 am	1	7:00 pm	2
8:00 am	1	8:00 pm	0
9:00 am	1	9:00 pm	0
10:00 am	1	10:00 pm	0
11:00 am	1	11:00 pm	0
Noon	1	Midnight	0

3.7.4.4 Seasonal Variations

Industrial processes often fluctuate depending on supply and demand requirements. This affects some sectors seasonally, particularly facilities involved in food processing. For example, soup production makes use of agricultural produce which is at its highest in the late summer. Production schedules for soup production typically ramp up resulting in different emissions during the late summer and early fall than at mid to late winter.

These emission differences can be accounted for by the application of variable emission factors, with control over the following time periods:

- By Season and hour-of-day
- By Season, hour-of-day, and day-of-week
- By Season, hour, week

3.8 Building Impacts

Buildings and other structures near a relatively short stack can have a substantial effect on plume transport and dispersion, and on the resulting ground-level concentrations that are observed. . There has long been a "rule of thumb" that a stack should be at least 2.5 times the height of adjacent buildings. Beyond that, much of what is known of the effects of buildings on plume transport and diffusion has been obtained from wind tunnel studies and field studies.

When the airflow meets a building (or other obstruction), it is forced up and over the building. On the lee side of the building, the flow separates, leaving a closed circulation containing lower wind

speeds. Farther downwind, the air flows downward again. In addition, there is more shear and, as a result, more turbulence. This is the turbulent wake zone (see Figure 3.6).

If a plume gets caught in the cavity, very high concentrations can result. If the plume escapes the cavity, but remains in the turbulent wake, it may be carried downward and dispersed more rapidly by the turbulence. This can result in either higher or lower concentrations than would occur without the building, depending on whether the reduced height or increased turbulent diffusion has the greater effect.

The height to which the turbulent wake has a significant effect on the plume is generally considered to be about the building height plus 1.5 times the lesser of the building height or width. This results in a height of 2.5 building heights for cubic or squat buildings, and less for tall, slender buildings. Since it is considered good engineering practice to build stacks taller than adjacent buildings by this amount, this height came to be called "good engineering practice" (GEP) stack height.

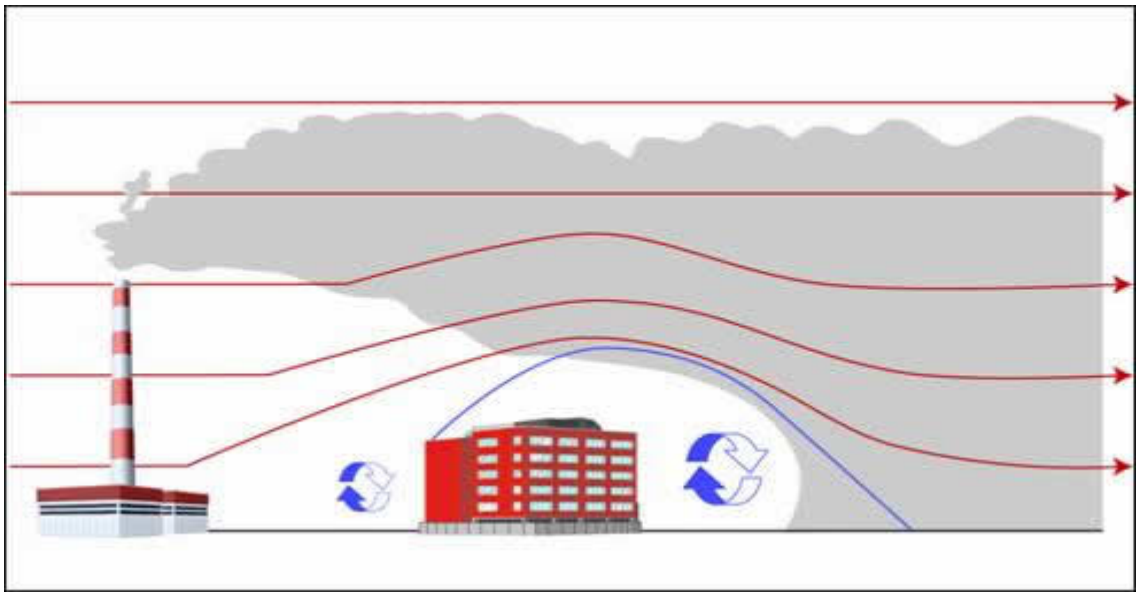


Figure 3.6 - The building downwash concept where the presence of buildings forms localized turbulent zones that can readily force pollutants down to ground level.

3.8.1 Good Engineering Practice (GEP) Stack Heights and Structure Influence Zones

The U.S. EPA[26] states that "If stacks for new or existing major sources are found to be less than the height defined by the EPA's refined formula for determining GEP height, then air quality impacts associated with cavity or wake effects due to the nearby building structures should be determined."

The U.S. EPA's refined formula for determining GEP stack height is:

GEP Stack Height = H + 1.5L

[26] U.S. Environmental Protection Agency, 1990. Stack Heights, Section 123, Clean Air Act, 40 CFR Part 51. U. S. Environmental Protection Agency, Research Triangle Park, NC.

where,

GEP = Good Engineering Practice

H = Building/Tier Height measured from ground to the highest point

L = Lesser of the Building Height (PB) or Projected Building Width (PBW)

Building downwash for point sources that are within the Area of Influence of a building should be considered. For U.S. EPA regulatory applications, a building is considered sufficiently close to a stack to cause wake effects when the distance between the stack and the nearest part of the building is less than or equal to five (5) times the lesser of the building height or the projected width of the building.

$Distance_{stack\text{-}bldg} <= 5L$

For point sources within the Area of Influence, building downwash information (direction-specific building heights and widths) should be included in your modeling project. Using BPIP-PRIME, you can compute these direction-specific building heights and widths.

Structure Influence Zone (SIZ): For downwash analyses with direction-specific building dimensions, wake effects are assumed to occur if the stack is within a rectangle composed of two lines perpendicular to the wind direction, one at 5L downwind of the building and the other at 2L upwind of the building, and by two lines parallel to the wind direction, each at 0.5L away from each side of the building, as shown below. L is the lesser of the height or projected width. This rectangular area has been termed a Structure Influence Zone (SIZ). Any stack within the SIZ for any wind direction is potentially affected by GEP wake effects for some wind direction, or range of wind directions, see Figure 3.7 and Figure 3.8.

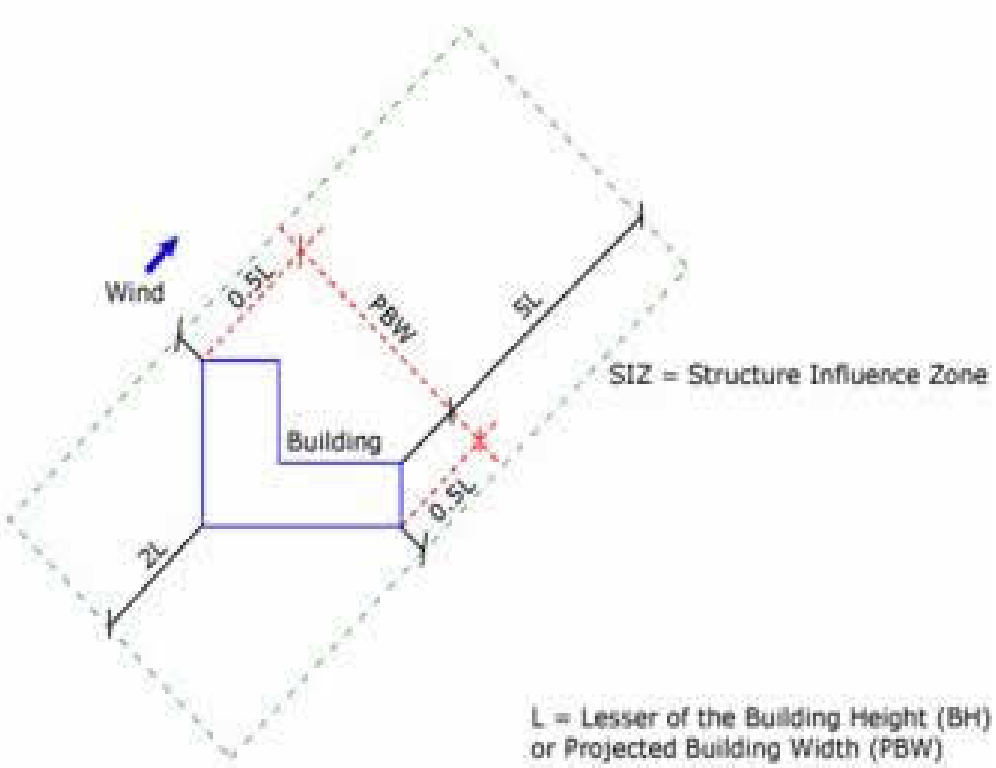


Figure 3.7 - GEP 5L and Structure Influence Zone (SIZ) Areas of Influence

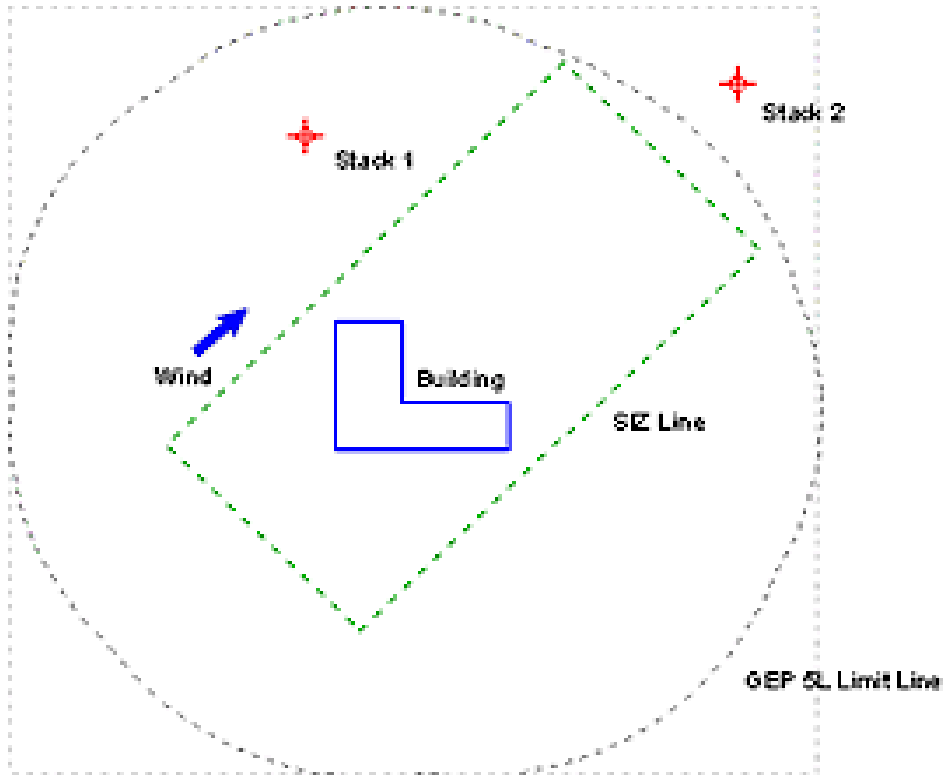


Figure 3.8 -GEP 360° 5L and Structure Influence Zone (SIZ) Areas of Influence

3.8.2 Defining Buildings

The recommended screening and refined models all allow for the consideration of building downwash. SCREEN3 considers the effects of a single building while AERMOD and ISCST3/ISC-PRIME can consider the effects of complicated sites consisting of up to hundreds of buildings. This results in different approaches to defining buildings as outlined below.

3.8.2.1 SCREEN3 Building Definition

Defining buildings in SCREEN3 is straightforward, as only one building requires definition. The following input data is needed to consider downwash in SCREEN3:

- Building Height: The physical height of the building structure in meters.
- Minimum Horizontal Building Dimension: The minimum horizontal building dimension in meters.
- Maximum Horizontal Building Dimension: The maximum horizontal building dimension in meters.

For Flare releases, SCREEN assumes the following:

- an effective stack gas exit velocity (V_s) of 20 m/s,
- an effective stack gas exit temperature (T_s) of 1,273 K, and
- an effective stack diameter based on the heat release rate.

Since building downwash estimates depend on transitional momentum plume rise and transitional buoyant plume rise calculations, the selection of effective stack parameters could influence the estimates. Therefore, building downwash estimates for flare releases should be used with extra caution[27].

If using Automated Distances or Discrete Distances option, wake effects are included in any calculations made. Cavity calculations are made for two building orientations, first with the minimum horizontal building dimension along wind, and second with the maximum horizontal dimension along wind. The cavity calculations are summarized at the end of the distance-dependent calculations (see SCREEN3 User's Guide[32] Section 3.6 for more details).

3.8.2.2 AERMOD and ISC-PRIME Building Definition

The inclusion of the PRIME (Plume Rise Model Enhancements) algorithm[28] to compute building downwash has produced more accurate results in air dispersion models. Unlike the earlier algorithms used in ISC3, the PRIME algorithm:

[27] U.S. Environmental Protection Agency, 1995. SCREEN3 Model User's Guide. EPA-454/B-95-004. Office of Air Quality Planning and Standards, Research Triangle Park, NC.

[28] Schulman, L.L., D.G. Strimaitis and J.S. Scire, 2000: Development and evaluation of the PRIME plume rise and building downwash model. Journal of the Air & Waste Management Association, 50:378-390.

- accounts for the location of the stack relative to the building;
- accounts for the deflection of streamlines up over the building and down the other side;
- accounts for the effects of the wind profile at the plume location for calculating plume rise;
- accounts for pollutants captured in the recirculation cavity to be transported to the far wake downwind (this is ignored in the earlier algorithms); and
- avoids discontinuities in the treatment of different stack heights, which were a problem in the earlier algorithms.

Refined models allow for the consideration of downwash effects from multiple buildings. AERMOD and ISCST3/ISC-PRIME require building downwash analysis to first be performed using BPIP-PRIME[28]. The results from BPIP-PRIME can then be incorporated into the modeling studies for consideration of downwash effects.

The U.S. EPA Building Profile Input Program – Plume Rise Model Enhancements (BPIP-PRIME) was designed to incorporate enhanced downwash analysis data for use with the U.S. EPA ISC-PRIME and current AERMOD models. Similar in operation to the U.S. EPA BPIP model, BPIP-PRIME uses the same input data requiring no modifications of existing BPIP projects. The following information is required to perform building downwash analysis within BPIP:

- X and Y location for all stacks and building corners.
- Height for all stacks and buildings (meters). For building with more than one height or roofline, identify each height (tier).
- Base elevations for all stacks and buildings.

The BPIP User's Guide[29] provides details on how to input building and stack data to the program.

The BPIP model is divided into two parts.

- Part One: Based on the GEP technical support document[30], this part is designed to determine whether or not a stack is subject to wake effects from a structure or structures. Values are calculated for GEP stack height and GEP related building heights (BH) and projected building widths (PBW). Indication is given to which stacks are being affected by which structure wake effects.
- Part Two: Calculates building downwash BH and PBW values based on references by Tickvart[31,32] and Lee[33]. These can be different from those calculated in Part One. The calculations are performed only if a stack is being influenced by structure wake effects.

In addition to the standard variables reported in the output of BPIP, BPIP-PRIME adds the following:

- BUILDLEN: Projected length of the building along the flow.

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[29] U.S. Environmental Protection Agency, 1995. User's Guide to the Building Profile Input Program, EPA-454/R-93-038, Office of Air Quality Planning and Standards, Research Triangle Park, N.C.

[30] U.S. Environmental Protection Agency, 1985. Guideline for Determination of Good Engineering Practice Stack Height (Technical Support Document for the Stack Height Regulations) – Revised EPA-450/4-80-023R, U.S. Environmental Protection Agency, Research Triangle Park, NC.

[31] Tickvart, J. A., May 11, 1988. Stack-Structure Relationships, Memorandum to Richard L. Daye, U.S. EPA.

[32] Tickvart, J. A., June 28, 1989. Clarification of Stack-Structure Relationships, Memorandum to Regional Modeling Contacts, Regions I-X, U.S. EPA.

[33] Lee, R. F., July 1, 1993. Stack-Structure Relationships – Further clarification of our memoranda dated May 11, 1988 and June 28, 1989, Memorandum to Richard L. Daye, U.S. EPA.

- XBADJ: Along-flow distance from the stack to the center of the upwind face of the projected building.
- YBADJ: Across-flow distance from the stack to the center of the upwind face of the projected building.

For a more detailed technical description of the EPA BPIP-PRIME model and how it relates to the EPA ISC-PRIME model see the Addendum to ISC3 User's Guide[34].

3.9 Multiple Pollutants

3.9.1 Modeling Multiple Pollutants from Multiple Sources

Industrial processes often emit multiple pollutants through one or several emission sources. The U.S. EPA models are not equipped to automatically perform modeling of different pollutants that may share the same emission source but have unique emission rates.

Traditional approaches to this scenario resulted in modelers performing separate model runs for each specific pollutant type, even though all other model site parameters remain the same. For projects consisting of many pollutants, this approach results in the modeler needing not only to be extremely organized but also requires high levels of computer resources as the project would need to be run separately for each pollutant scenario.

An alternative approach is applying unitized emission rate and summation concepts, which drastically reduce the computational time for large multiple pollutant projects.

3.9.1.1 Standard Approaches to Modeling Multiple Toxic Pollutants from Multiple Sources

For industrial processes that emit multiple pollutants through one or several emission sources, the following approach should be followed.

- Dispersion modeling should be conducted as outlined in this guidance document using a unit (normalized) emissions rate of 1 g/s, or 1/g/s/m^2 for area sources.
- All chemical analysis / risk calculations should be processed through the CARB HARP program http://www.arb.ca.gov/toxics/harp/harp.htm.
- Exceptions (Must be given prior approval by the district):
  - Analysis of multiple pollutants that only affect one acute toxicological endpoint or the same endpoints.
  - Analyses of multiple pollutants that only affect one chronic toxicological endpoint or the same endpoint and do not have a chronic oral value.
  - Analysis of multiple pollutants that are not multi-pathway (only inhalation)
    - One dispersion modeling run for

[34] Schulman, et al., 1997. Addendum - User's Guide for the Industrial Source Complex (ISC3) Dispersion Models, Volume 1. Office of Air Quality Planning and Standards, Research Triangle Park, NC.

- Acute Hazard Index,
- Chronic Hazard Index, and
- Cancer Risk.

3.9.2 Unitized (Normalized) Emission Rate and Summation Concepts

It is a well-known fact that air dispersion modeling is a non-linear process. The modeled site may have random meteorological variations, the dispersion process is non-linear, and the terrain elevations at the site may assume unlimited shapes. However, once the calculations to a receptor in space are complete, all chemical concentration levels vary linearly with their source release rate. Figure 3.9 helps visualize this concept, by describing an emission rate of 1 g/s.

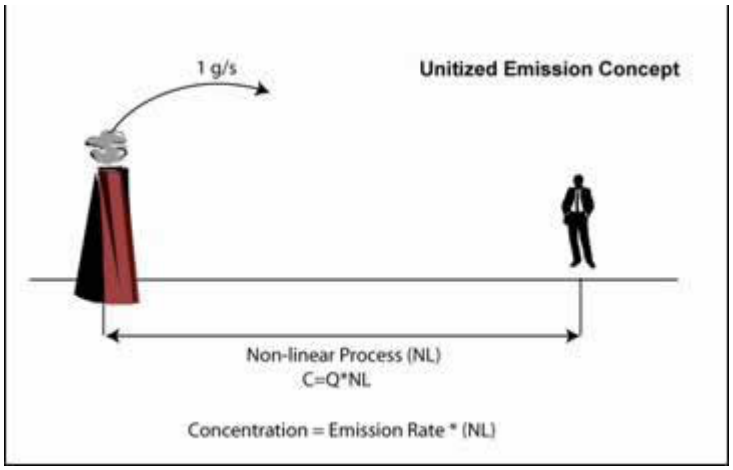


Figure 3.9 - Unitized Emission Rate Concept (1 g/s)

The Unitized Emission Rate Concept only applies to single sources. For assessments with multiple sources the authors recommend that each source be modeled independently, using unitized emission rate (1 g/s). The concentration at the receptor can then be multiplied by the actual chemical emission rate, and the final result from all the sources will be superimposed. This is called the Summation Concept, where the concentration and deposition fluxes at a receptor are the linear addition of the resulting values from each source. Figure 3.10 depicts the Summation concept.

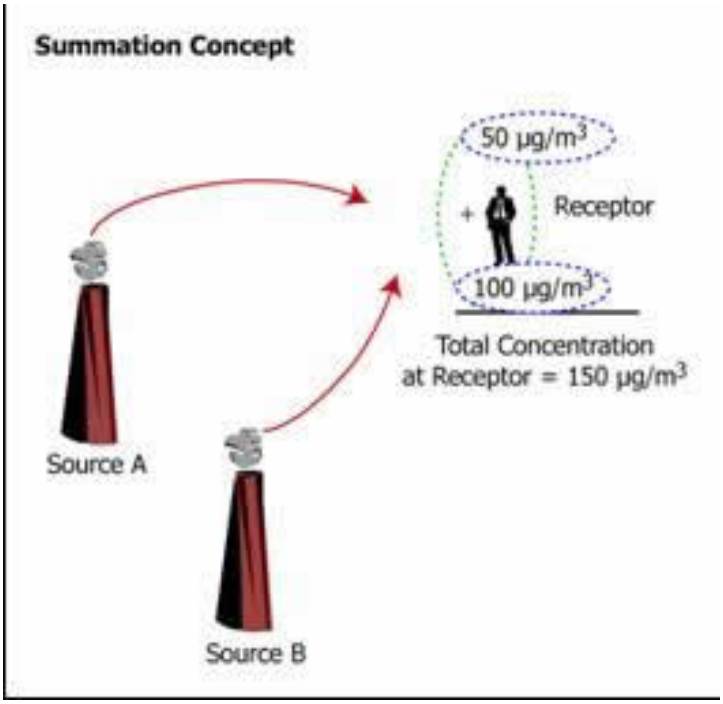


Figure 3.10 - The Summation Concept for two sources

A post-processor is needed to effectively process model results that have been performed using unitized emission rate and summation concepts. Final output will provide results for pollutant specific scenarios from multiple sources.

3.10 Modeling Roads

There are a number of dispersion models that can be used to predict concentrations from roadway emissions. Some models such as CAL3QHCR were developed solely for use in modeling roadway emissions. They use a line source algorithm. CAL3QHCR is a preferred/recommended U.S. Environmental Protection Agency (EPA) model for roadway modeling that uses local meteorology. EPA also recommends the CALINE3 model. But, CALINE3 does not use local meteorology. It is included in CAL3QHCR. The Industrial Source Complex – Short-Term (ISCST3) and the AERMOD models can be used to model roadways as a line of volume sources. AERMOD is the recommended EPA model. However, some Districts still use ISCST3 because they do not yet have the meteorological data needed for AERMOD. The methodology for modeling using AERMOD is the same as that for using ISCST3. The input data is almost identical because AERMOD was designed to use input similar to that used by ISCST3 and to provide similar outputs. The major differences between the inputs to the two models are the meteorological data sets. During the preparation of this guideline, an analysis was conducted to compare concentrations predicted by all three models for a specific example. This analysis showed that all three models provided similar concentration estimates, and that any of the three models could be used effectively to predict pollutant concentrations and the resulting risk from roadway emissions.

In the discussion below, use of CAL3QHCR is described first. That discussion includes a description of data sources to estimate emissions. The same approach can be used to develop emissions estimates for ISCST3/AERMOD.

3.10.1 Modeling Roads using CAL3QHCR

3.10.1.1 Introduction

This step by step guidance explains how to use the CAL3QHCR line source model to carry out diesel particulate matter air dispersion modeling, and how to calculate potential cancer risk. Nine potential receptors are assumed to lie directly south of an east-west free-flow freeway with a peak hour traffic count of 11,900 vehicles. The freeway is assumed to be 120 feet wide, with an additional 10 feet on each side to account for the wake of moving vehicles[35], making for a total link width of 140 feet.

This example represents one specific scenario. For guidance on other CAL3QHCR modeling scenarios not contained herein, contact your local air district or consult the User's Guide to CAL3QHC, Version 2.0 [36].

3.10.1.2 Data Sources

This example scenario relies on basic information needed to complete the site specific HRA. Such information includes:

- meteorological data,
- traffic data (from Caltrans), later developed into hourly data,
- vehicle emissions (derived from EMFAC),
- location of the nearest sensitive receptor to the edge of the travel lane, in addition to the generic receptor locations, if required (for example, at 10, 25, 50, 100, 200, 300, 400 and 500 feet) in X-Y coordinates, and
- roadway orientation in terms of its X-Y coordinates (arbitrary origin / 0,0), including length and width.

The above information, including additional information required by the model, is further discussed in the ensuing sections of this document.

3.10.1.3 Finding the Peak Hour Traffic Count

The peak hour traffic count nearest to the proposed receptors is used to develop the hourly traffic count information for input into CAL3QHCR. The peak hour traffic count should be found on Caltrans's website at http://www.dot.ca.gov/hq/traffops/saferesr/trafdata/index.htm. Select back peak hour for projects south or west of the nearest milepost location. For projects north or east of the nearest milepost location, select ahead peak hour.

[35] The mixing zone is an area where dispersion results are considered to be inaccurate.
[36] User's Guide to CAL3QHC Version 2.0, EPA-454/R-92-006 (Revised, with CAL3QHCR addendum), September 1995.

For the scenario considered herein, the Caltrans's data indicates a peak hour traffic count of 11,900 vehicles.

Running EMFAC to Produce Hourly PM10 Emissions and Data on Vehicle Miles Traveled

The most current version of EMFAC should be run to determine preliminary vehicle miles traveled (VMT) and emissions data. The VMT data will be used to develop the hourly traffic count information required by CAL3QHCR, and the PM10 exhaust emissions data will be used to determine the hourly PM10 emissions rates for input into CAL3QHCR.

The EMFAC run should be based on the following parameters:

- Year: first year of project build out,
- Season: annual,
- Burden: standard, and
- Output Frequency: hourly.

The following data from the EMFAC output file will be used:

- VMT/1000 for each hour,
- PM10 emissions for each hour.

Figure 3.11 is a screen shot of the first page of the EMFAC output file. The circled hourly data is the data that will be used.

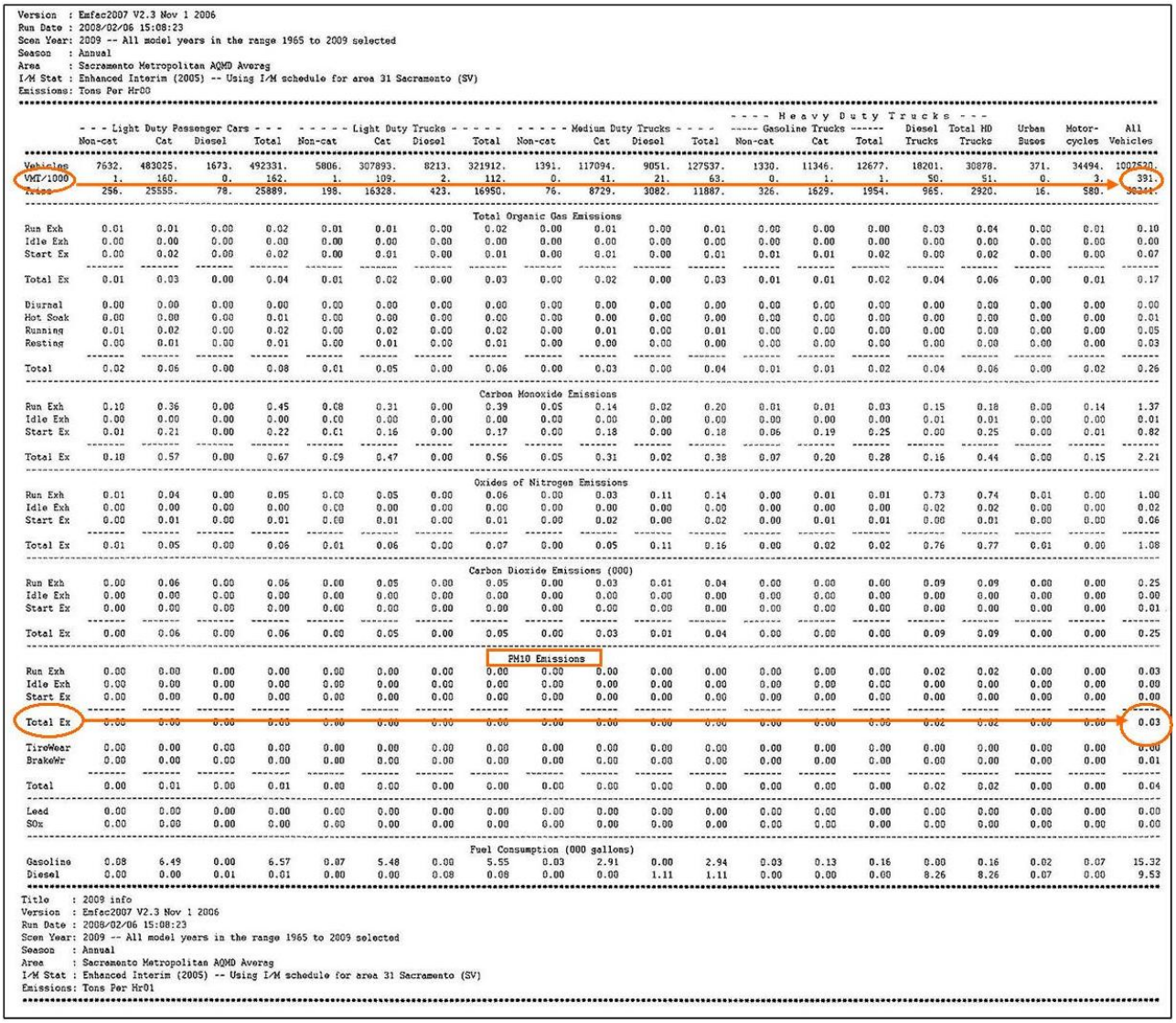
This methodology is a **screening method** to determine the cancer risk from diesel exhaust assuming that all vehicles traveling the roadway segment are diesel vehicles.

A refinement of the emission calculations can be made by using data on percentages of truck traffic from Caltrans and assuming that all trucks are diesel. If better data is not available, 10% is sometimes assumed as the diesel truck fraction of vehicles.

To refine the emissions calculations further to account for diesel emissions from diesel trucks, and to account for the emissions of the highest priority toxic substances (1,3 butadiene, acrolein, acetaldehyde, formaldehyde, and benzene) from all vehicles, the procedure in Appendix B should be followed.

Contact the local district to determine which method should be used to estimate diesel truck travel.

Figure 3.11: Example Scenario EMFAC Output, Page 1



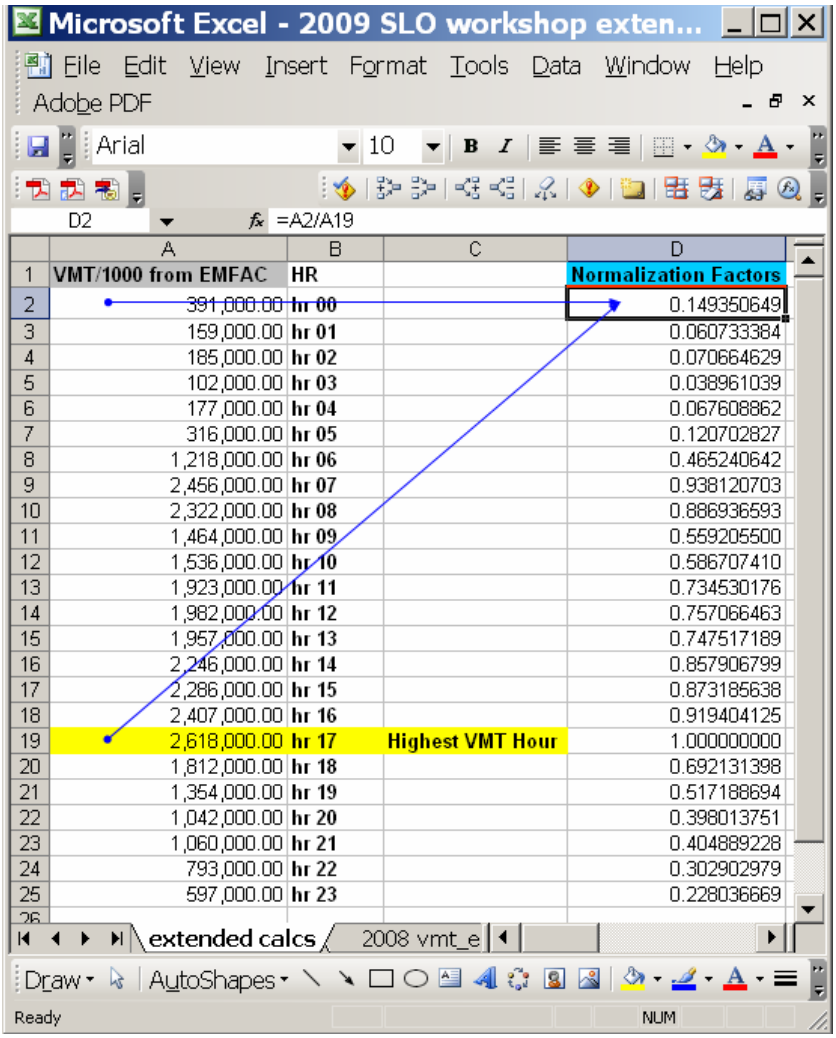
Version : Emfac2007 V2.3 Nov 1 2006
Run Date : 2008/02/06 15:08:23
Scen Year: 2009 -- All model years in the range 1965 to 2009 selected
Season : Annual
Area : Sacramento Metropolitan AQMD Averag
I/M Stat : Enhanced Interim (2005) -- Using I/M schedule for area 31 Sacramento (SV)
Emissions: Tons Per Hr00

	Light Duty Passenger Cars				Light Duty Trucks				Medium Duty Trucks				Heavy Duty Trucks - Gasoline Trucks			Diesel Trucks	Total HD Trucks	Urban Buses	Motor-cycles	All Vehicles
	Non-cat	Cat	Diesel	Total	Non-cat	Cat	Diesel	Total	Non-cat	Cat	Diesel	Total	Non-cat	Cat	Total					
Vehicles	7632.	483025.	1673.	492331.	5806.	307893.	8213.	321912.	1391.	117094.	9051.	127537.	1330.	11346.	12677.	18201.	30878.	371.	34494.	1007520.
VMT/1000	1.	160.	0.	162.	1.	109.	2.	112.	0.	41.	21.	63.	0.	1.	1.	50.	51.	0.	3.	391.
Trips	256.	25555.	78.	25889.	198.	16328.	423.	16950.	76.	8729.	3082.	11887.	326.	1629.	1954.	965.	2920.	16.	580.	30241.
Total Organic Gas Emissions																				
Run Exh	0.01	0.01	0.00	0.02	0.01	0.01	0.00	0.02	0.00	0.01	0.00	0.01	0.00	0.00	0.00	0.03	0.04	0.00	0.01	0.10
Idle Exh	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Start Ex	0.00	0.02	0.00	0.02	0.00	0.01	0.00	0.01	0.00	0.01	0.00	0.01	0.01	0.01	0.02	0.00	0.02	0.00	0.00	0.07
Total Ex	0.01	0.03	0.00	0.04	0.01	0.02	0.00	0.03	0.00	0.02	0.00	0.03	0.01	0.01	0.02	0.04	0.06	0.00	0.01	0.17
Diurnal	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hot Soak	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
Running	0.01	0.02	0.00	0.02	0.00	0.02	0.00	0.02	0.00	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05
Resting	0.00	0.01	0.00	0.01	0.00	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03
Total	0.02	0.06	0.00	0.08	0.01	0.05	0.00	0.06	0.00	0.03	0.00	0.04	0.01	0.01	0.02	0.04	0.06	0.00	0.02	0.26
Carbon Monoxide Emissions																				
Run Exh	0.10	0.36	0.00	0.45	0.08	0.31	0.00	0.39	0.05	0.14	0.02	0.20	0.01	0.01	0.03	0.15	0.18	0.00	0.14	1.37
Idle Exh	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.01
Start Ex	0.01	0.21	0.00	0.22	0.01	0.16	0.00	0.17	0.00	0.18	0.00	0.18	0.06	0.19	0.25	0.00	0.25	0.00	0.01	0.82
Total Ex	0.10	0.57	0.00	0.67	0.09	0.47	0.00	0.56	0.05	0.31	0.02	0.38	0.07	0.20	0.28	0.16	0.44	0.00	0.15	2.21
Oxides of Nitrogen Emissions																				
Run Exh	0.01	0.04	0.00	0.05	0.00	0.05	0.00	0.06	0.00	0.03	0.11	0.14	0.00	0.01	0.01	0.73	0.74	0.01	0.00	1.00
Idle Exh	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.02	0.00	0.00	0.02
Start Ex	0.00	0.01	0.00	0.01	0.00	0.01	0.00	0.01	0.00	0.02	0.00	0.02	0.00	0.01	0.01	0.00	0.01	0.00	0.00	0.06
Total Ex	0.01	0.05	0.00	0.06	0.01	0.06	0.00	0.07	0.00	0.05	0.11	0.16	0.00	0.02	0.02	0.76	0.77	0.01	0.00	1.08
Carbon Dioxide Emissions (000)																				
Run Exh	0.00	0.06	0.00	0.06	0.00	0.05	0.00	0.05	0.00	0.03	0.01	0.04	0.00	0.00	0.00	0.09	0.09	0.00	0.00	0.25
Idle Exh	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Start Ex	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
Total Ex	0.00	0.06	0.00	0.06	0.00	0.05	0.00	0.05	0.00	0.03	0.01	0.04	0.00	0.00	0.00	0.09	0.09	0.00	0.00	0.25
PM10 Emissions																				
Run Exh	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.02	0.00	0.00	0.03
Idle Exh	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Start Ex	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total Ex	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.02	0.00	0.00	0.03
TireWear	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
BrakeWr	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
Total	0.00	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.02	0.00	0.00	0.04
Lead	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SOx	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fuel Consumption (000 gallons)																				
Gasoline	0.08	6.49	0.00	6.57	0.07	5.48	0.00	5.55	0.03	2.91	0.00	2.94	0.03	0.13	0.16	0.00	0.16	0.02	0.07	15.32
Diesel	0.00	0.00	0.01	0.01	0.00	0.00	0.08	0.08	0.00	0.00	1.11	1.11	0.00	0.00	0.00	8.26	8.26	0.07	0.00	9.53

Title : 2009 info
Version : Emfac2007 V2.3 Nov 1 2006
Run Date : 2008/02/06 15:08:23
Scen Year: 2009 -- All model years in the range 1965 to 2009 selected
Season : Annual
Area : Sacramento Metropolitan AQMD Averag
I/M Stat : Enhanced Interim (2005) -- Using I/M schedule for area 31 Sacramento (SV)
Emissions: Tons Per Hr01

3.10.1.4 Preparing the Hourly Traffic Count Data

To develop hourly traffic count values needed by CAL3QHCR, first find the highest hourly Vehicle Miles Traveled (VMT) count reported by EMFAC. Figure 3.12 shows an example. In this example, the highest hourly VMT count is 2,618,000 miles, which falls on Hour 17, 5:00 pm. Next, divide each hourly VMT value from EMFAC by the highest hourly VMT count (2,618,000 miles). Each result is known as a normalization factor.



	A	B	C	D
1	VMT/1000 from EMFAC	HR		Normalization Factors
2	391,000.00	hr 00		0.149350649
3	159,000.00	hr 01		0.060733384
4	185,000.00	hr 02		0.070664629
5	102,000.00	hr 03		0.038961039
6	177,000.00	hr 04		0.067608862
7	316,000.00	hr 05		0.120702827
8	1,218,000.00	hr 06		0.465240642
9	2,456,000.00	hr 07		0.938120703
10	2,322,000.00	hr 08		0.886936593
11	1,464,000.00	hr 09		0.559205500
12	1,536,000.00	hr 10		0.586707410
13	1,923,000.00	hr 11		0.734530176
14	1,982,000.00	hr 12		0.757066463
15	1,957,000.00	hr 13		0.747517189
16	2,246,000.00	hr 14		0.857906799
17	2,286,000.00	hr 15		0.873185638
18	2,407,000.00	hr 16		0.919404125
19	2,618,000.00	hr 17	Highest VMT Hour	1.000000000
20	1,812,000.00	hr 18		0.692131398
21	1,354,000.00	hr 19		0.517188694
22	1,042,000.00	hr 20		0.398013751
23	1,060,000.00	hr 21		0.404889228
24	793,000.00	hr 22		0.302902979
25	597,000.00	hr 23		0.228036669

Figure 3.12: Example Scenario Development of Normalization Factors

Next multiply each normalization factor times the project's peak hour traffic count provided in this example by Caltrans (11,900 vehicles/hour during hour 17, 5:00 pm), Table 3.3. The results are normalized hourly traffic volumes for input into CAL3QHCR.

Time of day	Traffic Count (vehicles/hour)
Hr 00	1777
Hr 01	723
Hr 02	841
Hr 03	464
Hr 04	805
Hr 05	1436
Hr 06	5536
Hr 07	11164
Hr 08	10555
Hr 09	6655
Hr 10	6982
Hr 11	8741
Hr 12	9009
Hr 13	8895
Hr 14	10209
Hr 15	10391
Hr 16	10941
Hr 17	**11900**
Hr 18	8236
Hr 19	6155
Hr 20	4736
Hr 21	4818
Hr 22	3605
Hr 23	2714

Table 3. 3: Example Scenario Normalized Traffic Counts

3.10.1.5 Preparing the Hourly Emissions Data

PM10 emissions data is reported by EMFAC in tons/hour and needs to be converted to grams/hour. The grams/hour values then need to be divided by the overall VMT per hour for each hour (as reported by EMFAC), to obtain grams per vehicle mile needed for input into CAL3QHCR.

3.10.1.6 Defining the Calculational Domain for the Input File

The CAL3QHCR input file requires data that defines the calculational domain. The X-Y coordinates at the beginning and at the end of the roadway section need to be defined. These have an arbitrary origin, with the y axis aligned with north.

Additionally, the width (mixing zone) of the roadway needs to be defined. Always allow for an additional 10 feet added to the edge of nearest travel lane to the receptors to account for the wake of moving vehicles.

The minimum roadway length is 10,000 feet.

The elevation of the roadway compared to the surrounding area needs to be specified. For roadways at grade the height is 0; for elevated roadways the relative height is positive; and for depressed roadways the relative height is negative.

The z-coordinate (receptor breathing height) also needs to be defined. The default recommendation is 1.5 meters, or 6 feet.

In this scenario, the freeway is 120 feet wide, and after accounting for the wake, the total link width becomes 140 feet.

The length of the roadway modeled is 10,000 feet, or 5,000 feet on each side from the center point.

The roadway is at grade.

A receptor has been placed at the edge of the roadway to define the roadway dimensions; however the dispersion results for this receptor should be discarded as they are not accurate at roadway edges. See Figure 3.13 below.

Other parameters required by the model need to be defined. Table 3.4 below discusses recommended and/or default parameters. Any changes to the default recommended values should be thoroughly explained.

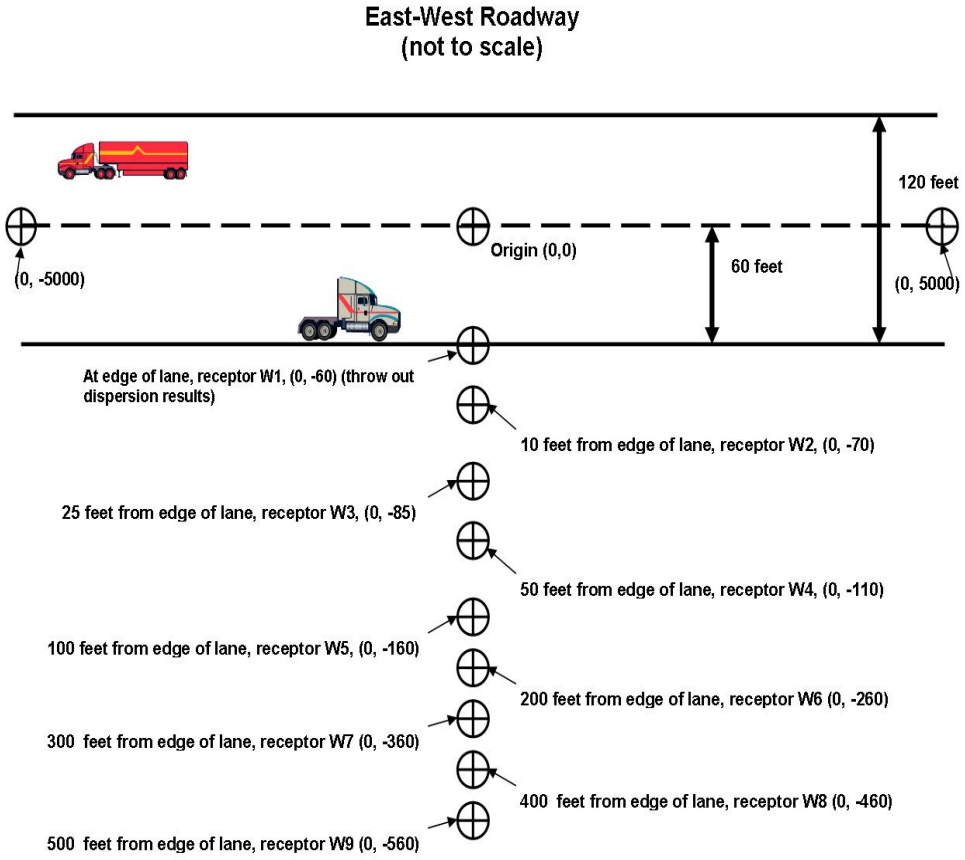


Figure 3.13: Example Scenario East-West Roadway and Receptors Illustration

Table 3.4: Other Recommended Parameters for Input into CAL3QHCR

Parameter	Default	
Calculation averaging time (min)	60	
Surface roughness (cm, from 3 to 400). For mixed uses and others not listed here, the modeler should make a reasonable assumption.	single family	108
	offices	170
	apartments	370
Settling velocity (cm/s)	0	
Deposition velocity (cm/s)	0	
Site setting (U=urban, R=rural)	U	
Form of traffic volume, emission rate data (1=one hour's data, 2=one week of hourly data)	2	
Pollutant (P for PM10 to give output in $\mu g/m^3$)	P	
Hourly ambient background concentration ($\mu g/m^3$)	0	
Roadway height indicator (AG=at grade, FL=elevated and filled, BR=bridge, DP=depressed)	AG	
Roadway height (ft, 0 if AG, relative height if FL, BR, or DP)	0	

3.10.1.7 Preparing the CAL3QHCR Files

3.10.2.7.1Downloading CAL3QHCR

Download the CAL3QHCR model from EPA's Preferred/Recommended Dispersion Models website at www.epa.gov/scram001/dispersion_prefrec.htm. There are five files needed to run the program:

- input file (.inp),
- batch file (.bat),
- control file (.ctl),
- meteorological data file (.asc), and
- executable file (.exe).

Decide on a name for the run. The name of the example scenario run is "2009south11900k".

Note that in setting up your run, you will be editing over data already present in the files.

Prepare the Batch File (.bat)**.**
The batch file is the DOS file batch command.

Right click on the file to open it for editing. (Note that opening or double clicking on the file will cause the program to run. If this happens, simply delete the files the program creates and start again.) Once the file is open, type in the name of your run after the word "Copy". Save the file with the name of the run. See Figure 3.14 below for the example scenario batch file.

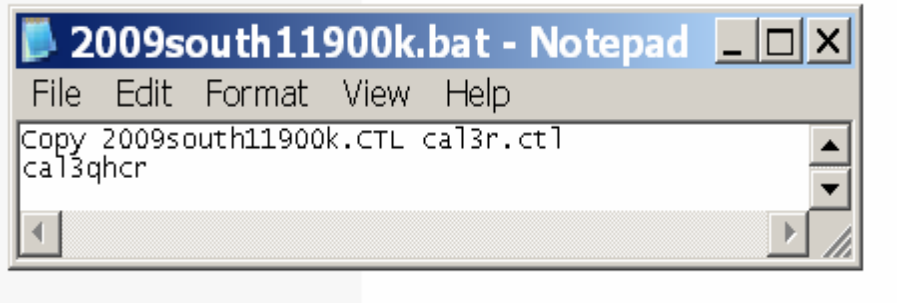


Figure 3.14: Example Scenario Batch File

3.10.1.7.2Prepare the Control File (.ctl)

CAL3QHCR looks to the control file to find the file names that are read into the program and outputted by the program.

Type the name of your run in front of each file extension, except the .ASC file, where you will type in the meteorological data file name. Save the control file with the name of your run. See Figure 3.15 below for the example scenario control file.

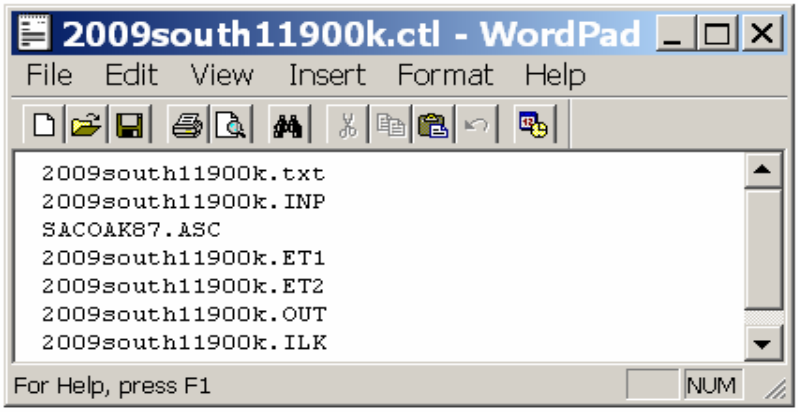


Figure 3.15: Example Scenario Control File

3.10.1.7.3Meteorological File (.asc)

The meteorological file should be in the .asc format. Contact your local air district for the recommended meteorological file. This file will not be edited.

3.10.1.7.4Executable File (.exe)

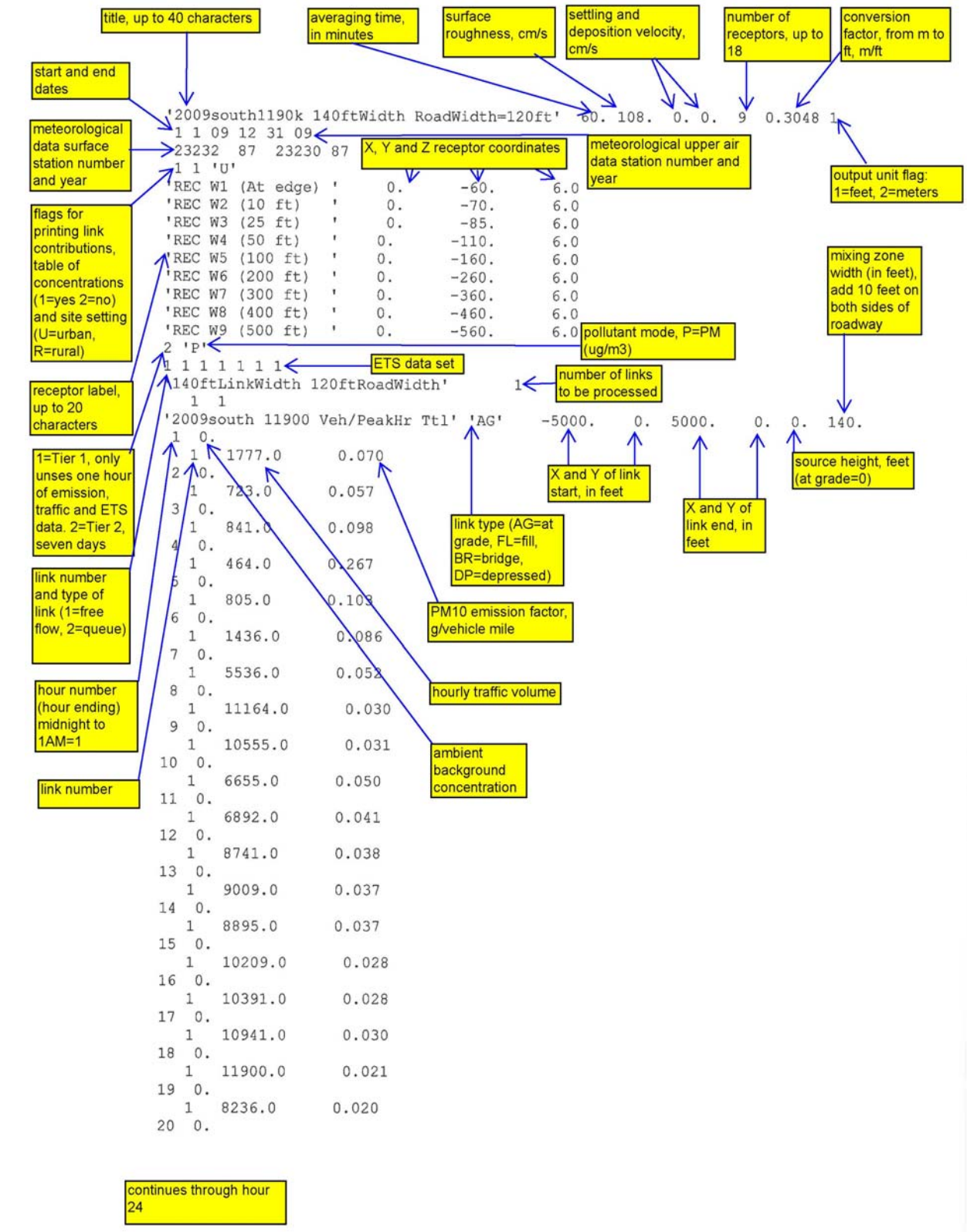
The executable file runs the program. This file will not be edited.

3.10.1.7.5Prepare the Input File (.inp)

The input file contains scenario parameters.

Prepare the input by editing over an example file provided with the model download, or by editing over a file provided by the local air district that more closely reflects the setup needed for this type of roadway modeling. Save the input file with the name of your run. See Figure 3.16 below for the example scenario input file and input explanations.

Figure 3.16: Example Scenario Input File and Input Explanations



3.10.1.8 Running the Model and Calculating Potential Cancer Risk

Double click on the .bat file to run the model. The model will produce a series of files with extensions .ET1, .ET2, .ILK, .OUT, .txt, and .ctl. Open the .txt and check to be sure the run was error-free.

The output file (.OUT) will show, among other information, the highest annual average concentrations. See Figure 3.17 below for the relevant section of the example scenario output file.

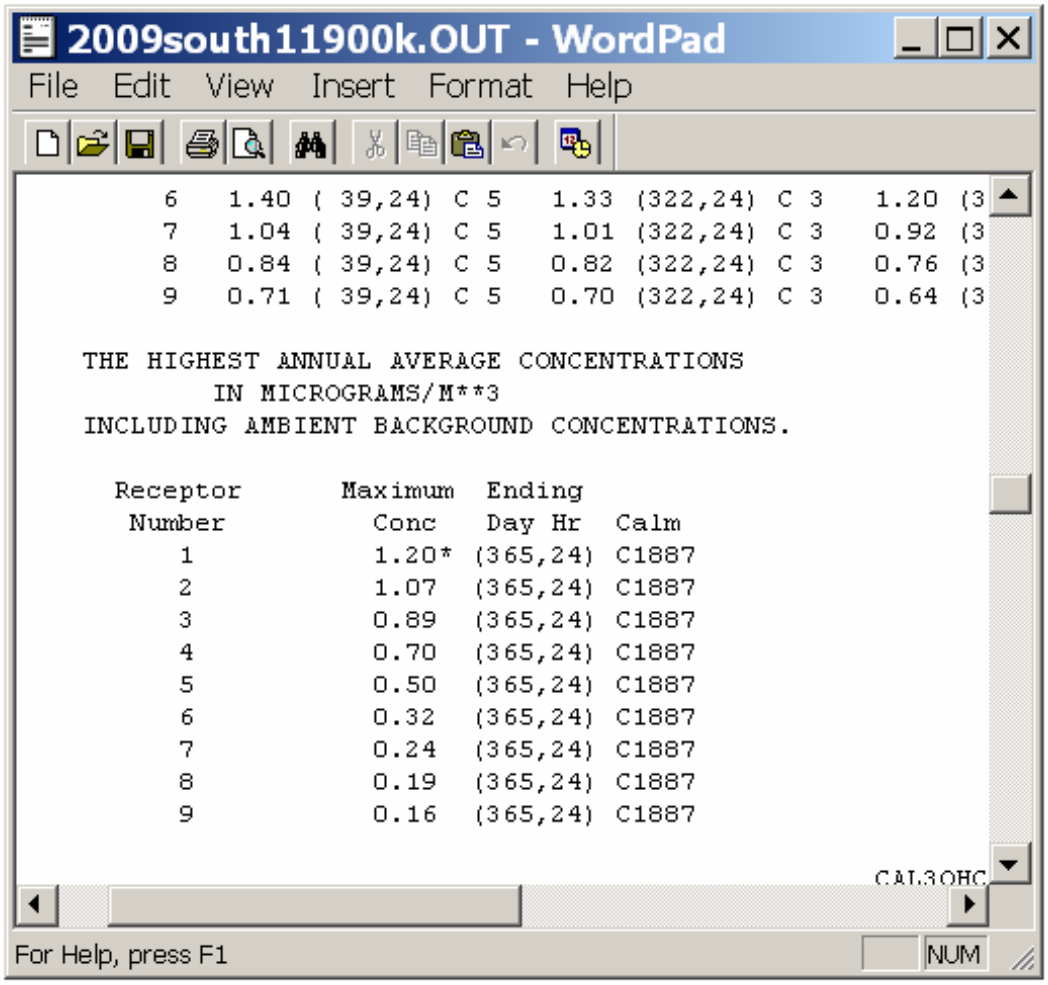


Figure 3.17: Example Scenario Output File, Highest Annual Average Concentrations

The example above shows downwind concentrations of diesel particulate matter at various receptor locations. The cancer risk due for diesel particulate is calculated by assuming that only the inhalation pathway applies. The default cancer risk calculation is based on the 80th percentile breathing rate, as recommended by the Office of Environmental Health Hazard Assessment. The cancer risk is calculated for receptor 4 (0.70 ug/m^3) as follows:

Cancer Risk = S_i * C_i * DBR * A * EF * ED / AT

Where:

S_i =	Cancer Potency Slope Factor for DPM	=	1.1 $(mg/kg\text{-}d)^{-1}$
C_i =	Concentration in the air of DPM	=	0.70 ug/m^3
DBR =	Daily Breathing Rate (default 80th %ile):	=	302 L/kg-day
	(Residential Receptors)		
	(Some districts may require the use of the 95th %ile):		
		=	393 L/kg-day
A =	Inhalation Absorption Rate	=	1
EF =	Exposure Frequency:	=	350 days
	(Residential Receptors)		
ED =	Exposure Duration:	=	70 years
	(Residential Receptors)		
AT =	Averaging Time (70 years)	=	25,550 days

Cancer Risk:

= $(1.1\ (mg/kg\text{-}d)^{-1})(0.70\ ug/m^3)$(302 L/kg-day)(1)(350 days)(70 years)/(25,550 days)

= 223 per million

3.10.1.9 Other CAL3QHCR Features

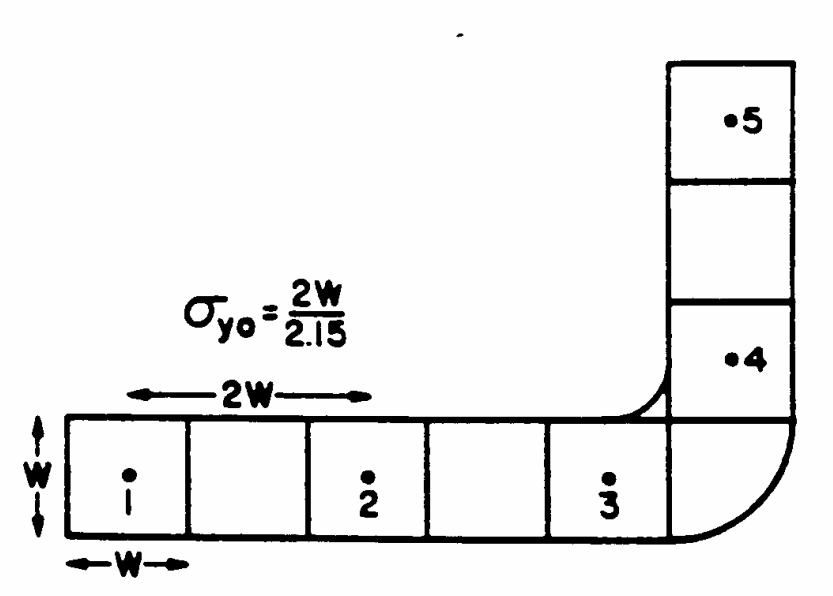
CAL3QHCR offers many other features that allow modeling traffic intersections, traffic signaling, and traffic queuing. Employing these features is quite site-specific. If these features must be employed, the user's guide should be consulted.

3.10.2 Modeling Roads using ISCST3 or AERMOD

CAL3QHCR is a roadway model. It can be used only to model highways. Often a project for which a health risk assessment is being prepared has additional sources. For example, a commercial development will have toxic emissions from truck idling, operation of transportation refrigeration units (TRUs), fast food restaurants, gasoline dispensing facilities, and dry cleaning operations. Large commercial operations may also have emergency diesel-fired internal combustion engines. These additional sources could be modeled in ISCST3 or AERMOD and their predicted risks superimposed upon those predicted by CAL3QHCR. Alternatively, all the sources including the roadways could be modeled using ISCST3 and AERMOD. The results of roadway modeling using ISCST3 and AERMOD are consistent with those from using CAL3QHCR. The procedures for using ISCST3 and AERMOD to model emissions from roadways are discussed below.

3.10.2.1 Introduction

ISCST3 and AERMOD can be used to predict the concentrations of pollutants emitted from vehicles on roads. These models have 4 basic types of sources (i.e., point, area, volume, and open pit). Emissions from idling vehicles located at a loading dock can be modeled as point sources. Area sources have been used in the past to model emissions from parking lots. The best method for modeling emissions from travelling vehicles is to use a line source or a series of multiple volume sources, as shown below.



View looking down along the length of a road segment (L_{RS})

The following steps can be used to construct a line source that represents diesel PM emissions from diesel trucks traveling along a road segment:

1. Determine the total emissions for the diesel trucks traveling along the road segment.

   E_T = Emissions total for road segment

2. Using the width of the road as the length of the side (W) of a single volume source, determine the number of volume sources along the length of the road by dividing the length of the road by 2W. Round the number of volume sources either up or down.

   W = Width of the road
   L_{RS} = Length of the road segment
   N = Number volume sources
   $N = L_{RS} / 2W$

3. Calculate the initial lateral dispersion:

$\sigma_y = 2W / 2.15$

3. Estimate the initial vertical dispersion using the height of the truck exhaust divided by 4.3.

   $\sigma_z = H / 4.3$
   $= 13 \text{ feet} / 4.3$
   $= 3.01 \text{ feet}$

4. Calculate the emission rate for each volume source by dividing the total emissions for the road segment by the number of volume sources.

   E_{VS} = Emission rate for each volume source
   $E_{VS} = E_T / N$

5. Model each individual volume source using ISCST or AERMOD separately, but as a group, using actual emissions for each volume source.

6. Identify the predicted concentrations at each receptor.

7. Next, calculate the risk at each receptor using the procedure outlined above in Section 3.10.1.8.

3.10.2.2 Data Requirements

The data that are required to model roadway emissions using ISCST3 and AERMOD are similar to those required for using CAL3QHCR. They include the following:

- **Meteorological data** – If the air district cannot provide preprocessed meteorological data, then nearby airport or monitored surface data from a meteorological station can be processed for use in ISCST3 or AERMOD. Contact your local district for availability of appropriate met data. Information on processing met data can be found in Appendix A.
- **Traffic data and vehicle emissions** – The same data as discussed above for the CAL3QCHR model are used.
- **Roadway configuration** – The width of the roadway is used as the length of a side for each volume source. Receptors should be located the same as with the CAL3QCHR model.
- **Terrain data** – For ISCST3, elevation data must be entered manually. AERMAP is used to generate the elevations and hill slopes for receptors and sources for input to the AERMOD model. Digital Elevation Model (DEM) files for use in AERMAP are available from a variety of sources.

Third-party software used to prepare the input file for ISCST3, and used to allow the model results to be viewed graphically, can also be used to determine terrain elevations using DEM files.

Once these data are assembled, the model input file can be created.

3.10.2.3 Preparing the Model Input File

The input files for ISCST3 and AERMOD are very similar. In the discussion below, only the input file for the ISCST3 model will be described.

The input file must contain the following components or sections:

CO – for overall job control options
SO – for source information
RE – for receptor information
ME – for meteorological data
TG – for a terrain grid (optional)
OU – for output options

Each of these sections is discussed briefly below. For more detailed information, the *User's Guide for the Industrial Source Complex (ISC3) Dispersion Models: Volume I – User Instructions* (EPA-454/B-95-003a) should be consulted.

3.10.2.3.1 Control Option Section

Each section begins with a STARTING command and ends with a FINISHED command. Model options that must be specified include: a title; model options such as default or "regulatory" dispersion options, rural or urban dispersion coefficients, and concentration or deposition estimates; the averaging time (period or annual for carcinogenic risk); the pollutant identification; and the RUNORNOT option. The following is a sample input for the example discussed above:

```
CO STARTING
   TITLEONE 2009south1190k
   MODELOPT DFAULT CONC  URBAN
   AVERTIME PERIOD
   POLLUTID DPM
   TERRHGTS ELEV
   FLAGPOLE 1.80
   RUNORNOT RUN
   ERRORFIL Road.err
CO FINISHED
```

In this sample input file, the regulatory default options are used. The model will calculate concentrations of DPM (i.e., diesel particulate matter) using urban dispersion coefficients. The receptors will all be modeled with a default height of 6 ft or 1.8 m. The model will run to completion and will output an error file.

3.10.2.3.2 Source Section

As discussed above, a series of volume sources will be modeled to simulate the roadway. The sample input file for this section is the following:

```
SO STARTING
** Source Location **
** Source ID - Type - X Coord. - Y Coord. **
** Line Source represented by Separated Volume Sources
** ------------------------------------------------------------------------
** LINE Source ID = SLINE1
** DESCRSRC 2009south1190k
** Length of Side = 36.58
** Emission Rate = 0.123435368
** Elevated
** Vertical Dimension = 0.85
** SZINIT = 0.20
** Nodes = 2
** 309476.00, 3916500.00, 0.00, 3.66, 0.0
** 312527.00, 3916500.00, 0.00, 3.66, 33.38
** ------------------------------------------------------------------------
   LOCATION L0000001 VOLUME 309494.288 3916500.000 0.00
   LOCATION L0000002 VOLUME 309566.060 3916500.000 0.00
   LOCATION L0000042 VOLUME 312436.939 3916500.000 0.00
   LOCATION L0000043 VOLUME 312508.711 3916500.000 0.00
** End of Line Source
** Source Parameters **
   SRCPARAM L0000001 0.00287058995348837 3.66 33.38 0.85
   SRCPARAM L0000002 0.00287058995348837 3.66 33.38 0.85
   SRCPARAM L0000042 0.00287058995348837 3.66 33.38 0.85
   SRCPARAM L0000043 0.00287058995348837 3.66 33.38 0.85
** Variable Emissions Type: "By Hour-of-Day"
** Variable Emission Scenario: "Scenario 1"
   EMISFACT L0000001 HROFDY 0.53 0.176 0.351 0.528 0.353 0.526
   EMISFACT L0000001 HROFDY 1.227 1.427 1.395 1.418 1.204 1.416
   SRCGROUP SRCGP1 L0000001 L0000002 L0000003 L0000004 L0000005 L0000006
   SRCGROUP SRCGP1 L0000043
SO FINISHED
```

In the above sample input, all lines with "**" are comments. This file was generated using an interface program for the model. In this interface, the information for the line source is input, and the program automatically generates the individual volume sources. As can be seen from the input file, there are 43 separate volume sources in this "line source". The location of the center of each volume source and its base elevation (i.e., 0 m) is given on the LOCATION command. The SRCPARAM commands specify the emission rate, the release height, the initial lateral dimension, and the initial vertical dimension. The average emission rate calculated from the information provided above was used. The program divides the emission rate for the line source by the number of volume sources.

A **release height** of 12 ft or 3.66 m was used to approximate the height of the plume from a heavy-duty diesel truck.

The width of the roadway was used as the **length of the side for each volume source**.

The length of the side is used to calculate an initial lateral dimension. For this example, the **initial lateral dimension** is 34.03 m or 2 x 36.58/2.15. (The initial lateral dimension actually used is 33.38 m to ensure that there are an equal number of volume sources in the length of road. This small difference in the calculated initial lateral dimension and the one actually used would not significantly affect the concentrations estimated.)

Based on this release height, an **initial vertical dimension** of 0.85 m or 3.66/4.3 was used.

Variable emission factors (EMISFACT) by the hour of the day (HROFDAY) were used to adjust the average emission rate by the appropriate factor based upon the discussion above for the CAL3QCHR run.

3.10.2.3.3Receptor Section

Receptors were located at the distances specified above in the discussion of CAL3QCHR modeling. The sample input file for this section is the following:

```
RE STARTING
** DESCRREC "FENCEGRD" "Receptors generated from Fenceline Grid"
   DISCCART    312530.00   3916454.00    0.00    1.80
   DISCCART    312505.15   3916454.00    0.00    1.80
** DESCRREC "FENCEPRI" "Cartesian plant boundary Primary Receptors"
   DISCCART    309473.00   3916457.00    0.00    1.80
   DISCCART    312530.00   3916457.00    0.00    1.80
   DISCCART    312530.00   3916543.00    0.00    1.80
   DISCCART    309473.00   3916543.00    0.00    1.80
** DESCRREC "FENCEINT" "Cartesian plant boundary Intermediate Receptors"
   DISCCART    309497.85   3916457.00    0.00    1.80
   DISCCART    309522.71   3916457.00    0.00    1.80
   DISCCART    309473.00   3916478.50    0.00    1.80
RE FINISHED
```

The interface program used allows the automatic creation of a telescopic fenceline grid around a facility. This feature was used to create the receptors in this sample input.

First, primary plant boundary receptors were located around the highway. The “plant boundary” was assumed to be the edge of the roadway (i.e., 10 ft on each side of the road from the roadway’s width).

Intermediate receptors were located at a distance of 25 m between receptors along the edge of the roadway.

Then, tiers of receptors at distances of 10 ft, 25 ft, 50 ft, 100 ft, 200 ft, 300 ft, 400 ft, and 500 ft from the roadway edge were entered.

These grid receptors were converted to discrete receptors, and any extraneous receptors were removed.

Note that specific receptors for residences or other **sensitive receptors** could be modeled directly with the ISCST3/AERMOD model.

The **elevation of receptors** was assumed to be zero.

A **receptor height** of 6 ft or 1.8 m was used to approximate the breathing height.

3.10.2.3.4Meteorology Section

The meteorology section specifies the meteorological data to be used. The sample input file for this section is the following:

```
ME STARTING
   INPUTFIL C:\MODELI~1\SACOAK85.asc
   ANEMHGHT 10 METERS
   SURFDATA 23232 1985 SACRAMENTO/EXECUTIVE_ARPT
   UAIRDATA 23230 1985 OAKLAND/WSO_AP
ME FINISHED
```

For this sample input file, the 1985 meteorological data from Sacramento was downloaded from the District's website. In the input file, the name and location of the met data file is specified. The height of the anemometer is given. (Most anemometers at airport weather stations are 10 m high.) And, the station number, year and name of the surface data and upper air stations are identified.

3.10.2.3.4Output Section

The output section specifies the files or reports to be output. The sample input file for this section is the following:

```
OU STARTING
** Auto-Generated Plotfiles
   PLOTFILE PERIOD SRCGP1 ROAD.IS\PE00G001.PLT
OU FINISHED
```

ISCST3/AERMOD have a variety of files and reports that can be output. One of the most useful filetypes that can be output is the plotfile. A plotfile has the following information:

```
* ISCST3 (02035): 2009south1190k
* MODELING OPTIONS USED:
*  CONC                    URBAN ELEV  FLGPOL DFAULT
*         PLOT FILE OF PERIOD VALUES FOR SOURCE GROUP: SRCGP1
*         FOR A TOTAL OF  2236 RECEPTORS.
*         FORMAT: (3(1X,F13.5),1X,F8.2,2X,A6,2X,A8,2X,I8.8,2X,A8)
*        X             Y      AVERAGE CONC   ZELEV     AVE     GRP      NUM HRS   NET ID
* ____________ ____________  ____________  _______  ______  ________  _________  ________
  312530.00000 3916454.00000       0.13119     0.00  PERIOD  SRCGP1    00008760     NA
```

For each receptor and each specified source group, this file contains the highest predicted concentration for the specified averaging time. Multiple files can be created for multiple source groups (which can be single sources or multiple sources depending upon those specified by the user) and for each averaging time modeled. These plotfiles can be used to generate a *.XOQ file for input into the Hot Spots Analysis and Reporting Program (HARP). They also can be used by graphics programs incorporated into the model interface programs or software such as SURFER to generate isopleths of concentration for a visual display of the results.

3.10.2.4 Analyzing Model Results

Concentrations predicted by ISCST3/AERMOD can be used to estimate risk using the procedure discussed above for cancer risk from emissions of diesel particulate matter. The plotfiles generated by the models can be used to create an input file for HARP. Importing the results into HARP can be useful if there are other sources that may contribute to the total risk (e.g., in the case of a commercial development). All sources can be modeled in ISCST3/AERMOD while only the roadway sources can be modeled in CAL3QCHR.

Chapter 4. Geographical Information Inputs

4.1 Comparison of Screening and Refined Model Requirements

Geographical information requirements range from basic for screening analyses to advanced for refined modeling. SCREEN3 makes use of geographical information only for terrain data for complex or elevated terrain where it requires simply distance from source and height in a straight-line. The AERMOD and ISCST3/ISC-PRIME models make use of complete three-dimensional geographic data with support for digital elevation model files and real-world spatial characterization of all model objects.

4.2 Coordinate System

4.2.1 Local

Local coordinates encompass coordinate systems that are not based on a geographic standard. For example, a facility may reference its coordinate system based on a local set datum, such as a predefined benchmark. All site measurements can relate to this benchmark which can be defined as the origin of the local coordinate system with coordinates of 0.0 m. All facility buildings and sources could then be related spatially to this origin.

However, local coordinates do not indicate where in the actual world the site is located. For this reason, it is advantageous to consider a geographic coordinate system that can specify the location of any object anywhere in the world with precision. The coordinate system most commonly used for air dispersion modeling is the Universal Transverse Mercator system.

4.2.2 UTM

As described earlier, the Universal Transverse Mercator (UTM) coordinate system uses meters as its basic unit of measurement and allows for more precise definition of specific locations than latitude/longitude. Google Earth may be used to determine the UTMs or latitude/longitude coordinates.

Ensure all model objects (sources, buildings, receptors) are defined in the same horizontal datum. Defining some objects based on a NAD27 (North American datum of 1927) while defining others within a NAD83 (North American datum of 1983) can lead to significant errors in relative locations.

4.3 Terrain

4.3.1 Terrain Concerns in Short-Range Modeling

Terrain elevations can have a large impact on the air dispersion and deposition modeling results and therefore on the estimates of potential risk to human health and the environment. Terrain elevation is the elevation relative to the facility base elevation.

The following section describes the primary types of terrain. The consideration of a terrain type is dependant on your study area, and the definitions below should be considered when determining the characteristics of the terrain for your modeling analysis.

4.3.2 Flat and Complex Terrain

The models consider three different categories of terrain as follows:
Complex Terrain: as illustrated in Figure 4.1, where terrain elevations for the surrounding area, defined as anywhere within 50 km from the stack, are above the top of the stack being evaluated in the air modeling analysis.

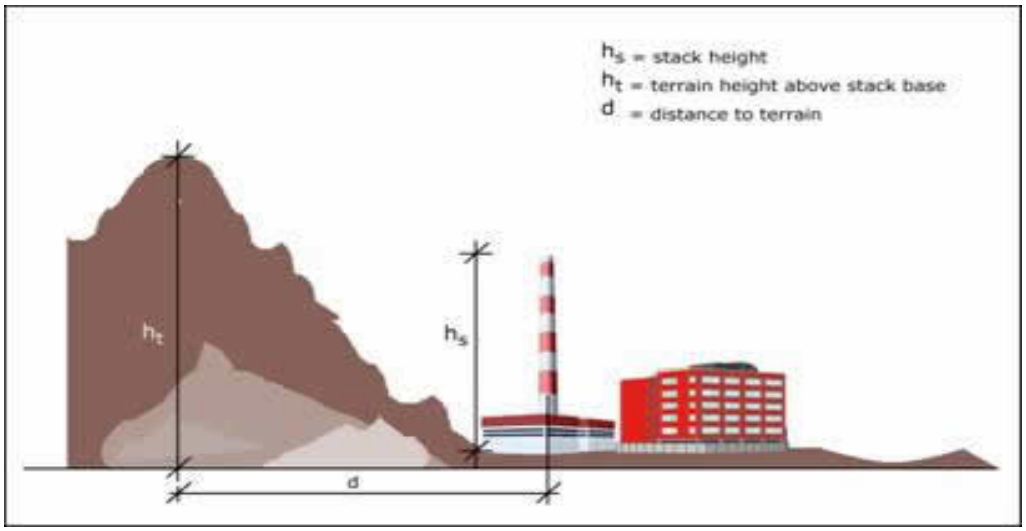


Figure 4.1 - Complex terrain conditions.

Simple Terrain: where terrain elevations for the surrounding area are not above the top of the stack being evaluated in the air modeling analysis. The "Simple" terrain can be divided into two categories:

- Simple Flat Terrain is used where terrain elevations are assumed not to exceed stack base elevation. If this option is used, then terrain height is considered to be 0.0 m.
- Simple Elevated Terrain, as illustrated in Figure 4.2 is used where terrain elevations exceed stack base but are below stack height.

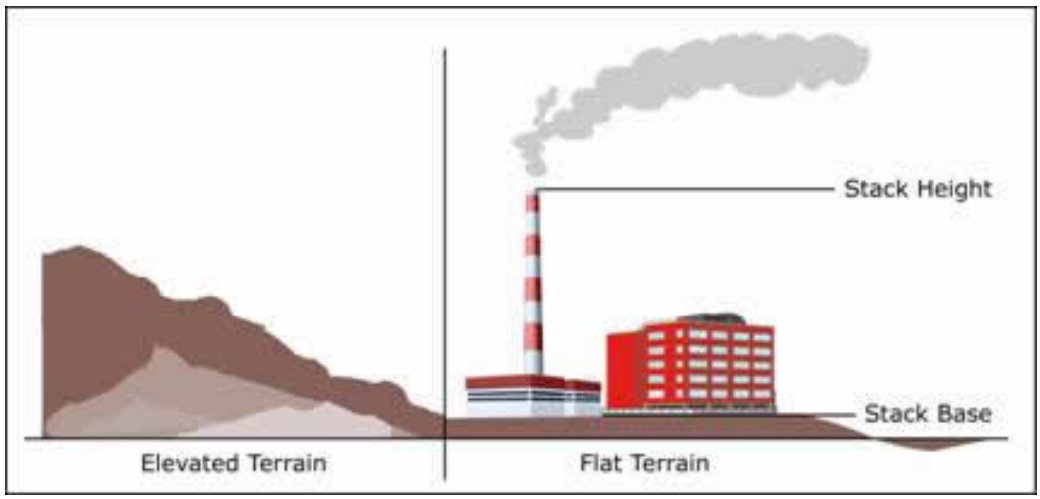


Figure 4.2 –Elevated and flat terrain conditions.

4.3.3 Criteria for Use of Terrain Data

Evaluation of the terrain within a given study area is the responsibility of the modeler. Complex terrain may need to be considered even in areas that appear to be relatively flat. It should be remembered that complex terrain is any terrain within the study area that is above the source release height.

The appropriate terrain environment can be determined through the use of digital elevation data or other geographic data sources. It should be noted that the refined models, ISCST3/ISC-PRIME and AERMOD, have similar run times regardless of whether or not terrain data is used. However AERMAP, the terrain pre-processor for AERMOD, does require additional time. If analysis of the terrain environment is performed using digital terrain data, minimal resources are required to execute a model run using that digital terrain dataset.

4.3.4 Obtaining Terrain Data

Terrain data that are input into the AERMOD and ISCST3/ISC-PRIME models should be provided in electronic form. Digital elevation terrain data is available from a variety of vendors in several different formats.

Digital elevation model (DEM) data are available for free from Lakes Environmental's Web GIS web page http://www.webgis.com.

4.3.5 Preparing Terrain Data for Model Use

It is strongly suggested that the 7.5-minute data be used in dispersion modeling rather than the coarse resolution 1 degree data. Keep in mind that the USGS DEMs can be in one of two horizontal datums. Older DEMs were commonly in NAD27 (North American Datum of 1927) while many of the latest versions are in NAD83 (North American Datum of 1983).

4.3.5.1 ISC / HARP

The ISCST3 model accepts elevation data for receptors and sources. This data should be obtained from the USGS topographic maps or Digital Elevation Model (DEM) files. USGS DEMs are available for California from ARB at (http://www.arb.ca.gov/toxics/harp/maps.htm) in 7.5-minute format for use in the ARB HARP program and from Lakes Environmental at http://www.webgis.com in 7.5 minute and 1 degree formats.

4.3.5.2 AERMOD

AERMAP is the digital terrain pre-processor for the AERMOD model. It analyzes and prepares digital terrain data for use within an air dispersion modeling project. AERMAP requires that the digital terrain data files be in native (non SDTS) USGS 1-degree or 7.5-minute DEM format.

4.4 Defining Urban and Rural Conditions

The classification of a site as urban or rural can be based on the Auer method specified in the EPA document *Guideline on Air Quality Models (40 CFR Part 51, Appendix W)*[37]. From the Auer's method, areas typically defined as Rural include:

[37] U.S. Environmental Protection Agency, 2001. Appendix W to Part 51 Guideline on Air Quality Models, 40 CFR Part 51. U. S. Environmental Protection Agency, Research Triangle Park, NC.

- Residences with grass lawns and trees
- Large estates
- Metropolitan parks and golf courses
- Agricultural areas
- Undeveloped land
- Water surfaces

Auer suggests that an area can be classified as Urban if it has less than 35% vegetation coverage or the area falls into one of the following use types:

Table 4.1 - Urban Land use

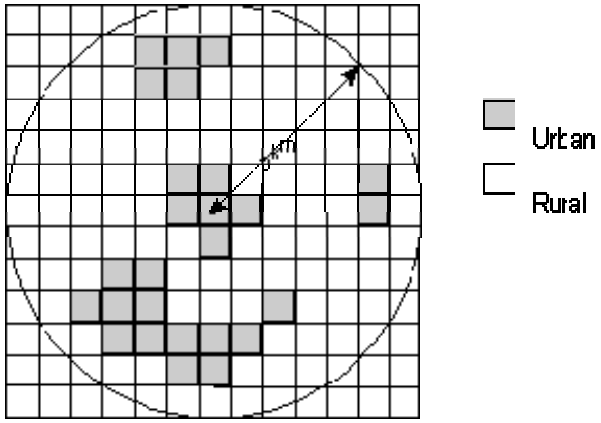
Type	Use and Structures	Vegetation
I1	Heavy industrial	Less than 5%
I2	Light/moderate industrial	Less than 5%
C1	Commercial	Less than 15%
R2	Dense single / multi-family	Less than 30%
R3	Multi-family, two-story	Less than 35%

Follow the Auer's method, explained below, for the selection of either urban or rural dispersion coefficients:

Step 1: Draw a circle with a radius of 3 km from the center of the stack or centroid of the polygon formed by the facility stacks.

Step 2: If land use types I1, I2, C1, R2, and R3 account for 50% or more of the area within the circle, then the area is classified as Urban, otherwise the area is classified as Rural.

To verify if the area within the 3 km radius is predominantly rural or urban, overlay a grid on top of the circle and identify each square as primarily urban or rural. If more than 50% of the total number of squares is urban than the area is classified as urban; otherwise the area is rural.[35]



An alternative approach to Urban/Rural classification is the Population Density Procedure: Compute the average population density, p, per square kilometer.

- If p > 750 people/km^2, select the Urban option,
- If p <= 750 people/km^2, select the Rural option.

Of the two methods above, the land use procedure is considered a more definitive criterion. The population density procedure should be used with caution and should not be applied to highly industrialized areas where the population density may be low and thus a rural classification would be indicated, but the area is sufficiently built-up so that the urban land use criteria would be satisfied. In this case, the classification should already be Urban and urban dispersion parameters should be used.

Prior to using either of the above methods, contact the district to determine whether the area in question has already been designated as urban or rural.

Chapter 5. Meteorological Data

5.0 Comparison of Screening and Refined Model Requirements

Meteorological data is essential for air dispersion model modeling as it describes the primary environment through which the pollutants being studied migrate. Similar to other data requirements, screening model requirements are less demanding than refined models.

SCREEN3 provides 3 methods of defining meteorological conditions:

- Full Meteorology: SCREEN will examine all six stability classes (five for urban sources) and their associated wind speeds. SCREEN examines a range of stability classes and wind speeds to identify the "worst case" meteorological conditions, i.e., the combination of wind speed and stability that results in the maximum ground level concentrations.
- Single Stability Class: The modeler can select the stability class to be used (A through F). SCREEN will then examine a range of wind speeds for that stability class only.
- Single Stability Class and Wind Speed: The modeler can select the stability class and input the 10-meter wind speed to be used. SCREEN will examine only that particular stability class and wind speed.

Contact the district for guidance if full meteorology is not being used in SCREEN.

See Appendix A for information on preparing meteorological data for refined modeling (AERMOD and ISC.

Chapter 6. Receptor Locations

6.0 Receptors

A receptor is defined as a point where an actual person (residential or worker) may be located for a given period of time. The period of time is based on the type of assessment that is being performed. When an acute (1-hour or longer, as applicable) risk assessment is to be prepared, all locations where a person could be located for a one hour period needs to be identified. When a cancer or chronic risk assessment is to be prepared, all locations where a person could be located for extended periods of time, such as a residence or workplace, need to be identified.

6.0.1 Residential Receptors

Homes, apartments, motels, trailer parks, residential camp grounds, and other places where people reside for long periods are defined as residential receptors. When a cancer risk is prepared, the exposure period should be 70 years. For acute risk assessments, the exposure period should be 1 hour for those substances with acute toxicity values based on one hour exposure periods.

6.0.2 Worker Receptors

Worksites, schools, and other locations where people are exposed for long periods of time are defined as worker receptors. When a cancer risk is prepared, the exposure period should be 40 years. For acute risk assessments, the exposure period should be 1 hour for those substances with acute toxicity values based on one hour exposure periods.

6.0.3 Offsite Receptors

Offsite receptors are included in risk assessments when they are not employed by the project.

6.0.4 Onsite Receptors

Onsite receptors are included in risk assessments if they are persons not employed by the project.

6.0.5 Sensitive Receptors

Sensitive receptors are defined as the following:

- Schools
- Daycare facilities other than home based
- Hospitals
- Care facilities (adult/elderly)

At the present time, the risk assessment calculations do not calculate different risk values for sensitive receptors compared to other receptors. However, sensitive receptors must be identified. Contact the district to determine the area in which sensitive receptors must be identified. Some

commonly used criteria are out to a distance of 2 kilometers from a project emission source or within the 1 in a million risk isopleth.

6.1 Receptor Grids

6.1.1 Cartesian Receptor Grids

Cartesian receptor grids are receptor networks that are defined by an origin with receptor points evenly (uniform) or unevenly (non-uniform) spaced around the origin. Figure 6.1 illustrates a sample uniform Cartesian receptor grid.

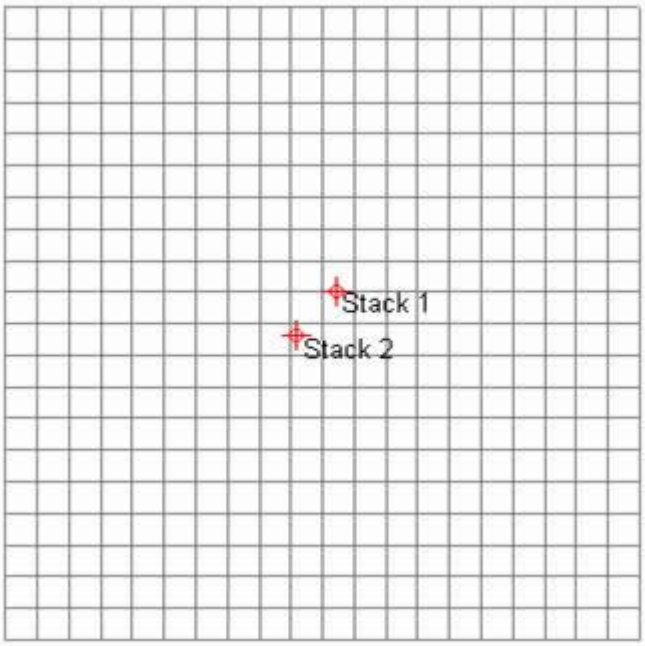


Figure 6.1 – Example of a Cartesian grid.

Tall stacks could require grids extending 1 to 3 km, while the grid for shorter stacks (10 to 20 m above ground) might only need to be extended a km or less from the property line.

6.1.2 Polar Receptor Grids

Polar receptor grids are receptor networks that are characterized by an origin with receptor points defined by the intersection of concentric rings, which have defined distances in meters from the origin, with direction radials that are separated by specified degree spacing. Figure 6.2 illustrates a sample uniform polar receptor grid.

Polar grids are a reasonable choice for facilities with only one source or one dominant source. However, for facilities with a number of significant emissions sources, receptor spacing can become too coarse when using polar grids. As a result, polar grids should generally be used in conjunction with another receptor grid, such as a multi-tier grid, to ensure adequate spacing.

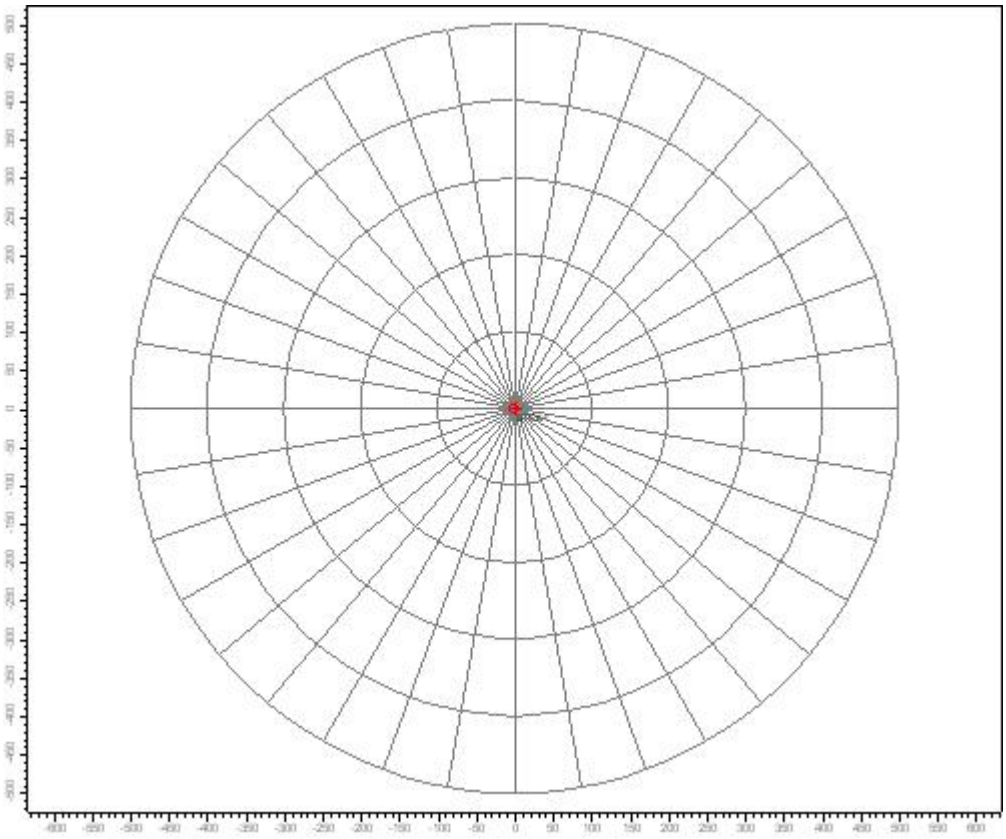


Figure 6.2 – Example of a polar grid.

6.1.3 Multi-Tier Grids

Each receptor point requires computational time. Consequently, it is not optimal to specify a dense network of receptors over a large modeling area; the computational time would negatively impact productivity and available time for proper analysis of results. An approach that combines aspects of coarse grids and refined grids in one modeling run is the multi-tier grid.

The multi-tier grid approach strives to achieve proper definition of points of maximum impact while maintaining reasonable computation times without sacrificing sufficient resolution. Figure 6.3 provides an example of a multi-tier grid.

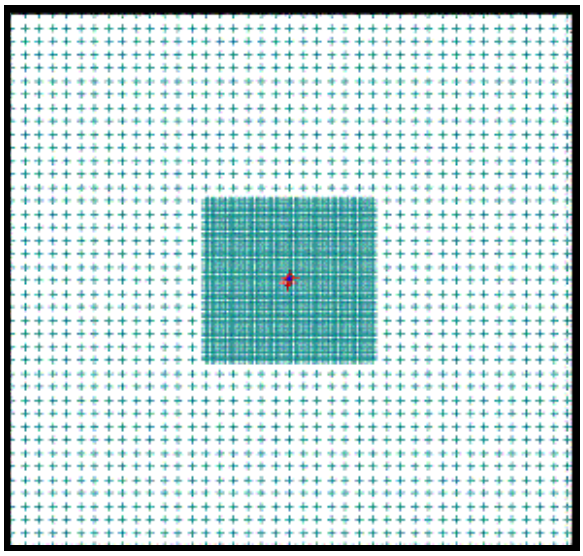


Figure 6.3 - Sample Multi-Tier Grid with 2 tiers of spacing.

6.1.4 Fence line Receptors

Unless on-site receptors are present, it is not necessary to model the locations within a property boundary. If on-site receptors may be present, contact the District concerning receptor placement. If a fence line receptor point does not represent an existing or reasonably anticipated person, it is not necessary to consider these results to determine the Maximum Exposed Individual (MEI), but fence line exposure should be considered to determine the Point of Maximum Impact (PMI).

A receptor network based on the shape of the property boundary that has receptors parallel to the boundaries is often a good choice for receptor geometry. The receptor spacing can then progress from fine to coarse spacing as distance increases from the facility, similar to the multi-tier grid.

6.1.5 Discrete & Sensitive Receptors

Receptor grids do not always cover precise locations that may be of interest in modeling projects. Specific locations of concern can be modeled by placing single receptors, or additional refined receptor grids, at desired locations. This enables the modeler to generate data on specific points for which data is especially critical. Examples of specific locations can include:

- Apartments,
- Residential zones,
- Schools,
- Apartment buildings,
- Day care centers,
- Air intakes on nearby buildings,
- Hospitals,
- Parks,
- Care Facilities, or

- Elevated receptors, such as balconies or air intakes on multilevel buildings, as concentrations of toxic substances can be higher there than at ground level.

Depending on the project resolution and location type, these can be characterized by discrete receptors, a series of discrete receptors, or an additional receptor grid.

6.2 Variable Receptor Spacing to include the Point of Maximum Impact (PMI)

The receptor grid must be designed to include the Point of Maximum Impact (PMI). For facilities with more than one emission source, the receptor network should include Cartesian or multi-tier grids to ensure that maximum concentrations are obtained. An indication as to the PMI can be determined by using SCREEN3 or AERSCREEN applied to the most significant sources at a facility.

The model could be first run with a coarser grid, and then run with finer grids in the areas showing the highest impacts. If this method is used, finer grids, as described above, should be used for all areas with high concentrations, not just the single highest area.

The densities of the receptors can progress from fine resolution near the source, centroid of the sources, or most significant source (not from the property line for polar grid) to coarser resolution farther away. Section 6.1.3 shows an example of multiple grid spacing to ensure that the maximum ground level offsite property concentrations are captured.

Receptors should also be placed along the property boundaries. The spacing of these receptors depends on the distance from the emission sources to the facility boundaries. For cases with emissions from short stacks or vents and a close property line, a receptor spacing of 25 m might be required. For taller stacks and greater distances to the property boundary, a receptor spacing greater than 25 m might be appropriate.

It is the responsibility of the modeler to demonstrate that the PMI has been identified and that the modeling includes all areas where Hazard Indices are above one, and the cancer risk is above ten per million, or other district standards.

6.2.1 Example Polar Grid Spacing

- 36 Directional Radials
- Radial Distances:
  - 25 m
  - 50 m
  - 100 m
  - 250 m
  - 500 m

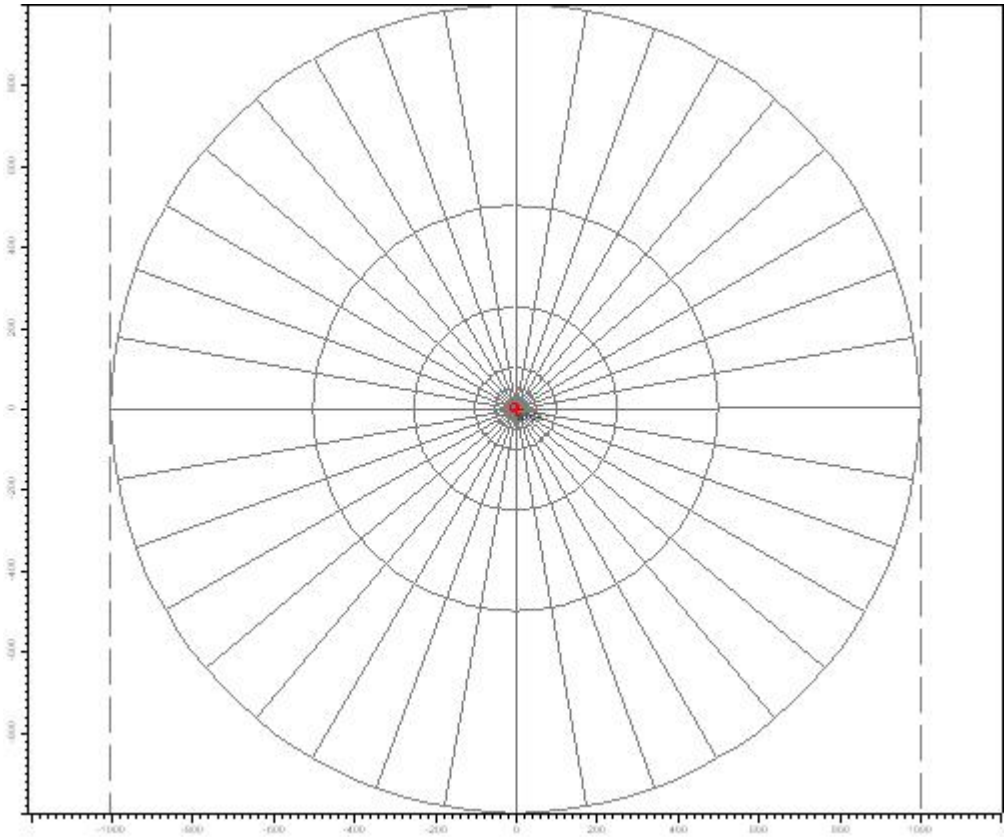


Figure 6.4 – Sample Polar Grid receptor grid layout.

Chapter 7. Other Modeling Considerations

7.0 Alternative Model Use

Due to some limitations inherent in AERMOD (and most other plume models), there are some situations where the use of an alternative model may be appropriate. Acceptable Alternative Models and their use are further described on EPA's Support Center for Regulatory Atmospheric Modeling (SCRAM) web page.

AERMOD is a steady-state plume model. For the purpose of calculating concentrations, the plume is assumed to travel in a straight line without significant changes in stability as the plume travels from the source to a receptor. At distances on the order of tens of kilometers downwind, changes in stability and wind are likely to cause the accuracy to deteriorate. For this reason, AERMOD should not be used for modeling at receptors beyond 50 kilometers. AERMOD may also be inappropriate for some near-field modeling in cases where the wind field is very complex due to terrain or a nearby shoreline.

AERMOD does not treat the effects of shoreline fumigation. Shoreline fumigation may occur along the shore of the ocean or large lake. When the land is warmer than the water, a sea breeze will form as the warmer lighter air inland rises. As the stable air from over the water moves inland, it is heated from below, resulting in a turbulent boundary layer of air that rises with downwind distance from the shoreline. The plume from a stack source located at the shoreline may intersect

the turbulent layer and be rapidly mixed to the ground, a process called "fumigation," resulting in high concentrations. In these and other situations, the use of alternative models may be desired.

The use of any alternative model should first be reviewed by the district for suitability to the study application. If an alternative model is used the reasons and argument for its use over a preferred model must be discussed. An understanding of the alternative model, its data requirements, and the quality of data applied with the model must be demonstrated.

7.1 Use of Modelled Results in Combination with Monitoring Data

Monitoring and modeling should be considered complementary tools to assess potential impacts on the local community.

Monitoring data could be used to provide verification of model results if sufficient monitoring data is available at locations impacted by facility emissions. Decisions on the adequacy of the monitoring data would be made on a case-by-case basis. Comparisons between measured and modeled results would depend on the amount of monitored data available. Advance consultation with the district is advisable if a comparison of model results with monitoring data is undertaken.

If model results do not agree with measured data, the facility source characteristics and emission data should be reviewed.

For cases where reliable information is available on the emission rates and source characteristics for a facility, modeled results can identify maximum impact areas and concentration patterns that could assist in siting monitors. Model runs using a number of years of meteorological data would show the variations in the locations and the magnitude of maximum concentrations and can also provide information on the frequency of high concentrations.

The U.S. EPA Guideline on Air Quality Models states that modeling is the preferred method for determining concentrations and that monitoring alone would normally not be accepted for determining emission limitations.

When monitoring data are used to verify modeling results for averaging times from 1 to 24 hours, more robust comparisons would be achieved using a percentile of the data rather than only the maximum concentrations. Percentile comparisons reduce the impacts of outliers in either the monitoring or the model results. For some contaminants, the impact of background sources on measured concentrations might need to be taken into consideration.

7.2 Information for Inclusion in a Modeling Assessment

A suggested checklist of parameters designed to provide an overview of all information that should be submitted for a refined air dispersion modeling assessment is outlined in Appendix B.

The checklist should not be considered exhaustive for all modeling studies; it provides the essential requirements for a general assessment. All sites can have site-specific scenarios that may call for additional information and result in a need for different materials and data to be submitted.

It is the responsibility of the submitter to ensure proper completion and analysis of any air dispersion modeling assessment delivered for review.

7.3 Level of Detail of Health Risk Assessments

Generally, a health risk assessment for CEQA purposes must include all sources of emissions that will emanate from a project. This includes existing and proposed facility-wide emissions. This includes all sources of potential emissions whether or not the project is subject to district permitting requirements. Additionally, all substances that the Office of Environmental Health Hazard Assessment has identified as having toxicity values must be included in the health risk assessment; some districts may allow a less detailed risk assessment.

It is not permissible to omit permitted sources in a CEQA risk assessment, even if these sources will be evaluated during the permit process. The permitting process does not evaluate the cumulative risk associated with the entire facility, only the individual permit unit. A challenge to the completeness of the risk assessments can be made if these sources are not included in the analysis.

It is also not permissible to omit criteria pollutants in the facility risk assessment, assuming that these emissions will be evaluated separately. Criteria pollutants have OEHHA approved RELs that must be included in the chronic and acute hazard indices. Again, a challenge to the completeness of the risk assessments can be made if these substances are omitted.

Chapter 8. Exposure Assessment Procedures

8.0 Cancer Risk Assessment Procedure for Inhalation Only Pathway Pollutants

The following procedure may be used to assess the health risks from facilities for which diesel particulate matter is emitted or other substances identified as only entering the body through the inhalation pathway. Risk Assessments involving substances that enter the body through other pathways must be analyzed for each pathway. A risk assessment involving multipathway substances can to be prepared using the HARP program available through the California Air Resources Board.

Cancer Risk Procedure for Inhalation only Substances:

- Model emissions to determine both the:
  - annual average ground-level concentrations, and the
  - one hour maximum concentration (or other period depending on the acutely toxic substance)
- Create a plot file for these ground-level concentrations.
- Open the plot file using Microsoft EXCEL or another spreadsheet program.
- Copy the data from the plot(s) into Excel.
- To determine the cancer risk, apply the following formula to each ground-level concentrations:

Cancer Risk = S_i * C_i * DBR * A * EF * ED *10^{-6} / AT

Where:

S_i = Slope Factor for substance i
C_i = Concentration in the air of substance i
DBR = Daily Breathing Rate:

Residential Receptors = 302 L/kg-day (default 80th %ile)
= 393 L/kg-day (95th %ile)

Worker Receptors = 149 L/kg-day

A = Inhalation Absorption Rate = 1

EF = Exposure Frequency:

Residential Receptors = 350 days

Worker Receptors = 245 days

ED = Exposure Duration:

See Section 1.3

AT = Averaging Time = 25,550 days

The result will be cancer risk for each source and receptor combination modeled.

For worker exposures, in addition to adjusting the breathing rate, exposure frequency, and exposure duration for workers bersus residents, the emission rate must be adjusted to ensure that he worker risk is based upon the pollutant concentrations to which the worker is exposed. For additional information, see Section 8.2.2b of OEHHA's Air Toxics Hot Spots Program Risk Assessment Guidelines: The Air Toxics Hot Spots Program Guidance Manual for Preparation of Health Risk Assessments, August 2003.

8.1 Cancer Risk Assessment Procedure for Multi-Pathway Pollutants

The procedure for preparing a multi-pathway risk assessment can be complex. The HARP User Guide and the OEHHA Air Toxics Hot Spots Program Risk Assessment Guidelines contains a detailed discussion of how to prepare multi-pathway risk assessments. These documents and others can be found on the CARB website at http://www.arb.ca.gov/toxics/harp/docs.htm.

8.2 Chronic Noncancer Health Impacts

The procedure for determining the impact of chronically toxic substances is described in detail in the OEHHA state guidelines[38]. Noncancer chronic inhalation impacts are calculated by dividing the annual average concentration by the REL (Reference Exposure Level) for that substance. The REL is defined as the concentration at which no adverse noncancer health effects are anticipated. For a single substance, this result of this calculation is called the Hazard Quotient. The following equation is used to calculate the Hazard Quotient:

Hazard Quotient = C_i/REL_i

Where:
C_i = Concentration in the air of substance i
REL_i = Chronic noncancer Reference Exposure Level for substance i

For multiple substances, the Hazard Index (HI) is calculated. The HI is calculated by summing the HQs from all substances that affect the same organ system. HQs for different organ systems are not added, for example, do not sum respiratory irritation HQs with cardiovascular effects. The following equation is used to calculate the Hazard Index for the eye irritation endpoint:

Hazard Index (HI_{eye}) = $HQ_{\text{substance 1(eye)}} + HQ_{\text{substance 2(eye)}}$

No exposure duration adjustment (e.g., 9/70) should be made for noncancer assessments.

For a chronic noncancer assessment involving multipathway pollutants, the California Air Resources Board HARP model can be used.

8.3 Acute Noncancer Health Impacts

The procedure for determining the impact of acutely toxic substances is also described in detail in the OEHHA state guidelines[39]. The calculation of acute noncancer impacts is similar to the procedure for chronic noncancer impacts. In most cases, for a single substance, the acute Hazard Quotient is the highest one hour air concentration divided by the acute REL for that substance. There are a few substances that have acute RELs for exposure periods other than 1 hour. In those cases, the maximum air concentration for the appropriate exposure period (e.g., 8 hours) is divided by the acute REL.

As with the chronic noncancer calculation, for multiple substances that impact the same organ system, the individual substance HQs are summed to determine the HI.

No exposure period adjustments are necessary for acute health impact calculations.

Acute exposures are calculated for the inhalation pathway only.

[38] OEHHA Air Toxics Hot Spots Program Guidance Manual for the Preparation of Risk, June 2002

Appendix A

Meteorological Data

1.0 Preparing Meteorological Data for Refined Modeling

AERMOD and ISC models require actual hourly meteorological conditions as inputs. The refined models require pre-processed meteorological data that contains information on surface characteristics and upper air definition. This data is typically provided in a raw or partially processed format that requires processing through a meteorological pre-processor. The ISC models make use of a pre-processor called PCRAMMET, while AERMOD uses a pre-processor known as AERMET described further in the following sections.

Airport surface data is available from the National Climatic Data Center (NCDC) and other sources. Mixing height data or upper air data were available from NCDC. If mixing heights have not been calculated for the year of interest, mixing height software is available from EPA for use in calculating mixing heights from upper air data. AERMET is used to process upper air and surface data for use in AERMOD. Unlike PCRAMMET, AERMET produces 2 files: a surface file (*.sfc) and a profile file (*.pfl).

1.1 Surface Data

1.1.1 Screening Meteorological Data

Screening surface data may be used in ISC when no applicable surface data is available for the area to be modeled. Most user interface on the market today can generate screening meteorological data for ISC. Please contact the district before using screening meteorological data to ensure that no data is available for the area of concern.

1.1.2 Hourly Meteorological Data

Hourly surface data is supported in several formats including:

- CD-144 – NCDC Surface Data: This file is composed of one record per hour, with all weather elements reported in an 80-column card image. Table 1.0 lists the data contained in the CD-144 file format that is needed to pre-process your meteorological data.

Table 1.0 – CD-144 Surface Data Record (80 Byte Record)

Element	Columns
Surface Station Number	1-5
Year	6-7
Month	8-9
Day	10-11
Hour	12-13
Ceiling Height (Hundreds of Feet)	14-16
Wind Direction (Tens of Degrees)	39-40
Wind Speed (Knots)	41-42
Dry Bulb Temperature (° Fahrenheit)	47-49
Opaque Cloud Cover	79

- MET-144 – SCRAM Surface Data: The SCRAM surface data format is a reduced version of the CD-144 data with fewer weather variables (28-character record). Table 1.1 lists the data contained in the SCRAM file format.

Table 1.1 - SCRAM Surface Data Record (28 Byte Record)

Element	Columns
Surface Station Number	1-5
Year	6-7
Month	8-9
Day	10-11
Hour	12-13
Ceiling Height (Hundreds of Feet)	14-16
Wind Direction (Tens of Degrees)	17-18
Wind Speed (Knots)	19-21
Dry Bulb Temperature (° Fahrenheit)	22-24
Total Cloud Cover (Tens of Percent)	25-26
Opaque Cloud Cover (Tens of Percent)	27-28

- The SCRAM data does not contain the following weather variables, which are necessary for dry and wet particle deposition analysis:
  - Surface pressure: for dry and wet particle deposition;
  - Precipitation type: for wet particle deposition only; or
  - Precipitation amount: for wet particle deposition only.

- SAMSON Surface Data: The SAMSON data contains all of the required meteorological variables for concentration, dry and wet particle deposition, and wet vapor deposition.
- NCDC data can be purchase online from the following web site: http://cdo.ncdc.noaa.gov/qclcd/QCLCD

If the processing of raw data is necessary, the surface data must be in one of the above formats in order to successfully pre-process the data using PCRAMMET or AERMET.

2.0 Mixing Height and Upper Air Data

Upper air data, also known as mixing height data, are required for pre-processing meteorological data required to run the ISC models. It is recommended that only years with complete mixing height data be used. In some instances, mixing height data may need to be obtained from more than one station to complete multiple years of data.

Mixing height data are available from:

- SCRAM BBS –download free of charge, mixing height data for the U.S. for years 1984 through 1991.
- WebMET.com –download free of charge, mixing height and upper air data from across North America, including Ontario.
- Free Upper air data can be downloaded from following web site (FSL Format) http://raob.fsl.noaa.gov/
- Table 2.1 lists the format of the mixing height data file used by PCRAMMET.

Table 2.1 - Upper Air Data File (SCRAM / NCDC TD-9689 Format)

Element	Columns
Upper Air Station Number (WBAN)	1-5
Year	6-7
Month	8-9
Day	10-11
AM Mixing Value	14-17
PM Mixing Value (NCDC)	25-28
PM Mixing Value (SCRAM)	32-35

AERMOD requires the full upper air sounding, unlike ISCST3/ISC-PRIME, which only require the mixing heights. The upper air soundings must be in the NCDC TD-6201 file format or one of the FSL formats.

2.1 AERMET and the AERMOD Model

The AERMET program is a meteorological preprocessor that prepares hourly surface data and upper air data for use in the U.S. EPA air quality dispersion model AERMOD. AERMET was designed to allow for future enhancements to process other types of data and to compute boundary layer parameters with different algorithms.

AERMET processes meteorological data in three stages:

- The first stage (Stage1) extracts meteorological data from archive data files and processes the data through various quality assessment checks.
- The second stage (Stage2) merges all data available for 24-hour periods (surface data, upper air data, and on-site data) and stores these data together in a single file.
- The third stage (Stage3) reads the merged meteorological data and estimates the necessary boundary layer parameters for use by AERMOD.

Out of this process two files are written for AERMOD:

- A Surface File of hourly boundary layer parameters estimates;
- A Profile File of multiple-level observations of wind speed, wind direction, temperature, and standard deviation of the fluctuating wind components.

2.2 PCRAMMET

The PCRAMMET program is a meteorological preprocessor, which prepares NWS data for use in the various U.S. EPA air quality dispersion models such as ISCST3/ISC-PRIME.

PCRAMMET is also used to prepare meteorological data for use by the CAL3QHCR model.

The operations performed by PCRAMMET include:

- Calculating hourly values for atmospheric stability from meteorological surface observations;
- Interpolating the twice daily mixing heights to hourly values;
- Optionally, calculating the parameters for dry and wet deposition processes;
- Outputting data in the standard (PCRAMMET unformatted) or ASCII format required by regulatory air quality dispersion models.

The input data requirements for PCRAMMET depend on the dispersion model and the model options for which the data is being prepared. The minimum input data requirements for PCRAMMET are:

- The twice-daily mixing heights,
- The hourly surface observations of: wind speed, wind direction, dry bulb temperature, opaque cloud cover, and ceiling height.

For dry deposition estimates, station pressure measurements are required. For wet deposition estimates, precipitation type and precipitation amount measurements for those periods where precipitation was observed are required.

The surface and upper air stations should be selected to ensure they are meteorologically representative of the general area being modeled.

2.3 Regional Meteorological Data

The district has/may prepare regional meteorological data sets for use in Tier 2 modeling in several formats. Please contact the District to determine what data is available:

- Regional pre-processed model ready data for AERMOD, with land characteristics for RURAL and URBAN conditions.
- Regional Merge files enabling customized surface characteristics to be specified and processed through AERMET Stage3.
- Hourly surface and upper air data files preprocessed for use in ISCST.

2.3.1 Pre-Processing Steps

Regional data for AERMOD can be processed in 2 forms:

- Merged: Data that has been processed through Stage2 of AERMET (AERMET stages are described in Section 7.1.3) to produce a "Merge" file. This file can then be processed through AERMET Stage3 with custom surface condition data to produce a meteorological data set specific to the site for use with AERMOD (Tier 3).
- Regional: Data that has been processed through Stage3 of AERMET with predefined Land Use characteristics for "Urban" and "Rural" environments. This data is ready for use with AERMOD (Tier 2).

2.3.1.1 Regional Meteorological Data Processing Background

Regional meteorological datasets are generated in AERMET, Stage3 processing step, using different wind independent surface conditions. It is assumed that surface conditions can be a weighted average over a radius of 3 km from the meteorological station and split into 12 sectors, or processed with other parameters approved by the district. The surface conditions needed are the albedo (A), the Bowen ratio (Bo) and the surface roughness (Zo). These parameter values can be derived from data in Tables 6.1, 6.2, 6.3 and 4.3 of the AERMET User's Guide[1].

[1] U.S. Environmental Protection Agency, 1998. Revised Draft - User's Guide for the AERMOD Meteorological Preprocessor (AERMET). Office of Air Quality Planning and Standards, Research Triangle Park, NC.

2.4 Availability and Use of District Meteorological Data

The district may provide meteorological data sets that can be used for air quality studies using ISCST or AERMOD. The data sets should not be modified. Use of custom meteorological data that is locally representative of site conditions can be created and applied for Tier 3 modeling analyses with district approval.

Meteorological data quality is of critical importance, particularly for reliable air dispersion modeling using refined models such as AERMOD. Meteorological data should be collected, processed and analyzed throughout the entire creation phase for completeness and quality control. Missing meteorological data and calm wind conditions can be handled by using EPA's missing data guidance document written by Russ Lee or guidance provided by the District.

The following factors determine the appropriateness of a meteorological data set, the:

- proximity of the meteorological site to the area being modeled,
- complexity of the terrain,
- exposure of the meteorological measurement site, and the
- time period of the data collection.

It should be emphasized that both the spatial and temporal aspects of the data set are the key requirement for determining the appropriateness of a meteorological data set. Not one, but all of these factors must be considered.

The meteorological data that is input to a model should be selected based on its appropriateness for the modeling project. More specifically, the meteorological data should be representative of the wind flow in the area being modeled, so that it can properly represent the transport and diffusion of the pollutants being modeled.

2.5 Expectations for Local Meteorological Data Use

Local meteorological data must be quality reviewed and the origin of the data and any formatting applied to the raw data must be outlined. The regulatory agency should review the plans to use local meteorological data prior to submission of a modeling report.

The sources of all of the data used including cloud data and upper air data must be documented. The proponent also needs to describe why the site chosen is representative for the modeling application. This would include a description of any topographic impacts or impacts from obstructions (trees, buildings etc.) on the wind monitor. Information on the heights at which the wind is measured is also required. The time period of the measurements along with the data completeness and the percentage of calm winds should be reported.

Wind roses showing the wind speed and directions should be provided with the modeling assessment. If wind direction dependent land use was used in deriving the final meteorological file, the selection of the land use should be described.

3.0 Land Use Characterization (AERMOD only)

Land use plays an important role in air dispersion modeling from meteorological data processing to defining modeling characteristics such as urban or rural conditions. Land use data can be obtained from digital and paper land-use maps.

These maps will provide an indication into the dominant land use types within an area of study, such as industrial, agricultural, forested and others. This information can then be used to determine dominant dispersion conditions and estimate values for parameters such as surface roughness, albedo, and Bowen ratio.

- Surface Roughness Length [m]: The surface roughness length, also referred to surface roughness height, is a measure of the height of obstacles to the wind flow. Surface roughness affects the height above local ground level that a particle moves from the ambient airflow above the ground into a "captured" deposition region near the ground. This height is not equal to the physical dimensions of the obstacles, but is generally proportional to them. Table 1.4 lists typical values for a range of land-use types as a function of season.

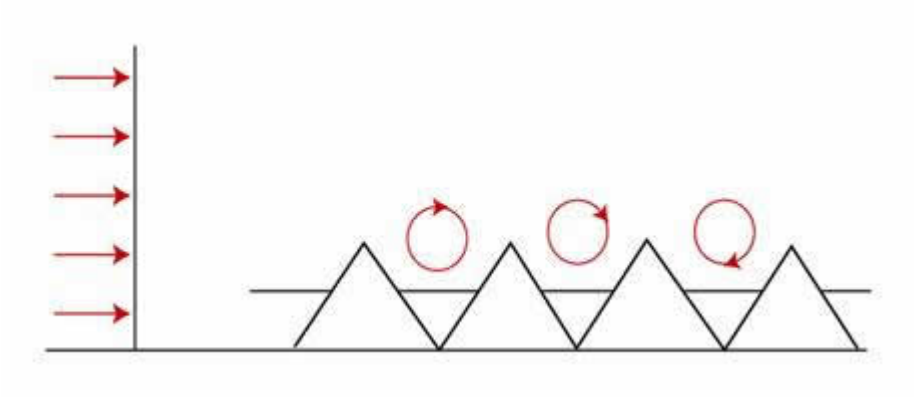


Figure 1.0 - For many modeling applications, surface roughness can be considered to be on the order of one tenth of the height of the roughness elements.

EPA has developed a modeling tool called AERSURFACE[2] to aid in obtaining realistic and reproducible surface characteristic values of albedo, Bowen ratio, and surface roughness length, for input to AERMET. The tool uses publicly available national land cover datasets and look-up tables of surface characteristics that vary by land cover type and season. AERSURFACE calculates the following 3 parameters for input into AERMET:

[2] AERSURFACE User's Guide, EPA-454/B-08-001 January 2008, http://www.epa.gov/scram001/dispersion_related.htm#aersurface

- Surface Roughness:
  The determination of the surface roughness length should be based on an inverse distance weighted geometric mean for a default upwind distance of 1 kilometer relative to the measurement site. Surface roughness length may be varied by sector to account for variations in land cover near the measurement site; however, the sector widths should be no smaller than 30 degrees.

- Bowen Ratio:
  The determination of the Bowen ratio should be based on a simple unweighted geometric mean (i.e., no direction or distance dependency) for a representative domain, with a default domain defined by a 10km by 10km region centered on the measurement site.

- Albedo:
  The determination of the albedo should be based on a simple unweighted arithmetic mean (i.e., no direction or distance dependency) for the same representative domain as defined for Bowen ratio, with a default domain defined by a 10km by 10km region centered on the measurement site.

AERMOD allows wind direction dependent surface characteristics to be used in the processing of the meteorological data. The AERMET procedure also uses the area-weighted average of the land use within 3 km of the site. The selection of wind direction dependent sectors is described in sections 3.1 to 3.3.

Alternative methods of determining surface roughness height may be proposed. The district should review any proposed values prior to use.

Table 3.1 –USGS NLCD92 Land Cover Categories used in AERSURFACE

Classification	Class Number	Land Cover Category
Water	11	Open Water
	12	Perennial Ice/Snow
Developed	21	Low Intensity Residential
	22	High Intensity Residential
	23	Commercial/Industrial/Transportation
Barren	31	Bare Rock/Sand/Clay
	32	Quarries/Strip Mines/Gravel Pits
	33	Transitional
Forested Upland	41	Deciduous Forest
	42	Evergreen Forest
	43	Mixed Forest
Shrubland	51	Shrubland
Non-natural Woody	61	Orchards/Vineyards/Other
Herbaceous Upland	71	Grasslands/Herbaceous
Herbaceous Planted/Cultivated	81	Pasture/Hay
	82	Row Crops
	83	Small Grains
	84	Fallow
	85	Urban/Recreational Grasses
Wetlands	91	Woody Wetlands
	92	Emergent Herbaceous Wetlands

Table 3.2 –AERSURFACE Seasonal Category Description

Seasonal Category	Season Description	Default Month Assignments
1	Midsummer with lush vegetation	Jun, Jul, Aug
2	Autumn with unharvested cropland	Sep, Oct, Nov
3	Late autumn after frost and harvest, or winter with no snow	Dec, Jan, Feb
4	Winter with continuous snow on ground	Dec, Jan, Feb
5	Transitional spring with partial green coverage or short annuals	Mar, Apr, May

Table 3.3 AERSURFACE Seasonal Values of Surface Roughness for the NLCD92 21-Land Cover Classification System

Class Number	Class Name	Seasonal Surface Roughness (m)				
		1	*2*	*3*	*4*	*5*
11	Open Water	0.001	0.001	0.001	0.001	0.001
12	Perennial Ice/Snow	0.002	0.002	0.002	0.002	0.002
21	Low Intensity Residential	0.54	0.54	0.50	0.50	0.52
22	High Intensity Residential	1	1	1	1	1
23	Commercial/Industrial/Transportation (Site at airport)	0.1	0.1	0.1	0.1	0.1
	Commercial/Industrial/Transportation (Not at airport)	0.8	0.8	0.8	0.8	0.8
31	Bare Rock/Sand/Clay (Arid Region)	0.05	0.05	0.05	NA	0.05
	Bare Rock/Sand/Clay (Non-arid Region)	0.05	0.05	0.05	0.05	0.05
32	Quarries/Strip Mines/Gravel Pits	0.3	0.3	0.3	0.3	0.3
33	Transitional	0.2	0.2	0.2	0.2	0.2
41	Deciduous Forest	1.3	1.3	0.6	0.5	1
42	Evergreen Forest	1.3	1.3	1.3	1.3	1.3
43	Mixed Forest	1.3	1.3	0.95	0.9	1.15
51	Shrubland (Arid Region)	0.15	0.15	0.15	NA	0.15
	Shrubland (Non-arid Region)	0.3	0.3	0.3	0.15	0.3
61	Orchards/Vineyards/Other	0.3	0.3	0.1	0.5	0.2
71	Grasslands/Herbaceous	0.1	0.1	0.01	0.005	0.05
81	Pasture/Hay	0.15	0.15	0.02	0.01	0.03
82	Row Crops	0.2	0.2	0.02	0.01	0.03
83	Small Grains	0.15	0.15	0.02	0.01	0.03
84	Fallow	0.05	0.05	0.02	0.01	0.02
85	Urban/Recreational Grasses	0.02	0.015	0.01	0.005	0.015
91	Woody Wetlands	0.7	0.7	0.6	0.5	0.7
92	Emergent Herbaceous Wetlands	0.2	0.2	0.2	0.1	0.2

- Noon-Time Albedo:

Noon-time albedo is the fraction of the incoming solar radiation that is reflected from the ground when the sun is directly overhead. Table 3.4 lists typical albedo values as a function of several land use types and season. For practical purposes, the selection of a single value for noon-time albedo, for a land use types and season combination, to process a complete year of meteorological data is desirable. If other conditions are used, the district should review the proposed noon-time albedo values used to pre-process the meteorological data.

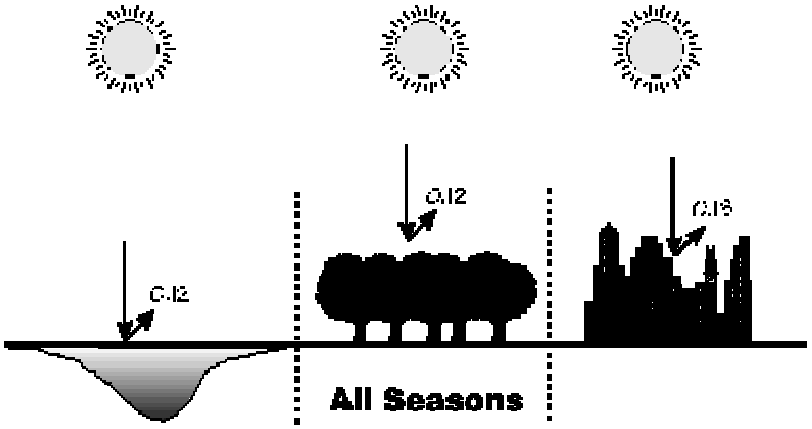


Table 3.4 AERSURFACE Seasonal Values of Albedo for the NLCD92 21-Land Cover Classification System

Class Number	Class Name	Seasonal Albedo Values				
		1	*2*	*3*	*4*	*5*
11	Open Water	0.1	0.1	0.1	0.1	0.1
12	Perennial Ice/Snow	0.6	0.6	0.7	0.7	0.6
21	Low Intensity Residential	0.16	0.16	0.18	0.45	0.16
22	High Intensity Residential	0.18	0.18	0.18	0.35	0.18
23	Commercial/Industrial/Transportation (Site at airport)	0.18	0.18	0.18	0.35	0.18
	Commercial/Industrial/Transportation (Not at airport)	0.18	0.18	0.18	0.35	0.18
31	Bare Rock/Sand/Clay (Arid Region)	0.2	0.2	0.2	NA	0.2
	Bare Rock/Sand/Clay (Non-arid Region)	0.2	0.2	0.2	0.6	0.2
32	Quarries/Strip Mines/Gravel Pits	0.2	0.2	0.2	0.6	0.2
33	Transitional	0.18	0.18	0.18	0.45	0.18
41	Deciduous Forest	0.16	0.16	0.17	0.5	0.16
42	Evergreen Forest	0.12	0.12	0.12	0.35	0.12
43	Mixed Forest	0.14	0.14	0.14	0.42	0.14
51	Shrubland (Arid Region)	0.25	0.25	0.25	NA	0.25
	Shrubland (Non-arid Region)	0.18	0.18	0.18	0.5	0.18
61	Orchards/Vineyards/Other	0.18	0.18	0.18	0.5	0.14
71	Grasslands/Herbaceous	0.18	0.18	0.2	0.6	0.18
81	Pasture/Hay	0.2	0.2	0.18	0.6	0.14
82	Row Crops	0.2	0.2	0.18	0.6	0.14
83	Small Grains	0.2	0.2	0.18	0.6	0.14
84	Fallow	0.18	0.18	0.18	0.6	0.18
85	Urban/Recreational Grasses	0.15	0.15	0.18	0.6	0.15
91	Woody Wetlands	0.14	0.14	0.14	0.3	0.14
92	Emergent Herbaceous Wetlands	0.14	0.14	0.14	0.3	0.14

- Bowen Ratio:

The Bowen ratio is a measure of the amount of moisture at the surface. The presence of moisture at the earth's surface alters the energy balance, which in turn alters the sensible heat flux and Monin-Obukhov length. Table 3.5 lists Bowen ratio values as a function of land-use types, seasons and moisture conditions. Bowen ratio values vary depending on the surface wetness. Average moisture conditions would be the usual choice for selecting the Bowen ratio. If other conditions are used the district should review the proposed Bowen ratio values used to pre-process the meteorological data.

Table 3.5 AERSURFACE Seasonal Values of Bowen Ratio for the NLCD92 21-Land Cover Classification System - Average moisture conditions

Class Number	Class Name	Seasonal Bowen Ratio Values-Average				
		1	*2*	*3*	*4*	*5*
11	Open Water	0.1	0.1	0.1	0.1	0.1
12	Perennial Ice/Snow	0.5	0.5	0.5	0.5	0.5
21	Low Intensity Residential	0.8	1	1	0.5	0.8
22	High Intensity Residential	1.5	1.5	1.5	0.5	1.5
23	Commercial/Industrial/Transportation (Site at airport)	1.5	1.5	1.5	0.5	1.5
	Commercial/Industrial/Transportation (Not at airport)	1.5	1.5	1.5	0.5	1.5
31	Bare Rock/Sand/Clay (Arid Region)	4	6	6	NA	3
	Bare Rock/Sand/Clay (Non-arid Region)	1.5	1.5	1.5	0.5	1.5
32	Quarries/Strip Mines/Gravel Pits	1.5	1.5	1.5	0.5	1.5
33	Transitional	1	1	1	0.5	1
41	Deciduous Forest	0.3	1	1	0.5	0.7
42	Evergreen Forest	0.3	0.8	0.8	0.5	0.7
43	Mixed Forest	0.3	0.9	0.9	0.5	0.7
51	Shrubland (Arid Region)	4	6	6	NA	3
	Shrubland (Non-arid Region)	1	1.5	1.5	0.5	1
61	Orchards/Vineyards/Other	0.5	0.7	0.7	0.5	0.3
71	Grasslands/Herbaceous	0.8	1	1	0.5	0.4
81	Pasture/Hay	0.5	0.7	0.7	0.5	0.3
82	Row Crops	0.5	0.7	0.7	0.5	0.3
83	Small Grains	0.5	0.7	0.7	0.5	0.3
84	Fallow	0.5	0.7	0.7	0.5	0.3
85	Urban/Recreational Grasses	0.5	0.7	0.7	0.5	0.3
91	Woody Wetlands	0.2	0.2	0.3	0.5	0.2
92	Emergent Herbaceous Wetlands	0.1	0.1	0.1	0.5	0.1

Table 3.6 AERSURFACE Seasonal Values of Bowen Ratio for the NLCD92 21-Land Cover Classification System - Wet moisture conditions

Class Number	Class Name	Seasonal Bowen Ratio Values-Wet				
		1	*2*	*3*	*4*	*5*
11	Open Water	0.1	0.1	0.1	0.1	0.1
12	Perennial Ice/Snow	0.5	0.5	0.5	0.5	0.5
21	Low Intensity Residential	0.6	0.6	0.6	0.5	0.6
22	High Intensity Residential	1	1	1	0.5	1
23	Commercial/Industrial/Transportation (Site at airport)	1	1	1	0.5	1
	Commercial/Industrial/Transportation (Not at airport)	1	1	1	0.5	1
31	Bare Rock/Sand/Clay (Arid Region)	1.5	2	2	NA	1
	Bare Rock/Sand/Clay (Non-arid Region)	1	1	1	0.5	1
32	Quarries/Strip Mines/Gravel Pits	1	1	1	0.5	1
33	Transitional	0.7	0.7	0.7	0.5	0.7
41	Deciduous Forest	0.2	0.4	0.4	0.5	0.3
42	Evergreen Forest	0.2	0.3	0.3	0.5	0.3
43	Mixed Forest	0.2	0.35	0.35	0.5	0.3
51	Shrubland (Arid Region)	1.5	2	2	NA	1
	Shrubland (Non-arid Region)	0.8	1	1	0.5	0.8
61	Orchards/Vineyards/Other	0.3	0.4	0.4	0.5	0.2
71	Grasslands/Herbaceous	0.4	0.5	0.5	0.5	0.3
81	Pasture/Hay	0.3	0.4	0.4	0.5	0.2
82	Row Crops	0.3	0.4	0.4	0.5	0.2
83	Small Grains	0.3	0.4	0.4	0.5	0.2
84	Fallow	0.3	0.4	0.4	0.5	0.2
85	Urban/Recreational Grasses	0.3	0.4	0.4	0.5	0.2
91	Woody Wetlands	0.1	0.1	0.1	0.5	0.1
92	Emergent Herbaceous Wetlands	0.1	0.1	0.1	0.5	0.1

Table 3.7 AERSURFACE Seasonal Values of Bowen Ratio for the NLCD92 21-Land Cover Classification System - Dry moisture conditions

Class Number	Class Name	Seasonal Bowen Ratio Values-Dry				
		1	*2*	*3*	*4*	*5*
11	Open Water	0.1	0.1	0.1	0.1	0.1
12	Perennial Ice/Snow	0.5	0.5	0.5	0.5	0.5
21	Low Intensity Residential	2	2.5	2.5	0.5	2
22	High Intensity Residential	3	3	3	0.5	3
23	Commercial/Industrial/Transportation (Site at airport)	3	3	3	0.5	3
	Commercial/Industrial/Transportation (Not at airport)	3	3	3	0.5	3
31	Bare Rock/Sand/Clay (Arid Region)	6	10	10	NA	5
	Bare Rock/Sand/Clay (Non-arid Region)	3	3	3	0.5	3
32	Quarries/Strip Mines/Gravel Pits	3	3	3	0.5	3
33	Transitional	2	2	2	0.5	2
41	Deciduous Forest	0.6	2	2	0.5	1.5
42	Evergreen Forest	0.6	1.5	1.5	0.5	1.5
43	Mixed Forest	0.6	1.75	1.75	0.5	1.5
51	Shrubland (Arid Region)	6	10	10	NA	5
	Shrubland (Non-arid Region)	2.5	3	3	0.5	2.5
61	Orchards/Vineyards/Other	1.5	2	2	0.5	1
71	Grasslands/Herbaceous	2	2	2	0.5	1
81	Pasture/Hay	1.5	2	2	0.5	1
82	Row Crops	1.5	2	2	0.5	1
83	Small Grains	1.5	2	2	0.5	1
84	Fallow	1.5	2	2	0.5	1
85	Urban/Recreational Grasses	1.5	2	2	0.5	1
91	Woody Wetlands	0.2	0.2	0.2	0.5	0.2
92	Emergent Herbaceous Wetlands	0.2	0.2	0.2	0.5	0.2

3.1 Wind Direction Dependent Land Use

AERMET also provides the ability to specify land characteristics for up to 12 different contiguous, non-overlapping wind direction sectors that define unique upwind surface characteristics. The following properties of wind sectors must be true:

- The sectors are defined clockwise as the direction from which the wind is blowing, with north at 360°.
- The sectors must cover the full circle so that the end value of one sector matches the beginning of the next sector.

- The beginning direction is considered part of the sector, while the ending direction is not.

Each wind sector can have a unique albedo, Bowen ratio, and surface roughness. Furthermore, these surface characteristics can be specified annually, seasonally, or monthly to better reflect site conditions.

3.2 Mixed Land Use Types

Study areas may contain several different regions with varying land use. This can be handled by AERMET through the use of wind sector specific characterization, as described in the previous section.

For models such as ISCST3/ISC-PRIME that do not take advantage of sector-specific characterization, the most representative conditions should be applied when land use characteristics are required.

The surface characteristics need to be assessed in a circle with a radius of one to three kilometers from the source. Contact the District to determine the appropriate parameters for meteorological data in accordance with EPA guidance. Data should be chosen for a meteorological data site with surface characteristics similar to those of the area around the source. To prepare the surface data, use the AERSURFACE module of AERMOD or perform a site survey using the standard land uses defined in the AERSURFACE documentation and the default surface roughness length for those land uses.

The surface characteristics are determined by assessing the land use across the monitoring site area and applying the appropriate values to the land characteristic parameters. A weighted average is then computed based on the area of each land use category.

For example: If the area under review is 15% cultivated land, 5% desert shrub land, and 80% Urban, the same weighted percentages would be used to derive a weighted average albedo, Bowen ratio, and surface roughness parameters.

3.3 Seasonal Land Use Characterization

Land use characteristics can be susceptible to seasonal variation. For example, winter conditions can bring increased albedo values due to snow accumulation.

AERMET allows for season-specific values for surface roughness, albedo, and Bowen ratio to be defined. Other models, such as ISCST3/ISC-PRIME, do not support multiple season surface characteristics to be defined. In such a case, the most representative conditions should be applied when land use characteristics are required.

3.4 Standard and Non-Default Surface Characteristics

The generation of local meteorological data files can incorporate site-specific surface characteristics. It should be noted that any local meteorological files generated for air dispersion modeling should provide a clear reasoning for the values used to describe surface characteristics. The district should review any proposed surface characteristics prior to submission of a modeling report.

Appendix B

Modeling and Exposure Assessment Input and Output Data

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The following information must be submitted with a risk assessment. It provides the essential requirements for a general assessment. Site-specific scenarios may call for additional information and result in a need for different materials and data to be submitted. It is the responsibility of the submitter to ensure proper completion and analysis of any air dispersion modeling assessment delivered for review. *Consultation with your local air district is strongly recommended.*

1.0 General Information

1.0.1 Submittal Date
1.0.2 Facility/Project Name
1.0.3 Facility/Project Location
1.0.4 Risk Assessor Name

1.1 Hazard Identification

1.1.1 Table of all toxic air contaminants (TAC) emitted by the Facility/Project including:

- CAS number,
- Chemical name(s) – include appropriate common names,
- Physical state as emitted.

1.1.2 Table of carcinogens,
1.1.3 Table of acutely toxic TACs, and
1.1.4 Table of chronically toxic non-carcinogenic TACs.
1.1.5 Table showing the processes and the TACs emitted from each process.

1.2 Exposure Assessment

1.2.1 Air Dispersion Model Options

1.2.1.1 Model Used

- AERMOD - version number,
- ISCST - version number,
- Other Model - Specify name, version number, and reason for use.

1.2.1.2 Regulatory Options Used

- Yes
- No - Provide justification for use of non-regulatory options. Note that use of non-regulatory options requires prior approval from the regulatory agency.

1.2.1.3 Dispersion Coefficients Used, and How they were Determined

- Urban
- Rural

(Urban or Rural conditions can be determined through the use of an Auer Land Use or Population Density analysis.)

1.2.1.4 Coordinate System Used

- UTM Coordinates
- Local Coordinates
- Other

(AERMOD requires UTM coordinates be used to define all model objects. Use of an alternative coordinate system requires advance consultation with the regulatory agency.)

1.2.2 Source Information

1.2.2.1 Source Summaries

Create tables which show the following point, area, volume, line, or flare modeling parameters. Following the tables must be a description of the reasoning for each modeling parameter chosen.

Point Sources Summary

- Source name
- Source location coordinates
  - X (m)
  - Y (m)
- Table showing the names of each TAC modeled and max hourly and annual emission rate in grams per second.
- Stack heights in meters
- Stack Diameter in meters
- Stack Exit Temperature in degrees K
- Stack Exit Velocity in meters per second
- Stack direction
  - Vertical exhaust direction
  - Horizontal exhaust direction
- Rain Cap Present
  If the stack is either horizontal in orientation or has a rain cap, stack parameters must be adjusted as per guidance.
- Operating Schedule.
  Create tables showing how the normal emission rates vary by source.

Area Sources Summary

- Source name
- Source location coordinates (Southwest Vertex):
  - X (m)
  - Y (m)
- Table showing the names of each TAC modeled and emission rate in grams per second-meter^2.
- Exhaust height in meters
- Easterly Dimension in meters
- Northerly Dimension in meters
- Initial Vertical Dimension in meters
- Angle from North in degrees.
- Operating Schedule.
  Create tables showing how the normal emission rates vary by source.

Volume Sources Summary

- Source name
- Source location coordinates (Center of Source):
  - X (m)
  - Y (m)
- Table showing the names of each TAC modeled and emission rate in grams per second.
- Source height in meters
- Initial Horizontal Dimension in meters
- Initial Vertical Dimension in meters

- Operating Schedule.
  Create tables showing how the normal emission rates vary by source.

Line Sources Summary (CAL3QHCR specific; for step by step guidance according to SMAQMD recommendations, see CAPCOA's CEQA Risk Assessment Guidelines)

- Source name (highway, freeway, or major roadway)
- Roadway compass orientation (in terms of x,y; arbitrary origin of 0,0)
- Location of nearest receptor to source and other receptors as required by local air district
- Calculation averaging time (such as 60 min)
- Surface roughness (cm, from 3 to 400)
- Settling velocity (cm/s)
- Deposition velocity (cm/s)
- Site setting, rural or urban
- Form of traffic volume (recommended: 1 for one hour's data)
- Pollutant (P for PM10)
- Hourly ambient background (0 or as recommended by air district)
- Roadway height indicator (AG for at grade; FL for elevated and filled; BR for bridge; DP for depressed)
- Roadway height (AG is 0)

Other input parameters are required for CAL3QHCR. See CAPCOA's CEQA Risk Assessment Guidelines or contact your local air district.

1.2.2.2 Emissions Profile during Abnormal Operations Start-Up or Shutdown

Create table showing how abnormal emission rates vary by source. Abnormal emission rates include start-up or shutdown.

1.2.2.3 Building Downwash

- Describe whether the stack(s) are located within 5L of a structure that is at least 40% of the stack height (L is the lesser of the height or the maximum projected building width for a structure).
- If it is, then prepare a building downwash analysis using the current version of the Building Profile Input Program – PRIME (BPIP-PRIME) and include results in air dispersion modeling assessment.

1.2.2.4 Scaled Plot Plan

Provide a scaled plot plan, preferably in electronic format, displaying:

- Emission release locations,
- Buildings (On site and neighboring),
- Tanks (On site and neighboring),
- Property boundaries,
- Model receptor locations,
- Sensitive receptors locations,
- Fenceline receptors locations.

1.2.2.5 Sensitive Receptors locations

Describe the location and nature of all nearby sensitive receptors (e.g. residences, schools, hospitals, etc...)

1.2.2.6 Points of Maximum Impact

Demonstrate that the actual point of maximum impact, residential point of maximum impact, and the offsite worker point of maximum impact have been reached.

1.2.3 Terrain Conditions

1.2.3.1 Elevated or complex terrain

Describe whether the modeled area contains elevated or complex terrain, and provide a discussion on the approach used to determine terrain characteristics of the assessment area.

1.2.3.2 Digital Terrain Data

Describe whether the data for digital terrain is:

- CDED 1-degree,
- CDED 15-minute,
- USGS 7.5-minute Ontario dataset, or
- Other, and describe other.

1.2.3.3 Elevation data import

Describe the technique used to determine elevations of receptors and related model entities such as sources.

1.2.4 Meteorological Data

1.2.4.1 Regional Meteorological data

Specify what Regional Meteorological data set was used and note the period of the record.

1.2.4.2 Was a Regional Meteorological Merge data file used?

Specify the Meteorological Data Set Merge file used and summarize land characteristics specified in its processing. This information should be reviewed by the District prior to submission of a modeling report.

1.2.4.3 Meteorological data preparation

Specify the Meteorological Data files used and summarize all steps and values used in processing these standard meteorological data files. This information should be reviewed by the District prior to submission of a modeling report.

1.2.4.4 Local Meteorological data

Specify the source, reliability, and representativeness of the local meteorological data as well as a discussion of data QA/QC and processing of data. State the time period of the measurements, wind direction dependent land use (if used), and any topographic or shoreline influences. This information should be reviewed by the District prior to submission of a modeling report.

1.2.4.5 Wind Information

The following items should be provided and discussed where applicable:

- Speed and direction distributions (wind roses),
- Topographic and/or obstruction impacts,
- Data completeness,

- Percentage of calms

1.2.4.6 Temperature, clouds, and upper air data

The following items should be provided and discussed where applicable:

- Data completeness,
- Mixing layer heights,
- Diurnal and seasonal variations.

1.2.4.7 Turbulence

The following should be provided and discussed if site specific data is being used:

- Frequency distributions,
- Diurnal and seasonal variations.

1.2.5 Dispersion Model Results

1.2.5.1 Modeling files

The following electronic model input and output files are to be provided:

- BPIP-PRIME - Input and Output files.
- ISCST3/ISC-PRIME or AERMOD - Input and Output files.
- ISCST3/ISC-PRIME or AERMOD - Plot files
- SCREEN3 - Input and Output files if applicable

1.2.5.2 Meteorological Data

The electronic meteorological data files must be provided.

1.2.5.3 Terrain Data

Digital elevation terrain data files must be provided if included in the analysis.

1.2.5.3 Plots and Maps

Include the following:

- Drawing/site plan with modeling coordinate system noted (digital format preferred).
- Plots displaying concentration/deposition results across study area.

1.2.5.5 Emission Summary

An emission summary table must be provided.

1.2.5.6 Discussion

The results overview should include a discussion of the following items, where applicable:

- The use of alternative models,
- The use of any non-default model options,
- Topographic effects on the predictions,
- All predicted concentrations based on the REL based exposure period.

1.3 Toxicity Data

1.3.1 Toxicity Values for Each TAC Emitted

A table must be provided that shows the following data for each TAC emitted:

- The cancer potency factors,
- The acute and chronic RELs,
- The averaging times for the acute RELs,

- The pathways the TAC enters the body, and
- The date these factors were updated.

1.3.2 Target Organ Systems for Each Acute and Non-Carcinogenic Chronic Substance

A table must be provided that shows the target organs and body systems each acute and non-carcinogenic chronic impact.

1.4 Risk Characterization

1.4.1 Points of Maximum Impact

The following points of maximum impact need to be identified:

- The Points of Maximum Impact (PMI),
- The Maximum Exposed Individual - Residential (MEIR), and
- The Maximum Exposed Individual – Worker (MEIW).

At these locations the following data must be provided:

- Locations (UTM coordinates, or Latitude/Longitude coordinates, or other coordinates),
- Cancer risk, acute and chronic hazard indices,
- Sources and pollutants that contribute to risks which exceed the district's cancer risk, or acute, or chronic hazard index significance levels.

1.4.2 Exposure Pathways

Identify each pathways used to determine the cancer risk and chronic hazard indices. Provide all assumptions used for pathways (e.g., the percentage of home-grown vegetables consumed locally, etc…).

1.4.3 Graphical Presentations

Maps must be provided which show the following:

- Locations of sensitive receptors,
- Location of PMI, MEIR, and MEIW for cancer, acute, and non-cancer chronic risks,
- Isopleth lines showing cancer risk, acute, and chronic hazard indices in magnitudes specified by the Air District (e.g., cancer risk starting at 10 per million and increasing by tens per million.)

1.4.4 Guidelines and Software

Specify:

- Describe whether these CAPCOA Guidelines have been applied or other Guidelines were applied,
- The risk assessment software utilized (e.g., Hot Spots Analysis and Reporting Program or HARP),
- If risk assessment software other than HARP is used, then and provide a demonstration that the results will show the same results as HARP,
- Discuss any software used to import model results into HARP.

2.0 Modeling Files

The following files from the air quality dispersion model and risk assessment software should be provided:

Air quality dispersion model (if HARP is not used)

- Input file (*.inp, *.ADI, *.dat)
- Output file (*.out, *.ADO, *.lst)
- Meteorological files

- Plotfiles

Building Downwash Analysis (BPIP) (if HARP is not used)

- Input file
- Output file

Risk assessment software (i.e., HARP):

- Transaction files for the facilities, buildings, and property boundaries (*.tra)
- Transaction files for the source receptors (*.rec)
- Facility database for included facilities building, and property boundaries (*.mdb) as an alternative to the transaction files
- Health factor database (Health.mdb)
- ISC Workbook file with all ISC parameters (*.isc)
- ISC input file generated by HARP when ISC is run (*.inp)
- ISC output file generated by HARP when ISC is run (*.out)
- List of error messages generated by ISC (*.err)
- Plot file generated by ISC (*.plt)
- Representative meteorological data used for the facility air dispersion modeling (*.met)
- Any digital elevation model files (if applicable) (*.dem)
- Average and maximum χ/Q for each source-receptor combination; generated by ISC (*.xoq)
- ISC binary output file (FOR REFINED ACUTE ANALYSIS ONLY); holds χ/Q data for each hour (*.bin)
- Source/receptor file; contains list of sources and receptors for the ISC run; generated by HARP when you set up ISC (*.src)
- Emission Rate files (if changes were made to database) (*.ems)
- Site-specific parameters used for all receptor risk modeling (*.sit)
- (Screening) Adjustment factor files (IF SCREEN MET IS USED) (*.adj)
- Point estimate risk reports generated by HARP; this file is updated automatically each time you perform one of the point estimate risk analysis functions ((e.g., acute, chronic, cancer, derived (adjusted). Etc.)) (*.rsk)
- Database for Census (population) file (census.mdb)
- Map file used to overlay facility and receptors (*.map)
- HARP Exception Report (ExceptionReport.txt)
- Risk result text files for key receptors (STANDARD REPORT SET) (*.txt)
- STOCHASTIC Raw sample file (*.csv)
- STOCHASTIC Sample file (*.spl)
- STOCHASTIC Summary report (*.txt)
- Equivalent files for software other than HARP

210376 Sherwin Paint Factory ; 1450 Sherwin St
CNFRM **Rcvd at** 10/25/11 15:5 **Contact at** 10/25/11 **ID#** 02155M
Rcvd_by 757
Occur at 10/25/11 15:50 **Report by** 550
Disp at 10/25/11 15:53 **Update** 5/8/12
Disp_to 550
Complaint type: Odor 'auto parts cleaner'
Site Alleged U9835
NOV#

210889 NONE ; NONE
UNCNF **Rcvd at** 1/8/12 16:39 **Contact at** 1/9/12 **ID#** 04074W
Rcvd_by 521
Occur at 1/8/12 16:00 **Report by** 550
Disp at 1/9/12 7:39 **Update** 5/1/12
Disp_to 550
Complaint type: Odor 'burning plastic'
Site Alleged Q2907
NOV#

211275 Construction ; Halleck St/Sherwin
UNCNF **Rcvd at** 3/28/12 9:47 **Contact at** 3/28/12 **ID#** 04083J
Rcvd_by 600
Occur at 3/28/12 8:00 **Report by** 550
Disp at 3/28/12 9:54 **Update** 2/5/13
Disp_to 550
Complaint type: Odor 'diesel'
Site Alleged V1944
NOV#

212832 NONE ; NONE
UNCNF **Rcvd at** 10/3/12 0:03 **Contact at** 10/3/12 **ID#** 04116U
Rcvd_by 999
Occur at 10/2/12 23:45 **Report by** 550
Disp at 10/3/12 8:27 **Update** 6/19/13
Disp_to 550
Complaint type: Odor 'refinery'
Site Alleged Q2907
NOV#

213142 NONE ; Highwary 80
UNCNF **Rcvd at** 11/19/12 11:5 **Contact at** 11/19/12 **ID#** 04122H
Rcvd_by 610
Occur at 11/19/12 11:45 **Report by** 557
Disp at 11/19/12 12:09 **Update** 11/20/13
Disp_to 557
Complaint type: Odor 'natural gas'
Site Alleged V6112
NOV#

SUMMARY

Complaints

Confirmed	1
Unconfirmed	4
Pending	0
Total	5

NOVs

Violation Notices Total: 0

210889 NONE ; NONE
UNCNF **Rcvd at** 1/8/12 16:39 **Contact at** 1/9/12 **ID#** 04074W
Rcvd_by 521
Occur at 1/8/12 16:00 **Report by** 550
Disp at 1/9/12 7:39 **Update** 5/1/12
Disp_to 550
Complaint type: Odor 'burning plastic'
Site Alleged Q2907
NOV#

211275 Construction ; Halleck St/Sherwin
UNCNF **Rcvd at** 3/28/12 9:47 **Contact at** 3/28/12 **ID#** 04083J
Rcvd_by 600
Occur at 3/28/12 8:00 **Report by** 550
Disp at 3/28/12 9:54 **Update** 2/5/13
Disp_to 550
Complaint type: Odor 'diesel'
Site Alleged V1944
NOV#

212832 NONE ; NONE
UNCNF **Rcvd at** 10/3/12 0:03 **Contact at** 10/3/12 **ID#** 04116U
Rcvd_by 999
Occur at 10/2/12 23:45 **Report by** 550
Disp at 10/3/12 8:27 **Update** 6/19/13
Disp_to 550
Complaint type: Odor 'refinery'
Site Alleged Q2907
NOV#

213142 NONE ; Highway 80
UNCNF **Rcvd at** 11/19/12 11:5 **Contact at** 11/19/12 **ID#** 04122H
Rcvd_by 610
Occur at 11/19/12 11:45 **Report by** 557
Disp at 11/19/12 12:09 **Update** 11/20/13
Disp_to 557
Complaint type: Odor 'natural gas'
Site Alleged V6112
NOV#

217916 STP ; NONE
UNCNF **Rcvd at** 10/24/14 8:3 **Contact at** 10/24/14 **ID#** 04226X
Rcvd_by 847
Occur at 10/24/14 8:30 **Report by** 560
Disp at 10/24/14 8:41 **Update** 11/17/14
Disp_to 560
Complaint type: Odor 'sweet perfume'
Site Alleged R4293
NOV#

SUMMARY

Complaints

Confirmed	0
Unconfirmed	5
Pending	0
Total	5

NOVs

Violation Notices Total: 0

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National Ambient Air Quality Standards (NAAQS)

The Clean Air Act, which was last amended in 1990, requires EPA to set National Ambient Air Quality Standards (40 CFR part 50) for pollutants considered harmful to public health and the environment. The Clean Air Act identifies two types of national ambient air quality standards. *Primary standards* provide public health protection, including protecting the health of "sensitive" populations such as asthmatics, children, and the elderly. *Secondary standards* provide public welfare protection, including protection against decreased visibility and damage to animals, crops, vegetation, and buildings.

EPA has set National Ambient Air Quality Standards for six principal pollutants, which are called "criteria" pollutants. They are listed below. Units of measure for the standards are parts per million (ppm) by volume, parts per billion (ppb) by volume, and micrograms per cubic meter of air ($\mu g/m^3$).

Pollutant [final rule cite]		Primary/ Secondary	Averaging Time	Level	Form
Carbon Monoxide [76 FR 54294, Aug 31, 2011]		primary	8-hour	9 ppm	Not to be exceeded more than once per year
			1-hour	35 ppm	
Lead [73 FR 66964, Nov 12, 2008]		primary and secondary	Rolling 3 month average	0.15 $\mu g/m^3$ (1)	Not to be exceeded
Nitrogen Dioxide [75 FR 6474, Feb 9, 2010] [61 FR 52852, Oct 8, 1996]		primary	1-hour	100 ppb	98th percentile of 1-hour daily maximum concentrations, averaged over 3 years
		primary and secondary	Annual	53 ppb (2)	Annual Mean
Ozone [73 FR 16436, Mar 27, 2008]		primary and secondary	8-hour	0.075 ppm (3)	Annual fourth-highest daily maximum 8-hr concentration, averaged over 3 years
Particle Pollution Dec 14, 2012	$PM_{2.5}$	primary	Annual	12 $\mu g/m^3$	annual mean, averaged over 3 years
		secondary	Annual	15 $\mu g/m^3$	annual mean, averaged over 3 years
		primary and secondary	24-hour	35 $\mu g/m^3$	98th percentile, averaged over 3 years
	PM_{10}	primary and secondary	24-hour	150 $\mu g/m^3$	Not to be exceeded more than once per year on average over 3 years
Sulfur Dioxide [75 FR 35520, Jun 22, 2010] [38 FR 25678, Sept 14, 1973]		primary	1-hour	75 ppb (4)	99th percentile of 1-hour daily maximum concentrations, averaged over 3 years
		secondary	3-hour	0.5 ppm	Not to be exceeded more than once per year

(1) Final rule signed October 15, 2008. The 1978 lead standard (1.5 µg/m3 as a quarterly average) remains in effect until one year after an area is designated for the 2008 standard, except that in areas designated nonattainment for the 1978, the 1978 standard remains in effect until implementation plans to attain or maintain the 2008 standard are approved.

(2) The official level of the annual NO2 standard is 0.053 ppm, equal to 53 ppb, which is shown here for the purpose of clearer comparison to the 1-hour standard.

(3) Final rule signed March 12, 2008. The 1997 ozone standard (0.08 ppm, annual fourth-highest daily maximum 8-hour concentration, averaged over 3 years) and related implementation rules remain in place. In 1997, EPA revoked the 1-hour ozone standard (0.12 ppm, not to be exceeded more than once per year) in all areas, although some areas have continued obligations under that standard ("anti-backsliding"). The 1-hour ozone standard is attained when the expected number of days per calendar year with maximum hourly average concentrations above 0.12 ppm is less than or equal to 1.

(4) Final rule signed June 2, 2010. The 1971 annual and 24-hour SO2 standards were revoked in that same rulemaking. However, these standards remain in effect until one year after an area is designated for the 2010 standard, except in areas

designated nonattainment for the 1971 standards, where the 1971 standards remain in effect until implementation plans to attain or maintain the 2010 standard are approved.

See historical tables of NAAQS standards

- Carbon Monoxide
- Lead
- Nitrogen Dioxide
- Ozone
- Particle Pollution
- Sulfur Dioxide

Menu of Control Measures for NAAQS Implementation

The Menu of Control Measures (MCM) provides state, local and tribal air agencies with the existing emission reduction measures as well as relevant information concerning the efficiency and cost effectiveness of the measures. State, local and tribal agencies will be able to use this information in developing emission reduction strategies, plans and programs to assure they attain and maintain the National Ambient Air Quality Standards (NAAQS). The MCM is a living document that can be updated with newly available or more current data as it becomes available.

- Menu of Control Measures (PDF) (66pp, 999k)
- Menu of Control Measures (Excel) (480k)

File Utilities

The NEW ENGLAND JOURNAL of MEDICINE

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The Effect of Air Pollution on Lung Development from 10 to 18 Years of Age

W. James Gauderman, Ph.D., Edward Avol, M.S., Frank Gilliland, M.D., Ph.D., Hita Vora, M.S., Duncan Thomas, Ph.D., Kiros Berhane, Ph.D., Rob McConnell, M.D., Nino Kuenzli, M.D., Fred Lurmann, M.S., Edward Rappaport, M.S., Helene Margolis, Ph.D., David Bates, M.D., and John Peters, M.D.

ABSTRACT

BACKGROUND

Whether exposure to air pollution adversely affects the growth of lung function during the period of rapid lung development that occurs between the ages of 10 and 18 years is unknown.

METHODS

In this prospective study, we recruited 1759 children (average age, 10 years) from schools in 12 southern California communities and measured lung function annually for eight years. The rate of attrition was approximately 10 percent per year. The communities represented a wide range of ambient exposures to ozone, acid vapor, nitrogen dioxide, and particulate matter. Linear regression was used to examine the relationship of air pollution to the forced expiratory volume in one second (FEV_1) and other spirometric measures.

RESULTS

Over the eight-year period, deficits in the growth of FEV_1 were associated with exposure to nitrogen dioxide (P=0.005), acid vapor (P=0.004), particulate matter with an aerodynamic diameter of less than 2.5 μm ($PM_{2.5}$) (P=0.04), and elemental carbon (P=0.007), even after adjustment for several potential confounders and effect modifiers. Associations were also observed for other spirometric measures. Exposure to pollutants was associated with clinically and statistically significant deficits in the FEV_1 attained at the age of 18 years. For example, the estimated proportion of 18-year-old subjects with a low FEV_1 (defined as a ratio of observed to expected FEV_1 of less than 80 percent) was 4.9 times as great at the highest level of exposure to $PM_{2.5}$ as at the lowest level of exposure (7.9 percent vs. 1.6 percent, P=0.002).

CONCLUSIONS

The results of this study indicate that current levels of air pollution have chronic, adverse effects on lung development in children from the age of 10 to 18 years, leading to clinically significant deficits in attained FEV_1 as children reach adulthood.

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There is mounting evidence that air pollution has chronic, adverse effects on pulmonary development in children. Longitudinal studies conducted in Europe[1-3] and the United States[4-6] have demonstrated that exposure to air pollution is associated with reductions in the growth of lung function, strengthening earlier evidence[7-12] based on cross-sectional data. However, previous longitudinal studies have followed young children for relatively short periods (two to four years), leaving unresolved the question of whether the effects of air pollution persist from adolescence into adulthood. The Children's Health Study[13] enrolled children from 12 southern California communities representing a wide range of exposures to ambient air pollution. We documented the children's respiratory growth from the ages of 10 to 18 years. Over this eight-year period, children have substantial increases in lung function. By the age of 18 years, girls' lungs have nearly matured, and the growth in lung function in boys has slowed considerably, as compared with the rate in earlier adolescence.[14] We analyzed the association between long-term exposure to ambient air pollution and the growth in lung function over the eight-year period from the ages of 10 to 18 years. We also examined whether any observed effect of air pollution on this eight-year growth period results in clinically significant deficits in attained lung function at the age of 18 years.

METHODS

STUDY SUBJECTS

In 1993, the Children's Health Study recruited 1759 fourth-grade children (average age, 10 years) from elementary schools in 12 southern California communities as part of an investigation of the long-term effects of air pollution on children's respiratory health.[6,12,13] Data on pulmonary function were obtained by trained field technicians, who traveled to study schools annually from the spring of 1993 through the spring of 2001 to perform maximal-effort spirometric testing of the children. Details of the testing protocol have been published previously.[12] We analyzed three measures of pulmonary function: forced vital capacity (FVC), forced expiratory volume in the first second (FEV_1), and maximal midexpiratory flow rate (MMEF). Pulmonary-function tests were not performed on any child who was absent from school on the day of testing, but such a child was still eligible for testing in subsequent years. Children who moved away from their recruitment community were classified as lost to follow-up and were not tested further. From the initial sample of the 1759 children in 1993, the number of children available for follow-up was 1414 in 1995, 1252 in 1997, 1031 in 1999, and 747 in 2001, reflecting the attrition of approximately 10 percent of subjects per year.

A baseline questionnaire, completed at study entry by each child's parents or legal guardian, was used to obtain information on the children's characteristics, including race, presence or absence of Hispanic ethnic background, level of parental education, presence or absence of a history of asthma diagnosed by a doctor, exposure to maternal smoking in utero, and household exposure to gas stoves, pets, and environmental tobacco smoke. Questions administered at the time of annual pulmonary-function testing were used to update information on asthma status, personal smoking status, and exposure to environmental tobacco smoke. The distribution of baseline characteristics of all study subjects and of two subgroups defined according to the length of follow-up (all eight years or less than eight years) is shown in the Supplementary Appendix (available with the full text of this article at www.nejm.org). The length of follow-up was significantly associated with factors related to the mobility of the population, including race, presence or absence of Hispanic ethnic background, presence or absence of exposure to environmental tobacco smoke, and parents' level of education. However, the length of follow-up was not significantly associated with baseline lung function or the level of exposure to air pollution, suggesting that the loss to follow-up did not differ with respect to the primary variables of interest.

The study protocol was approved by the institutional review board for human studies at the University of Southern California, and written informed consent was provided by a parent or legal guardian for all study subjects. We did not obtain assent from minor children, since this was not standard practice when the study was initiated.

AIR-POLLUTION DATA

Air-pollution–monitoring stations were established in each of the 12 study communities and provided continuous data, beginning in 1994. Each station measured average hourly levels of ozone, nitrogen

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dioxide, and particulate matter with an aerodynamic diameter of less than 10 μm (PM_{10}). Stations also collected two-week integrated-filter samples for measuring acid vapor and the mass and chemical makeup of particulate matter with an aerodynamic diameter of less than 2.5 μm ($PM_{2.5}$). Acid vapor included both inorganic acids (nitric and hydrochloric) and organic acids (formic and acetic). For statistical analysis, we used total acid, computed as the sum of nitric, formic, and acetic acid levels. Hydrochloric acid was excluded from this sum, since levels were very low and close to the limit of detection. In addition to measuring $PM_{2.5}$, we determined the levels of elemental carbon and organic carbon, using method 5040 of the National Institute for Occupational Safety and Health.[15] We computed annual averages on the basis of average levels in a 24-hour period in the case of PM_{10} and nitrogen dioxide, and a two-week period in the case of $PM_{2.5}$, elemental carbon, organic carbon, and acid vapor. For ozone, we computed the annual average of the levels obtained from 10 a.m. to 6 p.m. (the eight-hour daytime average) and of the one-hour maximal levels. We also calculated long-term mean pollutant levels (from 1994 through 2000) for use in the statistical analysis of the lung-function outcomes.

STATISTICAL ANALYSIS

The outcome data consisted of the results of 5454 pulmonary-function tests of 876 girls and 5300 tests of 883 boys over the eight-year period. We adopted a two-stage regression approach to relate the longitudinal pulmonary-function data for each child to the average air-pollution levels in each study community.

The first-stage model was a regression of each pulmonary-function measure (values were log-transformed) on age to obtain separate, community-specific average growth curves for girls and boys. To account for the growth pattern during this period, we used a linear spline model[14] that consisted of four straight lines over the age intervals of younger than 12 years, 12 to 14 years, 14 to 16 years, and older than 16 years, constrained to be connected at the three "knot" points. The model included adjustments for log values for height; body-mass index (the weight in kilograms divided by the square of the height in meters); the square of the body-mass index; race; the presence or absence of Hispanic ethnic background, doctor-diagnosed asthma, any tobacco smoking by the child in the preceding year, exposure to environmental tobacco smoke, and exercise or respiratory tract illness on the day of the test; and indicator variables for the field technician and the spirometer. In addition to these covariates, random effects were included to account for the multiple measurements contributed by each subject. An analysis of residual values confirmed that the assumptions of the model had been satisfied. The first-stage model was used to estimate the mean and variance of the growth in lung function over the eight-year period in each of the 12 communities, separately for girls and boys.

The second-stage model was a linear regression of the 24 sex- and community-specific estimates of the growth in lung function over the eight-year period on the corresponding average levels of each air pollutant in each community. Inverses of the first-stage variances were incorporated as weights, and a community-specific random effect was included to account for residual variation between communities. A sex-by-pollutant interaction was included in the model to evaluate whether there was a difference in the effect of a given pollutant between the sexes, and when this value was nonsignificant, the model was refitted to estimate the sex-averaged effect of the pollutant. Pollutant effects are reported as the difference in the growth in lung function over the eight-year period from the least to the most polluted community, with negative differences indicative of growth deficits with increasing exposure. We also considered two-pollutant models obtained by simultaneously regressing the growth in lung function over the eight-year period on pairs of pollutants.

In addition to examining the growth in lung function over the eight-year period, we analyzed the FEV_1 measurements obtained in 746 subjects during the last year of follow-up (average age, 17.9 years) to determine whether exposure to air pollution was associated with clinically significant deficits in attained FEV_1. We defined a low FEV_1 as an attained FEV_1 below 80 percent of the predicted value, a criterion commonly used in clinical settings to identify persons who are at increased risk for adverse respiratory conditions. To determine the predicted FEV_1, we first fitted a regression model for observed FEV_1 (using log-transformed values) with the following predictors: log-transformed height, body-mass index, the square of the body-mass index, sex, race or ethnic group, asthma status, field technician, and interactions between sex and log-transformed height, sex and asthma, and sex and

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race or ethnic group. This model explained 71 percent of the variance in the attained FEV_1 level. For each subject, we then computed the predicted FEV_1 from the model and considered subjects to have a low FEV_1 if the ratio of observed to predicted FEV_1 was less than 80 percent. Linear regression was then used to examine the correlation between the community-specific proportion of subjects with a low FEV_1 and the average level of each pollutant from 1994 through 2000. This model included a community-specific random effect to account for residual variation. Regression procedures in SAS software[16] were used to fit all models. Associations denoted as statistically significant were those that yielded a P value of less than 0.05, assuming a two-sided alternative hypothesis.

RESULTS

From 1994 through 2000, there was substantial variation in the average levels of study pollutants across the 12 communities, with relatively little year-to-year variation in the annual levels within each community (Fig. 1). From 1994 through 2000, the

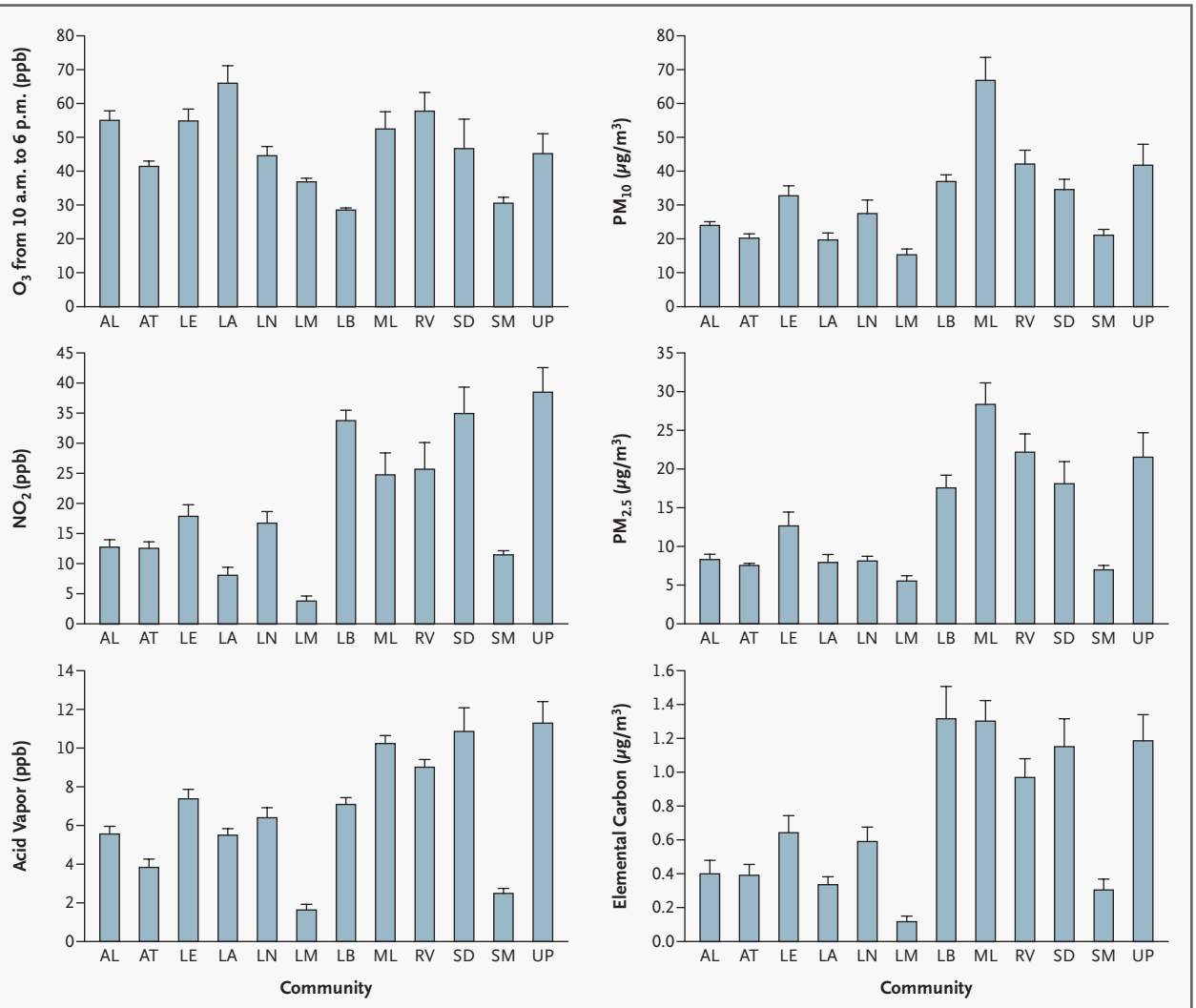


Figure 1. Mean (+SD) Annual Average Levels of Pollutants from 1994 through 2000 in the 12 Study Communities in Southern California.
AL denotes Alpine, AT Atascadero, LE Lake Elsinore, LA Lake Arrowhead, LN Lancaster, LM Lompoc, LB Long Beach, ML Mira Loma, RV Riverside, SD San Dimas, SM Santa Maria, and UP Upland. O_3 denotes ozone, NO_2 nitrogen dioxide, and PM_{10} and $PM_{2.5}$ particulate matter with an aerodynamic diameter of less than 10 μm and less than 2.5 μm, respectively.

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average levels of ozone were not significantly correlated across communities with any other study pollutant (Table 1). However, correlations between other pairs of pollutants were all significant, ranging from an R of 0.64 (P<0.05) for nitrogen dioxide and organic carbon, to an R of 0.97 (P<0.001) for PM_{10} and organic carbon. Thus, nitrogen dioxide, acid vapor, and the particulate-matter pollutants can be regarded as a correlated "package" of pollutants with a similar pattern relative to each other across the 12 communities.

Among the girls, the average FEV_1 increased from 1988 ml at the age of 10 years to 3332 ml at the age of 18 years, yielding an average growth in FEV_1 of 1344 ml over the eight-year period (Table 2). The corresponding averages in boys were 2082 ml and 4464 ml, yielding an average growth in FEV_1 of 2382 ml over the eight-year period. Similar patterns of growth over the eight-year period were observed for FVC and MMEF (Table 2).

Although the average growth in FEV_1 was larger in boys than in girls, the correlations of growth with air pollution did not differ significantly between the sexes, as shown for nitrogen dioxide in Figure 2. The sex-averaged analysis, depicted by the regression line in Figure 2, demonstrated a significant negative correlation between the growth in FEV_1 over the eight-year period and the average nitrogen dioxide level (P=0.005). The estimated difference in the average growth in FEV_1 over the eight-year period from the community with the lowest nitrogen dioxide level to the community with the highest nitrogen dioxide level, represented by the slope of the plotted regression line in Figure 2, was −101.4 ml.

Estimated differences in the growth of FEV_1, FVC, and MMEF during the eight-year period with respect to all pollutants are summarized in Table 3. Deficits in the growth of FEV_1 and FVC were observed for all pollutants, and deficits in the growth of MMEF were observed for all but ozone, with several combinations of outcome variables and pollutants attaining statistical significance. Specifically, for FEV_1 we observed significant negative correlations between the growth in this variable over the eight-year period and exposure to acid vapor (P=0.004), $PM_{2.5}$ (P=0.04), and elemental carbon (P=0.007), in addition to the above-mentioned correlation with nitrogen dioxide. As with FEV_1, the effects of the various pollutants on FVC and MMEF did not differ significantly between boys and girls. Significant deficits in FVC were associated with exposure to nitrogen dioxide (P=0.05) and acid vapor (P=0.03), whereas deficits in MMEF were associated with exposure to nitrogen dioxide (P=0.02) and elemental carbon (P=0.04). There was no significant evidence that ozone, either the average value obtained from 10 a.m. to 6 p.m. or the one-hour maximal level, was associated with any measure of lung function. In two-pollutant models for any of the measures of pulmonary function, adjustment for ozone did not substantially alter the effect estimates or significance levels of any other pollutant (data not shown). In general, two-pollutant models for any pair of pollutants did not provide a significantly better fit to the data than the corre-

Table 1. Correlation of Mean Air-Pollution Levels from 1994 through 2000 across the 12 Study Communities.*

Pollutant	O_3 (10 a.m.–6 p.m.)	NO_2	Acid Vapor†	PM_{10}	$PM_{2.5}$	Elemental Carbon	Organic Carbon
			R value				
O_3							
1-Hour maximal level	0.98	0.10	0.53	0.31	0.33	0.17	0.25
10 a.m.–6 p.m.		−0.11	0.35	0.18	0.18	−0.03	0.13
NO_2			0.87	0.67	0.79	0.94	0.64
Acid vapor†				0.79	0.87	0.88	0.76
PM_{10}					0.95	0.85	0.97
$PM_{2.5}$						0.91	0.91
Elemental carbon							0.82

* Unless otherwise noted, values are the 24-hour average pollution levels. O_3 denotes ozone, NO_2 nitrogen dioxide, and PM_{10} and $PM_{2.5}$ particulate matter with an aerodynamic diameter of less than 10 μm and less than 2.5 μm, respectively.
† Acid vapor is the sum of nitric, formic, and acetic acid levels.

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Table 2. Mean Levels of Growth in Pulmonary Function during the Eight-Year Study Period, from 1993 to 2001.*

Pulmonary-Function Measure	Girls			Boys		
	Age of 10 yr	Age of 18 yr	Average 8-yr growth	Age of 10 yr	Age of 18 yr	Average 8-yr growth
FVC (ml)	2262	3790	1528	2427	5202	2775
FEV_1 (ml)	1988	3332	1344	2082	4464	2382
MMEF (ml/sec)	2311	3739	1428	2287	4709	2422

* Levels at the ages of 10 and 18 years are derived from the growth model described in the Methods section. FVC denotes forced vital capacity, FEV_1 forced expiratory volume in one second, and MMEF maximal midexpiratory flow rate.

sponding single-pollutant models; this was not surprising, given the strong correlation between most pollutants.

The association between pollution and the growth in FEV_1 over the eight-year period remained significant in a variety of sensitivity analyses (Table 4). For example, estimates of the effect of acid vapor and elemental carbon (model 1 in Table 4) changed little with adjustment for in-utero exposure to maternal smoking (model 2), presence in the home of a gas stove (model 3) or pets (model 4), or parental level of education (model 5). To account for possible confounding by short-term effects of air pollution, we fitted a model that adjusted for the average ozone, nitrogen dioxide, and PM_{10} levels on the three days before each child's pulmonary-function test. This adjustment also had little effect on the estimates of the long-term effects of air pollution (model 6). Table 4 also shows that the effects of pollutants remained large and significant in the subgroups of children with no history of asthma (model 7) and those with no history of smoking (model 8). The effects of pollutants were not significant among the 457 children who had a history of asthma or among the 483 children who had ever smoked (data not shown), although the sample sizes in these subgroups were small. Model 9 demonstrates that the extremes in pollutant levels did not drive the observed associations; in other words, we found similar effect estimates after eliminating the two communities with the highest and lowest levels of each pollutant. Finally, model 10 shows the effects of pollutants in the subgroup of subjects who underwent pulmonary-function testing in both 1993 and 2001 (i.e., subjects who participated in both the first and last year of the study). The magnitudes of effects in this subgroup were similar to those in the entire sample (model 1), suggesting that observed effects of pollutants in the entire sample cannot be attributed to biased losses to follow-up across communities. These sensitivity analyses were also applied to the other pollutants and to FVC and MMEF, with similar results.

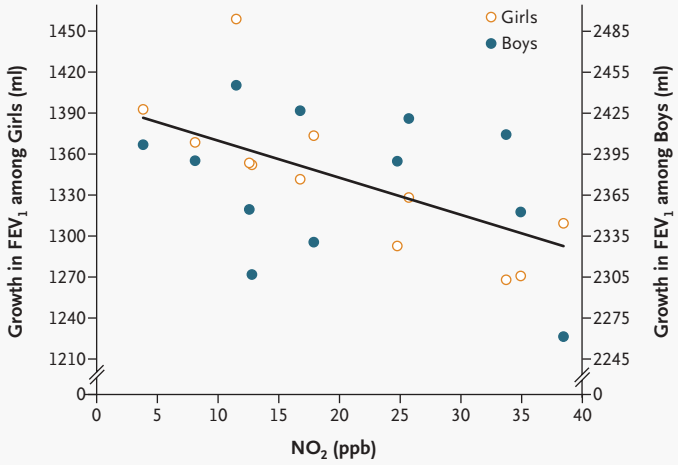


Figure 2. Community-Specific Average Growth in FEV_1 among Girls and Boys During the Eight-Year Period from 1993 to 2001 Plotted against Average Nitrogen Dioxide (NO_2) Levels from 1994 through 2000.

Pollution-related deficits in the average growth in lung function over the eight-year period resulted in clinically important deficits in attained lung function at the age of 18 years (Fig. 3). Across the 12 communities, a clinically low FEV_1 was positively correlated with the level of exposure to nitrogen dioxide (P=0.005), acid vapor (P=0.01), PM_{10} (P=0.02), $PM_{2.5}$ (P=0.002), and elemental carbon (P=0.006). For example, the estimated proportion of children with a low FEV_1 (represented by the regression line in Fig. 3) was 1.6 percent at the lowest level of exposure to $PM_{2.5}$ and was 4.9 times as great (7.9 percent) at the highest level of exposure to $PM_{2.5}$

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Table 3. Difference in Average Growth in Lung Function over the Eight-Year Study Period from the Least to the Most Polluted Community.*

Pollutant	FVC		FEV_1		MMEF	
	Difference (95% CI)	P Value	Difference (95% CI)	P Value	Difference (95% CI)	P Value
	ml		*ml*		*ml/sec*	
O_3						
10 a.m.–6 p.m.	−50.6 (−171.0 to 69.7)	0.37	−22.8 (−122.3 to 76.6)	0.62	85.6 (−130.0 to 301.1)	0.40
1-Hour maximal level	−70.3 (−183.3 to 42.6)	0.20	−44.5 (−138.9 to 50.0)	0.32	45.7 (−172.3 to 263.6)	0.65
NO_2	−95.0 (−189.4 to −0.6)	0.05	−101.4 (−164.5 to −38.4)	0.005	−211.0 (−377.6 to −44.4)	0.02
Acid vapor	−105.2 (−194.5 to −15.9)	0.03	−105.8 (−168.8 to −42.7)	0.004	−165.0 (−344.8 to 14.7)	0.07
PM_{10}	−60.2 (−190.6 to 70.3)	0.33	−82.1 (−176.9 to 12.8)	0.08	−154.2 (−378.3 to 69.8)	0.16
$PM_{2.5}$	−60.1 (−166.1 to 45.9)	0.24	−79.7 (−153.0 to −6.4)	0.04	−168.9 (−345.5 to 7.8)	0.06
Elemental carbon	−77.7 (−166.7 to 11.3)	0.08	−87.9 (−146.4 to −29.4)	0.007	−165.5 (−323.4 to −7.6)	0.04
Organic carbon	−58.6 (−196.1 to 78.8)	0.37	−86.2 (−185.6 to 13.3)	0.08	−151.2 (−389.4 to 87.1)	0.19

* Values are the differences in the estimated rate of eight-year growth at the lowest and highest observed levels of the indicated pollutant. Differences are scaled to the range across the 12 study communities in the average level of each pollutant from 1994 through 2000 as follows: 37.5 ppb of O_3 (measured from 10 a.m. to 6 p.m.), 46.0 ppb of O_3 (the one-hour maximal level), 34.6 ppb of NO_2, 9.6 ppb of acid vapor, 51.4 μg of PM_{10} per cubic meter, 22.8 μg of $PM_{2.5}$ per cubic meter, 1.2 μg of elemental carbon per cubic meter, and 10.5 μg of organic carbon per cubic meter. CI denotes confidence interval.

(P=0.002). Similar associations between these pollutants and a low FEV_1 were observed in the subgroup of children with no history of asthma and the subgroup with no history of smoking (data not shown). A low FEV_1 was not significantly correlated with exposure to ozone in any group.

DISCUSSION

The results of this study provide robust evidence that lung development, as measured by the growth in FVC, FEV_1, and MMEF from the ages of 10 to 18 years, is reduced in children exposed to higher levels of ambient air pollution. The strongest associations were observed between FEV_1 and a correlated set of pollutants, specifically nitrogen dioxide, acid vapor, and elemental carbon. The effects of these pollutants on FEV_1 were similar in boys and girls and remained significant among children with no history of asthma and among those with no history of smoking, suggesting that most children are susceptible to the chronic respiratory effects of breathing polluted air. The magnitude of the observed effects of air pollution on the growth in lung function during this age interval was similar to those that have been reported for exposure to maternal smoking[17,18] and smaller than those reported for the effects of personal smoking.[17,19]

Cumulative deficits in the growth in lung function during the eight-year study period resulted in a strong association between exposure to air pollution and a clinically low FEV_1 at the age of 18 years. In general, lung development is essentially complete in girls by the age of 18 years, whereas in boys it continues into their early 20s, but at a much reduced rate. It is therefore unlikely that clinically significant deficits in lung function at the age of 18 years will be reversed in either girls or boys as they complete the transition into adulthood. Deficits in lung function during young adulthood may increase the risk of respiratory conditions — for example, episodic wheezing that occurs during a viral infection.[20] However, the greatest effect of pollution-related deficits may occur later in life, since reduced lung function is a strong risk factor for complications and death during adulthood.[21-27]

Deficits in lung function were associated with a correlated set of pollutants that included nitrogen dioxide, acid vapor, fine-particulate matter ($PM_{2.5}$), and elemental carbon. In southern California, the primary source of these pollutants is motor vehicles, either through direct tailpipe emissions or downwind physical and photochemical reactions of vehicular emissions. Both gasoline- and diesel-powered engines contribute to the tons of pollutants exhausted into southern California's air every day, with diesel vehicles responsible for disproportionate amounts of nitrogen dioxide, $PM_{2.5}$, and ele-

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Table 4. Sensitivity Analysis of the Effects of Acid Vapor and Elemental Carbon on Growth in FEV_1 over the Eight-Year Study Period.*

Model	Acid Vapor	Elemental Carbon
	Difference (95% Confidence Interval)	
Main model (model 1)†	−105.8 (−168.8 to −42.7)	−87.9 (−146.4 to −29.4)
Additional covariates‡		
Main model + in-utero exposure to maternal smoking (model 2)	−108.8 (−173.3 to −44.2)	−85.8 (−147.4 to −24.1)
Main model + exposure to gas stove (model 3)	−106.0 (−181.5 to −30.6)	−84.8 (−154.7 to −14.9)
Main model + pets in home (model 4)	−108.4 (−171.6 to −45.2)	−89.8 (−149.1 to −30.6)
Main model + parental level of education (model 5)	−100.7 (−167.2 to −34.2)	−80.9 (−142.7 to −19.0)
Main model + short-term effects of pollution (model 6)§	−112.4 (−201.4 to −23.3)	−103.2 (−181.8 to −24.5)
Subgroup effects		
No history of asthma (model 7)¶	−98.1 (−166.4 to −29.8)	−88.9 (−149.2 to −28.6)
No history of smoking (model 8)‖	−115.6 (−233.7 to 2.5)	−113.3 (−214.9 to −11.6)
After exclusion of communities with lowest and highest levels of pollution (model 9)**	−106.7 (−192.3 to −21.2)	−94.7 (−173.7 to −15.7)
Complete follow-up (model 10)††	−132.4 (−226.2 to −38.7)	−97.4 (−195.6 to 0.9)

* Values are the differences in the estimated rate of eight-year growth at the lowest and highest observed levels of the indicated pollutant. Differences are scaled to the range across the 12 study communities in the average level of each pollutant from 1994 through 2000 as follows: 9.6 ppb of acid vapor and 1.2 μg of elemental carbon per cubic meter.
† Model 1 is equivalent to effect estimates for FEV_1 in Table 3 and is based on data on 1759 children.
‡ The main model was adjusted for each of the covariates listed.
§ Values were adjusted for the average levels of O_3, NO_2, and PM_{10} on the three days before each child's pulmonary-function test.
¶ The analysis includes data on 1302 children with no history of doctor-diagnosed asthma.
‖ The analysis includes data on 1276 children with no history of active tobacco smoking at any time during follow-up.
** The analysis excludes children from the two communities with the lowest and highest levels of each pollutant. This leaves 1507 children (excluding those from Lompoc and Upland) in the analysis of acid vapor and 1484 children (excluding those from Lompoc and Long Beach) in the analysis of elemental carbon.
†† The analysis includes 713 children who underwent pulmonary-function testing in both 1993 and 2001 (i.e., those observed throughout the study).

mental carbon. In the current study, however, we could not discern the independent effects of pollutants because they came from common sources and there was a high degree of intercorrelation among them; similar difficulties have also been encountered in other studies of lung function and air-pollutant mixtures.[1,2,9,28-30] Since ozone is also formed during photochemical reactions involving fuel-combustion products, one might expect ozone to be correlated with the other study pollutants and therefore to show similar associations with lung function. However, the Children's Health Study was specifically designed to minimize the correlation of ozone with other pollutants across the 12 study communities. Thus, although ozone has been convincingly linked to acute health effects in many other studies,[11] our results provide little evidence that ambient ozone at current levels is associated with chronic deficits in the growth of lung function in children. Only a few other studies have addressed the long-term effects of ozone on lung development in children, and results have been inconsistent.[31] Although we found little evidence of an effect of ozone, this result needs to be interpreted with caution given the potential for substantial misclassification of exposure to ozone.[32,33]

The mechanism whereby exposure to pollutants could lead to reduced lung development is unknown, but there are many possibilities. Our observation of associations between air pollution and all three measures of lung function — FVC, FEV_1, and MMEF — suggests that more than one process is involved. FVC is largely a function of the number and size of alveoli, with differences in volume pri-

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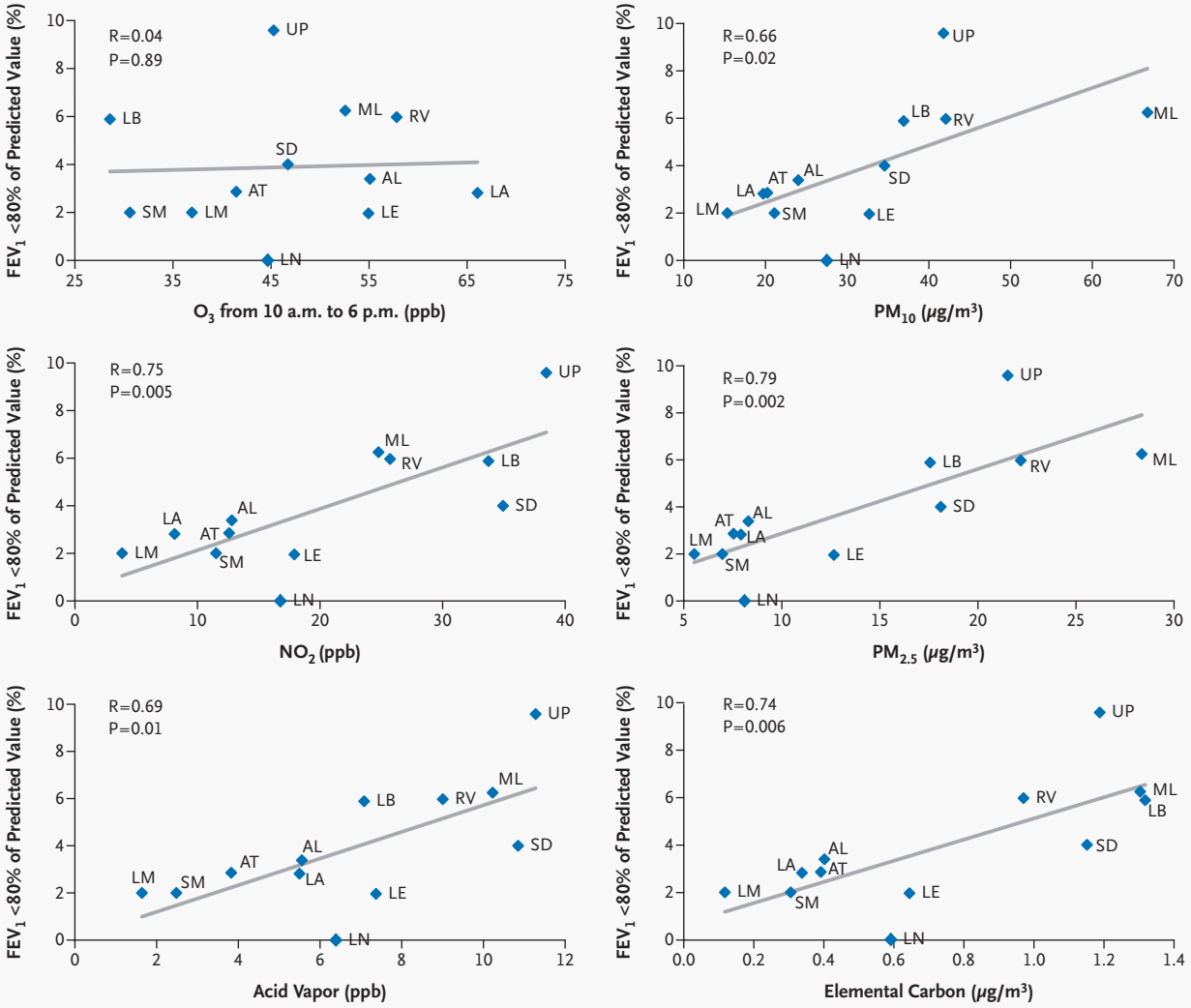


Figure 3. Community-Specific Proportion of 18-Year-Olds with a FEV_1 below 80 Percent of the Predicted Value Plotted against the Average Levels of Pollutants from 1994 through 2000.

The correlation coefficient (R) and P value are shown for each comparison. AL denotes Alpine, AT Atascadero, LE Lake Elsinore, LA Lake Arrowhead, LN Lancaster, LM Lompoc, LB Long Beach, ML Mira Loma, RV Riverside, SD San Dimas, SM Santa Maria, and UP Upland. O_3 denotes ozone, NO_2 nitrogen dioxide, and PM_{10} and $PM_{2.5}$ particulate matter with an aerodynamic diameter of less than 10 μm and less than 2.5 μm, respectively.

marily attributable to differences in the number of alveoli, since their size is relatively constant.[34] However, since the postnatal increase in the number of alveoli is complete by the age of 10 years, pollution-related deficits in the growth of FVC and FEV_1 during adolescence may, in part, reflect a reduction in the growth of alveoli. Another plausible mechanism of the effect of air pollution on lung development is airway inflammation, such as occurs in bronchiolitis; such changes have been observed in the airways of smokers and of subjects who lived in polluted environments.[35,36]

A strength of our study was the long-term, prospective follow-up of a large cohort, with exposure and outcome data collected in a consistent manner throughout the study period. As in any epidemiologic study, however, the observed effects could be biased by underlying associations of the exposure and outcome to some confounding variables. We adjusted for known potential confounders, includ-

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ing personal characteristics and other sources of exposure to pollutants, but the possibility of confounding by other factors still exists. Over the eight-year follow-up period, approximately 10 percent of study subjects were lost to follow-up each year. Attrition is a potential source of bias in a cohort study if loss to follow-up is related to both exposure and outcome. However, we did not see evidence that the loss of subjects was related to either baseline lung function or exposure to air pollution. In addition, we observed significant associations between air pollution and lung growth in the subgroup of children who were followed for the full eight years of the study, with effects that were similar in magnitude to those in the group as a whole, thus making loss of subjects an unlikely source of bias.

We have shown that exposure to ambient air pollution is correlated with significant deficits in respiratory growth over an eight-year period, leading to clinically important deficits in lung function at the age of 18 years. The specific pollutants that were associated with these deficits included nitrogen dioxide, acid vapor, $PM_{2.5}$, and elemental carbon. These pollutants are products of primary fuel combustion, and since they are present at similar levels in many other areas,[37,38] we believe that our results can be generalized to children living outside southern California. Given the magnitude of the observed effects and the importance of lung function as a determinant of morbidity and mortality during adulthood, continued emphasis on the identification of strategies for reducing levels of urban air pollutants is warranted.

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CORRECTION

The Effect of Air Pollution on Lung Development from 10 to 18 Years of Age

The Effect of Air Pollution on Lung Development from 10 to 18 Years of Age . On page 1059, under the heading Statistical Analysis, in the list of model adjustments, lines 18 through 20 of the left-hand column should have read ``the square of log values for height,'' rather than ``body-mass index (the weight in kilograms divided by the square of the height in meters); the square of the body-mass index,'' as printed. Also, in the right-hand column, lines 3 and 4 should have read ``ordinal variables for the field technician and the spirometer,'' rather than ``indicator variables,'' as printed. These errors had no bearing on the analysis of persons with clinically low lung function. Adjustment for body-mass index and indicator variables as intended changes the results slightly but does not affect the reported associations between growth and pollution during an eight-year period. The corrected values for Table 2 (page 1062), Table 3 (1063), and Table 4 (1064) and for Figure 2 (page 1062) are available at the *Journal*'s Web site at www.nejm.org.

Table 2. Mean Levels of Growth in Pulmonary Function during the Eight-Year Study Period, from 1993 to 2001.

Table 2. Mean Levels of Growth in Pulmonary Function during the Eight-Year Study Period, from 1993 to 2001.*

Pulmonary-Function Measure	Girls			Boys		
	Age of 10 yr	Age of 18 yr	Average 8-yr growth	Age of 10 yr	Age of 18 yr	Average 8-yr growth
FVC (ml)	2227	3757	1530	2392	5227	2835
FEV_1 (ml)	1951	3286	1335	2050	4467	2418
MMEF (ml/sec)	2284	3686	1402	2255	4676	2420

* Levels at the ages of 10 and 18 years are derived from the growth model described in the Methods section. FVC denotes forced vital capacity, FEV_1 forced expiratory volume in one second, and MMEF maximal midexpiratory flow rate.

Table 3. Difference in Average Growth in Lung Function over the Eight-Year Study Period from the Least to the Most Polluted Community.

Table 3. Difference in Average Growth in Lung Function over the Eight-Year Study Period from the Least to the Most Polluted Community.*

Pollutant	FVC		FEV_1		MMEF	
	Difference (95% CI)	P Value	Difference (95% CI)	P Value	Difference (95% CI)	P Value
	ml		*ml*		*ml/sec*	
O_3						
10 a.m.–6 p.m.	−36.4 (−124.5 to 51.6)	0.38	−17.8 (−101.7 to 66.0)	0.65	79.7 (−155.5 to 314.8)	0.47
1-Hour maximal level	−51.9 (−135.1 to 31.3)	0.20	−37.1 (−117.4 to 43.3)	0.33	34.5 (−202.1 to 271.2)	0.75
NO_2	−70.4 (−139.8 to −1.1)	0.05	−89.1 (−154.0 to −24.2)	0.01	−232.7 (−410.4 to −54.9)	0.01
Acid vapor	−81.0 (−148.5 to −13.6)	0.02	−95.7 (−159.7 to −31.6)	0.007	−191.8 (−382.1 to −1.5)	0.05
PM_{10}	−57.8 (−150.4 to 34.9)	0.20	−85.6 (−168.7 to −2.6)	0.04	−175.9 (−413.9 to 62.0)	0.13
$PM_{2.5}$	−51.0 (−127.1 to 25.2)	0.17	−78.3 (−145.6 to −11.0)	0.03	−191.8 (−379.8 to 3.7)	0.05
Elemental carbon	−65.4 (−127.1 to −3.8)	0.04	−83.5 (−141.2 to −25.9)	0.009	−185.2 (−353.5 to −16.9)	0.03
Organic carbon	−57.3 (−155.4 to 40.8)	0.22	−91.7 (−178.3 to −5.1)	0.04	−175.9 (−428.2 to 76.5)	0.15

* Values are the differences in the estimated rate of eight-year growth at the lowest and highest observed levels of the indicated pollutant. Differences are scaled to the range across the 12 study communities in the average level of each pollutant from 1994 through 2000 as follows: 37.5 ppb of O_3 (measured from 10 a.m. to 6 p.m.), 46.0 ppb of O_3 (the one-hour maximal level), 34.6 ppb of NO_2, 9.6 ppb of acid vapor, 31.4 μg of PM_{10} per cubic meter, 22.8 μg of $PM_{2.5}$ per cubic meter, 1.2 μg of elemental carbon per cubic meter, and 10.3 μg of organic carbon per cubic meter. CI denotes confidence interval.

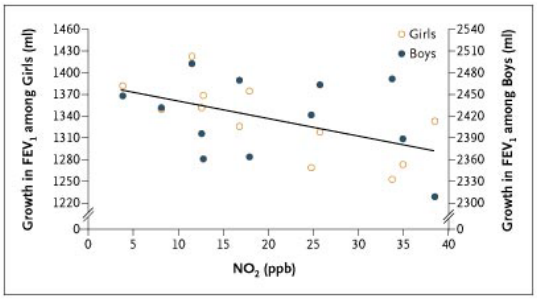
Table 4. Sensitivity Analysis of the Effects of Acid Vapor and Elemental Carbon on Growth in FEV_1 over the Eight-Year Study Period.

Table 4. Sensitivity Analysis of the Effects of Acid Vapor and Elemental Carbon on Growth in FEV_1 over the Eight-Year Study Period.*

Model	Acid Vapor	Elemental Carbon
	Difference (95% Confidence Interval)	
Main model (model 1)†	−95.7 (−159.7 to −31.6)	−83.5 (−141.2 to −25.9)
Additional covariates‡		
Main model + in-utero exposure to maternal smoking (model 2)	−98.9 (−164.0 to −33.7)	−80.8 (−141.4 to −20.1)
Main model + exposure to gas stove (model 3)	−95.8 (−171.0 to −20.7)	−80.8 (−148.9 to −12.8)
Main model + pets in home (model 4)	−98.2 (−162.3 to −34.2)	−85.2 (−143.3 to −27.2)
Main model + parental level of education (model 5)	−91.4 (−160.1 to −22.6)	−78.0 (−140.0 to −15.9)
Main model + short-term effects of pollution (model 6)§	−104.2 (−207.1 to −1.2)	−97.2 (−188.1 to −6.2)
Subgroup effects		
No history of asthma (model 7)¶	−90.4 (−163.4 to −17.4)	−87.5 (−150.3 to −24.6)
No history of smoking (model 8)‖	−102.1 (−221.9 to 17.8)	−107.3 (−209.5 to −5.1)
After exclusion of communities with lowest and highest levels of pollution (model 9)**	−105.6 (−189.5 to −21.7)	−88.4 (−156.7 to −20.1)
Complete follow-up (model 10)††	−127.4 (−216.4 to −38.3)	−96.0 (−184.2 to −7.8)

* Values are the differences in the estimated rate of eight-year growth at the lowest and highest observed levels of the indicated pollutant. Differences are scaled to the range across the 12 study communities in the average level of each pollutant from 1994 through 2000 as follows: 9.6 ppb of acid vapor and 1.2 μg of elemental carbon per cubic meter.
† Model 1 is equivalent to effect estimates for FEV_1 in Table 3 and is based on data on 1759 children.
‡ The main model was adjusted for each of the covariates listed.
§ Values were adjusted for the average levels of O_3, NO_2, and PM_{10} on the three days before each child's pulmonary-function test.
¶ The analysis includes data on 1302 children with no history of doctor-diagnosed asthma.
‖ The analysis includes data on 1276 children with no history of active tobacco smoking at any time during follow-up.
** The analysis excludes children from the two communities with the lowest and highest levels of each pollutant. This leaves 1507 children (excluding those from Lompoc and Upland) in the analysis of acid vapor and 1484 children (excluding those from Lompoc and Long Beach) in the analysis of elemental carbon.
†† The analysis includes 713 children who underwent pulmonary-function testing in both 1993 and 2001 (i.e., those observed throughout the study).

Figure 2. Community-Specific Average Growth in FEV_1 among Girls and Boys During the Eight-Year Period from 1993 to 2001 Plotted against Average Nitrogen Dioxide (NO_2) Levels from 1994 through 2000.



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Research
Children's Health

Traffic, Susceptibility, and Childhood Asthma

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See "The Freeway Running through the Yard: Traffic Exhaust and Asthma in Children" on page A305.

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Abstract

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Results from studies of traffic and childhood asthma have been inconsistent, but there has been little systematic evaluation of susceptible subgroups. In this study, we examined the relationship of local traffic-related exposure and asthma and wheeze in southern California school children (5–7 years of age). Lifetime history of doctor-diagnosed asthma and prevalent asthma and wheeze were evaluated by questionnaire. Parental history of asthma and child's history of allergic symptoms, sex, and early-life exposure (residence at the same home since 2 years of age) were examined as susceptibility factors. Residential exposure was assessed by proximity to a major road and by modeling exposure to local traffic-related pollutants. Residence within 75 m of a major road was associated with an increased risk of lifetime asthma [odds ratio (OR) = 1.29; 95% confidence interval (CI), 1.01–1.86], prevalent asthma (OR = 1.50; 95% CI, 1.16–1.95), and wheeze (OR = 1.40; 95% CI, 1.09–1.78). Susceptibility increased in long-term residents with no parental history of asthma for lifetime asthma (OR = 1.85; 95% CI, 1.11–3.09), prevalent asthma (OR = 2.46; 95% CI, 0.48–4.09), and recent wheeze (OR = 2.74; 95% CI, 1.71–4.39). The higher risk of asthma near a major road decreased to background rates at 150–200 m from the road. In children with a parental history of asthma and in children moving to the residence after 2 years of age, there was no increased risk associated with exposure. Effect of residential proximity to roadways was also larger in girls. A similar pattern of effects was observed with traffic-modeled exposure. These results indicate that residence near a major road is associated with asthma. The reason for larger effects in those with no parental history of asthma merits further investigation.

Keywords: air pollution, asthma, child, epidemiology, traffic

Childhood asthma prevalence and incidence have been associated with local variation in traffic patterns within communities in many (Brauer et al. 2002; Gauderman et al. 2005; Nicolai et al. 2003; van Vliet et al. 1997; Venn et al. 2000; Zmirou et al. 2004) but not all (English et al. 1999; Waldron et al. 1995; Wjst et al. 1993) studies that have examined the impact of local traffic or traffic-related air pollutants near children's homes. However, many studies did not evaluate exposure at early age, which may be an important determinant of risk from traffic-related pollution (Zmirou et al. 2004) and which might vary depending on residential stability of study participants. The duration of residence at the same home might also be expected to increase any risk of asthma associated with traffic-related exposure. Other characteristics that might make children more susceptible to this exposure include parental history of asthma and childhood allergy, which are strong risk factors for asthma (London et al. 2001; Peden 2000). A recent study found larger associations of traffic with asthma in children without a parent with asthma (Gordian et al. 2005), and we have previously found that children with incident asthma associated with ozone were less likely to have a parental history of asthma than were other children with asthma (McConnell et al. 2002). Susceptibility to second-hand tobacco smoke exposure, another environmental combustion product, and traffic-related pollutants has been found to vary by atopy in some studies that have examined this relationship (Janssen et al. 2003; Kershaw 1987; Palmieri et al. 1990; Strachan and Cook 1998; Strachan et al. 1996a, 1996b; Zmirou et al. 2004). Some evidence also suggests that girls may be more susceptible than boys to traffic-related exposure (Oosterlee et al. 1996; Pershagen et al. 1995; Shima et al. 2003; van Vliet et al. 1997; Venn et al. 2001).

Concentrations of pollutants in fresh vehicular exhaust are high near roadways but decline markedly within 150 –300 m (Gilbert et al. 2005; Zhu et al. 2002). Accurate assessment of this large but very local variation in exposure may be important to identify health hazards. One promising approach has been to estimate residential distance to a major roadway. This can be done with relatively little error in measurement, using geographic information systems and accurately located roadways. Some studies have found increased asthma prevalence in children living within 100 m of a major road, and there is evidence that the risk increases dramatically within 75 m (van Vliet et al. 1997; Venn et al. 2001).

In this population-based study, we examined characteristics that might increase childhood susceptibility to the effects of traffic-related air pollution in a new cohort in the southern California Children's Health Study, an ongoing longitudinal evaluation of air pollution and respiratory health (Künzli et al. 2003). We evaluated whether parental history of asthma and child age at exposure, symptoms of allergy, and sex influenced susceptibility to the risk of childhood asthma and wheeze associated with exposure to traffic.

Materials and Methods

Go to:

Population. A new cohort was recruited in 2003 from schools in 13 southern California communities (shown in Figure 1). Nine communities were the same as in the original Children's Health Study cohorts, and four were new. All students present in 2003 in all kindergarten and first grade classrooms (5–7 years of age) in participating schools were given a questionnaire and informed consent to take home for parents to complete. Informed consent, approved for this study by the University of Southern California Institutional Review Board, was obtained, and questionnaires were completed and returned for 5,341 (65%) of 8,193 eligible children.



Figure 1
Location of study communities.

Assessment of exposure to traffic-related pollutants. We estimated distance of each participant's residence to the nearest major road, including freeways, other highways, and arterial roads. Participant residence addresses were standardized, and their locations were geocoded to 13 m perpendicular to the side of the adjacent road, using the Tele Atlas Multinet road network data (Tele Atlas Inc., Menlo Park, CA). Distance to the nearest major road was estimated using ArcGIS software (version 8.3; Environmental Systems Research Institute Inc., Redlands, CA). Each direction of travel was represented as a separate roadway, and the shortest distance was estimated from

the residence to the middle of the nearest side of the freeway or major road. We included in the analysis only children with addresses that could be accurately geocoded. Specifically, only residential addresses for which the Tele Atlas geocoding software assigned its highest-quality match code were included. These addresses are located on the correct side of the street with their relative position between cross-streets determined by linear interpolation of residence number between the nearest intersections.

Residential distance to a major road was categorized as < 75 m, 75–150 m, > 150–300 m, and > 300 m, based on results of previous studies showing markedly increased exposure and risk of asthma within 75 m of large roadways, which decreased to background levels by 150–300 m (Gilbert et al. 2005; van Vliet et al. 1997; Venn et al. 2001; Zhu et al. 2002). We also estimated residential exposure to fresh traffic-modeled pollutants from local freeway and nonfreeway sources, accounting for traffic volume, wind speed, and direction in each community, using a line source dispersion model, as described in the accompanying online supplemental material (http://www.ehponline.org/members/2006/8594/suppl.pdf).

Health outcomes and other questionnaire information. We classified lifetime asthma based on a questionnaire response to the question "Has a doctor ever diagnosed this child as having asthma?" Current wheeze was defined to include children with any wheezing in the previous 12 months [International Study of Asthma and Allergies in Children (ISAAC) Steering Committee 1998]. Prevalent asthma was defined as the reported use of controller medications for asthma (inhaled corticosteroids, leukotriene inhibitors, cromolyn sodium, or long-acting beta agonists) in the previous year or lifetime asthma with any wheeze in the previous year. In addition, children without a physician's diagnosis who had severe wheeze in the previous 12 months were included as prevalent asthmatics to identify asthma undiagnosed because of poor access to medical care. Severe wheeze included four or more attacks of wheeze, one or more nights per week of wheeze, or wheeze with shortness of breath so severe as to interfere with speech (ISAAC Steering Committee 1998).

We collected personal and family covariates and housing characteristics by questionnaire, including child's race and date of birth and the language in which the questionnaire was completed (Spanish or English). Potentially susceptible groups were identified based on child's sex, allergic characteristics defined as a history of hay fever or a problem with sneezing or runny or blocked nose when the child did not have a cold, parental history of asthma, and residence (exposure) in the current home since 2 years of age or earlier. Information on potentially confounding exposures or characteristics included maternal smoking while pregnant with the child, current second-hand tobacco smoke exposure, family income and responding parent's education, current coverage of the child by a health insurance plan, and housing characteristics, which included pets inside the home (dog, cat, bird, other furry or hairy pets, or other pets), cockroaches, rats or mice, carpeting, water damage or mold or mildew in the home since the child lived there, use of an air conditioner, second-hand tobacco smoke, and a combustion source for nitrogen dioxide in the home (a gas oven or stove or heating unit with a pilot light).

Statistical analysis. The odds ratio (OR) for each distance category was estimated with residences further than 300 m as the reference group, using logistic regression. All models were adjusted for the child's age, sex, race, community, and language of questionnaire completion. To assess the effect of long-term and early-life exposure, some analyses were stratified into children living since 2 years of age or younger at the same residence and those moving to the current residence at a later age. Confounding was evaluated by assessing whether the coefficient of the log OR for exposure changed by > 10% after adding an additional covariate to this basic model. We assessed effect modification by parental history of asthma and the child's history of allergic symptoms and sex by modeling the interaction of the potential effect modifier with exposure category (or with traffic-modeled exposure, as described in the online supplemental material) and by examining the effects of exposure by strata.

We also fitted logistic additive models (Hastie and Tibshirani 1990) to assess the functional relationship between childhood asthma and proximity to major roads. These models used the smoothing spline with 3 degrees of freedom for the continuous distance from major road and used the same adjustment variables as in the linear logistic models described above.

Significance was defined as two-sided $p < 0.05$ for all analyses. The logistic additive models were fitted using the S-plus programming language (Venables et al. 2002). All other analyses were performed using the Statistical Analysis System (SAS version 9.0; SAS Institute Inc., Cary, NC).

Results

Go to:

Of the 5,341 children completing a questionnaire and informed consent, 4,762 had an address that could be accurately matched and geocoded. Among these, there were 650 reports of ever physician-diagnosed asthma (14%); 577 cases of prevalent asthma (13%) based on current severe symptoms, use of controller medications, or lifetime asthma with current wheeze; and 682 children with current wheeze during the previous year (15%). Although there was some overlap of these phenotypes, 38% of children with lifetime asthma had no current wheeze, 16% with prevalent asthma had no current wheeze (based primarily on use of controller medications in prevalent asthma), and 17% of prevalent asthma cases had no lifetime reported doctor diagnosis of asthma. The mean (± SD) age was 6.5 ± 0.68 years. The frequency of other characteristics of children, parents, and households is shown in Table 1. Most children were Hispanic, and almost one-quarter of parents completed a questionnaire in Spanish. Eighteen percent of parents reported that annual household income was < $15,000, and 22% had less than a high school education. Forty-two percent of children had lived at the same address since 2 years of age or younger.

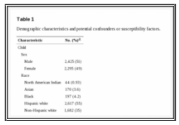


Table 1

Demographic characteristics and potential confounders or susceptibility factors.

The mean (± SD) distance from the child's residence to a major road was 418 ± 519 m (median, 254 m; range, 0.02–7,516 m). (Error in precisely locating homes and roadways accounted for distances less than the 13-m offset from the street used in geocoding residences.) Most residences (56.6%) were within 300 m of a major road: 25.2% were between 150 and 300 m, 16.4% between 75 and 150 m, and 15% within 75 m.

The risk of asthma-related outcomes was associated with residential distance to a major road (Table 2). Compared with those living at least 300 m from a major road, there were increased risks for all three outcomes among children within 75 m. For both prevalent asthma and current wheeze, there was increasing risk with decreasing residential distance to the roadway. Among long-term residents (living since 2 years of age at the same home), risk was increased only among those living within 75 m of a major road, and the ORs were slightly larger than the corresponding ORs in the entire population. Confounding by housing characteristics or other covariates from Table 1 was assessed among long-term residents, and the effect of living within 75 m of a major road was not substantially changed.

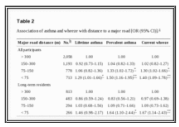
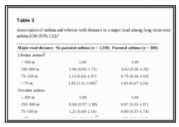


Table 2

Association of asthma and wheeze with distance to a major road [OR (95% CI)].[a]

We examined interactions of exposure with the susceptibility factors in the sample restricted to long-term residents, because exposure in this group was more likely to have been accurately assigned for the period during which asthma developed than for children moving later. Parental asthma modified the effect of living within 75 m of a major road (Table 3). There were almost 2-fold (lifetime asthma) to almost 3-fold increased risks (current wheeze) associated with this exposure, but only among those children without a parental history of asthma. The interaction of parental history with residential proximity within 75 m was significant for prevalent asthma (1 degree of freedom, Wald chi-square 4.39; $p = 0.04$) and for current wheeze ($p = 0.01$), but not for lifetime asthma.

Table 3



Association of asthma and wheeze with distance to a major road among long-term residents, by parental history of asthma [OR (95% CI)].[a]

Among long-term residents who had no allergic symptoms, greater than 2-fold increased risks of all three outcomes were associated with living in a residence within 75 m of a major road (Table 4). However, there were no significant interactions of allergy with this exposure for any of the three outcomes.

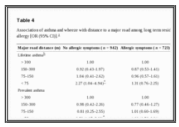


Table 4

Association of asthma and wheeze with distance to a major road among long term residents, by child's history of allergy [OR (95% CI)].[a]

Among boys, there was little evidence of increased risk associated with residential distance to a major road (Table 5). Among girls, strong associations with living within 75 m of a major road were observed for all three outcomes, and the difference between boys and girls was significant for lifetime asthma (1 degree of freedom interaction, $p = 0.02$).

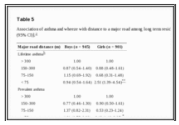


Table 5

Association of asthma and wheeze with distance to a major road among long term residents, by child's sex [OR (95% CI)].[a]

Among children with no family history of asthma, we examined further the relationship of asthma and distance to a major road within 500 m of the home, using smoothed models. Among long-term residents, an increasing rate of prevalent asthma was observed with residential proximity to the nearest major road, and the risk decreased to background levels at 150–200 m (Figure 2). This trend was observed only among children living at the same address since 2 years of age. Children moving to the current residence after 2 years of age showed no effect of proximity to a major road. A similar pattern of effects was observed for lifetime asthma and wheeze (data not shown).

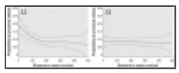


Figure 2

Prevalence of asthma by distance of residence to a major road within 500 m, among long-term (*A*) and short-term (*B*) residents with no family history of asthma. Dotted lines indicate 95% confidence interval.

The effects of pollutants in fresh traffic exhaust modeled from traffic volume, distance, and meteorology were generally consistent with those observed for proximity to a major road (see online supplemental material). There were significant associations of nonfreeway (but not of freeway or total) traffic-modeled exposure with prevalent asthma and current wheeze, and these effects were stronger in long-term residents (Table S-2 in the online supplemental material). The stratum-specific pattern of traffic-modeled effects was also stronger in those with no parental history and with no allergic symptoms and among girls (Table S-3 in the online supplemental material).

Discussion

Go to:

Asthma and wheeze were strongly associated with residential proximity to a major road. These associations were strongest among children with no parental history of asthma who had lived at the same address since early in life. In this group, the highest risk occurred adjacent to the major road, and risk decreased to background rates at 150 –200 m from the road. Larger risks of asthma associated with long-term residence within 75 m of a major road were observed among girls than among boys.

If traffic-related pollutants were responsible for the observed associations with asthma, the increased risk among the longer-term residents might be expected because they had a larger cumulative exposure to the pollutant indicators used in this analysis. However, the absence of any effect of a major road among children moving to their residence after 2 years of age (Figure 2) may indicate vulnerability during the prenatal period or infancy. Although the study design did not allow us to distinguish between these two possibilities, there is evidence that other early-life exposures may increase the risk of asthma (Martinez 1999). Recent case–control and cohort studies have found an increased risk of asthma with early-life exposure to local residential traffic-related pollutants (Brauer et al. 2002; Zmirou et al. 2004). In addition, several recent studies suggest that early-life (especially *in utero*) exposure to tobacco smoke, which like fresh vehicular exhaust is a complex mixture of air pollutants, is more strongly associated with increased risk of subsequent asthma than is exposure later in childhood (Gilliland et al. 2001, 2002). The larger effect of proximity to a major roadway among girls in our study also is consistent with previous reports (Oosterlee et al. 1996; Pershagen et al. 1995; Shima et al. 2003; van Vliet et al. 1997; Venn et al. 2001).

We previously found that children with an increased risk of incident asthma associated with exercise in high-ozone environments were less likely to have a parental history of asthma (McConnell et al. 2002), and another recent study found that the risk of traffic-associated prevalent asthma was larger in children without parental history (Gordian et al. 2005). However, both family history of asthma and child allergy are strong risk factors for asthma independent of exposure to air pollution (London et al. 2001; Peden 2000). In our study, among long-term residents living > 300 m from a major road, parental history was associated with a 3.6-fold increased risk of prevalent asthma [95% confidence interval (CI), 2.3–5.8] and child symptoms of allergy with a 6.4-fold increased risk (95% CI, 4.5–9.1). Therefore, one possible explanation for the larger effects of traffic exposure in children without these strong risk factors is that other risks, for example, dietary factors, indoor allergens, or other environmental exposures, produced asthma in the high-risk group, regardless of traffic-related exposures. It is possible that, among those with parental asthma or allergic symptoms, there was no additional risk of childhood asthma associated with traffic or that any small additional effect of traffic was undetectable in the high background rate of asthma in these children.

Parental history of asthma is an indication of genetic susceptibility, so the absence of risk among those with parental history may also indicate that asthma caused by pollutants in fresh traffic exhaust is less likely to be inherited, or at least is not mediated through the same genetic pathways that account for asthma in the parents of these children. Nonallergic asthma is one possible alternative pathway, which may be consistent with the stronger observed effect of traffic among children without hay fever or other allergic symptoms. Like parental history of asthma, allergic symptoms are associated with atopic asthma (Peden 2000). Atopy is characterized by a positive skin test or immunoglobulin E–specific response to environmental allergens. Recent studies indicate that nonallergic asthma (without airway eosinophilia or atopy) may account for as much as half of all asthma (Beasley et al. 2001; Douwes et al. 2002; Pearce et al. 1999), and it has been suggested that risk factors for this asthma phenotype, including particulate air pollution, may differ from those for allergic asthma (Douwes et al. 2002). Some studies of the risk of asthma and wheeze due to second-hand smoke, another mix of oxidant pollutants, have shown stronger effects among children without atopy or atopic symptoms (Kershaw 1987; Palmieri et al. 1990; Strachan and Cook 1998; Strachan et al. 1996a, 1996b). In addition, drug-induced and occupational asthma commonly occur in the absence of atopy, and many of the exposures responsible for “irritant-induced asthma” in the workplace are also present in the general population (Gautrin et al. 2003; Kitani et al. 1993). However, in other studies, stronger associations of asthma and wheeze with traffic-related pollutants were found among atopic children (Janssen et al. 2003; Zmirou et al. 2004) and with second-hand tobacco smoke exposure among children with an atopic parent (Jaakkola et al. 2001). In addition, laboratory evidence suggests that exposure to oxidant air pollution promotes the effect of allergens on asthma severity and on the pathogenesis of asthma (Jenkins et al. 1999; Kehrl et al. 1999; Li et al. 2003; Schelegle et al. 2003). Based on these studies, an effect of traffic-related pollutants might have been expected to be stronger among children with allergy. Further investigation is warranted to identify the reason for the apparent susceptibility of children without allergy and parental history of

asthma in our study. Better phenotypic characterization of atopy both in the study children and in their parents and of allergen exposure in children would be useful to interpret the relationship of these characteristics to traffic and asthma.

In a previous cohort in the Children's Health Study, we observed strong associations of lifetime asthma with residential ambient NO_2, an indicator of variability within communities of traffic-related pollutants, which was measured at a sample of homes (Gauderman et al. 2005). Measured NO_2 was moderately correlated with total traffic-modeled pollution ($R = 0.59$). Strong associations also were observed with residential distance to a freeway and with traffic-modeled exposure from freeways (but not from non-freeway traffic–modeled pollution). We have now extended these observations to a larger population and to residential distance to other major roadways. The association of asthma in our new cohort with non-freeway traffic–modeled exposure, but not with freeway-modeled exposure, may reflect differences in the distribution of freeways and major roads around homes in the different cohorts. The association of asthma with non-freeway traffic–modeled exposure is consistent with the observed association with distance to a major road, because there were few children within 75 m of a freeway in our study. Residential distance to a major roadway also is computationally easier to estimate from data that are more readily available than the meteorologic and traffic volume data required to model exposure. An increased risk associated with proximity to a major roadway also is more easily explained to policy makers and to the general public than is the risk associated with traffic-modeled exposure.

Our results are also consistent with several European studies that found increased risks of childhood asthma with increased traffic counts in close proximity to the home (Morris et al. 2000; Nicolai et al. 2003; van Vliet et al. 1997; Venn et al. 2001; Zmirou et al. 2004). One large British study that focused on traffic within 150 m of children's homes found a gradient in risk that increased markedly with decreasing residential distance to a main road (Venn et al. 2001). There have been few other studies of traffic and childhood asthma in the United States. A recent study in northern California found an association between measured traffic-related pollutants at schools and childhood asthma (Kim et al. 2004). However, another large study in southern California based on records of children covered by Medicaid (public insurance for low-income persons) found no association between asthma prevalence and traffic counts within 168 m of the home, although an association with asthma medication was observed (English et al. 1999). Some of the inconsistencies in the literature could perhaps be explained by the failure of many studies to account for the pattern of effect modification by parental history of asthma and by age and duration of residential exposure to traffic-related pollutants that vary markedly at different locations. The larger effects of traffic in girls has been observed in previous studies of traffic and asthma and related symptoms, but the reason for the apparent susceptibility of girls is not known (Oosterlee et al. 1996; Pershagen et al. 1995; Shima et al. 2003; van Vliet et al. 1997; Venn et al. 2001).

A causal relationship between asthma and traffic-related exposures is biologically plausible, because ambient particulate matter and other oxidant pollutants have been shown to elicit responses relevant to the pathogenesis of asthma (Li et al. 2003). In addition, studies in southern California and elsewhere have shown that the largest gradients in traffic-related pollutants occur within the 150–200 m from roadways over which we saw decreasing risk of asthma (Gilbert et al. 2003; Zhu et al. 2002). In studies in which NO_2 and other markers of traffic-related exposure have been measured in close proximity to major roadways, variability has usually been best explained by traffic volume within 300 m (Briggs et al. 2000; Gilbert et al. 2003; Ross et al. 2005), although weaker correlations have also been observed over longer distances from the highest volume traffic corridors (Gauderman et al. 2005; Gilbert et al. 2003, 2005; Ross et al. 2005).

We considered bias as an explanation for our results. Parents with asthma who were susceptible to environmental triggers might have selected homes away from major roads, perhaps even before the children were born. If the children of these parents had high rates of asthma, this might have explained the observed lack of effect of a major road in families with parental asthma. There is some evidence that parents may intervene to reduce household exposure to indoor allergens, another perceived risk for asthma and asthma severity (Almqvist et al. 2003; van Strien et al. 2002). However, this bias is unlikely to explain our results, because we examined and

found no significant differences in rates of parental history of asthma by exposure to a major road (data not shown). Selection bias related to factors influencing participation could not be evaluated, because characteristics of nonparticipants are not known. However, there were some modest differences between participants whose addresses could be geocoded, who were of higher socioeconomic status than were participants whose addresses could not be geocoded. For example, of those with family income < $7,500, 85% could be geocoded, compared with 93% of those with ≥$100,000. Of those without insurance, 85% could be geocoded, compared with 90% of those with insurance. The differences between those whose homes could and could not be geocoded were heavily influenced by 299 subjects (of 579 total that could not be geocoded) who completed a questionnaire but did not provide an address. However, none of the three asthma outcomes was associated with absence of a home geocode, and the associations of asthma with traffic were robust to our adjustment for socioeconomic status. It has also been suggested that traffic-related noise might cause asthma through a pathway mediated by stress (Ising and Ising 2002). However, to date there is little evidence to support this hypothesis. Other potential confounders, including sociodemographic factors, second-hand or *in utero* tobacco smoke exposure, or housing characteristics that are commonly associated with asthma also did not explain our results. A final possible limitation to the interpretation of these results is the assessment of asthma by questionnaire. However, self-report of physician-diagnosed asthma has been reported to accurately reflect what physicians have told the patient, at least in adults, and validity of questionnaires as reported by repeatability of response is good (Ehrlich et al. 1995). For these reasons, self-report of physician-diagnosed asthma has been widely used in epidemiologic studies and has been recommended as the preferred outcome assessment for use in large population-based studies, because a more precise diagnosis is not available (Burr 1992). In addition, the consistency of associations with lifetime asthma, prevalent asthma based on a combination of symptoms reporting and doctor diagnosis, and recent wheezing suggests that diagnostic bias is unlikely to have explained the observed results.

We conclude that living in a residence with more nearby traffic increases the risk of childhood asthma. Children with no parental history of asthma who had long-term residential exposure (or early-life exposure) constituted a susceptible population, and the risk was larger for girls than for boys. Because a substantial number of southern California children live near a major road, this exposure is potentially an important public health problem that could be remediable by transportation and residential development policy and by more effective control of vehicular emissions. Among those long-term residents with no parental history of asthma who lived within 75 m of a major road, 59% of asthma was attributable to residential proximity to the road. Further investigation is warranted to understand why the absence of parental asthma history increased susceptibility to traffic-related exposure.

Supplementary Material

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Supplemental Figures and Tables

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Air Toxics Hot Spots Program

Risk Assessment Guidelines

Guidance Manual for Preparation of Health Risk Assessments

February 2015

Air, Community, and Environmental Research Branch
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February 2015

Air Toxics Hot Spots Program
Risk Assessment Guidelines

The Air Toxics Hot Spots Program Guidance Manual for Preparation of Health Risk Assessments

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Preface

The draft of the *Air Toxics Hot Spots Program Guidance Manual for Preparation of Health Risk Assessments* (Guidance Manual) is a description of the algorithms, recommended exposure variates, cancer and noncancer health values, and the air modeling protocols needed to perform a health risk assessment (HRA) under the Air Toxics Hot Spots Information and Assessment Act of 1987(Health and Safety Code Section 44300 et seq., see Appendix B). The Children's Environmental Health Protection Act of 1999 (Health and Safety Code Section 39606, also contained in Appendix B), which requires explicit consideration of infants and children in assessing risks from air toxics, necessitated revisions of the methods for both noncancer and cancer risk assessment, and of the exposure variates. This draft version of the Guidance Manual updates the previous version (OEHHA, 2003), and reflects advances in the field of risk assessment along with explicit consideration of infants and children.

The information presented in the draft manual is compiled from three technical support documents (TSDs) released by the Office of Environmental Health Hazard Assessment (OEHHA) for the Hot Spots Program. The three TSDs (which are also revised versions, replacing the original four Hot Spots TSDs adopted between 1999 and 2003) underwent public comment and peer review and were adopted for use in the Air Toxics Hot Spots program by the Director of OEHHA. The Technical Support Document for the Derivation of Noncancer Reference Exposure Levels (June, 2008) addressed the methodology for deriving acute, chronic and eight hour Reference Exposure Levels. The Technical Support Document for Cancer Potency Factors (May 2009) addresses the methodology for deriving cancer potency factors and adjusting cancer potency to account for the increased sensitivity of early-in-life exposure to carcinogens. The Technical Support Document for Exposure Assessment and Stochastic Analysis (June 2012) presents the exposure model for the Hot Spots program and reviews the available literature on exposure and relevant fate and transport variates. All three TSDs are available on OEHHA's web site at: http://www.oehha.ca.gov/air/hot_spots/index.html. Excerpts of these three TSDs are presented in this document. There is relatively little new information in the Guidance Manual since the adoption of the TSDs.

The draft Guidance Manual was released for public review. Public comments were received and changes were made in response to some comments. Responses were developed to all public comments. Both the Guidance Manual and OEHHA's response to comments were then reviewed by the State's Scientific Review Panel on Toxic Air Contaminants (SRP), who previously reviewed the three TSDs upon which this guidance is based. Following review by the SRP, OEHHA finalized this Guidance Manual. This Guidance Manual supersedes the risk assessment methods presented in the Air Toxics Hot Spots Program Guidance Manual for Preparation of Health Risk Assessments (OEHHA, 2003), which in turn replaced earlier guidance provided by the California Air Pollution Control Officer's Association (CAPCOA, 1993). This manual updates health effects values, exposure pathway variates (e.g., breathing rates), and

continues to use a tiered approach for performing HRAs based on current science and policy assessment. The Technical Support Document for Cancer Potency Factors (OEHHA, 2009) recommends a tenfold early-in-life potency factor adjustment for the third trimester and ages zero to less than two, and a threefold adjustment factor for ages two to less than sixteen. In addition, we recommend evaluating residency periods of nine, thirty and seventy years. This means that exposure variates are needed for the third trimester, ages zero to less than two, ages two to less than nine, ages two to less than 16, ages 16 to less than 30, and ages 16 to 70.

The tiered approach presented in this draft manual provides a risk assessor with flexibility and allows consideration of site-specific differences. Furthermore, risk assessors can tailor the level of effort and refinement of an HRA by using the point-estimate exposure variates or the stochastic treatment of distributions of exposure variates. The four-tiered approach to risk assessment primarily applies to residential cancer risk assessment. Compared to the OEHHA 2003 document, the exposure pathways in the Guidance Manual remain the same. The exposure and risk algorithms are similar, but they have been revised to accept new data or variables that are used in the tiered risk assessment approach.

The draft manual also contains example calculations and an outline for a modeling protocol and an HRA report. A software program, the Hot Spots Analysis and Reporting Program (HARP), has been developed by the Air Resources Board in consultation with OEHHA and Air Pollution Control/Air Quality Management District representatives. The HARP software, which is being updated with the new exposure variates and health values, is the recommended model for calculating and presenting HRA results for the Hot Spots Program. Information on obtaining the HARP software can be found on the ARB's web site at *www.arb.ca.gov* under the Hot Spots Program.

The intent of the Guidance Manual and the HARP software is to incorporate children's health concerns, update risk assessment practices, and to provide consistent risk assessment procedures. The use of consistent risk assessment methods and report presentation has many benefits, such as expediting the preparation and review of HRAs, minimizing revision and resubmission of HRAs, allowing a format for facility comparisons, and cost-effective implementation of HRAs and the Hot Spots Program. Risk assessments prepared with this Guidance Manual may be used for permitting new or modified stationary sources, or public notification, and risk reduction requirements of the Hot Spots Program. The use of uniform procedures allows comparison of risks from different facilities and enables identification of facilities that are problematic from a public health perspective. OEHHA reviews the HRAs to insure they are adequate for decision making, but does not play a role in permitting decisions that may result from the HRAs. OEHHA will provide advice to the Districts when requested on any of the risk assessment methods or health values they have used.

References

CAPCOA, 1993. CAPCOA Air Toxics Hot Spots Program Revised 1992 Risk Assessment Guidelines. California Air Pollution Control Officers Association, October 1993.

OEHHA, 2003. Air Toxics Hot Spots Risk Assessment Guidelines: The Air Toxics Hot Spots Program Guidance Manual for Preparation of Health Risk Assessments.

OEHHA, 2008. Air Toxics Hot Spots Risk Assessment Guidelines Technical Support Document for the Derivation of Noncancer Reference Exposure Levels. Available online at: http://www.oehha.ca.gov

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OEHHA, 2012. Air Toxics Hot Spots Program Risk Assessment Guidelines; Technical Support Document for Exposure Assessment and Stochastic Analysis. Available online at http://www.oehha.ca.gov

1 - Introduction

1.1 Development of Guidelines

The Air Toxics Hot Spots Information and Assessment Act is designed to provide information to state and local agencies and to the general public on the extent of airborne emissions from stationary sources and the potential public health impacts of those emissions. The Hot Spots Act requires that the Office of Environmental Health Hazard Assessment (OEHHA) develop risk assessment guidelines for the Hot Spots program (Health and Safety Code (HSC) Section 44360(b)(2)) (see Appendix B for the text of the HSC). In addition, the Hot Spots Act specifically requires OEHHA to develop a "likelihood of risks" approach to health risk assessment. In response, OEHHA developed a tiered approach to risk assessment where a point estimate approach is first employed. If a more detailed analysis is needed, OEHHA has developed a stochastic, or probabilistic, approach using exposure factor distributions that can be applied in a stochastic estimate of the exposure. A detailed presentation of the tiered approach, risk assessment algorithms, selected exposure variates (e.g., breathing rate), and distributions with a literature review is presented in the *Air Toxics Hot Spots Program Risk Assessment Guidelines*; *Technical Support Document for Exposure Assessment and Stochastic Analysis* (OEHHA, 2012). A summary of this information can be found in Chapter 5 of this document.

The Technical Support Document for the Derivation of Noncancer Reference Exposure Levels (OEHHA, 2008) addresses dose response relationships for noncancer health effects and the methodology for deriving acute, chronic and 8-hour Reference Exposure Levels (RELs). Currently there are 53 acute RELs, 82 chronic RELs, and 10 eight-hour RELs. Review and revision of RELs to take into account new information and sensitive subpopulations including infants and children is an ongoing process. All draft RELs for individual chemicals revised under the current noncancer methodology will undergo public comment and peer review, as mandated by the Hot Spots Act. The Technical Support Document for Cancer Potency Factors (OEHHA, 2009) addresses the methodology for deriving cancer potency factors and adjusting cancer potency to account for the increased sensitivity to early-in-life exposure to carcinogens. This document contains inhalation cancer potency factors and oral cancer potency factors for 142 toxicants and toxicant compound classes developed by OEHHA or developed by other authoritative bodies and endorsed by OEHHA. The OEHHA website (*www.oehha.ca.gov*) should be consulted for the most current adopted chronic, acute and 8-hour RELs and cancer potency factors. In addition, for a small subset of these substances that are subject to airborne deposition and hence human oral and dermal exposure, oral chronic RELs and oral cancer potency factors have been developed by OEHHA. A summary of cancer and noncancer health effects values can be found in Appendix L and Chapters 6 and 7 of the Guidance Manual. All three Technical Support Documents have undergone public and peer review and have been approved by the state's Scientific Review Panel on Toxic Air Contaminants and adopted by OEHHA. The Guidance Manual is undergoing the same public and peer review process.

The Guidance Manual contains a description of the algorithms, recommended exposure variates, and cancer and noncancer health values, and modeling protocols needed to perform a Hot Spots risk assessment under the Hot Spots Act (see Appendix B). The information for the Guidance Manual is taken from the three TSDs. The Guidance Manual supersedes the risk assessment methods presented in the Air Toxics Hot Spots Program Guidance Manual for Preparation of Health Risk Assessments (OEHHA, 2003).

The Guidance Manual is intended to address health risks from airborne contaminants released by stationary sources. Some of the methodology used is common to other regulatory risk assessment applications, particularly for California programs. However, if the reader needs to prepare a Health Risk Assessment (HRA) under another program, the HRA may need additional analyses. Therefore, appropriate California and federal agencies should be contacted. For example, if a facility must comply with HRA requirements under the Resource Conservation and Recovery Act (RCRA) or the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), the California Department of Toxic Substances Control (DTSC) must be contacted to determine if an HRA written to comply with AB 2588 will also satisfy RCRA/CERCLA requirements.

1.2 Use of the Guidance Manual

The intent in developing this Guidance Manual is to provide HRA procedures for use in the Air Toxics Hot Spots Program or for the permitting of existing, new, or modified stationary sources. The Air Resources Board (ARB) website (*www.arb.ca.gov*) provides more information on the Hot Spots Program and risk management guidelines, including recommendations for permitting existing, new, or modified stationary sources. The use of consistent risk assessment procedures and report presentation allows comparison of one facility to another, expedites the review of HRAs by reviewing agencies, and minimizes revision and resubmission of HRAs.

OEHHA recognizes that no one risk assessment procedure or set of exposure variates could perfectly address the many types of stationary facilities in diverse locations in California. Therefore a tiered risk assessment approach was developed to provide flexibility and allow consideration of site-specific differences. The tiered approach to risk assessment is discussed in detail in Chapter 8 of this Guidance.

These guidelines should be used in conjunction with the emission data collected and reported pursuant to requirements of the ARB's *Emission Inventory Criteria and Guidelines Regulations (Title 17, California Code of Regulations, Sections 93300-93300.5*), and the *Emission Inventory Criteria and Guidelines Report for the Air Toxics "Hot Spots" Program* (EICG Report), which is incorporated by reference therein (see ARB's web site: http://www.arb.ca.gov/ab2588/2588guid.htm for the most current version, which was approved on August 27, 2007). This regulation outlines requirements for the collection of emission data, based on an inventory plan, which must be approved by the Air Pollution Control or Air Quality Management District (District). The emissions reported under this program are routine or predictable and include continuous

and intermittent releases and predictable process upsets or leaks. Emissions for unpredictable releases (e.g., accidental catastrophic releases) are not reported under this program.

For landfill sites, these guidelines should be applied to the results of the landfill testing required under Health and Safety Code Section 41805.5 as well as to any emissions reported under the emission inventory requirements of the Air Toxics Hot Spots Act (e.g., from flares or other on-site equipment). Districts should be consulted to determine the specific landfill testing data to be used.

1.3 Who is Required to Conduct a Risk Assessment

The Hot Spots Act requires that each local Air Pollution Control District or Air Quality Management District (hereinafter referred to as District) determine which facilities will prepare an HRA. As defined under the Hot Spots Act, an HRA includes a comprehensive analysis of the dispersion of hazardous substances in the environment, their potential for human exposure, and a quantitative assessment of both individual and population-wide health risks associated with those levels of exposure.

Districts are to determine which facilities will prepare an HRA based on a prioritization process outlined in the law. The process by which Districts identify priority facilities for risk assessment involves consideration of potency, toxicity, quantity of emissions, and proximity to sensitive receptors such as hospitals, daycare centers, schools, work-sites, and residences. The District may also consider other factors that may contribute to an increased potential for significant risk to human receptors. As part of this process Districts categorize facilities as high, intermediate, or low priority. The District prioritization process is described in the *CAPCOA Air Toxics Hot Spots Program Facility Prioritization Guidelines, July 1990* (CAPCOA, 1990), although some Districts may have adopted their own method for prioritizing facilities for the purposes of AB2588, permitting, etc. Consult the District for updates to the Prioritization Guidelines. See the Hot Spots Program on ARB's web site at *www.arb.ca.gov* for more information on facility prioritization procedures.

Facilities designated by a District as "high priority" are required to submit an HRA to the District within 150 days of designation. Districts may grant a 30-day extension. However, a District may require any facility to prepare and submit an HRA according to the District priorities established for purposes of the Hot Spots Act.

1.4 The Hot Spots Analysis and Reporting Program (HARP) Software

The ARB and the Districts have identified a critical need for software to assist with the programmatic aspects of the Hot Spots Program. HARP is computer software used by the ARB, OEHHA, Districts, and facility operators to promote statewide consistency, efficiency, and cost-effective implementation of HRAs and the Hot Spots Program. The HARP software package includes: 1) an Emissions Inventory Database Module, 2) an Air Dispersion Modeling Module, and 3) a Risk Analysis Module. The user-friendly Windows-based package provides for:

1. Electronic implementation of the risk assessment methods presented in the OEHHA guidelines (Guidance Manual);
2. Electronic data transfer from facilities and Districts;
3. The production of reports;
4. Facility prioritization;
5. Air dispersion modeling (AERMOD) of multiple emission releases or facilities for cumulative impact evaluations;
6. A summary report of acute, 8-hour, and chronic health hazard quotients or indices, and cancer risk at the point of maximum impact (PMI), maximally exposed individual resident (MEIR), maximally exposed individual worker (MEIW) and other receptors to be evaluated as needed;
7. Mapping displays of facility property boundaries, risk isopleths, and elevation contours;
8. The ability to display combined risk contours from multiple emission sources;
9. Output of data for use in other “off-the-shelf” Geographic Information Systems (GIS) programs for additional types of analysis; and
10. Census data for determining population-related health impacts showing the number of people exposed at various cancer risk levels and cancer burden.

1.5 Risk Assessment Review Process

The Hot Spots Act risk assessments are reviewed by the local District and by OEHHA. The Districts focus their review on the emissions data and the air dispersion modeling. OEHHA provides comments on the HRA’s general concordance with the Guidelines Manual and the completeness of the reported health risks. The District, taking into account the comments of OEHHA, approves the HRA or returns it to the facility for revision and resubmission. If the HRA is not revised and resubmitted by the facility within 60 days, the District may modify the HRA and approve it as modified. Based on the approved HRA, the District determines if there is a significant health risk associated with emissions from the facility. If the District determines that facility emissions pose a significant health risk, the facility operator provides notice to all exposed individuals regarding the results of the HRA and may be required to take steps to reduce emissions by implementing a risk reduction audit and plan. Notification is to be made according to

procedures specified by the District. Each District determines its own levels of significance for cancer and noncancer health effects for notification and risk reduction. See the Hot Spots Program on ARB's web site at *www.arb.ca.gov* for more information on significance levels selected by each District.

1.6 Uncertainty in Risk Assessment

OEHHA has striven to use the best science available in developing these risk assessment guidelines. However, there is a great deal of uncertainty associated with the process of risk assessment. The uncertainty arises from lack of data in many areas necessitating the use of assumptions. The assumptions used in these guidelines are designed to err on the side of health protection in order to avoid underestimation of risk to the public. Sources of uncertainty, which may overestimate or underestimate risk, include: 1) extrapolation of toxicity data in animals to humans, 2) uncertainty in the estimation of emissions, 3) uncertainty in the air dispersion models, and 4) uncertainty in the exposure estimates. In addition to uncertainty, there is a natural range or variability in measured parameters defining the exposure scenario. Scientific studies with representative sampling and large enough sample sizes can characterize this variability. In the specific context of a Hot Spots risk assessment, the source of variability with the greatest quantitative impact is variation among the human population in such properties as height, weight, food consumption, breathing rates, and susceptibility to chemical toxicants. OEHHA captures at least some of the variability in exposure by developing data driven distributions of intake rates, where feasible, in the TSD for Exposure Assessment (OEHHA, 2012).

Interactive effects of exposure to more than one carcinogen or toxicant are addressed in the risk assessment with default assumptions of additivity. Cancer risks from all carcinogens addressed in the HRA are added. Similarly, non-cancer hazard quotients for substances impacting the same target organ/system are added to determine the hazard index (HI). Although such effects of multiple chemicals are assumed to be additive by default, several examples of synergism (interactive effects greater than additive) are known. For substances that act synergistically, the HRA could underestimate the risks. Some substances may have antagonistic effects (lessen the toxic effects produced by another substance). For substances that act antagonistically, the HRA could overestimate the risks.

Other sources of uncertainty, which may underestimate or overestimate risk, can be found in exposure estimates where little or no data are available (e.g., soil half-life and dermal penetration of some substances from a soil matrix).

The differences among species and within human populations usually cannot be easily quantified and incorporated into risk assessments. Factors including metabolism, target site sensitivity, diet, immunological responses, and genetics may influence the response to toxicants. The human population is much more diverse both genetically and culturally (e.g., lifestyle, diet) than inbred experimental animals. The intraspecies variability among humans is expected to be much greater than in laboratory animals.

In most cases, cancer potency values have been estimated only for the single most affected tumor site. This represents a source of uncertainty in the cancer risk assessment. Adjustment for tumors at multiple sites induced by some carcinogens may result in a higher potency. Some recent assessments of carcinogens include such adjustments. Other uncertainties arise 1) in the assumptions underlying the dose-response model used, and 2) in extrapolating from large experimental doses, where other toxic effects may compromise the assessment of carcinogenic potential, to usually much smaller environmental doses.

When occupational epidemiological data are used to generate a carcinogenic potency or a health protective level for a non-carcinogen, less uncertainty is involved in the extrapolation from workplace exposures to environmental exposures. When using human data, no interspecies extrapolation is necessary eliminating a significant source of uncertainty. However, children are a subpopulation with hematological, nervous, endocrine, and immune systems that are still developing and may be more sensitive to the effects of toxicants. The worker population and risk estimates based on occupational epidemiological data are more uncertain for children than adults. Current risk assessment guidelines include procedures designed to address the possibly greater sensitivity of infants and children, but there are only a few compounds for which these effects have actually been measured experimentally. In most cases, the adjustment relies on default assumptions which may either underestimate or overestimate the true risks faced by infants and children exposed to toxic substances or carcinogens.

Risk estimates generated by an HRA should not be interpreted as the expected rates of disease in the exposed population but rather as estimates of potential for disease, based on current knowledge and a number of assumptions.

In the Hot Spots program, cancer risk is often expressed as the maximum number of new cases of cancer projected to occur in a population of one million people due to exposure to the cancer-causing substance over a 30-year residential period. However, there is uncertainty associated with the cancer risk estimate. An individual's risk of contracting cancer from exposure to facility emissions may be less or more than the risk calculated in the risk assessment. An individual's risk not only depends on the individual's exposure to a specific chemical but also on his or her genetic background, health, diet, lifestyle choices and other environmental and workplace exposures. OEHHA uses health-protective exposure assumptions to avoid underestimating risk. For example, the risk estimate for airborne exposure to chemical emissions uses the health-protective assumption that the individual has a high breathing rate and exposure began early in life when cancer risk is highest.

A Reference Exposure Level (REL) is the concentration level at or below which no adverse non-cancer health effects are anticipated for the specified exposure duration. RELs are based on the most sensitive, relevant, adverse health effect reported in the medical and toxicological literature. RELs are designed to protect the most sensitive individuals in the population by the inclusion of factors that account for uncertainties as well as individual differences in human susceptibility to chemical exposures. The factors used in the calculation of RELs are meant to err on the side of public health

protection in order to avoid underestimation of non-cancer hazards. Exceeding the REL does not automatically indicate an adverse health impact. However, increasing concentrations above the REL value increases the likelihood that the health effect will occur.

Risk assessments under the Hot Spots program are often used to compare one source with another and to prioritize concerns. Consistent approaches to risk assessment are necessary to fulfill this function.

1.7 Tiered Approach to Risk Assessment

OEHHA developed a tiered approach to accommodate consideration of site-specific data that may be more appropriate for a given facility than the default variate. The first tier is the simplest point estimate approach to estimating exposure to facility emissions. Tier 1 is the first step in conducting a comprehensive risk assessment using algorithms and point estimates of input values described in the *Technical Support Document for Exposure Assessment and Stochastic Analysis*. (OEHHA, 2012) Each facility conducts a Tier 1 risk assessment to promote consistency across the state in facility risk assessments and facilitate comparisons across facilities. To be health-protective, high-end estimates for the key intake exposure variates are used for the dominant exposure pathways.

Tier 2 allows use of site-specific point estimates of exposure variates as long as these estimates can be justified. For example, if there are data indicating that consumption of fish from an impacted body of water is lower than the OEHHA-recommended fish consumption rate, then the facility can use that data to generate a point estimate for sport-fish consumption from that body of water. The risk assessor must supply the data and methods used for the site-specific estimates, and the site-specific estimates must be reproducible and approved by both the District and OEHHA.

Tier 3 risk assessment involves stochastic analysis of exposure using data-based distributions for the key exposure variates compiled in the OEHHA (2012) *Technical Support Document*. Since a stochastic approach to risk assessment provides more information about the range of risk estimates based on the range of exposures, Tier 3 can serve as a useful supplement to the Tier 1 and 2 approaches. Variance propagation methods (e.g., Monte Carlo analysis) are used to derive a range of cancer risk estimates reflecting the known variability in the inputs. Finally, a Tier 4 approach would use distributions of exposure variates that may be more appropriate for a site, such as the distribution of fish consumption rates for a specific body of water impacted by a facility. As in a Tier 2 approach, the risk assessment must supply the data and methods used for the site-specific distributions for exposure variates, and the site-specific estimates must be justified to and reproducible by the Districts and OEHHA.

1.8 References

CAPCOA, 1990. *CAPCOA Air Toxics Hot Spots Program Facility Prioritization Guidelines.* California Air Pollution Control Officers Association, July 1990.

OEHHA, 2003. Air Toxics Hot Spots Risk Assessment Guidelines: The Air Toxics Hot Spots Program Guidance Manual for Preparation of Health Risk Assessments.

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2 - Overview of Health Risk Assessment

2.1 The Model for Risk Assessment

The standard approach currently used for health risk assessment (HRA) was originally proposed by the National Academy of Sciences in the 1983 book: *Risk Assessment in the Federal Government: Managing the Process* (NAS, 1983) and was updated in the Academy's 1994 book: *Science and Judgment in Risk Assessment* (NAS, 1994). In 2009 the National Academy published *Science and Decisions: Advancing Risk Assessment* (NAS, 2009), in which a number of recommendations are made on improving the risk assessment process and expanding it to include community concerns and cumulative risks. The four steps involved in the risk assessment process are 1) hazard identification, 2) exposure assessment, 3) dose-response assessment, and 4) risk characterization. These four steps are briefly discussed below.

2.2 Hazard Identification

For air toxics sources, hazard identification involves the pollutant(s) of concern emitted by a facility, and the types of adverse health effects associated with exposure to the chemical(s), including whether a pollutant is a potential human carcinogen or is associated with other types of adverse health effects. For the Air Toxics Hot Spots Program (Hot Spots), the emitted substances that are addressed in a risk assessment are found in the list of substances designated in the ARB's *Emission Inventory Criteria and Guidelines Regulations (Title 17, California Code of Regulations, Sections 93300-93300.5), and the Emission Inventory Criteria and Guidelines Report* (EICG Report), which is incorporated by reference therein (ARB, 2007*)*. This list of substances is contained in Appendix A of this document and the EICG Report. The list of substances also identifies those substances that are considered human carcinogens or potential human carcinogens.

2.3 Exposure Assessment

The purpose of the exposure assessment is to estimate the extent of public exposure to emitted substances. For the Hot spots program, in practice this means estimating exposures for those emitted substances for which potential cancer risk or noncancer health hazards for acute, repeated 8-hour, and chronic exposures will be evaluated. This involves emission quantification, modeling of environmental transport, evaluation of environmental fate, identification of exposure routes, identification of exposed populations, and estimation of short-term (e.g., 1-hour maximum), 8-hour average, and long-term (annual) exposure levels. These activities are described in Chapters 4 and 5. Chapter 5 also discusses the tiered approach to risk assessment.

The ARB's Emission Inventory Criteria and Guidelines (EICG) Report provides assistance in determining those substances that must be evaluated in an HRA and the reporting requirements of facilities, while the Hot Spots Analysis and Reporting Program (HARP) software can be used to model ground level concentrations at specific off-site

locations resulting from facility emissions. The United States Environmental Protection Agency (U.S. EPA) has adopted the AERMOD air dispersion model into its list of regulatory approved models, in place of the previously used ISCST3 model. AERMOD is a steady-state plume model that incorporates air dispersion based on planetary boundary layer turbulence structure and scaling concepts, including treatment of both surface and elevated sources, and both simple and complex terrain (U.S. EPA, 2009). The Air Resources Board recommends AERMOD for Hot Spots risk assessments. The AERMOD air modeling software will be incorporated into the HARP software, which allows the user to input all dispersion parameters directly into the program to generate air dispersion data. Alternatively, the air dispersion data may be generated separately from HARP using other air dispersion models, and then imported into HARP to generate risk estimates. Data imported into HARP must already be in the format required by HARP. HARP has the flexibility to generate a summary of the risk data necessary for an HRA by either of the above approaches.

Most of the toxicants assessed under the Hot Spots program are volatile organic compounds that remain as gases when emitted into the air. These chemicals are not subject to appreciable deposition to soil, surface waters, or plants. Therefore, human exposure via ingestion or dermal exposure, at least at concentrations typically encountered in the ambient air, is not considered for volatile organic compounds in the Hot Spots risk assessments. While some models indicate potential for dermal exposure to certain volatile organic compounds, at this time, the Hot spots program does not consider this pathway. Significant exposure to volatile organic toxicants emitted into the air occurs through the inhalation pathway, and this pathway is the primary consideration in the Hot Spots risk assessments. A small subset of Hot Spots substances consists of semi-volatile organic and metal toxicants emitted partially or totally as particles subject to deposition. Ingestion and dermal pathways as well as the inhalation pathway must be evaluated for these chemicals. A few of these semi-volatile organic and metal toxicants must also include the breast milk ingestion pathway. Additional ingestion pathways may also need to be evaluated depending on the pathways of exposure for the specific receptor of interest. Table 5.1 in Chapter 5, Table 6.4 in Chapter 6, and Table 7.1 in Chapter 7 list the substances that must be evaluated for multipathway impacts. HARP is designed to assess potential health impacts posed by substances that must be analyzed by a multipathway approach.

2.4 Dose-Response Assessment

Dose-response assessment is the process of characterizing the relationship between exposure to an agent and incidence of an adverse health effect in exposed populations. In quantitative carcinogenic risk assessment, the dose-response relationship is expressed in terms of a potency slope that is used to calculate the probability or risk of cancer associated with an estimated exposure. Cancer potency factors are expressed as the 95^{th} percent upper confidence limit of the slope of the dose response curve estimated assuming continuous lifetime exposure to a substance. Typically, potency factors are expressed as units of inverse dose (e.g., $(mg/kg\ BW/day)^{-1}$) or inverse concentration (e.g., $(\mu g/m^3)^{-1}$). It is assumed in cancer risk assessments that risk is directly proportional to dose and that there is no threshold for carcinogenesis.

The Office of Environmental Health Hazard Assessment (OEHHA) has compiled cancer potency factors, which should be used in risk assessments for the Hot Spots program, in Table 7.1. Cancer potency factors listed in Table 7.1 were derived either by the U.S. EPA or by OEHHA, underwent public and peer-review, and were adopted for use in the program. Chapter 8 describes procedures for use of potency values in estimating excess cancer risk. For a detailed description of cancer potency factors, refer to the *Technical Support Document for Cancer Potency Factors* (OEHHA, 2009).

For noncarcinogenic effects, dose-response data developed from animal or human studies are used to develop acute, 8-hour, and chronic noncancer Reference Exposure Levels (RELs). The acute, 8-hour and chronic RELs are defined as the concentration at which no adverse noncancer health effects are anticipated even in sensitive members of the general population, with infrequent one hour exposures, repeated 8-hour exposures over a significant fraction of a lifetime, or continuous exposure over a significant fraction of a lifetime, respectively. The most sensitive health effect is chosen to develop the REL if the chemical affects multiple organ systems. Unlike cancer health effects, noncancer health effects are generally assumed to have thresholds for adverse effects. In other words, injury from a pollutant will not occur until exposure to that pollutant has reached or exceeded a certain concentration (i.e., threshold) and/or dose. The acute, 8-hour, and chronic RELs are air concentrations intended to be below the threshold for health effects for the general population.

The actual threshold for health effects in the general population is generally not known with any precision. Uncertainty factors are applied to the Lowest Observed Adverse Effects Level (LOAEL) or No Observed Adverse Effects Level (NOAEL) or Benchmark Concentration values from animal or human studies to help ensure that the chronic, 8-hour and acute REL values are below the threshold for human health for nearly all individuals. This guidance manual provides the acute, 8-hour, and chronic Reference Exposure Levels in Tables 6.1 through 6.3. Some substances that pose a chronic or repeated 8-hour inhalation hazard may also present a chronic hazard via non-inhalation routes of exposure (e.g., ingestion of contaminated water, foods, or soils, and dermal absorption). The oral RELs for these substances are presented in Table 6.4. The methodology and derivations for acute, 8-hour, and chronic, RELs are described in the *Technical Support Document for the Derivation of Noncancer Reference Exposure Levels* (OEHHA, 2008).

2.5 Risk Characterization

This is the final step of risk assessment. In this step, modeled concentrations and exposure information, which are determined through exposure assessment, are combined with potency factors and RELs that are developed through dose-response assessment. The use of cancer potency factors to assess total cancer risk and the use of the hazard index approach for evaluating the potential for noncarcinogenic health effects are described in Chapter 8. Example calculations for determining (inhalation) cancer risk and noncancer acute, 8-hour, and chronic hazard quotients and hazard indices are presented in Appendix I. Chapter 9 provides an outline that specifies the content and recommended format of HRA results.

Under the Hot Spots Act, health risk assessments are to quantify both individual and population-wide health impacts (Health and Safety Code, Section 44306) (Appendix B). The health risk assessments are facility specific and the calculated risk should be combined for all pollutants emitted by a single facility. For example, cancer risk from multiple carcinogens is considered additive. For exposures to multiple non-carcinogen pollutants, a hazard index approach is applied for air contaminants affecting the same organ system. All substances emitted by the facility that are on the Hot Spots Act list of substances must be identified in the HRA, including those on the list that do not have a potency value or REL.

For assessing risk, OEHHA has developed two methods for determining dose via inhalation, dermal absorption, and ingestion pathways. These two methods, the point estimate approach and the stochastic exposure assessment approach, are described below and in Chapters 5 and 8. Detailed presentations of these methods can be found in*: Technical Support Document for Exposure Assessment and Stochastic Analysis* (OEHHA, 2012*)*.

2.5.1 *Point Estimate Approach*

OEHHA provides information in this document on average and high-end values for key exposure pathways (e.g., breathing rate for the inhalation exposure pathway). The average and high-end of point estimates in this document are defined in terms of the probability distribution of values for that variate. The mean represents the average values for point estimates and the 95th percentiles represent the high-end point estimates from the distributions identified in OEHHA (2012). Thus, within the limitations of the data, average and high-end point estimates are supported by the distribution.

Tier 1 of the tiered approach to risk assessment, which is briefly discussed in Section 2.5.3 and presented in more detail in Chapter 8, utilizes a combination of the average and high-end point estimates to more realistically estimate exposure in multipathway risk assessments. This method uses high-end exposure estimates for the pathways that are the main drivers of exposure and the average point estimate for the other non-driving exposure pathways. This approach will lessen the issue of compounding high-end exposure estimates, while retaining a health-protective approach for the more important exposure pathways. It is unlikely that an individual receptor would be on the high-end of exposure for all exposure pathways. See Chapter 8 for detailed discussions of how this multipathway methodology is applied to cancer and noncancer calculations. The HARP software can perform this analysis (referred to as the derived approach in the HARP software).

In addition to using an estimate of average and high-end consumption rates, cancer risk evaluations at individual receptors are presented for 9, 30, and 70-year exposure durations. The 9 and 30-year durations correspond to the average and high-end of residency time recommended by U.S. EPA (1997). The California data presented in Appendix L of the Exposure TSD (OEHHA, 2012) are generally supportive of the nationwide data. The 9 and 70-year exposure durations present potential impacts over the range of residency periods, while the 30-year exposure duration is recommended

for use as the basis for estimating cancer risk at the MEIR in all HRAs. Population-wide impacts should use the 70-year exposure duration.

The parameters used for all exposure durations assume exposure begins in the last trimester of pregnancy and progresses through the exposure duration of interest (e.g., 9, 30, or 70 years). These assumptions are thus protective of children. Children have higher intake rates on a per kilogram body weight basis (e.g., they breathe, drink and eat more per kg body weight than adults) and thus receive a higher dose from contaminated media. See Chapter 5 for the point estimates that can be used to estimate impacts for children. Chapters 5 and 8 discuss how to calculate cancer risk based on various exposure durations and point estimates. Appendix I contains an example calculation and Chapter 9 clarifies how to present the findings in an HRA.

2.5.2 *Stochastic Exposure Assessment*

OEHHA was directed under the Air Toxics "Hot Spots" program (SB 1731, Calderon, stat. 1992; Health and Safety Code Section 44360(b)(2)) to develop a "likelihood of risk" approach to risk assessment. To satisfy this requirement, OEHHA developed a stochastic approach to risk assessment that utilizes distributions for exposure variates such as breathing rate and water consumption rate rather than a single point estimate. The variability in exposure can be propagated through the risk assessment model using the distributions as input and a Monte Carlo or similar method. The result of such an analysis is a range of risks that at least partially characterizes variability in exposure.

Distributions of key exposure variates that are presented in the *Technical Support Document for Exposure Assessment and Stochastic Analysis* (OEHHA, 2012) were taken from the literature, if adequate, or developed from raw data of original studies. Intake variates such as vegetable consumption are relatively data rich; for these variates reasonable probability distributions can be constructed. However, the data necessary to characterize the variability in risk assessment variates are not always available. For example, for the fate and transport variates (e.g., fish bioaccumulation factors), there are only a few measurements for a given chemical available which precludes the adequate characterization of a probability distribution. We only developed distributions for those key exposure variates that were adequately characterized by data. Development of distributions is described in detail in the *Technical Support Document for Exposure Assessment and Stochastic Analysis* (OEHHA, 2012).

2.5.3 *Tiered Approach to Risk Assessment*

OEHHA recommends using a tiered approach to risk assessment. Tier 1 is a standard point estimate approach using the recommended point estimates presented in this document. If site-specific information is available to modify some point estimates developed in the *Technical Support Document for Exposure Assessment and Stochastic Analysis* (OEHHA, 2012) and is more appropriate to use than the recommended point estimates in this document, then Tier 2 allows use of that site-specific information. Site-specific information should be presented to the District before being used. The District may contact OEHHA for additional advice. Note that all non-default variates need to be adequately justified to OEHHA and the Districts to be used. In Tier 3, a stochastic approach to exposure assessment is used with the data distributions developed in the TSD (OEHHA, 2012) and presented in this document. Tier 4 is also a stochastic approach but allows for utilization of site-specific distributions, if they are justifiable (to OEHHA and the Districts) and more appropriate for the site under evaluation than those recommended in this document. Persons preparing an HRA that has a Tier 2 through Tier 4 evaluation must also include the results of a Tier 1 evaluation. Tier 1 evaluations are required for all HRAs prepared for the Hot Spots Program to promote consistency across the state for all facility risk assessments and allow comparisons across facilities. Chapter 8 provides a summary of the tiered approach and the TSD (OEHHA, 2012) discusses it in detail. Chapter 9 provides an outline that specifies the content and recommended format of HRA results.

2.6 References

ARB, 2007. *Emission Inventory Criteria and Guidelines Regulations (Title 17, California Code of Regulations, Sections 93300-93300.5), and the Emission Inventory Criteria and Guidelines Report* (EICG Report).

NAS, 1983. National Academy of Sciences. *Risk Assessment in the Federal Government: Managing the Process*. National Research Council. National Academy Press, Washington D.C.

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U.S. EPA, 1997. *Exposure Factors Handbook, Volume I, General Factors*. EPA/600/P-95/002Fa.

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3 - Hazard Identification - Air Toxics Hot Spots Emissions

3.1 The Air Toxics Hot Spots List of Substances and Emissions Inventory

For air toxics sources, hazard identification involves identifying pollutants of concern and whether these pollutants are potential human carcinogens or associated with other types of adverse health effects. For the Air Toxics Hot Spots (Hot Spots) Program, the emitted substances that are addressed in a health risk assessment (HRA) are found in the list of hazardous substances designated in the Air Resources Board's (ARB's) *Emission Inventory Criteria and Guidelines Regulations (Title 17, California Code of Regulations, Sections 93300-93300.5), and the Emission Inventory Criteria and Guidelines Report* (EICG Report), which is incorporated by reference therein (ARB, 2007). This list of substances is contained in both Appendix A of this document and the EICG Report. The list of substances also identifies those substances that are considered human carcinogens or potential human carcinogens.

The substances included on the Hot Spots Program list of substances are defined in the statute as those substances found on lists developed by the following sources:

- International Agency for Research on Cancer (IARC);
- U.S. Environmental Protection Agency (U.S. EPA);
- U.S. National Toxicology Program (NTP);
- ARB Toxic Air Contaminant Identification Program List;
- Hazard Evaluation System and Information Service (HESIS) (State of California);
- Proposition 65 (Safe Drinking Water and Toxic Enforcement Act of 1986) list of carcinogens and reproductive toxicants (State of California);
- Any additional substance recognized by the State Board as presenting a chronic or acute threat to public health when present in the ambient air.

All substances emitted by the facility that are on the Hot Spots Act list of substances must be identified in the HRA.

The ARB EICG Report (ARB, 2007) specifies that each facility subject to the Hot Spots Act must submit an Emission Inventory Report to the local air pollution control or air quality management district. This Emission Inventory Report must identify and account for all listed substances used, manufactured, formulated, or released by the facility. All routine, predictable releases must be reported. These inventory reports include the emission data necessary to estimate off-site levels of facility-released Hot Spots substances. These inventory reports will be discussed in further detail in Chapter 4. See Chapter 9 for an outline that specifies the content and recommended format for presenting the air dispersion modeling and HRA results. As presented in Appendix A, the EICG Report divides the list into three groups for reporting purposes. Potency or severity of toxic effects and potential for facility emission were considered in placing compounds into the three groups.

For the first group (listed in these guidelines in Appendix A-I), all emissions of these substances must be quantified in the HRA. For substances in the second group (listed in these guidelines in Appendix A-II), emissions are not quantified; however, facilities must report whether the substance is used, produced, or otherwise present on-site (i.e., these substances are simply listed in a table in the HRA). Lastly, substances in the third group (Appendix A-III) also only need to be reported in a table in the HRA if they are manufactured by the reporting facility.

Facilities that must comply with the Resource Conservation and Recovery Act and Comprehensive Environmental Response, Compensation and Liability Act (RCRA/CERCLA) requirements for risk assessment need to consult the California Department of Toxic Substances Control (DTSC) Remedial Project Manager to determine which substances must be evaluated in their risk assessment. Some RCRA/CERCLA facilities may emit substances which are not currently listed under the Hot Spots Program but which may require evaluation in a RCRA/CERCLA risk assessment.

3.2 References

ARB, 2007. *Emission Inventory Criteria and Guidelines Regulations (Title 17, California Code of Regulations, Sections 93300-93300.5), and the Emission Inventory Criteria and Guidelines Report* (EICG Report).

4 - Air Dispersion Modeling

The information contained in this section is primarily an abbreviated version of the material found in Chapter 2 of the Air Toxics Hot Spots Risk Assessment Guidelines; Exposure Assessment and Stochastic Analysis Technical Support Document (OEHHA, 2012). Several references have been included in this section to indicate those areas that are covered in more detail in Chapter 2 of the Technical Support Document. However, some air dispersion concepts and procedures have been added to assist the reader in the health risk assessment (HRA) process. In particular, a brief summary of the Hot Spots Analysis and Reporting Program (HARP) software applicability to air dispersion analysis has been included. The HARP software has been developed by the Air Resources Board (ARB), in consultation with OEHHA and Air Pollution Control or Air Quality Management District (District) representatives. The HARP software is the recommended model for calculating and presenting HRA results for the Air Toxics Hot Spots Program (Hot Spots). Information on obtaining the HARP software can be found under the Hot Spots Program on the ARB's web site at *www.arb.ca.gov*. See Chapter 9 for an outline that specifies the content and recommended format for presenting the air dispersion modeling and HRA results.

The U.S. EPA has adopted the AERMOD air dispersion model into their list of regulatory approved models, in place of the previously used ISCST3 model. AERMOD is a steady-state plume model that incorporates air dispersion based on planetary boundary layer turbulence structure and scaling concepts, including treatment of both surface and elevated sources, and both simple and complex terrain (U.S. EPA, 2009). The Air Resources Board recommends AERMOD for Hot Spots risk assessments.

4.1 Air Dispersion Modeling in Exposure Assessment: Overview

Estimates of air concentrations of emitted toxicants in the surrounding community from a facility's air emissions are needed in order to determine cancer and noncancer risks. One approach to determining the concentration of air pollutants emitted from the facility is to do air monitoring in the surrounding community. However, there are a number of disadvantages to this approach. Ambient air monitoring is costly because good estimates of an annual average concentration typically require monitoring at least one day in six over a year. Because it is costly, monitoring is usually limited to a select number of pollutants, and a limited number of sites. There can be significant risks from some chemicals at or even below the monitoring detection limit, which can add considerable uncertainty to risk estimates if many of the measurements are below or near the detection limit. Monitoring measures not only facility emissions but also general ambient background as well. It can be difficult and expensive to distinguish between the two using monitoring, particularly if general ambient background levels are high relative to the contribution of facility emissions. These limitations often make it impractical to use monitoring in a program such as the Air Toxics Hot Spots program with hundreds of facilities.

Air dispersion models have several advantages over monitoring. Modeling can provide greater spatial detail and the costs are relatively cheap by comparison. For example, dispersion models can estimate the pollutant concentration in air at many receptor locations (hundreds to thousands) and for a multitude of averaging periods. Air dispersion models have been validated using air monitoring.

There are, however, uncertainties associated with the typical usage of air dispersion modeling. The use of meteorological data from the nearest airport may not ideally be the best representation of localized conditions. Gaussian plume air dispersion models ignore calm hours. This can bias model predictions towards underestimation. Some dispersion models offer limited chemical reactions within the algorithms; however, we generally assume the pollutant is inert for the near-field atmospheric travel time. This may bias estimated concentrations towards over-prediction for those pollutants that are highly reactive in the atmosphere. Air dispersion model results are only as good as the emissions estimates and emissions estimates can be uncertain. However, on the whole, the advantages of air dispersion modeling for a program like the Air Toxics Hot Spots far outweigh the disadvantages.

Professional judgment is required throughout the dispersion modeling process. The local air quality district has final authority on modeling protocols. The following guidance is intended to assist in the understanding of dispersion modeling for risk assessments.

Air dispersion modeling includes the following steps (see Figure 1):

1. Create an emission inventory of the toxic releases (Section 4.2)
2. Identify the source types (Section 4.3)
3. Identify the terrain type and land use (Section 4.4)
4. Determine the detail needed for the analysis: screening or refined (Section 4.5)
5. Identify the population exposure (Section 4.6)
6. Identify the receptor network (Section 4.7)
7. Obtain meteorological data (for refined air dispersion modeling only) (Section 4.8)
8. Select an air dispersion model (Section 4.9)
9. Prepare a modeling protocol and submit to the local Air District (hereafter referred to as “the District”) (Section 4.14)
10. Complete the air dispersion analysis
11. If necessary, redefine the receptor network and return to Step 10

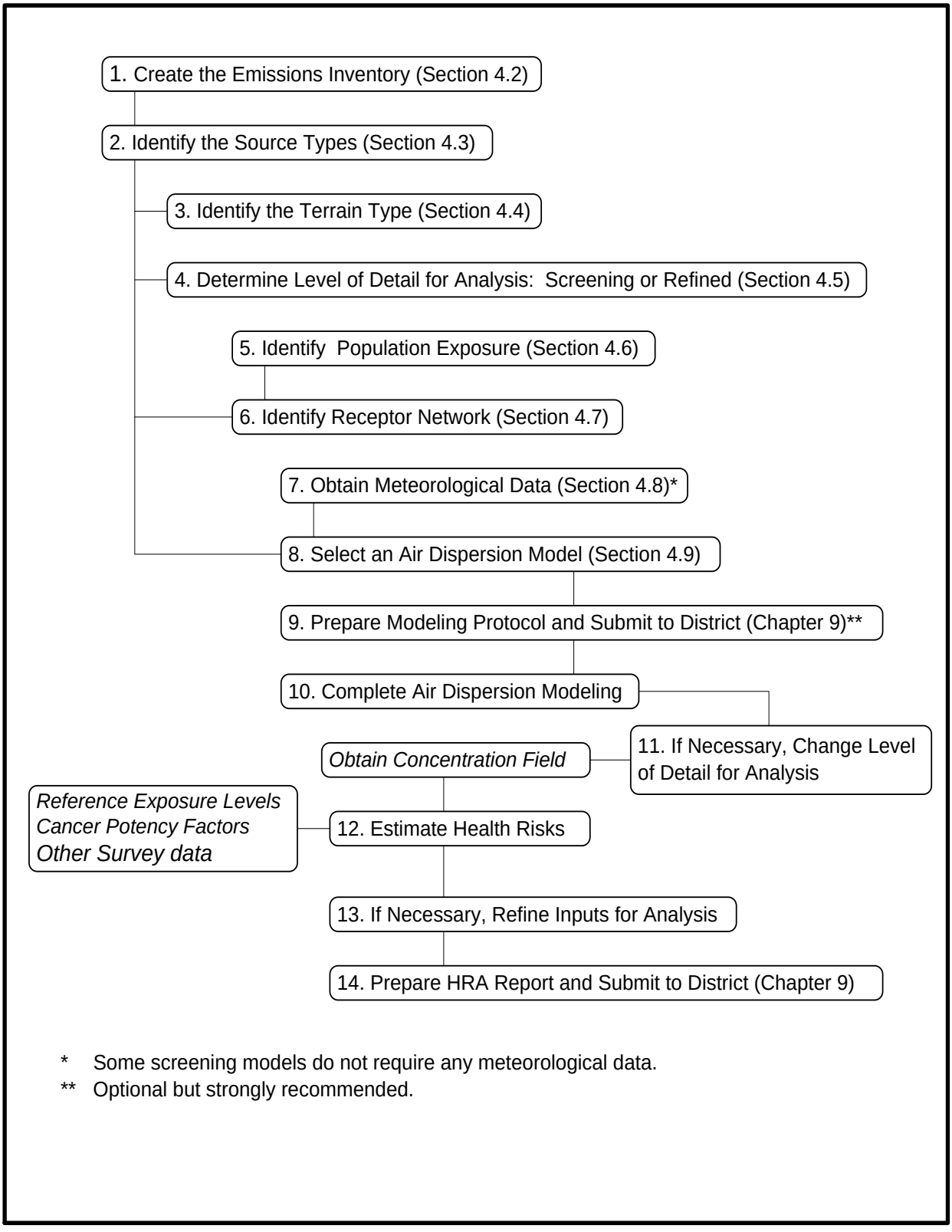
12. Complete the risk assessment

13. If necessary, refine the inputs and/or the model selection and return to Step 8

14. Present the HRA results (Chapter 9 provides an outline that specifies the content and recommended format of HRA results).

The output of the air dispersion modeling analysis includes a receptor field of ground level concentrations of the pollutant in ambient air. These concentrations can be used to estimate an inhaled or ingested dose for the estimation of multipathway cancer risk, or used to determine a hazard index for acute (inhalation), and chronic noncancer multipathway risks. It should be noted that in the Air Toxics "Hot Spots" program, facilities simulate the dispersion of the chemical emitted as an inert compound, and do not model any atmospheric transformations or dispersion of products from such reactions. The U.S. EPA Guideline on Air Quality Models (U.S. EPA, 2005) should be consulted when evaluating reactive pollutants for other regulatory purposes.

Figure 1 Overview of the Air Dispersion Modeling Process.



* Some screening models do not require any meteorological data.
** Optional but strongly recommended.

4.2 Emission Inventories

The Emission Inventory Reports (Inventory Reports) developed under the Hot Spots Program provide data to be used in the HRA and in the air dispersion modeling process. The Inventory Reports contain information regarding emission sources, emitted substances, emission rates, emission factors, process rates, and release parameters (area and volume sources may require additional release data beyond that generally available in Emissions Inventory reports). This information is developed according to the ARB's *Emission Inventory Criteria and Guidelines Regulations (Title 17, California Code of Regulations, Sections 93300-93300.5)*, and the *Emission Inventory Criteria and Guidelines Report* (EICG Report), which is incorporated by reference therein (ARB, 2007*)*.

Updated emission data for process changes, emission factor changes, material/fuel changes, or shutdown must be approved by the District prior to the submittal of the health risk assessment (HRA). Ideally, the District review of updated emissions could be completed within the modeling protocol. In addition, it must be stated clearly in the risk assessment if the emission estimates are based on updated or revised emissions (e.g., emission reductions). This section summarizes the requirements that apply to the emission data which are used for Air Toxics "Hot Spots" Act risk assessments.

4.2.1 *Air Toxics Hot Spots Emissions*

As noted in Chapter 3, Hazard Identification, the HRA should identify all substances emitted by the facility, which are on the Hot Spots Act list of substances (see Appendix A of the Guidance Manual or the EICG Report). The EICG Report specifies that Inventory Reports must identify and account for all listed substances used, manufactured, formulated, or released by the facility. All routine, predictable releases must be reported. Under the regulations, the list is divided into three groups for reporting purposes. The first group (listed in Appendix A-I of the Inventory Guidelines Report) has all pollutants whose emissions must be quantified. The second group (listed in Appendix A-II of the Inventory Guidelines Report) includes substances where emissions do not need to be quantified; however, facilities must report whether the substance is used, produced, or otherwise present on-site. The third group (listed in Appendix A-III of the Emissions Inventory Guidelines Report) includes substances whose emissions need not be reported unless the substance is manufactured by the facility. Chemicals or substances in the second and third groups should be listed in a table in the risk assessment.

Facilities that must comply with the Resource Conservation and Recovery Act and Comprehensive Environmental Response, Compensation and Liability Act (RCRA/CERCLA) requirements for risk assessment need to consult the Department of Toxic Substances Control (DTSC) Remedial Project Manager to determine which substances must be evaluated in their risk assessment in addition to the list of "Hot Spots" chemicals. Some RCRA/CERCLA facilities may emit chemicals that are not currently listed under the "Hot Spots" Program. Chapter 9 provides an outline that specifies the content and recommended format of HRA results.

4.2.1.1 Emission Estimates Used in the Risk Assessment

The HRA must include emission estimates for all substances that are required to be quantified in the facility's emission inventory report. Specifically, HRAs should include both annual average emissions and maximum 1-hour emissions for each pollutant. Maximum 1-hour emissions are used for acute noncancer health impacts while annual emissions are used for chronic exposures (i.e., chronic and 8-hour noncancer health impacts or cancer risk assessment).

Emissions for each substance must be reported for individual emitting processes associated with unique devices within a facility. Total facility emissions for an individual air contaminant will be the sum of emissions, reported by process, for that facility. Information on daily and annual hours of operation, and relative monthly activity, must be reported for each emitting process. Devices and emitting processes must be clearly identified and described and must be consistent with those reported in the emissions inventory report.

The HRA should include tables that present the emission information (i.e., emission rates for each substance released from each process) in a clear and concise manner. The District may allow the facility operator to base the HRA on more current emission estimates than those presented in the previously submitted emission inventory report (i.e., actual enforceable emission reductions realized by the time the HRA is submitted to the District). If the District allows the use of more current emission estimates, the District must review and approve the new emissions estimates prior to use in the HRA. The HRA report must clearly state what emissions are being used and when any reductions became effective. Specifically, a table presenting emission estimates included in the previously submitted emission inventory report as well as those used for the HRA should be presented. The District should be consulted concerning the specific format for presenting the emission information. Chapter 9 provides an outline that specifies the content and recommended format of HRA results. A revised emission inventory report must be submitted to the District prior to submitting the HRA and forwarded by the District to the ARB, if revised emission data are used.

4.2.1.1.1 Molecular Weight Adjustments for the Emissions of Metal Compounds

For most of the Hot Spots toxic metals, the OEHHA cancer potency factors, acute and chronic RELs apply to the weight of the toxic metal atom contained in the overall compound. Some of the Hot Spots compounds contain various elements along with the toxic metal atom (e.g., "Nickel hydroxide", CAS number 12054-48-7, has a formula of H_2NiO_2). Therefore, an adjustment to the reported pounds of the overall compound is needed before applying the OEHHA cancer potency factor for "Nickel and compounds" to such a compound. This ensures that the cancer potency factor, acute or chronic REL is applied only to the fraction of the overall weight of the emissions that are associated with health effects of the metal. In other cases, the Hot Spots metals are already reported as the metal atom equivalent (e.g., CAS 7440-02-0, "Nickel"), and these cases do not use any further molecular weight adjustment. (Refer to Note [7] in Appendix A,

List of Substances in the EICG Report for further information on how the emissions of various Hot Spots metal compounds are reported.)

The appropriate molecular weight adjustment factors (MWAF) to be used along with the OEHHA cancer potency factors, acute and chronic RELs for Hot Spots metals can be found in the MWAF column[1] of the table containing OEHHA/ARB Approved Health Values for use in Hot Spots Facility Risk Assessments that is in Appendix L of this document.

As an example, the compound "Nickel hydroxide" has a molecular formula of H_2NiO_2. The atomic weight of each of the elements in this compound, and the fraction they represent of the total weight, are therefore as follows:

Element	Number of atoms	Atomic Weight	Fraction of Total Weight = MWAF
1 x Nickel (Ni)	1 x	58.70	58.70 / 92.714 = **0.6332** (MWAF for Nickel)
2 x Oxygen (O)	2 x	15.999	
2 x Hydrogen (H)	2 x	1.008	
Total Molecular Weight of H_2NiO_2:		92.714	

So, for example, assume that 100 pounds of "Nickel hydroxide" emissions are reported under CAS number 12054-48-7. To get the Nickel atom equivalent of these emissions, multiply by the listed MWAF (0.6332) for Nickel hydroxide:

- 100 pounds x 0.6332 = 63.32 pounds of Nickel atom equivalent.

This step should be completed prior to applying the OEHHA cancer potency factor for "Nickel and compounds" in a calculation for a prioritization score or risk assessment calculation. (Note - The HARP software automatically applies the appropriate MWAF for each Hot Spots chemical (by CAS number), so the emissions should not be manually adjusted when using HARP. Therefore, if using HARP, you would use 100 pounds for Nickel hydroxide and HARP will make the MWAF adjustment for you. If not using HARP, you would use 63.32 pounds.)

[1] The value listed in the MWAF column for Asbestos is not a molecular weight adjustment. This is a conversion factor for adjusting mass and fibers or structures. See Appendix C for more information on Asbestos reporting and risk assessment information or see the EICG report for reporting guidance.

4.2.1.2 Release Parameters

Emission release parameters (e.g., stack height and inside diameter, stack gas exit velocity, release temperature and emission source location in UTM coordinates) are needed as inputs to the air dispersion model. The Inventory Guidelines specify the release parameters that must be reported for each stack, vent, ducted building, exhaust site, or other site of exhaust release. Additional information may be required to characterize releases from non-stack (volume and area) sources; see U.S. EPA dispersion modeling guidelines or specific user's manuals. This information should also be included in the air dispersion section of the risk assessment. This information must be presented in tables included in the risk assessment. Note that some dimensional units needed for the dispersion model may require conversion from the units reported in the Inventory Report (e.g., Kelvin (K) vs. degrees Fahrenheit (°F)). Chapter 9 provides an outline that specifies the content and recommended format of HRA results.

4.2.1.3 Operation Schedule

The HRA should include a discussion of the facility operation schedule and daily emission patterns. For AB2588 purposes, emissions should be reported based on routine and predictable operations. Weekly or seasonal emission patterns may vary and should be discussed. This is especially important in a refined HRA. Diurnal emission patterns should be simulated in the air dispersion model because of diurnal nature of meteorological observations. Diurnal evaluations are important to include since diurnal weather patterns and emission releases may cause significant differences in the concentration at a receptor of interest.

A table should be included listing the emission schedule on an hourly and yearly basis. In addition, the emission schedule and exposure schedule should corroborate any exposure adjustment factors used for approximating an inhaled dose. For more information about exposure adjustment factors, see Section 4.8.1. Alternatively, exposure adjustments can be made through refining the air dispersion analysis. See Section 4.11.1.2(h) for special case modeling or Appendix M. An alternative to including modeling that addresses diurnal influences would be to include a sensitivity study showing, and/or text explaining, the reason(s) why there are no significant differences due to diurnal influences on the emissions from the facility or at the receptor(s) of interest. For more guidance, you can contact the district or reviewing authority**.** Chapter 9 provides an outline that specifies the content and recommended format of HRA results.

4.2.1.4 Emission Controls

The HRA should include a description of control equipment, the emitting processes it serves, and its efficiency in reducing emissions of substances on the Air Toxics “Hot Spots” list. The EICG Report requires that this information be included in the Inventory Reports, along with the emission data for each emitting process. If the control equipment did not operate full-time throughout the year, then the reported overall control efficiency must be adjusted to account for any predictable downtime of the

control equipment. Any entrainment of toxic substances to the atmosphere from control equipment should be accounted for; this includes fugitive releases during maintenance and cleaning of control devices (e.g., baghouses and cyclones). Contact the District for guidance with control equipment adjustments. Recommended default deposition rates that are used when calculating potential noninhalation health impacts are listed in Section 5.3.2. Chapter 9 provides an outline that specifies the content and recommended format of HRA results.

4.2.2 *Landfill Emissions*

Emission estimates for landfill sites should be based on testing required under Health and Safety Code, Section (HSC) 41805.5 (AB 3374, Calderon) and any supplemental AB 2588 source tests or emission estimates used to characterize air toxics emissions from landfill surfaces or through off-site migration. The District should be consulted to determine the specific Calderon data to be used in the HRA. The "Hot Spots" Program HRA for landfills should also include emissions of listed substances for all applicable power generation and maintenance equipment at the landfill site. Processes that need to be addressed include stationary internal combustion engines, flares, evaporation ponds, composting operations, boilers, and gasoline dispensing systems.

4.3 Source Characterization

Pollutants are released into the atmosphere in many different ways. The release conditions need to be properly identified and characterized to appropriately use the air dispersion models.

4.3.1 *Source Type*

Source types can be identified as point, line, area, or volume sources for input to the air dispersion model. Several air dispersion models have the capability to simulate more than one source type.

4.3.1.1 Point Sources

Point sources are probably the most common type of source and most air dispersion models have the capability to simulate them. Typical examples of point sources include exhaust stacks. Isolated vents from buildings are special examples of point sources.

4.3.1.2 Line Sources

The version 12345 or newer of the AERMOD can accommodate line sources. Line sources can be also treated as a special case of either an area or a volume source. Examples of line sources include: conveyor belts and rail lines, freeways, and busy roadways. Not all mobile sources may be subject to the Hot Spots program; however, non-motor vehicles that operate within a facility (e.g., ships, trains, and cranes, etc.) are subject to the Hot Spots program. For more information, see the ARB's Emission Inventory and Criteria Guidelines document or ARB's interpretation and guidance

memorandum to CAPCOA regarding mobile sources which are subject to the "Hot Spots" program. This memo can be found at http://www.arb.ca.gov/ab2588/motorv.pdf.

Mobile sources and rail lines are required to be evaluated under SB 352. SB 352 requires a risk assessment performed under the Hot Spots risk assessment guidance for proposed school sites within 500 feet of a busy roadway. Dedicated air dispersion models are available for motor vehicle emissions from roadways which are a special type of line source. These models (i.e., CALINE3, CAL3QHCR, and CALINE4) are designed to simulate the mechanical turbulence and thermal plume rise due to the motor vehicle activity on the roadway. However, these dedicated models use the Pasquill-Gifford dispersion stability classes for dispersion; the AERMOD dispersion model uses a more advanced continuous stability estimation method based on observations. The limitation with AERMOD is that the user needs to estimate initial mixing (Szo and Syo) for mechanical turbulence and thermal plume rise. Consult with the District prior to conducting roadway modeling to determine model use.

For practical information on how to simulate roadway emission dispersion using these models, see the California Air Pollution Control Officer's Association (CAPCOA) website at http://www.capcoa.org or the Sacramento Metropolitan AQMD (SMAQMD) website at http://www.airquality.org/ceqa/RoadwayProtocol.shtml. The SMAQMD has a document titled, "Recommended Protocol for Evaluating the Location of Sensitive Land Uses Adjacent to Major Roadways"(January, 2010). The ARB recommends this document for SB-352 risk assessments.

4.3.1.3 Area Sources

Emissions that are to be modeled as area sources are typical of fugitive sources characterized by non-buoyant emissions containing negligible vertical extent (e.g., no plume rise or emissions distributed over a large horizontal area).

Fugitive particulate (PM2.5, PM10, TSP) emission sources include areas of disturbed ground (e.g., open pits, parking lots) which may be present during operational phases of a facility's life. Also included are areas of exposed material (e.g., storage piles and slag dumps) and segments of material transport where potential fugitive emissions may occur (uncovered haul trucks or rail cars, emissions from unpaved roads). Fugitive emissions may also occur during stages of material handling where particulate material is exposed to the atmosphere (uncovered conveyors, hoppers, and crushers).

Other fugitive emissions emanating from many points of release may be modeled as area sources. Examples include fugitive emissions from valves, flanges, venting, and other connections that occur at ground level or at an elevated level or deck if on a building or structure. Modern dispersion models include an option for an initial vertical extent (Szo) where needed.

Modeling portable equipment as an area source is a case-by-case situation that should be discussed with the District or reviewing authority. Situations may exist where this type of operation is best represented as another type of release.

4.3.1.4 Volume Sources

Non-point sources with emissions containing an initial vertical extent should be modeled as volume sources. The initial vertical extent may be due to plume rise or a vertical distribution of numerous smaller sources over a given area. Examples of volume sources include buildings with natural fugitive or passive ventilation, and line sources such as conveyor belts and rail lines.

4.3.2 *Quantity of Sources*

The number of sources at a facility may influence the selection of the air dispersion model. Some dispersion models are capable of simulating only one source at a time, and are therefore referred to as single-source models (e.g., AERSCREEN).

In some cases, for screening purposes, single-source models may be used in situations involving more than one source using one of the following approaches:

- Combining all sources into one single “representative” source

In order to be able to combine all sources into one single source, the individual sources must have similar release parameters. For example, when modeling more than one stack as a single “representative” stack, the stack gas exit velocities and temperatures must be similar. In order to obtain a conservative estimate, the values leading to the higher concentration estimates should typically be used (e.g., the lowest stack gas exit velocity and temperature, the height of the shortest stack, and a receptor distance and spacing that will provide maximum concentrations, etc.).

- Running the model for each individual source and superimposing results

Superimposition of results of single sources of emissions is the actual approach followed by all the Gaussian models capable of simulating more than one source. Simulating sources in this manner may lead to conservative estimates if worst-case meteorological data are used or if the approach is used with a model that automatically selects worst-case meteorological conditions, especially wind direction. The approach will typically be more conservative the farther apart the sources are because each run would use a different worst-case wind direction.

Additional guidance regarding source merging is provided by the U.S. EPA (1995a). It should be noted that depending upon the population distribution, the total burden can actually increase when pollutants are more widely dispersed. If the total burden from the facility or zone of impact (see Section 4.6.1) could increase for the simplifying modeling assumptions described above, the District should be consulted.

4.4 Terrain Type

Two types of terrain characterizations are required to select the appropriate model. One classification is made according to land type and another one according to terrain topography.

4.4.1 *Terrain Type – Land Use*

Some air dispersion models (e.g., CALINE) use different dispersion coefficients (sigmas) depending on the land use over which the pollutants are being transported. The land use type is also used by some models to select appropriate wind profile exponents. Traditionally, the land type has been categorized into two broad divisions for the purposes of dispersion modeling: urban and rural. Accepted procedures for determining the appropriate category are those suggested by Irwin (1978): one based on land use classification and the other based on population.

The land use procedure is generally considered more definitive. Population density should be used with caution and should not be applied to highly industrialized areas where the population density may be low. For example, in low population density areas a rural classification would be indicated, but if the area is sufficiently industrialized the classification should already be "urban" and urban dispersion parameters should be used.

If the facility is located in an area where land use or terrain changes abruptly, for example, on the coast, the District should be consulted concerning the classification. If need be, the model should be run in both urban and rural modes and the District may require a classification that biases estimated concentrations towards over prediction. As an alternative, the District may require that receptors be grouped according to the terrain between source and receptor.

AERMOD is the U.S. EPA's preferred dispersion model for a wide range of applications in rural or urban conditions. The users should refer to section 5.0 of the AERMOD Implementation Guide to determine urban or rural conditions.

The Land Use and the Population Density Procedures discussed above are described as follows.

4.4.1.1 Land Use Procedure

(1) Classify the land use within the total area A, circumscribed by a 3 km radius circle centered at the source using the meteorological land use typing scheme proposed by Auer (1978) and shown in Table 4.1.

(2) If land use types I1, I2, C1, R2 and R3 account for 50 percent or more of the total area *A* described in (1), use urban dispersion coefficients. Otherwise, use appropriate rural dispersion coefficients.

4.4.1.2 Population Density Procedure

(1) Compute the average population density (*p*) per square kilometer with *A* as defined in the Land Use procedure described above. (Population estimates are also required to determine the exposed population; for more information see Section 4.6.3.)

(2) If *p* is greater than 750 people/km^2 use urban dispersion coefficients, otherwise, use appropriate rural dispersion coefficients.

Table 4.1 Identification and classification of land use types (Auer, 1978)

Used to define rural and urban dispersion coefficients in certain models.

Type	Use and Structures	Vegetation
I1	*Heavy Industrial* Major chemical, steel and fabrication industries; generally 3-5 story buildings, flat roofs	Grass and tree growth extremely rare; <5% vegetation
I2	*Light-moderate industrial* Rail yards, truck depots, warehouses, industrial parks, minor fabrications; generally 1-3 story buildings, flat roofs	Very limited grass, trees almost totally absent; <5% vegetation
C1	*Commercial* Office and apartment buildings, hotels; >10 story heights, flat roofs	Limited grass and trees; <15% vegetation
R1	*Common residential* Single family dwelling with normal easements; generally one story, pitched roof structures; frequent driveways	Abundant grass lawns and light-moderately wooded; >70% vegetation
R2	*Compact residential* Single, some multiple, family dwelling with close spacing; generally <2 story, pitched roof structures; garages (via alley), no driveways	Limited lawn sizes and shade trees; <30% vegetation
R3	*Compact residential* Old multi-family dwellings with close (<2 m) lateral separation; generally 2 story, flat roof structures; garages (via alley) and ashpits, no driveways	Limited lawn sizes, old established shade trees; <35% vegetation
R4	*Estate residential* Expansive family dwelling on multi-acre tracts	Abundant grass lawns and lightly wooded; >80% vegetation
A1	*Metropolitan natural* Major municipal, state, or federal parks, golf courses, cemeteries, campuses; occasional single story structures	Nearly total grass and lightly wooded; >95% vegetation
A2	Agricultural rural	Local crops (e.g., corn, soybean); >95% vegetation
A3	*Undeveloped* Uncultivated; wasteland	Mostly wild grasses and weeds, lightly wooded; >90% vegetation
A4	Undeveloped rural	Heavily wooded; >95% vegetation
A5	*Water surfaces* Rivers, lakes	

4.4.2 *Terrain Type - Topography*

Surface conditions and topographic features generate turbulence, modify vertical and horizontal winds, and change the temperature and humidity distributions in the boundary layer of the atmosphere. These in turn affect pollutant dispersion and models differ in their need to take these factors into account.

The classification according to terrain topography should ultimately be based on the topography at the receptor location with careful consideration of the topographical features between the receptor and the source. Differentiation of simple versus complex terrain is unnecessary with AERMOD. In complex terrain, AERMOD employs the well-known dividing-streamline concept in a simplified simulation of the effects of plume-terrain interactions. For other plume models, topography can be classified as follows:

4.4.2.1 Simple Terrain (also referred to as "Rolling Terrain")

Simple terrain is all terrain located below stack height including gradually rising terrain (i.e., rolling terrain). Note that *Flat Terrain* also falls in the category of simple terrain.

4.4.2.2 Intermediate Terrain

Intermediate terrain is terrain located above stack height and below plume height. The recommended procedure to estimate concentrations for receptors in intermediate terrain is to perform an hour-by-hour comparison of concentrations predicted by simple and complex terrain models. The higher of the two concentrations should be reported and used in the risk assessment.

4.4.2.3 Complex Terrain

Complex terrain is terrain located above plume height. Complex terrain models are necessarily more complicated than simple terrain models. There may be situations in which a facility is "overall" located in complex terrain but in which the nearby surroundings of the facility can be considered simple terrain. In such cases, receptors close to the facility in this area of simple terrain will "dominate" the risk analysis and there may be no need to use a complex terrain model. It is unnecessary to determine which terrain dominates the risk analysis for users of AERMOD.

4.5 Level of Detail: Screening vs. Refined Analysis

Air dispersion models can be classified according to the level of detail which is used in the assessment of the concentration estimates as "screening" or "refined". Refined air dispersion models use more robust algorithms capable of using representative meteorological data to predict more representative and usually less conservative estimates. Refined air dispersion models are, however, more resource intensive than their screening counterparts. It is advisable to first use a screening model to obtain conservative concentration estimates and calculate health risks. If the health risks are estimated to be above the threshold of concern, then use of a refined model to calculate

more representative concentration and health risk estimates would be warranted. There are situations when screening models represent the only viable alternative (e.g., when representative meteorological data are not available). The district or reviewing authority should be consulted to determine the appropriate method for determining the level of detail in the modeling analysis. The HARP software will incorporate the capability of using either representative meteorological data from AERMOD or the default meteorological conditions from the AERSCREEN model.

It is acceptable to use a refined air dispersion model in a "screening" mode for this program's health risk assessments. In this case, a refined air dispersion model is used:

- with worst-case meteorology instead of representative meteorology;

- with a conservative averaging period conversion factor to calculate longer term concentration estimates (see Section 4.10 for more discussion on screening air dispersion models and adjustments factors).

Note that use of worst case meteorology in a refined model is not the normal practice in New Source Review or Ambient Air Quality Standard evaluation modeling.

4.6 Population Exposure

The level of detail required for the analysis (e.g., screening or refined), and the procedures to be used in determining geographic resolution and exposed population require case-by-case analysis and professional judgment. The District should be consulted before beginning the population exposure estimates, and as results are generated, further consultation may be necessary. Some suggested approaches and methods for handling the breakdown of population and performance of a screening or detailed risk analysis are provided in this section.

In addition to estimating individual cancer risk at specific points such as the MEI (maximally exposed individual), OEHHA recommends determining the number of people who reside within the 1×10^{-6}, 1×10^{-5}, $1x\ 10^{-4}$, and higher cancer risk isopleths. For noncancer population evaluations, the number of people who reside within the 0.5, one, five, or higher hazard index isopleths should be reported. The HARP software can provide population exposure estimates as cancer burden or as the number of persons exposed to a selected (user identified) health risk/impact level. Information on obtaining the HARP software can be found under the Hot Spots Program on the ARB's web site at *www.arb.ca.gov*. Chapter 9 provides an outline that specifies the content and recommended format of HRA results.

4.6.1 *Zone(s) of Impact*

As part of the estimation of the population exposure for the cancer risk analysis, it is necessary to determine the geographic area affected by the facility's emissions. An initial approach to define a "zone of impact" surrounding the source is to generate an isopleth where the total excess lifetime cancer risk from inhalation exposure to all emitted carcinogens is greater than 10^{-6} (one in 1,000,000).

For noncarcinogens, a second, third, and fourth isopleth (to represent the chronic, 8-hour, and acute impacts) should be created to define the zone of impact for the hazard index from both inhalation and noninhalation pathways greater than or equal to 1.0. For clarity these isopleths may need to be presented on separate maps in the HRA.

Contact the District or reviewing authority to discuss inclusion of isopleth maps if all potential health risks fall within the facility boundary and no receptors have, or will ever, be present within the boundary (also see Section 4.7.1 for a discussion of on-site receptors).

The initial "zone of impact" can be determined as follows:

- Use a screening dispersion model (e.g., AERSCREEN) to obtain concentration estimates for each emitted pollutant at varying receptor distances from the source. Several screening models feature the generation of an automatic array of receptors which is particularly useful for determining the zone of impact. In order for the model to generate the array of receptors the user needs to provide some information normally consisting of starting distance, increment and number of intervals.

- Calculate total cancer risk and hazard index (HI) for each receptor location by using the methods provided in the risk characterization sections in Chapter 8 of the Air Toxics Hot Spots Risk Assessment Guidance Manual.

- Find the distance where the total inhalation cancer risk is equal to 10^{-6}; this may require redefining the receptor array in order to have two receptor locations that bound a total cancer risk of 10^{-6}. Next, find the distance where the chronic, 8-hour, and acute health hazard indices are declared significant by the District (e.g., acute, 8-hour, or chronic HI = 1.0).

Some Districts may prefer to use a cancer risk of 10^{-7} or an HI of 0.5 as the zone of impact. Therefore, the District should be consulted before modeling efforts are initiated. If the zone of impact is greater than 25 km from the facility at any point, then the District should be consulted. The District may specify limits on the area of the zone of impact. Ideally, these preferences would be presented in the modeling protocol (see Section 4.14).

Note that when depicting the risk assessment results, risk isopleths must present the total cancer and noncancer risk from both inhalation and noninhalation pathways. The zone of impact should be clearly shown on a map with geographic markers of adequate resolution (see Section 4.6.3.1). The text below discusses methodology for defining the zone of impact and has format recommendations. Chapter 9 provides an outline that specifies the content and recommended format of all HRA results.

The zone of impact can be defined once the exposure assessment (air dispersion modeling) process has determined the pollutant concentrations at each designated off-site receptor and a risk analysis (see Chapter 8) has been performed. For clarity, the cancer and noncancer zone(s) of impact should be presented on separate maps. A

map illustrating the carcinogenic zone of impact is required. The District may at its discretion ask for the map illustrating the potential carcinogenic zone of impact to identify the zone of impact for the minimum exposure pathways (inhalation, soil, dermal, and mother's milk) and the zone of impact for all applicable pathways of exposure (minimum pathways plus site/route dependent pathways). Two maps may be needed to accomplish this. The legend of these maps should state the level(s) used for the zone of impact and identify the exposure pathways that were included in the assessment.

The noncancer maps should also clearly identify the noncancer zones of impact. These include the acute (inhalation) zone of impact, 8-hour (inhalation) zone of impact and the chronic (including both inhalation, multipathway) zone of impact. The District may at its discretion require separate chronic inhalation and chronic multipathway zones of impact maps. For clarity, presentation of the two chronic zones of impact may also require two or more maps. The legend of these maps should state the level(s) used for the zone of impact and identify the exposure pathways (and target organs) that were included in the assessment. Further information regarding the methods for determination of hazard indices and cancer risk are discussed in Chapter 8 and Appendix I.

4.6.2 *Screening Population Estimates for Risk Assessments*

A screening risk assessment should include an estimate of the maximum exposed population. For screening risk assessments, a detailed description of the exposed population is not required. The impact area to be considered should be selected to be health protective (i.e., will not underestimate the number of exposed individuals). A health-protective assumption is to assume that all individuals within a large radius of the facility are exposed to the maximum concentration. If a facility must also comply with the RCRA/CERCLA risk assessment requirements, health effects to on-site workers may also need to be addressed. The DTSC's Remedial Project Manager should be consulted on this issue. The District should be consulted to determine the population estimate that should be used for screening purposes. Guidance for one screening method is presented here.

1. Use a screening dispersion model (e.g., AERSCREEN) to obtain concentration estimates for each emitted pollutant at varying receptor distances from the source. Several screening models feature the generation of an automatic array of receptors that is particularly useful for determining the zone of impact. In order for the model to generate the array of receptors, the user needs to provide some information normally consisting of starting distance, increment, and number of intervals.

2. Calculate the potential cancer risk and hazard index for each receptor location by using the methods provided in the risk characterization sections of this document (Chapter 8).

3. Find the distance where the potential cancer risk is equal to District specified levels (e.g., 10^{-6}); this may require redefining the receptor array in order to have

two receptor locations that bound a total cancer risk of 10^{-6}. This exercise should be repeated for the noncancer health impacts.

4. Calculate cancer burden by estimating the number of people in the grid and stipulate that all are exposed at the highest level.

4.6.3 *Refined Population Estimates for Risk Assessments*

The refined HRA requires a detailed analysis of the population exposed to emissions from the facility. Where possible, a detailed population exposure analysis provides estimates of the number of individuals in residences and offsite workplaces, as well as at sensitive receptor sites such as schools, daycare centers and hospitals. The District may require that locations with high densities of sensitive individuals be identified (e.g., schools, daycare centers, hospitals). These population analyses can include exposure estimates for workers and residents through the use of land use maps or other tools. The overall exposed residential and worker populations should be apportioned into smaller geographic subareas. The information needed for each subarea is:

1. The number of exposed persons, and
2. The receptor location at which the calculated ambient air concentration is assumed to be representative of the exposure to the entire population in the subarea.

A multi-tiered approach is suggested for the population analysis. Census tracts, which the facility could significantly impact, should be identified (see Section 4.6.3.1). A census tract should be divided into smaller subareas if it is close to the facility where ambient concentrations vary widely. The District may determine that census tracts provide sufficient resolution near the facility to adequately characterize population exposure or they may prefer the census information to be evaluated using smaller blocks. Further downwind where ambient concentrations are less variable, the census tract level may be acceptable to the District. The District may determine that the aggregation of census tracts (e.g., when the census tracts making up a city are combined) is appropriate for receptors that are considerable distances from the facility.

If a facility must also comply with the RCRA/CERCLA HRA requirements, health effects to on-site workers may also need to be addressed. The DTSC's Remedial Project Manager should be consulted on this issue. In some cases it may be appropriate to evaluate risks to on-site receptors. The district should be consulted about special cases for which evaluation of on-site receptors is appropriate, such as facilities frequented by the public or where people may reside (e.g., military facilities).

4.6.3.1 Census Tracts

For a refined risk assessment, the boundaries of census tracts can be used to define the geographic area to be included in the population exposure analysis. Digital maps showing the census tract boundaries in California can be obtained from "The Thomas

Guide"® on the World Wide Web. Statistics for each census tract can be obtained from the U.S. Census Bureau. The website address for the U.S. Census Bureau is http://www.census.gov. Numerous additional publicly accessible or commercially available sources of census data can be found on the World Wide Web. A specific example of a census tract is given in Appendix K. The HARP software includes U.S. census data and is a recommended tool for performing population exposure estimates.

The two basic steps in defining the area under analysis are:

(1) Identify the "zone of impact" (as defined previously in Section 4.6.1) on a map detailed enough to provide for resolution of the population to the subcensus tract level. (The U.S. Geological Survey (USGS) 7.5-minute series maps and the maps within the HARP software provide sufficient detail.) This is necessary to clearly identify the zone of impact, location of the facility, and sensitive receptors within the zone of impact. If significant development has occurred since the USGS survey, this should be indicated. A specific example of a 7.5-minute series map is given in Appendix K.

(2) Identify all census tracts within the zone of impact using a U.S. Bureau of Census or equivalent map (e.g., Thomas Brothers, HARP Software). If only a portion of the census tract lies within the zone of impact, then only the population that falls within the isopleth should be used in the population estimate or burden calculation. To determine this level of detail, local planning and zoning information may need to be collected. When this more detailed information is not available, then a less refined approach is to include the census data if the centroid of the census block falls within the isopleths of interest. The census tract boundaries should be transferred to a map, such as a USGS map (referred to hereafter as the "base map".)

An alternative approach for estimating population exposure in heavily populated urban areas is to apportion census tracts to a Cartesian grid cell coordinate system. This method allows a Cartesian coordinate receptor concentration field to be merged with the population grid cells. This process can be computerized and minimizes manual mapping of centroids and census tracts. The HARP software includes this function and will provide population estimates that are consistent with the methodology discussed here.

The District may determine that aggregation of census tracts (e.g., which census tracts making up a city can be combined) is appropriate for receptors that are located at considerable distances from the facility. If the District permits such an approach, it is suggested that the census tract used to represent the aggregate be selected in a manner to ensure that the approach is health protective. For example, the census tract included in the aggregate that is nearest (downwind) to the facility should be used to represent the aggregate.

4.6.3.1.1 Subcensus Tract

Within each census tract are smaller population units. These units [urban block groups (BG) and rural enumeration districts (ED)] contain about 1,100 persons. BGs are

further broken down into statistical units called blocks. Blocks are generally bounded by four streets and contain an average of 70 to 100 persons. However, this range in population is an average and population units may vary significantly. In some cases, the EDs are very large and identical to a census tract.

The area requiring detailed (subcensus tract) resolution of the exposed residential and worker population will need to be determined on a case-by-case basis through consultation with the District. The District may determine that census tracts provide sufficient resolution near the facility to adequately characterize population exposure.

Employment population data can be obtained at the census tract level from the U.S. Census Bureau or from local planning agencies. This degree of resolution will generally not be sufficient for most risk assessments. For the area requiring detailed analysis, zoning maps, general plans, and other planning documents should be consulted to identify subareas with worker populations.

The boundaries of each residential and employment population area should be transferred to the base map.

4.6.4 *Sensitive Receptor Locations*

Individuals who may be more sensitive to toxic exposures than the general population are distributed throughout the total population. Sensitive populations may include young children and chronically ill individuals. The District may require that locations with high densities of sensitive individuals be identified (e.g., schools, nursing homes, residential care facilities, daycare centers, and hospitals). The HRA should state what the District requirements are regarding identification of sensitive receptor locations.

Although protection of sensitive individuals is incorporated into OEHHA's risk assessment methodology in both cancer risk and noncancer risk assessment, the assessment of risk at the specific location of such sensitive individuals (e.g., schools, hospitals, or nursing homes) may be useful to assure the public that such individuals are being considered in the analysis. For some chemicals (e.g., mercury and manganese) children have been specifically identified as the sensitive subpopulation for noncancer health impacts, so it can be particularly appropriate to assess school sites.

4.7 Receptor Siting

4.7.1 *Receptor Points*

The modeling analysis should contain a network of receptor points with sufficient detail (in number and density) to permit the estimation of the maximum concentrations. Locations that must be identified include:

- The maximum estimated off-site impact or point of maximum impact (PMI),
- The maximum exposed individual at an existing residential receptor (MEIR),
- The maximum exposed individual at an existing occupational worker receptor (MEIW).

Note that some situations may also require that on-site receptor (worker or residential) locations be evaluated. The risk assessor can contact the District or reviewing authority for guidance if on-site exposure situations are present at the emitting facility. However, these on-site locations should be included in the HRA. Some examples where the health impacts of on-site receptors may be appropriate could be military base housing, prisons, universities, day care facilities, or locations where the public may have regular access for the appropriate exposure period (e.g., a lunch time café or museum for acute exposures). When a receptor lives and works on the facility, site, or property, then these receptors should be evaluated and reported under both residential and worker scenarios and the one that is most health protective should be used for risk management decisions. The cancer risk estimates for the onsite residents may use a 30-year exposure duration while the 25-year exposure duration is used for a worker. Under a Tier 2 analysis, alternate exposure durations may be evaluated and presented with all assumptions supported.

All of these locations (i.e., PMI, MEIR, and MEIW) must be identified for potential multipathway carcinogenic and noncarcinogenic effects. It is possible that the estimated PMI, MEIR, and MEIW risk for cancer, chronic noncancer, 8-hour, and acute noncarcinogenic risks occur at different locations or that some of these evaluations may not be necessary (e.g., the receptor does not exist). For example, some facilities will not have off-site workers in the vicinity of the facility and will not need to evaluate worker exposure, or the exposure situation may only require the evaluation of short-term carcinogenic or acute noncancer impacts (see Section 8.2.10 for a discussion of short-term projects). The approval to revise the exposure assessment for a receptor, or to omit the MEIW receptor, should be verified in writing with the District or reviewing authority and included in the HRA.

Other sensitive receptor locations may also be of interest and required to be included in the HRA. The District or reviewing authority should be consulted to determine which sensitive receptor locations must be included.

The results from a screening model (if available) can be used to identify the area(s) where the maximum concentrations are likely to occur. Receptor points should also be located at the population centroids (see Section 4.7.2) and sensitive receptor locations (see Section 4.6.4). The exact configuration of the receptor array used in an analysis will depend on the topography, population distribution patterns, and other site-specific factors. All receptor locations should be identified in the HRA using UTM (Universal Transverse Mercator) coordinates and receptor number. The receptor numbers in the summary tables should match receptor numbers in the computer output (e.g., HARP output files). In addition to actual UTM coordinates, the block/street locations (i.e., north side of 3,000 block of Smith Street) should be provided in the HRA for the PMI, MEIR, and MEIW for carcinogenic and noncarcinogenic health effects. Chapter 9 provides an outline that specifies the content and recommended format of HRA results.

4.7.1.1 Receptor Height

To evaluate localized impacts, receptor height should be taken into account at the point of maximum impact on a case-by-case basis. For example, receptor heights may have to be included to account for receptors significantly above ground level. Flagpole receptors at the height of the breathing zone of a person may need to be considered when the source receptor distance is less than a few hundred meters. Consideration must also be given to the noninhalation pathway analysis which requires modeling of chemical deposition onto soil or water at ground level. For the inhalation pathway, a health protective approach is to select a receptor height from 0 meters to 1.8 meters that will result in the highest predicted downwind concentration. Final approval of this part of the modeling protocol should be with the District or reviewing authority.

4.7.2 *Centroid Locations*

For each subarea analyzed, a centroid location (the location at which a calculated ambient concentration is assumed to represent the entire subarea) should be determined. When population is uniformly distributed within a population unit, a geographic centroid based on the shape of the population unit can be used. If only a portion of the census tract lies within the isopleth or area of interest, then only the population that falls within the isopleth should be used in the calculation for population exposure. To determine this level of detail, local planning and zoning information may need to be collected. Where populations are not uniformly distributed, a population-weighted centroid may be used. Another alternative uses the concentration at the point of maximum impact within that census tract as the concentration to which the entire population of that census tract is exposed. While this less refined approach is commonly accepted, Districts should be contacted to approve this method prior to its use in a risk assessment.

The centroids represent locations that should be included as receptor points in the dispersion modeling analysis. Annual average concentrations should be calculated at each centroid using the modeling procedures presented in this chapter.

For census tracts and BG/EDs, judgments can be made using census tracts maps and street maps to determine the centroid location. At the block level, a geographic centroid is sufficient.

4.7.3 *Spatial Averaging*

Since the inception of the “Hot Spots” and California’s Air Toxics Programs, HRA results for an individual receptor have typically been based on air dispersion modeling results at a single point or location. With a few exceptions, this method has been traditionally used for all types of receptors (e.g., PMI, MEIR, MEIW, pathway receptors, etc.). The assumptions used in risk assessment are designed to prevent underestimation of health impacts to the public resulting in a health protective approach. However, basing risk estimates on a single highest point (PMI, MEIR, or MEIW) does not take into account that a person does not remain at one location on their property, or in one location at the

workplace over an extended period of time. Therefore, the average air concentration over a small area is likely to be more representative than using the air concentration at a single point, particularly in those situations where concentrations fall off rapidly around that single point. The concept of averaging air concentrations over a small area is known as spatial averaging.

In order to understand how spatial averaging can impact air dispersion modeling results with various types of facilities, the ARB, in conjunction with the OEHHA, performed sensitivity analyses to evaluate the impacts of spatially averaging air dispersion modeling results (see Appendix C of the Air Toxics Hot Spots Program Risk Assessment Guidelines: Technical Support Document for Exposure Assessment and Stochastic Analysis (EASA)). Based on these sensitivity analyses, it is reasonable and appropriate to include spatial averaging techniques in air toxic risk assessments as supplemental information to Tier 1 information (i.e., modeling results that are based on the air concentration from a single point or location). While all risk assessments must include results based on Tier 1 methodology, the spatially averaged concentrations around the point of interest (e.g., PMI, MEIR, MEIW, multipathway exposure evaluations, etc.) could also be included as an option in risk assessments and acceptable for risk management decisions subject to approval by the District or reviewing agency. Spatial averaging is an option for the purpose of additional refinement to the risk assessment.

A few reasons that support the inclusion of spatially averaged modeled concentrations in risk assessment include the following:

- Averaging results over a small domain will give a more representative picture of individual exposure and risk than an estimate based on one single location within their property.
- Spatial averaging will allow air dispersion modeling and risk assessment results to be characterized as the estimated concentration and risk in a discrete area of interest, rather than an exact value for a single location.
- From a risk communication standpoint, the ARB and OEHHA feel it is more appropriate to present the modeling output and the calculated health impacts as the potential impacts within a small or discrete area, rather than an exact value at a specific point on a grid or map.
- Spatial averaging is the recommended procedure in ARB's Lead Risk Management Guidelines (2001) and has been used in several complex source HRAs [e.g., Roseville Railyard (2004), Ports of LA/LB (2006), Port of Oakland (2008)].
- Spatially averaging the deposition concentrations over pasture land, a garden, or a water body for multipathway exposure scenarios is a planned upgrade for the HARP Software. This will provide an option that will refine multipathway exposure assessments. Average deposition on these types of areas (e.g., a water body) is not necessarily well represented by the single highest point of deposition, or deposition at the geographic center of the water body. Likewise, since produce is grown over the entire surface of the garden and cows graze the

entire pasture, deposition is better estimated by evaluating the entire area rather than using a single point.

4.7.3.1 Spatial Averaging Methodology

The spatial averaging sensitivity study in Appendix C of the EASA is based on simulating emissions from point, volume, area, and line sources. Most source types (e.g., point) are simulated as a small, medium or large source. Line sources are only simulated as small and large. In addition, meteorological data collected at five different locations in California were used. Nested spatial average grids of various domains were used to study the differences on the spatial average concentration. In the case of the 20 meter by 20 meter spatial average nested grid, the spatial average concentration showed little change over the PMI for medium and large sources. In the case for small sources, the spatial average concentration is approximately 45% to 80% of the PMI concentration. Individual source type and meteorological conditions will cause variations in these results.

The results of the spatial averaging sensitivity study in Appendix C of the EASA shows that sources with low plume rise that result in a PMI, MEIW, or MEIR located at or near the property fence line are most sensitive to spatial averaging. Source types with high plume rise (e.g., tall stacks) show a PMI far downwind where the concentration gradient is more gradual and therefore spatial averaging has a lesser effect. While spatial averaging can be used regardless of source size or the location of the PMI, the following conditions generally apply when a source is a good candidate for spatial averaging:

- The MEIR, MEIW, or PMI is located at the fence line or close to the emission source.
- The concentration gradient is high near the PMI. This is more associated with low level plumes such as fugitive, volume, area, or short stacks.
- A long term average is being calculated to represent a multi-year risk analysis based on one to five years of meteorological data. Note that spatial averaging should **not** be used for short term (acute) calculations.

In general, the method for calculating the spatial average in air toxic risk assessments includes the following steps:

1. Locate the point(s) of interest and receptor(s) (i.e., PMI, MEIW, MEIR, and any additional receptor locations of interest or concern) with a grid resolution spacing of no greater than five meters. To achieve this, two or more modeling runs with successively finer nested grid resolutions may be needed to find the final location where the nested grid that will be used for spatial averaging will be placed.

2. Center the spatial average nested grid on the each receptor's location of interest determined in step 1. Limit the nested grid to no larger than 20 meters by 20 meters or 400 square meters. Note that if a portion of the centered and nested grid falls within the facility boundary and the receptor location of interest is outside of the boundary, then adjustments to the nested grid to obtain the spatially-averaged concentration for the offsite receptor are reasonable. This may be done by either repositioning the nested grid to cover 400 square meters of off-boundary area surrounding the receptor or center the nested grid and delete any on-site grid points so that only the offsite grid points surrounding the receptor are used in the spatially averaged concentration. The grid resolution spacing should be no greater than five meters. With a five meter grid resolution, the 20 meter by 20 meter domain will result in 25 receptors. The size, shape, and placement of the domain and the resolution of points are subject to approval by the District, ARB, or other reviewing authority. See the Sections 4.7.3.1.2 and 4.7.3.1.3 below for additional discussion on domain sizing and grid spacing at worksites, pastures, gardens, and water bodies.

3. Some configurations of source activity and meteorological conditions result in a predominant downwind plume center line that is significantly askew from one of the four ordinate directions. In this case, a tilted nested grid is necessary to coincide with the dominant plume centerline. Polar receptors are easier to implement than a tilted rectangular grid. The domain of the polar receptor field should be limited to a 15 meter radius. See Appendix C of the EASA for detailed instructions on tilted polar receptors.

4. Calculate the arithmetic mean of the long term period average concentration (e.g., annual average) of the nested grid of receptors to represent the spatial average. This average is used in the risk calculations.

5. Document and include all methods, assumptions, data, maps, and files used in the spatial averaging analysis and clearly present this information in the risk assessment following the requirements of the District or reviewing authority. Note that in the update to the HARP software, functionality will be included that will assist with spatial averaging and the methodology discussed.

The following sections discuss the use of spatial averaging for various receptor types and exposure pathways.

4.7.3.1.1 Residential Receptors

Follow the steps in Section 4.7.3 outlining the spatial averaging methodology. To remain health protective when evaluating a residential receptor, spatial averaging should not take place using large nested domains. The domain used for spatial averaging should be no larger than 20 meters by 20 meters with a maximum grid spacing resolution of equal to or less than five meters. This domain represents an area

that is approximately the size of a small urban lot. The size of the domain and resolution of points shall be subject to approval by the District, ARB, or other reviewing authority.

4.7.3.1.2 Worker Receptors

Offsite worker locations (e.g. MEIW) may also be a candidate for spatial averaging. However, workers can be at the same location during almost their entire daily work shift (e.g., desk/office workers). When this is the situation, then the traditional method of using a single location and corresponding modeled concentration is appropriate. If spatial averaging is used, care should be taken to determine the proper domain size and grid resolution. Follow the steps in Section 4.7.3 outlining the spatial averaging methodology. To be consistent with the residential receptor assumptions and remain health protective, a modeling domain size no larger than 20 meters by 20 meters is recommended with a grid spacing resolution of equal to or less than five meters. However, if workers routinely and continuously move throughout the worksite over a space greater than 20 meters by 20 meters, then a larger domain may be considered.

The HRA or modeling protocol shall support all assumptions used, including, but not limited to, documentation for all workers showing the area where each worker routinely performs their duties and the percentage of time spent in those areas. The final domain size should not be greater than the smallest area of worker movement. Other considerations for determining domain size and grid spacing resolution may include an evaluation of the concentration gradients across the worker area. The grid spacing used within the domain to find the concentration that will be used to calculate health impacts should be sufficient in number and detail to obtain a representative concentration across the area of interest. The size of the domain and resolution of points shall be subject to approval by the District, ARB, or other reviewing authority.

4.7.3.1.3 Pastures, Gardens, or Water Bodies

The simplified approach of using the concentration (deposition rate) at the centroid, a specific point of interest, or the PMI location for an area being evaluated for noninhalation exposures (e.g., a body of water used for fishing, a pasture used for grazing, area of a garden, etc.) is acceptable for use in HRA. However, evaluating deposition concentrations over pasture land, a garden, or a water body for multipathway exposure scenarios using spatial averaging could give more representative estimates of the overall deposition rate. Use of spatial averaging in this application is subject to approval by the District, ARB, or other reviewing authority.

If spatial averaging will be done, follow the steps in Section 4.7.3.1 outlining the spatial averaging methodology. When using spatial averaging over the deposition area, care should be taken to determine the proper domain size to make sure it includes all reasonable areas of potential deposition. The size and shape of the area of interest (e.g., pasture or water body) should be identified and used for the modeling domain. The grid spacing or resolution used within the domain should be sufficient in detail to obtain a representative deposition concentration across the area of interest. One way

to determine the grid resolution is to include an evaluation of the concentration gradients across the deposition area. The HRA or modeling protocol shall support all assumptions used, including, but not limited to, documentation of the deposition area (e.g., size and shape of the pasture, garden, or water body, maps, representative coordinates, grid resolution, concentration gradients, etc.). The size of the domain and grid resolution is subject to approval by the reviewing authority.

In lieu of following the details in the paragraph above, the approach used for the other receptors (e.g., MEIR, MEIW) that uses a domain size not greater than 20 meters by 20 meters, located on the PMI within the area of interest, with a maximum grid spacing resolution of five meters, can be used. This default refined approach would apply to deposition areas greater than 20 meters by 20 meters. For smaller deposition areas, the simplified approach of using the PMI for the area, the concentration at the centroid or a specific point of interest, or averaging over the actual smaller domain can be used. This again is subject to approval by the reviewing authority.

The HRA or modeling protocol shall support all assumptions used, including, but not limited to, documentation of the deposition area (e.g., size and shape of the water body, pasture, or garden; all data; maps; representative coordinates, and etc.), and the details clarifying how and where the averaging was done (e.g., location and magnitude of concentration gradients, the grid spacing used).

4.8 Meteorological Data

Refined air dispersion models require hourly meteorological data. The first step in obtaining meteorological data should be to check with the District and the ARB for data availability. Other sources of data include the National Weather Service (NWS), National Climatic Data Center (NCDC), Asheville, North Carolina, ARB meteorological database (METDB), military stations and private networks. Meteorological data for a subset of NWS stations are available from the U.S. EPA Support Center for Regulatory Air Models (SCRAM). The SCRAM can be accessed at www.epa.gov/scram001/main.htm. All meteorological data sources should be approved by the District. Data not obtained directly from the District or the ARB should be checked for quality, representativeness, and completeness. It should be approved by the District before use. U.S. EPA provides guidance (U.S. EPA, 1995e) for these data. Meteorological data may need further processing. Data users can consult with the District or the ARB on how to process the raw meteorological data. The risk assessment should indicate if the District required the use of a specified meteorological data set. All memos indicating District approval of meteorological data should be attached in an appendix. If no representative meteorological data are available, screening procedures should be used as indicated in Section 4.10.

The analyst should acquire enough meteorological data to ensure that the worst-case meteorological conditions are represented in the model results. The US-EPA Guideline on Air Quality Models (U.S. EPA 2005) prefers that the latest five years of consecutive meteorological data be used to represent long term averages (i.e., cancer and chronic impacts). Previous OEHHA guidance allowed the use of the worst-case year to save

computer time. The processing speed of modern computers has increased to the point where processing five years of data over one year is no longer burdensome. However, the District may determine that one year of representative meteorological data is sufficient to adequately characterize the facility's impact. This may especially be the case when five years of quality consecutive data are not available.

To determine long term average concentrations the data can be averaged. For calculation of the one-hour maximum concentrations needed to evaluate acute effects, the worst-case year should be used in conjunction with the maximum hourly emission rate. For example, the long term average concentration and one-hour maximum concentration at a single receptor for five years of meteorological data are calculated below:

Year	Annual Average ($\mu g/m^3$)	Maximum One-Hour ($\mu g/m^3$)
1	7	100
2	5	80
3	9	90
4	8	110
5	6	90
5-year average	7	

In the above example, the long-term average concentration over five years is 7 $\mu g/m^3$. Therefore, 7 $\mu g/m^3$ should be used to evaluate carcinogenic and chronic effects (i.e., annual average concentration). The one-hour maximum concentration is the highest one-hour concentration in the five-year period. Therefore, 110 $\mu g/m^3$ is the peak one-hour concentration that should be used to evaluate acute effects.

The higher hourly concentration usually occurs when meteorological dispersion conditions become worse, such as, calm or light wind, inversion, etc. Inversion usually happens in late afternoon through early morning. As the sun goes down, the atmospheric temperature near surface starts to fall, usually faster than the temperature in the upper atmosphere causing a temperature inversion layer to form and extend downward. This inversion layer usually sustains throughout the night, and remains until early morning. Because of the inversion (cold air sitting on warm air at the top of the inversion layer), pollutant vertical mixing is very low in the morning.

When predicted concentrations are high and the mixing height is very low for the corresponding averaging period, the modeling results deserve additional consideration. For receptors in the near field, it is within the model formulation to accept a very low mixing height for short durations. However, it would be unlikely that the very low mixing height would persist long enough for the pollutants to travel into the far field. In the

event that the analyst identifies any of these time periods, they should be discussed with the District on a case-by-case basis.

4.8.1 *Meteorological Data Formats*

Most short-term dispersion models require input of hourly meteorological data in a format which depends on the model. U.S. EPA provides software for processing meteorological data for use in U.S. EPA recommended dispersion models. U.S. EPA recommended meteorological processors include the Meteorological Processor for Regulatory Models (MPRM), PCRAMMET, and AERMET. Use of these processors will ensure that the meteorological data used in an U.S. EPA recommended dispersion model will be processed in a manner consistent with the requirements of the model.

Meteorological data for a subset of NWS stations are available on the World Wide Web at the U.S. EPA SCRAM address, http://www.epa.gov/scram001.

4.8.2 *Treatment of Calms*

Calms are hours when the wind speed is below the starting threshold of the anemometer. Gaussian plume models require a wind speed and direction to estimate plume dispersion in the downwind direction.

U.S. EPA's policy is to disregard calms until such time as an appropriate analytical approach is available. The recommended U.S. EPA models contain a routine that eliminates the effect of the calms by nullifying concentrations during calm hours and recalculating short-term and annual average concentrations. Certain models lacking this built-in feature can have their output processed by U.S. EPA's CALMPRO program (U.S. EPA, 1984a) to achieve the same effect. Because the adjustments to the concentrations for calms are made by either the models or the postprocessor, actual measured on-site wind speeds should always be input to the preprocessor. These actual wind speeds should then be adjusted as appropriate under the current U.S. EPA guidance by the preprocessor.

Following the U.S. EPA methodology, measured on-site wind speeds of less than 1.0 m/s, but above the instrument threshold, should be set equal to 1.0 m/s by the preprocessor when used as input to Gaussian models. Calms are identified in the preprocessed data file by a wind speed of 1.0 m/s and a wind direction equal to the previous hour. For input to AERMOD, no adjustment should be made to the site specific wind data. AERMOD can produce model estimates for conditions when the wind speed may be less than 1 m/s but still greater than the instrument threshold. Some air districts provide pre-processed meteorological data for use in their district that treats calms differently. Local air districts should be consulted for available meteorological data. In addition, to reduce the number of calms and missing winds in the surface data, EPA has developed a pre-processor – AERMINUTE – to process 1-minute ASOS wind data for generating hourly average wind speed and directions for input to AERMET in Stage 2. The details can be found in the EPA's AERMINUTE User's Instructions at:

http://www.epa.gov/ttn/scram/models/aermod/aerminute_userguide_v11059_draft.pdf

If the fraction of calm hours is excessive, then an alternative approach may need to be considered to characterize dispersion. The Calpuff model modeling system can simulate calm winds as well as complex wind flow and therefore is a viable alternative. The local air district should be consulted for alternative approaches.

4.8.3 *Treatment of Missing Data*

Missing data refer to those hours for which no meteorological data are available from the primary on-site source for the variable in question. When missing values arise, they should be handled in one of the following ways listed below, in the following order of preference:

(1) If there are other on-site data, such as measurements at another height, they may be used when the primary data are missing. If the height differences are significant, corrections based on established vertical profiles should be made. Site-specific vertical profiles based on historical on-site data may also be appropriate to use if their determination is approved by the reviewing authority. If there is question as to the representativeness of the other on-site data, they should not be used.

(2) If there are only one or two missing hours, then linear interpolation of missing data may be acceptable, however, caution should be used when the missing hour(s) occur(s) during day/night transition periods.

(3) If representative off-site data exist, they may be used. In many cases this approach may be acceptable for cloud cover, ceiling height, mixing height, and temperature. This approach will rarely be acceptable for wind speed and direction. The representativeness of off-site data should be discussed and agreed upon in advance with the reviewing authority.

(4) An imputation methodology may be acceptable, provided it is well-documented, sufficiently justified, and properly applied.

(5) Failing any of the above, the data field should be coded as missing using missing data codes appropriate to the applicable meteorological pre-processor.

Appropriate model options for treating missing data, if available in the model, should be employed. Substitutions for missing data should only be made in order to complete the data set for modeling applications, and should not be used to attain the “regulatory completeness” requirement of 90%. That is, the meteorological data base must be 90% complete on a monthly basis (before substitution) in order to be acceptable for use in air dispersion modeling. The use of any data substitution technique should be thoroughly documented to provide the District or reviewing authority with all the information necessary to determine its approvability.

If the recommended methods for addressing missing meteorological data cannot be achieved as described, then alternative approaches should be discussed and developed in conjunction with the District or reviewing authority.

4.8.4 *Representativeness of Meteorological Data*

The atmospheric dispersion characteristics at an emission source need to be evaluated to determine if the collected meteorological data can be used to adequately represent atmospheric dispersion for the project.

Such determinations are required when the available meteorological data are acquired at a location other than that of the proposed source. In some instances, even though meteorological data are acquired at the location of the pollutant source, they still may not correctly characterize the important atmospheric dispersion conditions.

Considerations of representativeness are always made in atmospheric dispersion modeling whether the data base is "on-site" or "off-site." These considerations call for the judgment of a meteorologist or an equivalent professional with expertise in atmospheric dispersion modeling. If in doubt, the District should be consulted.

4.8.4.1 Spatial Dependence

The location where the meteorological data are acquired should be compared to the source location for similarity of terrain features. For example, in complex terrain, the following considerations should be addressed in consultation with the District:

- Aspect ratio of terrain, i.e., ratio of:
    - Height of valley walls to width of valley;
    - Height of ridge to length of ridge; and
    - Height of isolated hill to width of hill at its base
- Slope of terrain
- Ratio of terrain height to stack/plume height
- Distance of source from terrain (i.e., how close to valley wall, ridge, isolated hill)
- Correlation of terrain feature to prevailing meteorological conditions

Likewise, if the source is located on a plateau or plain, the source of meteorological data used should be from a similar plateau or plain.

Judgments of representativeness should be made only when sites are climatologically similar. Sites in nearby, but different air sheds, often exhibit different weather patterns. For instance, meteorological data acquired along a shoreline are not normally representative of inland sites and vice versa.

Meteorological data collected need to be examined to determine if drainage, transition, and synoptic flow patterns are characteristics of the source, especially those critical to the regulatory application. Consideration of orientation, temperature, and ground cover should be included in the review.

An important aspect of space dependence is height above the ground. Where practical, meteorological data should be acquired at the release height, as well as above or below, depending on the buoyancy of the source's emissions. AERMOD at a minimum requires wind observations at a height above ground between seven times the local surface roughness height and 100 meters.

4.8.4.2 Temporal Dependence

To be representative, meteorological data must be of sufficient duration to define the range of sequential atmospheric conditions anticipated at a site. As a minimum, one full year of on-site meteorological data is necessary to prescribe this time series. Multiple years of data are used to describe variations in annual and short-term impacts. Consecutive years from the most recent, readily available 5-year period are preferred to represent these yearly variations.

4.8.4.3 Further Considerations

It may be necessary to recognize the non-homogeneity of meteorological variables in the air mass in which pollutants disperse. This non-homogeneity may be essential in correctly describing the dispersion phenomena. Therefore, measurements of meteorological variables at multiple locations and heights may be required to correctly represent these meteorological fields. Such measurements are generally required in complex terrain or near large land-water body interfaces.

It is important to recognize that, although certain meteorological variables may be considered unrepresentative of another site (for instance, wind direction or wind speed), other variables may be representative (such as temperature, dew point, cloud cover). Exclusion of one variable does not necessarily exclude all. For instance, one can argue that weather observations made at different locations are likely to be similar if the observers at each location are within sight of one another - a stronger argument can be made for some types of observations (e.g., cloud cover) than others. Although by no means a sufficient condition, the fact that two observers can “see” one another supports a conclusion that they would observe similar weather conditions.

Other factors affecting representativeness include change in surface roughness, topography and atmospheric stability. Currently there are no established analytical or statistical techniques to determine representativeness of meteorological data. The establishment and maintenance of an on-site data collection program generally fulfills the requirement for “representative” data. If in doubt, the District should be consulted.

4.8.5 *Alternative Meteorological Data Sources*

It is necessary, in the consideration of most air pollution problems, to obtain data on site-specific atmospheric dispersion. Frequently, an on-site measurement program must be initiated. As discussed in Section 4.8.3, representative off-site data may be used to substitute for missing periods of on-site data. There are also situations where current or past meteorological records from a National Weather Service station may suffice. These considerations call for the judgment of a meteorologist or an equivalent professional with expertise in atmospheric dispersion modeling. More information on Weather Stations including: National Weather Service (NWS), military observations, supplementary airways reporting stations, upper air and private networks, is provided in "On-Site Meteorological Program Guidance for Regulatory Modeling Applications" (U.S. EPA, 1995e).

4.8.5.1 Recommendations

On-site meteorological data should be processed to provide input data in a format consistent with the particular models being used. The input format for U.S. EPA short-term regulatory models is defined in U.S. EPA's MPRM. The input format for AERMOD is defined in the AERMET meteorological pre-processor. Processors are available on the SCRAM web site. The actual wind speeds should be coded on the original input data set. Wind speeds less than 1.0 m/s but above the instrument threshold should be set equal to 1.0 m/s by the preprocessor when used as input to Gaussian models. Wind speeds below the instrument threshold of the cup or vane, whichever is greater, should be considered calm, and are identified in the preprocessed data file by a wind speed of 1.0 m/s and a wind direction equal to the previous hour. For input to AERMOD, no adjustment should be made to the site specific wind data. AERMOD can produce model estimates for conditions when the wind speed may be less than 1 m/s but still greater than the instrument threshold.

If data are missing from the primary source, they should be handled as follows, in order of preference: (1) substitution of other representative on-site data; (2) linear interpolation of one or two missing hours; (3) substitution of representative off-site data; (4) use of a well-documented and justified imputation methodology; or (5) coding as a missing data field, according to the discussions in Section 4.8.3. The use of any data substitution technique should be thoroughly documented to provide the District or reviewing authority with all the information necessary to determine its approvability.

If the data processing recommendations in this section cannot be achieved, then alternative approaches should be discussed and developed in conjunction with the District or reviewing authority.

4.8.6 *Quality Assurance and Control*

The purpose of quality assurance and maintenance is the generation of a representative amount (90% of hourly values for a year on a monthly basis) of valid data. For more information on data validation consult reference U.S. EPA (1995e). Maintenance may

be considered the physical activity necessary to keep the measurement system operating as it should. Quality assurance is the management effort to achieve the goal of valid data through plans of action and documentation of compliance with the plans.

Quality assurance (QA) will be most effective when following a QA Plan which has been signed-off by appropriate project or organizational authority. The QA Plan should contain the following information (paraphrased and particularized to meteorology from Lockhart):

1. Project description - how meteorology data are to be used
2. Project organization - how data validity is supported
3. QA objective - how QA will document validity claims
4. Calibration method and frequency - for data
5. Data flow - from samples to archived valid values
6. Validation and reporting methods - for data
7. Audits - performance and system
8. Preventive maintenance
9. Procedures to implement QA objectives - details
10. Management support - corrective action and reports

It is important for the person providing the quality assurance (QA) function to be independent of the organization responsible for the collection of the data and the maintenance of the measurement systems. Ideally, the QA auditor works for a separate company.

4.9 Model Selection

There are several air dispersion models that can be used to estimate pollutant concentrations and new ones are likely to be developed. U.S. EPA added AERMOD, which incorporates the PRIME downwash algorithm, to the list of preferred models in 2005 as a replacement to ISCST3. CalPuff was added in 2003. The latest version of the U.S. EPA recommended models can be found at the SCRAM Bulletin board located at http://www.epa.gov/scram001. However, any model, whether a U.S. EPA guideline model or otherwise, must be approved for use by the local air district. Recommended models and guidelines for using alternative models are presented in this section. All air dispersion models used to estimate pollutant concentrations for risk assessment analyses must be in the public domain. Classification according to terrain, source type and level of analysis is necessary before selecting a model (see Section 4.4). The selection of averaging times in the modeling analysis is based on the health effects of concern. Annual average concentrations are required for an analysis of carcinogenic or other chronic effects. One-hour maximum concentrations are required for analysis of acute effects.

4.9.1 *Recommended Models*

Recommended air dispersion models to estimate concentrations for risk assessment analyses are generally referenced in US EPA's Guideline on Air Quality Models

available at http://www.epa.gov/scram001. Currently AERMOD is recommended for most refined risk assessments in flat or complex terrain and in rural or urban environments[1]. In addition, CalPuff is available where spatial wind fields are highly variable or transport distances are large (e.g., 50 km). AERSCREEN is a screening model based on AERMOD. AERSCREEN can be used when representative meteorological data are unavailable. CTSCREEN is available for screening risk assessments in complex terrain. The most current version of the models should be used for risk assessment analysis. Some facilities may also require models capable of special circumstances such as dispersion near coastal areas. For more information on modeling special cases see Sections 4.12 and 4.13.

Most air dispersion models contain provisions that allow the user to select among alternative algorithms to calculate pollutant concentrations. Only some of these algorithms are approved for regulatory application such as the preparation of health risk assessments. The sections in this guideline that provide a description of each recommended model contain information on the specific switches and/or algorithms that must be selected for regulatory application.

To further facilitate the model selection, the District should be consulted for additional recommendations on the appropriate model(s) or a protocol submitted for District review and approval (see Section 4.14.1).

4.9.2 *Alternative Models*

Alternative models are acceptable if applicability is demonstrated or if they produce results identical or superior to those obtained using one of the preferred models referenced in Section 4.9.1. For more information on the applicability of alternative models refer to the following documents:

- U.S. EPA (2005). "Guideline on Air Quality Models" Section 3.2.2
- U.S. EPA (1992). "Protocol for Determining the Best Performing Model"
- U.S. EPA (1985a). "Interim Procedures for Evaluating Air Quality Models – Experience with Implementation"
- U.S. EPA (1984b). "Interim Procedures for Evaluating Air Quality Models (Revised)"

4.10 Screening Air Dispersion Models

A screening model may be used to provide a maximum concentration that is biased toward overestimation of public exposure. Use of screening models in place of refined modeling procedures is optional unless the District specifically requires the use of a refined model. Screening models are normally used when no representative meteorological data are available and may be used as a preliminary estimate to determine if a more detailed assessment is warranted.

[1] AERMOD was promulgated by U.S. EPA as a replacement to ISCST3 on November 9, 2006.

Some screening models provide only 1-hour average concentration estimates. Other averaging periods can be estimated based on the maximum 1-hour average concentration in consultation and approval of the responsible air district. Because of variations in local meteorology, the exact factor selected may vary from one district to another. Table 4.2 provides guidance on the range and typical values applied. The conversion factors are designed to bias predicted longer term averaging periods towards overestimation.

Table 4.2 Recommended Factors to Convert Maximum 1-hour Avg. Concentrations to Other Averaging Periods (U.S. EPA, 2011, 1995a; ARB, 1994).

Averaging Time	Range	Typical SCREEN3 Recommended	AERSCREEN Recommended
3 hours	0.8 - 1.0	0.9	1.0
8 hours	0.5 - 0.9	0.7	0.9
24 hours	0.2 - 0.6	0.4	0.6
30 days	0.2 - 0.3	0.3	
Annual	0.06 - 0.1	0.08	0.1

AERSCREEN automatically provides the converted concentration for longer than 1-hour averaging periods. For area sources, the AERSCREEN 3, 8, and 24-hour average concentration are equal to the 1-hour concentration. No annual average concentration is calculated. SCREEN3 values are shown for comparison purposes.

4.10.1 *AERSCREEN*

The AERSCREEN (U.S. EPA, 2011) model is now available and should be used in lieu of SCREEN3 with approval of the local District. AERSCREEN is a screening level air quality model based on AERMOD. AERSCREEN does not require the gathering of hourly meteorological data. Rather, AERSCREEN requires the use of the MAKEMET program which generates a site specific matrix of meteorological conditions for input to the AERMOD model. MAKEMET generates a matrix of meteorological conditions based on local surface characteristics, ambient temperatures, minimum wind speed, and anemometer height.

AERSCREEN is currently limited to modeling a single point, capped stack, horizontal stack, rectangular area, circular area, flare, or volume source. More than one source may be modeled by consolidating the emissions into one emission source.

4.10.2 *Valley Screening*

The Valley model is designed to simulate a specific worst-case condition in complex terrain, namely that of a plume impaction on terrain under stable atmospheric conditions. The algorithms of the VALLEY model are included in other models such as SCREEN3 and their use is recommended in place of the VALLEY model. The usefulness of the VALLEY model and its algorithms is limited to pollutants for which only long-term average concentrations are required. For more information on the Valley model consult the user's guide (Burt, 1977).

4.10.2.1 Regulatory Options

Regulatory application of the Valley model requires the setting of the following values during a model run:

- Class F Stability (rural) and Class E Stability (urban)
- Wind Speed = 2.5 m/s
- 6 hours of occurrence of a single wind direction (not exceeding a 22.5 deg sector)
- 2.6 stable plume rise factor

4.10.3 *CTSCREEN*

The CTSCREEN model (Perry et al., 1990) is the screening mode of the Complex Terrain Dispersion Model (CTDMPLUS). CTSCREEN can be used to model single point sources only. It may be used in a screening mode for multiple sources on a case by case basis in consultation with the District. CTSCREEN is designed to provide conservative, yet theoretically sounder, worst-case 1-hour concentration estimates for receptors located on terrain above stack height. Internally-coded time-scaling factors are applied to obtain other averages (see Table 4.3). These factors were developed by comparing the results of simulations between CTSCREEN and CTDMPLUS for a variety of scenarios and provide conservative estimates (Perry et al., 1990). CTSCREEN produces identical results as CTDMPLUS if the same meteorology is used in both models. CTSCREEN accounts for the three-dimensional nature of the plume and terrain interaction and requires detailed terrain data representative of the modeling domain. A summary of the input parameters required to run CTSCREEN is given in Table 4.4. The input parameters are provided in three separate text files. The terrain topography file (TERRAIN) and the receptor information file (RECEPTOR) may be generated with a preprocessor that is included in the CTSCREEN package. In order to generate the terrain topography file the analyst must have digitized contour information.

Table 4.3 Time-scaling factors internally coded in CTSCREEN

Averaging Period	Scaling Factor
3 hours	0.7
24 hour	0.15
Annual	0.03

Table 4.4 Input Parameters Required to Run CTSCREEN

Parameter	File
Miscellaneous program switches	CTDM.IN
Site Latitude and Longitude (degrees)	CTDM.IN
Site TIME ZONE	CTDM.IN
Meteorology Tower Coordinates (user units)	CTDM.IN
Source Coordinates: x and y (user units)	CTDM.IN
Source Base Elevation (user units)	CTDM.IN
Stack Height (m)	CTDM.IN
Stack Diameter (m)	CTDM.IN
Stack Gas Temperature (K)	CTDM.IN
Stack Gas Exit Velocity (m/s)	CTDM.IN
Emission Rate (g/s)	CTDM.IN
Surface Roughness for each Hill (m)	CTDM.IN
Meteorology: Wind Direction (optional)	CTDM.IN
Terrain Topography	TERRAIN
Receptor Information (coordinates and associated hill number)	RECEPTOR

4.11 Refined Air Dispersion Models

Refined air dispersion models are designed to provide more representative concentration estimates than screening models. In general, the algorithms of refined models are more robust and have the capability to account for site-specific meteorological conditions. For more information regarding general aspects of model selection see Section 4.9.

4.11.1 *AERMOD*

For a wide variety of applications in all types of terrain, the recommended model is AERMOD. AERMOD is a steady-state plume dispersion model for assessment of pollutant concentrations from a variety of sources. AERMOD simulates transport and dispersion from multiple point, area, or volume sources based on an up-to-date characterization of the atmospheric boundary layer. Sources may be located in rural or urban areas and receptors may be located in simple or complex terrain. AERMOD accounts for building wake effects (i.e., plume downwash) based on the PRIME building downwash algorithms. The model employs hourly sequential preprocessed meteorological data to estimate concentrations for averaging times from one hour to one year (also multiple years). AERMOD is designed to operate in concert with two pre-processor codes: AERMET processes meteorological data for input to AERMOD, and AERMAP processes terrain elevation data and generates receptor information for input to AERMOD. Guidance on input requirements may be found in the AERMOD Users Guide.

4.11.1.1 Regulatory Options

U.S. EPA regulatory application of AERMOD requires the selection of specific switches (i.e., algorithms) during a model run. All the regulatory options can be set by selecting the DFAULT keyword. The U.S. EPA regulatory options, automatically selected when the DFAULT keyword is used, are:

- Stack-tip downwash
- Incorporates the effects of elevated terrain
- Includes calms and missing data processing routines
- Does not allow for exponential decay for applications other than a 4-hour half life for SO_2

Additional information on these options is available in the AERMOD User's Guide.

4.11.1.2 Special Cases

a. Building Downwash:
AERMOD automatically determines if the plume is affected by the wake region of buildings when their dimensions are given. The specification of building dimensions does not necessarily mean that there will be downwash. See

Section 4.13.1 for guidance on how to determine when downwash is likely to occur.

b. Area Sources:
The area source algorithm in AERMOD estimates source emission strength by integrating an area upwind of the receptor location. Receptors may be placed within the area itself, downwind of the area or adjacent to the area. However, since the vertical distribution parameter (σ_z) goes to zero as the downwind distance goes to zero, the plume function solution is infinite for a downwind receptor distance of zero. In order to avoid such singularity in the plume function solution, the AERMOD model arbitrarily sets the plume function to zero when the receptor distance is less than one meter. As a result, the area source algorithm will not provide reliable solutions for receptors located within or adjacent to very small areas, with dimensions on the order of a few meters across. In these cases, the receptor should be placed at least one meter outside of the area.

c. Volume Sources:
The volume source algorithms in AERMOD require an estimate of the initial distribution of the emission source. The initial distribution of emissions for a volume source is in the horizontal and vertical directions. When modeling volume source emissions, one needs to provide initial horizontal (σ_{y0}) and vertical (σ_{z0}) dimensions as accurate as possible so that pollutant buoyancy and dispersion are also calculated accurately. US EPA's AERMOD User Guide provides suggested procedures to estimate these initial dimensions based on source type (Table 3-1) (U.S. EPA, 2004a).

d. Line Sources:
Examples of line sources include conveyor belts or roads. Depending on the source, these can be modeled three ways; as a line source, as a series of volume sources, or as an elongated area source. Where the emission source is neutrally buoyant, such as a conveyor belt, AERMOD can be used according to the user guide. In the event that the line source is a roadway, then additional considerations are required.

At the present time, CALINE (CALINE3, CAL3QHCR, and CALINE4) is the only model dedicated to modeling the enhanced mechanical and thermal turbulence created by motor vehicles traveling on a roadway. Of these, CAL3QHCR is the only model that accepts hourly meteorological data and can estimate annual average concentrations. However, CALINE uses the Pasquill-Gifford stability categories which are used in the ISCST model. AERMOD is now the preferred plume model over ISCST3 with continuous plume dispersion calculations based on observations but AERMOD does not include the enhanced roadway turbulence. Therefore, in the case where roadway emissions dominate the risk assessment, it may be most important to simulate the enhanced thermal and mechanical turbulence from motor vehicles with the CAL3QHCR model.

In the case where roadway emissions are a subset of all emissions for the risk assessment, including roadway emissions along with facility emissions, it may be best to use AERMOD for all emissions, roadway and facility, in order to maintain continuity with one dispersion model for the risk assessment. If AERMOD is used, it is important to consider that a major freeway may act similar to a large building which can cause some mixing and therefore initial vertical dispersion. This dispersion could be estimated with sensitivity studies based on wind speed, wind angle, roadway orientation, roadway width, and etc. This could be a complex estimation and needs very adept modeling skills. Roadway modeling should be evaluated on a case-by-case basis in consultation with the District or the reviewing authority.

Line sources inputs include a composite fleetwide emission factor, roadway geometry, hourly vehicle activity (i.e., diurnal vehicle per hour pattern), hourly meteorological data, and receptor placement. For practical information on how to simulate roadway emissions using these models, see CAPCOA's website at http://www.capcoa.org or the Sacramento Metropolitan AQMD (SMAQMD) website at http://www.airquality.org/ceqa/RoadwayProtocol.shtml. The SMAQMD has a document titled, "Recommended Protocol for Evaluating the Location of Sensitive Land Uses Adjacent to Major Roadways"(January, 2010).

e. Complex Terrain:
AERMOD uses the Dividing Streamline (Hc) concept for complex terrain. Above Hc, the plume is assumed to be "terrain following" in the convective boundary layer. Below Hc, the plume is assumed to be "terrain impacting" in the stable boundary layer. AERMOD computes the concentration at any receptor as a weighted function between the two plume states (U.S. EPA, 2004b).

f. Deposition:
AERMOD contains algorithms to model settling and deposition and requires additional information to do so including particle size distribution. For more information consult the AERMOD User's Guide (U.S. EPA, 2004a).

g. Diurnal Considerations:
Systematic diurnal changes in atmospheric conditions are expected along the coast (or any large body of water) or in substantially hilly terrain. The wind speed and direction are highly dependent on time of day as the sun rises and begins to heat the Earth. The sun heats the surface of the land faster than the water surface. Therefore the air above the land warms up sooner than over water. This creates a buoyant effect of warm air rising over land and the cool air from over water moves in to fill the void. Near large bodies of water (e.g., the ocean) this is known as a sea breeze. In complex terrain this is known as upslope flow as the hot air follows the terrain upwards. When the sun sets and the surface of the land begins to cool, the air above also cools and creates a draining effect. Near the water this is the land breeze; in complex terrain this is known as downslope or drainage flow. In addition, for the sea breeze, the atmospheric

conditions change rapidly from neutral or stable conditions over water to unstable conditions over land.

Near the large bodies of water the sea breeze is typical in the afternoon and the land breeze is typical for the early morning before sunrise. In complex terrain upslope flow is typical in the afternoon, while drainage flow is typical at night. Diurnal profiles need to be evaluated in conjunction with the facility emissions since sources can have varied emission profiles (e.g., some sources are continuously emitting while others are intermittent). These intermittent emission profiles may be influenced by diurnal patterns; therefore, they need to be evaluated to properly estimate potential exposures. For these reasons, it is especially important to simulate facility emissions with a hourly diurnal pattern reflective of source activity so that the risk assessment is representative of daily conditions.

h. 8-hour Modeling for the Offsite Worker's Exposure and Residential Exposure: If the ground level air concentrations from a facility operating 5 days a week, 8 hours per day have been estimated by a 24 hour per day annual average, an adjustment factor can be applied to estimate the air concentration that an offsite worker with the same schedule would be exposed to. The 24-hour annual average concentration is multiplied times 4.2.

If the meteorology during the time that the facility is emitting is used, hourly model simulations need to be post-processed to cull out the data needed for the offsite worker exposure. See Appendix M for information on how to calculate the refined offsite worker concentrations using the hourly raw results from the AERMOD air dispersion model. For more discussion on worker exposure, see Section 4.8.1.

Eight-hour exposure modeling can be used to evaluate the potential for health impacts (including effects of repeated exposures) in children and teachers exposed during school hours. Although not required in the HRA, 8-hour exposure modeling could also be performed at the discretion of the District to a residential scenario (i.e., the MEIR) where a facility operates only a portion of the day and exposure to residences are not adequately reflected by averaging concentrations over a 24 hour day.

4.11.1.3 HARP Dispersion Analysis

It is highly recommended that air dispersion analysis be performed using the HARP software. HARP can perform refined dispersion analysis by utilizing the U.S. EPA standard program AERMOD. In the future, the updated version of HARP will link the AERMOD outputs with risk assessment modules.

4.11.2 *CTDMPLUS*

CTDMPLUS is a Gaussian air quality model for use in all stability conditions in complex terrain. In comparison with other models, CTDMPLUS requires considerably more

detailed meteorological data and terrain information that must be supplied using specifically designed preprocessors. CTDMPLUS was designed to handle up to 40 point sources.

4.12 Modeling to Obtain Concentrations used for Various Health Impacts

The following section outlines how emissions and air dispersion modeling results are used or adjusted for a receptor that is exposed to either a non-continuous or continuously emitting source.

4.12.1 *Emission Rates for Cancer, Chronic, and Acute Health Impacts*

As discussed in Section 4.2.1.1, the HRA should include both annual average emissions and maximum 1-hour emissions for each pollutant emitted by the facility. Maximum 1-hour emissions are used for acute noncancer health impacts while annual emissions are used for chronic exposures (i.e., chronic and 8-hour noncancer health impacts or cancer risk assessment). When applying the emission rates in the air dispersion analysis, it is important not to artificially inflate or deplete the reported emission inventory.

For annual average emissions, the emissions are spread evenly over the entire year for continuous emitting sources. However, for sources where the emission patterns vary (i.e., non-continuous emitting sources), the emission rate should also account for the facility's emission schedule. If appropriate, the variable emissions rate option (e.g., hour-of-day) should be used in the air dispersion analysis. For more information consult the AERMOD User's Guide (U.S. EPA, 2004a). Also, when calculating emission rates for acute health impacts, it is important the emission rates never exceed the reported maximum 1-hour emissions.

4.12.2 *Modeling and Adjustments for Inhalation Cancer Risk at a Worksite*

Modeled long-term averages are typically used for cancer risk assessments for residents and workers. In an inhalation cancer risk assessment for an offsite worker, the long-term average should represent what the worker breathes during their work shift. However, the long-term averages calculated from AERMOD typically represent exposures for receptors that were present 24 hours a day and seven days per week (i.e., the schedule of a residential receptor). To estimate the offsite worker's concentration, there are two approaches. The more refined, complex, and time consuming approach is to post-process the hourly raw dispersion model output and examine the hourly concentrations that fall within the offsite worker's shift. See Appendix M for information on how to simulate the long-term concentration for the offsite worker that can be used to estimate inhalation cancer risk.

In lieu of post-processing the hourly dispersion model output, the more typical approach is to obtain the long-term average concentration as you would for modeling a residential receptor and approximate the worker's inhalation exposure using an adjustment factor. The actual adjustment factor that is used to adjust the concentration may differ from the example below based on the specifics of the source and worker receptor

(e.g., work-shift overlap). Once the worker's inhalation concentration is determined, the inhalation dose is calculated using additional exposure frequency and duration adjustments. See Chapter 5 for more information on the inhalation dose equation.

4.12.2.1 Non-Continuous Sources

When modeling a non-continuously emitting source (e.g., operating for eight hours per day and five days per week), the modeled long-term average concentrations are based on 24 hours a day and seven days per week for the period of the meteorological data set. Even though the emitting source is modeled using a non-continuous emissions schedule, the long-term concentration is still based on 24 hours a day and seven days per week. Thus, this concentration includes the zero hours when the source was not operating. For the offsite worker inhalation risk, we want to determine the long-term concentration the worker is breathing during their work shift. Therefore, the long-term concentration needs to be adjusted so it is based only on the hours when the worker is present. For example, assuming the emitting source and worker's schedules are the same, the adjustment factor is 4.2 = (24 hours per day/8 hours per shift)x(7 days in a week/5 days in a work week). In this example, the long term residential exposure is adjusted upward to represent the exposure to a worker. Additional concentration adjustments may be appropriate depending on the work shift overlap. These adjustments are discussed below.

The calculation of the adjustment factor from a non-continuous emitting source is summarized in the following steps.

a. Obtain the long-term concentrations from air dispersion modeling as is typical for residential receptors (all hours of a year for the entire period of the meteorological data set).

b. Determine the coincident hours per day and days per week between the source's emission schedule and the offsite worker's schedule.

c. Calculate the worker adjustment factor (WAF) using Equation 4.1. When assessing inhalation cancer health impacts, a discount factor (*DF*) may also be applied if the offsite worker's schedule partially overlaps with the source's emission schedule. The discount factor is based on the number of coincident hours per day and days per week between the source's emission schedule and the offsite worker's schedule (see Equation 4.2). The DF is always less than or equal to one.

Please note that worker adjustment factor does not apply if the source's emission schedule and the offsite worker's schedule do not overlap. Since the worker is not present during the time that the source is emitting, the worker is not exposed to the source's emission (i.e., the DF in Equation 4.2 becomes 0).

$$WAF = \frac{H_{residentid}}{H_{source}} \times \frac{D_{residentid}}{D_{source}} \times DF \qquad \text{Eq. 4.1}$$

Where:
WAF = the worker adjustment factor
$H_{residential}$= the number of hours per day the long-term residential concentration is based on (always 24 hours)
H_{source} = the number of hours the source operates per day
$D_{residential}$ = the number of days per week the long-term residential concentration is based on (always 7 days)
D_{source}= the number of days the source operates per week
DF = a discount factor for when the offsite worker's schedule partially overlaps the source's emission schedule. Use 1 if the offsite worker's schedule occurs within the source's emission schedule. If the offsite worker's schedule partially overlaps with the source's emission schedule, then calculate the discount factor using Equation 4.2 below.

$$DF = \frac{H_{coincident}}{H_{worker}} \times \frac{D_{coincident}}{D_{worker}} \qquad \text{Eq. 4.2}$$

Where:
DF = the discount factor for assessing cancer impacts
$H_{coincident}$ = the number of hours per day the offsite worker's schedule and the source's emission schedule overlap
$D_{coincident}$= the number of days per week the offsite worker's schedule and the source's emission schedule overlap
H_{worker} = the number of hours the offsite worker works per day
D_{worker}= the number of days the offsite worker works per week

d. The final step is to estimate the offsite worker's inhalation concentration by multiplying the worker adjustment factor with the long-term residential concentration. The worker's concentration is then plugged into the dose equation and risk calculation.

The HARP software has the ability to calculate worker impacts using an approximation factor and, in the future, it will have the ability to post-process refined worker concentrations using the hourly raw results from an air dispersion analysis.

4.12.2.2 Continuous Sources

If the source is continuously emitting, then the worker is assumed to breathe the long-term annual average concentration during their work shift. Equation 4.1 becomes one and no concentration adjustments are necessary in this situation when estimating the inhalation cancer risk. Note however, if an assessor does not wish to apply the assumption the worker breathes the long-term annual average concentration during the work shift, then a refined concentration can be post-processed as described in Appendix M. All alternative assumptions should be approved by the reviewing authority and supported in the presentation of results.

4.12.3 *Modeling and Adjustments for Noncancer 8-Hour RELs*

For 8-hour noncancer health impacts, we evaluate if the receptor (e.g., worker or resident) is exposed to an 8 hour average concentration, occurring daily, that exceeds the 8-hour REL. The 8 hour RELs were derived primarily for the offsite worker scenario. Although not required in an HRA, residential receptors can be evaluated with an 8-hour

REL at the discretion of the District or Reviewing authority. For ease, we use a worker receptor in this discussion and in the discussion below for a non-continuously emitting source. The daily average concentration is intended to represent the long-term average concentration the worker is breathing during the work shift. In general, there are two approaches for estimating the concentration used for the 8-hour hazard index. The more refined, complex, and time consuming approach is to post-process the hourly dispersion model output and use only the hourly concentrations that are coincident with the offsite worker hours to obtain the long-term concentration. See Appendix M for information on how to simulate the daily average concentration through air dispersion modeling.

Before proceeding through a refined analysis described in Appendix M, the assessor may wish to approximate the long-term concentration, as described below, and calculate the 8-hour hazard index. In lieu of post-processing the hourly dispersion model output described in Appendix M, the more typical approach is to obtain the long-term average concentration as you would for modeling a residential receptor and approximate the worker's inhalation concentration using an adjustment factor. The method for applying the adjustment factor is described in the section below.

The results from the 8-hour hazard index calculations should not be combined with the chronic or acute hazard indices. Each of the potential noncancer health impacts should be reported independently. See Chapter 8 for more discussion on calculating health impacts.

4.12.3.1 Non-Continuous Sources

When modeling a non-continuously emitting source (e.g., operating for eight hours per day and five days per week), the modeled long-term average concentrations are based on 24 hours a day and seven days per week for the period of the meteorological data set. Even though the emitting source is modeled using a non-continuous emissions schedule, the long-term concentration is still based on 24 hours a day and seven days per week. Thus, this concentration includes the zero hours when the source was not operating. For the offsite worker 8-hour hazard index, we want to determine the long-term average daily concentration the worker may be breathing during their work shift. This is similar to the cancer approximation adjustment method with one difference; there is no adjustment for partial overlap between the worker's schedule and the source's emission schedule. The reason for this difference in methodology is because the 8-hour REL health factors are designed for repeated 8-hour exposures and cannot readily be adjusted to other durations of exposure. The 8-hour RELs should be used for typical daily work shifts of 8-9 hours. For further questions, assessors should contact OEHHA, the District, or reviewing authority to determine if the 8-hour RELs should be used in your HRA. Any discussions or directions to exclude the 8-hour REL evaluation should be documented in the HRA.

When calculating the long-term average daily concentration for the 8-hour REL comparison, the long-term residential concentration needs to be adjusted so it is based only on the operating hours of the emitting source with the assumption the offsite

worker's shift falls within the emitting source's schedule. For example, assuming the emitting source operates 8 hours per day, 5 days per week and the offsite worker's schedules falls anywhere within this period of emissions, then the adjustment factor is 4.2 = (24 hours per day/8 hours of emissions per day)x(7 days in a week/5 days of emissions per week). In this example, the long term residential exposure is adjusted upward to represent the 8-hour exposure to a worker. No adjustments are applied for partial work shift overlap with the emitting source. If the source emits at night, then see Appendix N for additional recommendations.

Using the approximation factor is a screening method. If the 8-hour hazard index is above a threshold of concern with this method, the district or assessor should contact OEHHA for further guidance regarding the substance of concern. If necessary, further evaluation can be performed using the refined daily average modeling methodology discussed in Appendix M.

The calculation of the adjustment factor from a non-continuous emitting source is summarized in the following steps.

b. Obtain the long-term concentrations from air dispersion modeling as is typical for residential receptors (all hours of a year for the entire period of the meteorological data set).

c. Calculate the worker adjustment factor (WAF) using Equation 4.3. The source's emission schedule is assumed to overlap offsite worker's schedule. Note that the worker adjustment factor and the 8-hour inhalation REL do not apply if the source's emission schedule and the offsite worker's schedule do not overlap at some point.

$$WAF = \frac{H_{residentid}}{H_{source}} \times \frac{D_{residentid}}{D_{source}} \qquad \text{Eq. 4.3}$$

Where:

WAF = the worker adjustment factor
$H_{residential}$= the number of hours per day the long-term residential concentration is based on (always 24 hours)
H_{source} = the number of hours the source operates per day
$D_{residential}$ = the number of days per week the long-term residential concentration is based on (always 7 days).
D_{source}= the number of days the source operates per week.

d. The final step is to estimate the offsite worker's daily average inhalation concentration by multiplying the WAF with the long-term residential concentration. The worker's concentration is then used to calculate the 8-hour hazard index. This method using the approximation factor is a screening method. If the 8-hour hazard index is above a threshold of concern, the district or assessor should contact OEHHA for further guidance regarding the substance of concern.

In the future, the HARP software will have the ability to use 8-hour RELs, calculate worker impacts using an approximation factor, and to post-process worker concentrations using the hourly raw results from an air dispersion analysis.

4.12.3.2 Continuous Sources

If the source is continuously emitting, then the worker is assumed to breathe the long-term annual average concentration during their work shift and no concentration adjustments are made when estimating 8-hour health impacts. Note however, if an assessor does not wish to assume the worker breathes the long-term annual average concentration during the work shift, then a refined concentration can be post-processed as described in Appendix M. All alternative assumptions should be approved by the reviewing authority and supported in the presentation of results.

Note that 8-hour RELs are not typically used for continuously emitting sources for residential receptors. In this situation it is only necessary to estimate a chronic Hazard Index using the annual average concentrations and chronic RELs. However, there may be situations where the District may wish to assess an 8-hour Hazard Index, for example, where there are significant differences in modeled concentration of emissions during the day due to diurnal wind patterns.

4.12.4 *Modeling and Adjustment Factors for Noncancer Chronic RELs*

Potential chronic noncancer health impacts use the long-term annual average concentration regardless of the emitting facility's schedule. No adjustment factors should be used to adjust this concentration. Chronic RELs are used to assess not only residential health impacts, but in many cases worker health impacts as well. There are currently only a limited number of substances with an 8-hour inhalation REL, and a facility may emit only, or mostly, substances that currently have just a chronic REL. Until there are 8-hour RELs for all the Hot Spots substances emitted from a specified facility, we recommend determining the chronic HI for the MEIW to adequately protect the offsite worker.

The results from the chronic hazard index calculations are not combined with the 8-hour or acute hazard indices. All potential noncancer results should be reported independently. See Chapter 8 for more discussion on calculating health impacts.

4.12.5 *Modeling and Adjustments for Oral Cancer Potencies and Oral RELs*

When estimating the cancer risk or noncancer health impacts from noninhalation pathways, no adjustment is made to the long-term annual average concentration regardless of the emitting facility's schedule. Since the media (e.g., soil) at the receptor location where deposition takes place for noninhalation pathways is continuously present, the concentrations used for all noninhalation pathways are not adjusted (up or down) by an adjustment factor. However, some adjustments are made to the concentration once the pollutants reach the media, for example, pollutants undergo decay in soils. In addition, when the dose for each pathway is calculated, exposure adjustments may also be made. See Chapter 5 of this document and the Technical

Support Document for Exposure Assessment and Stochastic Analysis (OEHHA, 2012) to get more information on these types of adjustments. Oral cancer potencies and oral RELs are used to assess both residential or worker health impacts.

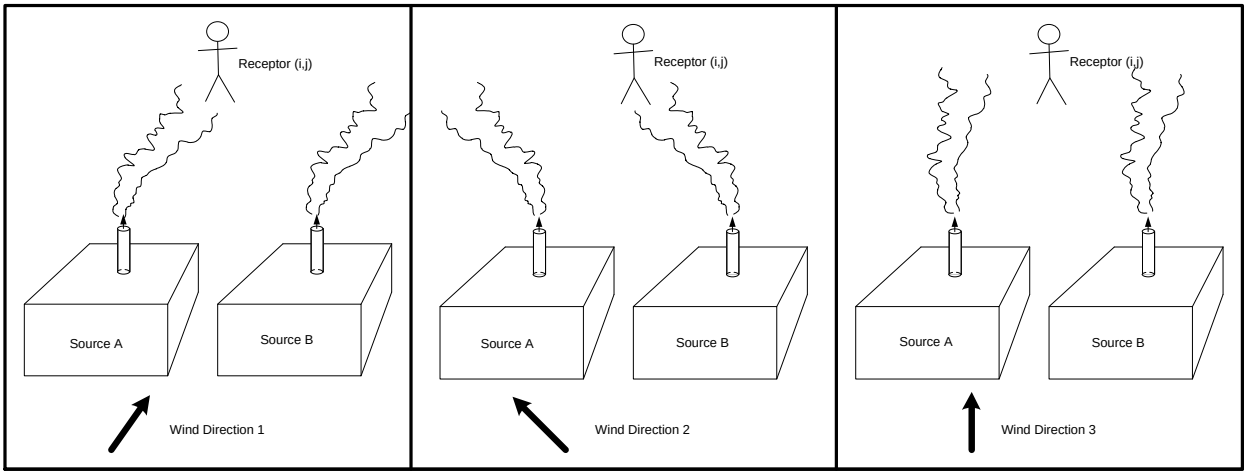
4.12.6 *Modeling One-Hour Concentrations using Simple and Refined Acute Calculations*

Modeled one-hour concentrations are needed for the acute health hazard index calculations. HARP has two methods to calculate this concentration: Simple and Refined. As an aid to understanding the differences between Simple and Refined, Figure 2 shows three possible conditions showing how wind direction may vary and impact a downwind receptor (i,j) differently from just two sources (A and B).

For the Simple calculation, HARP stores only the maximum one-hour concentration at each receptor (i,j) from each source (A and B) as the dispersion model marches down each hour of the simulation (e.g., one to five years of hourly data). At the end of the simulation period, HARP reports back only the maximum impacts at each receptor from each source regardless of which hour of the simulation period this occurred. For example, the Simple Maximum Acute Impacts would be the summation of Source A impacts from Wind Direction 1 and Source B impacts from Wind Direction 2 as shown in Figure 2.

For the Refined simulation, HARP stores each hourly concentration at each receptor (i,j) from each source. At the end of the simulation period, HARP evaluates the coincident impact at each receptor from all sources for each hour of the simulation period. In this case the maximum impacts will be identified by a particular hour of the period with associated wind speed, direction, and atmospheric conditions. For example, the Refined Maximum Acute impact from Sources A and B on receptor (i,j) could be from any wind direction (1,2, or 3) as shown in Figure 2. Since HARP stores all simulations for all sources – at all receptors – for all hours to calculate the refined impacts, there is great potential to fill large amounts of disk storage space. The Refined simulation provides a more representative picture of the maximum acute hazard index from a facility. The Simple calculation will provide an upper bound to the acute hazard index.

Figure 2 Acute Scenarios



4.13 Modeling Special Cases; Specialized Models

Special situations arise in modeling some sources that require considerable professional judgment; a few are outlined below. It is recommended that the reader consider retaining professional consultation services if the procedures are unfamiliar. The following sections, taken mostly from the document "On-Site Meteorological Program Guidance for Regulatory Modeling Applications" (U.S. EPA, 1995e), provide general information on data formats and representativeness. Some Districts may have slightly different recommendations from those given here.

4.13.1 *Building Downwash*

The entrainment of a plume in the wake of a building can result in the "downwash" of the plume to the ground. This effect can increase the maximum ground-level concentration downwind of the source. Therefore, stack sources must be evaluated to determine whether building downwash is a factor in the calculation of maximum ground-level concentrations.

The PRIME algorithm, included with AERMOD, has several advances in modeling building downwash effects including enhanced dispersion in the wake, reduced plume rise due to streamline deflection and increased turbulence, and continuous treatment of the near and far wakes (Schulman, 2000).

Complicated situations involving more than one building may necessitate the use of the Building Profile Input Program (BPIP) which can be used to generate the building dimension section of the input file of the ISC models (U.S. EPA, 1993). The BPIP program calculates each building's direction-specific projected width. The Building Profile Input Program for PRIME (BPIPPRM) is the same as BPIP but includes an algorithm for calculating downwash values for input into the PRIME algorithm which is contained in such models as AERMOD. The input structure of BPIPPRM is the same as that of BPIP.

4.13.2 *Deposition*

There are two types of deposition: wet deposition and dry deposition. Wet deposition is the incorporation of gases and particles into rain-, fog- or cloud water followed by a precipitation event and also rain scavenging of particles during a precipitation event. Wet deposition of gases is therefore more important for water soluble chemicals; particles (and hence particle-phase chemicals) are efficiently removed by precipitation events (Bidleman, 1988). Dry deposition refers to the removal of gases and particles from the atmosphere.

In the Air Toxics "Hot Spots" program, deposition is quantified for particle-bound pollutants and not gases. Wet deposition of water-soluble gas phase chemicals is thus not considered. When calculating pollutant mass deposited to surfaces without including depletion of pollutant mass from the plume, airborne concentrations remaining in the plume and deposition to surfaces can be overestimated, thereby resulting in overestimates of both the inhalation and multi-pathway risk estimates. However, neglecting deposition in the air dispersion model, while accounting for it in the multipathway health risk assessment, is a conservative, health protective approach (CAPCOA, 1987; Croes, 1988). Misapplication of plume depletion can also lead to possible underestimates of multi-pathway risk and for that reason no depletion is the default assumption. If plume depletion is incorporated, then some consideration for possible resuspension is warranted. An alternative modeling methodology accounting for plume depletion can be discussed with the Air District and used in an approved modeling protocol.

Although not generally used, several air dispersion models can provide downwind concentration estimates that take into account the upwind deposition of pollutants to surfaces and the consequential reduction of mass remaining in the plume. Air dispersion models having deposition and plume depletion algorithms require particle distribution data that are not always readily available. These variables include particle size, mass fraction, and density for input to AERMOD. In addition, the meteorological fields need to include additional parameters including relative humidity, precipitation, cloud cover, and surface pressure. Consequently, depletion of pollutant mass from the plume often is not taken into account.

In conclusion, multipathway risk assessment analyses normally incorporate deposition to surfaces in a screening mode, specifically by assigning a default deposition velocity of 2 cm/s for controlled sources and 5 cm/s for uncontrolled sources in lieu of actual measured size distributions (ARB, 1989). For particles (and particle-phase chemicals), the deposition velocity depends on particle size and is minimal for particles of diameter approximately 0.1-1 micrometer; smaller and larger particles are removed more rapidly.

4.13.3 *Short Duration Emissions*

Short-duration emissions (i.e., much less than an hour) require special consideration. In general, "puff models" provide a better characterization of the dispersion of pollutants having short-duration emissions. Continuous Gaussian plume models have traditionally

been used for averaging periods as short as about 10 minutes and are not recommended for modeling sources having shorter continuous emission duration.

4.13.4 *Fumigation*

Fumigation occurs when a plume that was originally emitted into a stable layer in the atmosphere is mixed rapidly to ground-level when unstable air below the plume reaches plume level. Fumigation can cause very high ground-level concentrations. Typical situations in which fumigation occurs are:

- Breaking up of a nocturnal radiation inversion by solar warming of the ground surface (rising warm unstable air); note that the break-up of a nocturnal radiation inversion is a short-lived event and should be modeled accordingly.

- Shoreline fumigation caused by advection of pollutants from a stable marine environment to an unstable inland environment

- Advection of pollutants from a stable rural environment to a turbulent urban environment

SCREEN3 incorporates concentrations due to inversion break-up and shoreline fumigation and is limited to maximum hourly evaluations. The Offshore and Coastal Dispersion Model incorporates overwater plume transport and dispersion as well as changes that occur as the plume crosses the shoreline – hourly meteorological data are needed from both offshore and onshore locations.

4.13.5 *Raincap on Stack*

The presence of a raincap or any obstacle at the top of the stack hinders the momentum of the exiting gas. The extent of the effect is a function of the distance from the stack exit to the obstruction and of the dimensions and shape of the obstruction.

On the conservative side, the stack could be modeled as having a non-zero, but negligible exiting velocity, effectively eliminating any momentum rise. Such an approach would result in final plume heights closer to the ground and therefore higher concentrations nearby. There are situations where such a procedure might lower the actual population-dose and a comparison with and without reduced exit velocity should be examined.

Plume buoyancy is not strongly reduced by the occurrence of a raincap. Therefore, if the plume rise is dominated by buoyancy, it is not necessary to adjust the stack conditions. (The air dispersion models determine plume rise by either buoyancy or momentum, whichever is greater.)

The stack conditions should be modified when the plume rise is dominated by momentum and in the presence of a raincap or a horizontal stack. Sensitivity studies with the SCREEN3 model, on a case-by-case basis, can be used to determine whether

plume rise is dominated by buoyancy or momentum. The District should be consulted before applying these procedures.

- Set exit velocity to 0.001 m/sec
- Turn stack tip downwash off
- Reduce stack height by 3 times the stack diameter

Stack tip downwash is a function of stack diameter, exit velocity, and wind speed. The maximum stack tip downwash is limited to three times the stack diameter in the AERMOD air dispersion model. In the event of a horizontal stack, stack tip downwash should be turned off and no stack height adjustments should be made. Note: This approach may not be valid for large (several meter) diameter stacks.

An alternative, more refined, approach could be considered for stack gas temperatures which are slightly above ambient (e.g., ten to twenty degrees Fahrenheit above ambient). In this approach, the buoyancy and the volume of the plume remain constant and the momentum is minimized.

- Turn stack tip downwash off
- Reduce stack height by 3 times the stack diameter ($3D_o$)
- Set the stack diameter (D_b) to a large value (e.g., 10 meters)
- Set the stack velocity to $V_b = V_o (D_o/D_b)^2$

Where V_o and D_o are the original stack velocity and diameter and V_b and D_b are the alternative stack velocity and diameter for constant buoyancy. This approach is advantageous when $D_b >> D_o$ and $V_b << V_o$ and should only be used with District approval.

In the presence of building downwash and in the event that PRIME downwash is being utilized in AERMOD, an alternative approach is recommended. PRIME algorithms use the stack diameter to define initial plume radius and to solve conservation laws. The user should input the actual stack diameter and exit temperature but set the exit velocity to a nominally low value (e.g., 0.001 m/s). Also since PRIME does not explicitly consider stack-tip downwash, no adjustments to stack height should be made.

Currently U.S. EPA is BETA testing options for capped and horizontal releases in AERMOD. It is expected that these options will replace the above guidance when BETA testing is complete.

4.13.6 *Landfill Sites*

Landfills should be modeled as area sources. The possibility of non-uniform emission rates throughout the landfill area should be investigated. A potential cause of non-uniform emission rates would be the existence of cracks or fissures in the landfill cap (where emissions may be much larger). If non-uniform emissions exist, the landfill should be modeled with several smaller areas assigning an appropriate emission factor to each one of them, especially if there are nearby receptors (distances on the same order as the dimensions of the landfill).

4.14 Specialized Models

Some models have been developed for application to very specific conditions. Examples include models capable of simulating sources where both land and water surfaces affect the dispersion of pollutants and models designed to simulate emissions from specific industries.

4.14.1 *Buoyant Line and Point Source Dispersion Model (BLP)*

BLP is a Gaussian plume dispersion model designed for the unique modeling problems associated with aluminum reduction plants, and other industrial sources where plume rise and downwash effects from stationary line sources are important.

4.14.1.1 Regulatory Application

Regulatory application of BLP model requires the selection of the following options:

- rural (IRU=l) mixing height option;
- default (no selection) for all of the following: plume rise wind shear (LSHEAR), transitional point source plume rise (LTRANS), vertical potential temperature gradient (DTHTA), vertical wind speed power law profile exponents (PEXP), maximum variation in number of stability classes per hour (IDELS), pollutant decay (DECFAC), the constant in Briggs' stable plume rise equation (CONST2), constant in Briggs' neutral plume rise equation (CONST3), convergence criterion for the line source calculations (CRIT), and maximum iterations allowed for line source calculations (MAXIT); and
- terrain option (TERAN) set equal to 0.0, 0.0, 0.0, 0.0, 0.0, 0.0.

For more information on the BLP model consult the user's guide (Schulman and Scire, 1980).

4.14.2 *Offshore and Coastal Dispersion Model (OCD)*

OCD (DiCristofaro and Hanna, 1989) is a straight-line Gaussian model developed to determine the impact of offshore emissions from point, area or line sources on the air quality of coastal regions. OCD incorporates "over-water" plume transport and dispersion as well as changes that occur as the plume crosses the shoreline. Hourly meteorological data are needed from both offshore and onshore locations. Additional data needed for OCD are water surface temperature, over-water air temperature, mixing height, and relative humidity.

Some of the key features include platform building downwash, partial plume penetration into elevated inversions, direct use of turbulence intensities for plume dispersion, interaction with the overland internal boundary layer, and continuous shoreline fumigation.

4.14.2.1 Regulatory Application

OCD has been recommended for use by the Minerals Management Service for emissions located on the Outer Continental Shelf (50 FR 12248; 28 March 1985). OCD is applicable for over-water sources where onshore receptors are below the lowest source height. Where onshore receptors are above the lowest source height, offshore plume transport and dispersion may be modeled on a case-by-case basis in consultation with the District.

4.14.3 *Shoreline Dispersion Model (SDM)*

SDM (PEI, 1988) is a hybrid multipoint Gaussian dispersion model that calculates source impact for those hours during the year when fumigation events are expected using a special fumigation algorithm and the MPTER regulatory model for the remaining hours.

SDM may be used on a case-by-case basis for the following applications:

- tall stationary point sources located at a shoreline of any large body of water;
- rural or urban areas;
- flat terrain;
- transport distances less than 50 km;
- 1-hour to 1-year averaging times.

4.15 Interaction with the District

The risk assessor must contact the District to determine if there are any specific requirements. Examples of such requirements may include, but are not limited to: specific receptor location guidance, specific usage of meteorological data, and specific report format (input and output). See Chapter 9 for more information on the format and content of modeling protocols and HRAs.

4.15.1 *Submittal of Modeling Protocol*

It is strongly recommended that a modeling protocol be submitted to the District for review and approval prior to extensive analysis with an air dispersion model. The modeling protocol is a plan of the steps to be taken during the air dispersion modeling process. Following is an example of the format that may be followed in the preparation of the modeling protocol. **Consult with the District to confirm format and content requirements or to determine the availability of District modeling guidelines before submitting the protocol.**

Outline for a Modeling Protocol

I. Introduction

Include the facility name, address, and a brief overview describing the facility's operations.

- Provide a description of the terrain and topography surrounding the facility and potential receptors.

- Indicate the format in which data will be provided. Ideally, the report and summary of data will be on paper and all data and model input and output files will be provided electronically (e.g., compact disk or CD).

- Identify the guidelines used to prepare the protocol (e.g., District Guidelines).

II. Emissions

For each pollutant and process whose emissions are required to be quantified in the HRA, list the annual average emissions (pounds/year and grams/second) and the maximum one-hour emissions (pounds/hour and grams/second)[2]. Maximum 1-hour emissions are used for acute noncancer health impacts while annual emissions are used for chronic exposures (i.e., chronic and 8-hour noncancer health impacts or cancer risk assessment).

- Identify the reference and method(s) used to determine emissions (e.g., source tests, emission factors, etc.). Clearly indicate any emission data that are not reflected in the previously submitted emission inventory report. In this event, a revised emission inventory report will need to be submitted to the District.

- Identify if this will be a multipathway assessment based on emitted substances.

III. Models / Modeling Assumptions

Specify the model and modeling assumptions

- Identify the model(s) to be used, including the version number.

- Identify the model options that will be used in the analysis.

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[2] Except radionuclides, for which annual and hourly emissions are reported in Curies/year and millicuries/hour, respectively.

- Identify the modeling domain(s) and the spacing of receptor grid(s). Grid spacing should be sufficient in number and detail to capture the concentration at all of the receptors of interest.

- Indicate complex terrain options that may be used, if applicable.

- Identify the source type(s) that will be used to represent the facility's operations (e.g., point, area, or volume sources, flare options or other).

- Indicate the preliminary source characteristics (e.g., stack height, gas temperature, exit velocity, dimensions of volume source, etc.).

- Identify and support the use of urban or rural dispersion coefficients for those models that require dispersion coefficients. For other models, identify and support the parameters required to characterize the atmospheric dispersion due to land characteristics (e.g., surface roughness, Monin-Obukhov length).

IV. Meteorological Data

Specify the type, source, and year(s) of hourly meteorological data (e.g., hourly surface data, upper air mixing height information).

- State how the data are representative for the facility site.

- Describe QA/QC procedures.

- Identify any gaps in the data; if gaps exist, describe how the data gaps are filled.

V. Deposition

- Specify the method to calculate deposition (if applicable).

VI. Receptors

Specify the type and location of receptors. Include all relevant information describing how the individual and population-related receptors will be evaluated.

- Identify and describe the location(s) of known or anticipated potential sensitive receptors, the point of maximum impact (PMI), and the maximum exposed individual residential (MEIR) and worker (MEIW) receptors. Identify any special considerations or grids that will be used to model these receptors. This information should correspond with information provided in Section III (e.g., fine receptor spacing of 20 meters at the fence line and centered on the maximum impacts; coarse receptor spacing of 100 meters out to 2,000 meters; extra coarse spacing of 1,000 meters out to 20,000 meters).

- Identify if spatial averaging will be used. Include necessary background information on each receptor including how the domain and spacing will be determined for each receptor or exposure pathway.

- Describe how the cancer burden or population impact estimates are calculated. Clarify the same information for the presentation of noncancer population impacts (e.g., centroids of the census tracts in the area within the zone of impact).

- Specify that actual UTM coordinates and the block/street locations (i.e., north side of 3,000 block of Smith Street), where possible, will be provided for specified receptor locations.

- Identify and support the use of any exposure adjustments (e.g., time a location, diurnal).

- Include the list of anticipated exposure pathways that will be included and indicate which substance will be evaluated in the multipathway assessment. Identify if sensitive receptors are present and which receptors will be evaluated in the HRA.

VII. Maps

Identify how the information will be graphically presented.

- Indicate which cancer risk isopleths will be plotted for the cancer zone of impact (e.g., 10^{-7}, 10^{-6} see Section 4.6.1).

- Indicate the hazard quotients or hazard indices to be plotted for the noncancer acute, 8 hour, and chronic zones of impact (e.g., 0.5, 1.0, etc.).

4.16 Health Risk Assessment Report

This section describes the information related to the air dispersion modeling process that needs to be reported in the risk assessment. This section is also presented in Chapter 9, Summary of the Requirements for a Modeling Protocol and a Health Risk Assessment Report, in Section 9.2. The District may have specific requirements regarding format and content (see Section 4.15). Sample calculations should be provided at each step to indicate how reported emissions data were used. Reviewing agencies must receive input, output, and supporting files of various model analyses on computer-readable media (e.g., CD).

4.16.1 *Information on the Facility and its Surroundings*

Report the following information regarding the facility and its surroundings:

- Facility Name

- Location (UTM coordinates and street address)
- Land use type (see Section 2.4)
- Local topography
- Facility plot plan identifying:
  - source locations
  - property line
  - horizontal scale
  - building heights
  - emission sources

4.16.2 *Source and Emission Inventory Information*[3]

4.16.2.1 Release Parameters

Report the following information for each release location in table format:

- Release location identification number
- Release name
- Release type (e.g., point, volume, area, line, pit, etc.)
- Source identification number(s) used by the facility that emit out of this release location
- Release location using UTM coordinates
- Release parameters by release type (e.g., shown for point source):
  - Stack height (m), stack diameter (building dimensions for downwash), exhaust gas exit velocity (m/s), exhaust gas volumetric flow rate (ACFM), exhaust gas exit temperature (K), etc.

4.16.2.2 Source Description and Operating Schedule

The description and operating schedule for each source should be reported in table form including the following information:

- Source identification number used by the facility
- Source name
- Number of operating hours per day and per year (e.g., 0800-1700, 2700 hr/yr)
- Number of operating days per week (e.g., Mon-Sat)
- Number of operating days or weeks per year (e.g., 52 wk/yr excluding major holidays)
- Release point identification number(s) for where source emissions are released

[3] Health and Safety Code section 44346 authorizes facility operators to designate certain "Hot Spots" information as trade secret. Section 44361(a) requires districts to make health risk assessments available for public review upon request. Section 44346 specifies procedures to be followed upon receipt of a request for the release of trade secret information. See also the Inventory Guidelines Report regarding the designation of trade secret information in the Inventory Reports.

- Fraction of source emissions emitted at each release point by release point ID number

4.16.2.3 Emission Control Equipment and Efficiency

Report emission control equipment and efficiency by source and by substance

4.16.2.4 Emissions Data Grouped By Source

Report emission rates for each toxic substance, grouped by source (i.e., emitting device or process identified in Inventory Report), in table form including the following information:

- Source name
- Source identification number
- Substance name and CAS number (from Inventory Guidelines)
- Annual average emissions for each substance (lb/yr)
- Hourly maximum emissions for each substance (lb/hr)

4.16.2.5 Emissions Data Grouped by Substance

Report facility total emission rate by substance for all emitted substances listed in the Air Toxics “Hot Spots” Program including the following information:

- Substance name and CAS number (from Inventory Guidelines)
- Annual average emissions for each substance (lb/yr)
- Hourly maximum emissions for each substance (lb/hr)

4.16.2.6 Emission Estimation Methods

Report the methods used in obtaining the emissions data indicating whether emissions were measured or estimated. Clearly indicate any emission data that are not reflected in the previously submitted emission inventory report and submit a revised emission inventory report to the district. A reader should be able to reproduce the risk assessment without the need for clarification.

4.16.2.7 List of Substances

Include tables listing all "Hot Spots" Program substances which are emitted, plus any other substances required by the District. Indicate substances to be evaluated for cancer risks and noncancer health impacts.

4.16.3 *Exposed Population and Receptor Location*

Report the following information regarding exposed population and receptor locations. See Chapter 9 and specific sections within this chapter for more detailed information.

- Description of zone of impact including map showing the location of the facility, boundaries of zone of impact, census tracts, emission sources, sites of maximum exposure, and the location of all appropriate receptors. This should be a true map (one that shows roads, structures, etc.), drawn to scale, and not just a schematic drawing. USGS 7.5 minute maps or GIS based maps are usually the most appropriate choices. (If significant development has occurred since the user's survey, this should be indicated.)
- Separate maps for the cancer risk zone of impact and the hazard index (noncancer) zone of impact(s). The cancer zone of impact should include isopleths down to at least the 1/1,000,000 risk level. Because some districts use a level below 1/1,000,000 to define the zone of impact, the District should be consulted. Three separate maps (to represent both chronic, 8-hour, and acute HI) should be created to define the zone of impact for the hazard index from both inhalation and noninhalation pathways greater than or equal to 0.5. The point of maximum impact (PMI), maximum exposed individual at a residential receptor (MEIR), the maximum exposed individual worker (MEIW), and any other locations of interest for both cancer and noncancer risks should be located on the maps.
- Tables identifying population units and sensitive receptors (UTM coordinates, receptor IDs, and street addresses of specified receptors).
- Heights or elevations of the receptor points.
- For each receptor type (e.g., PMI, MEIR, MEIW, and any other location(s) of interest) that will utilize spatial averaging, the domain size and grid resolution must be clearly identified. If another domain or grid resolution other than 20 meters by 20 meters with 5-meter grid spacing will be used for a receptor, then care should be taken to determine the proper domain size and grid resolution that should be used. For a worker, the HRA shall support all assumptions used, including, but not limited to, documentation for all workers showing the area where each worker routinely performs their duties. The final domain size should not be greater than the smallest area of worker movement. Other considerations for determining domain size and grid spacing resolution may include an evaluation of the concentration gradients across the worker area. The grid spacing used within the domain should be sufficient in number and detail to obtain a representative concentration across the area of interest. When spatial averaging over the deposition area of a pasture, garden, or water body, care should be taken to determine the proper domain size to make sure it includes all reasonable areas of potential deposition. The size and shape of the pasture, garden, or water body of interest should be identified and used for the modeling domain. The grid spacing or resolution used within the domain should be sufficient in detail to obtain a representative deposition concentration across the area of interest. One way to determine the grid resolution is to include an evaluation of the concentration gradients across the deposition area. The HRA shall support all assumptions used, including, but not limited to, documentation of the deposition area (e.g., size and shape of the pasture or water body, maps,

representative coordinates, grid resolution, concentration gradients, etc.). The use or spatial averaging is subject to approval by the reviewing authority. This includes the size of the domain and grid resolution that is used for spatial averaging of a worksite or multipathway deposition area.

4.16.4 *Meteorological Data*

If meteorological data were not obtained directly from the District, then the report must clearly indicate the data source and time period used. Meteorological data not obtained from the District must be submitted in electronic form along with justification for their use including information regarding representativeness and quality assurance.

The risk assessment should indicate if the District required the use of a specified meteorological data set. All memos indicating the District's approval of meteorological data should be attached in an appendix.

4.16.5 *Model Selection and Modeling Rationale*

The report should include an explanation of the model chosen to perform the analysis and any other decisions made during the modeling process. The report should clearly indicate the name of the models that were used, the level of detail (screening or refined analysis) and the rationale behind the selection.

Also report the following information for each air dispersion model used:

- version number
- selected options and parameters in table form
- Identify the modeling domain(s) and the spacing of receptor grid(s). Grid spacing should be sufficient in number and detail to capture the concentration at all receptors of interest.

4.16.6 *Air Dispersion Modeling Results*

- Maximum hourly and annual average concentrations of chemicals at appropriate receptors such as the residential and worker MEI receptors
- Annual average and maximum one-hour (and 30-day average for lead only) concentrations of chemicals at appropriate receptors listed and referenced to computer printouts of model outputs
- Model printouts (numbered), annual concentrations, maximum hourly concentrations
- Disk with input/output files for air dispersion program (e.g., the AERMOD input file containing the regulatory options and emission parameters, receptor locations, meteorology, etc.)
- Include tables that summarize the annual average concentrations that are calculated for all the substances at each site. The use of tables that present the relative contribution of each emission point to the receptor concentration is recommended. (These tables should have clear reference to the computer

model which generated the data. It should be made clear to any reader how data from the computer output were transferred to these tables.) [As an alternative, the above two tables could contain just the values for sites of maximum impact (i.e., PMI, MEIR and MEIW), and sensitive receptors, if required. All the values would be found in the Appendices.]

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5 - Exposure Assessment
Estimation of Concentration and Dose

5.1 Introduction

This chapter provides a summary of how toxicant ground level air concentrations estimated from air dispersion modeling or monitoring results are used to determine dose at receptors of interest. This chapter includes all the algorithms and data (e.g., point estimates, distributions, and transfer factors) that are needed to determine the substance-specific concentration in exposure media and the dose at a receptor of interest. The determination of exposure concentration and dose precedes the calculations of potential health impacts. See Chapter 8 and Appendix I for information on calculating potential health impacts.

At a minimum, three receptors are evaluated in Hot Spots health risk assessments (HRA) (see Section 4.7); these are:

- the Point of Maximum Impact (PMI),
- the Maximally Exposed Individual Resident (MEIR), and
- the Maximally Exposed Individual Worker (MEIW).

The PMI is defined as the receptor point(s) with the highest acute, 8-hour, chronic, or cancer health impact outside the facility boundary. The facility boundary is defined as the property line. Often the fence is on the property line. The MEIR is typically defined as the existing off-site residence(s) (i.e., house, apartment or other dwelling) with the highest acute, chronic, or cancer health impact. Calculating an 8-hour hazard index is not required for the MEIR, but can be performed at the discretion of the District. The MEIW is typically defined as the existing offsite workplace with the highest acute, 8-hour, chronic, or cancer health impact.

In addition, it may be necessary to determine risks at sensitive receptors (e.g., schools, day care centers, elder care centers, and hospitals). The District or reviewing authority should be consulted in order to determine the appropriate sensitive receptors for evaluation. Some situations may require that on-site receptor (worker or residential) locations be evaluated. Some examples where the health impacts of on-site receptors may be appropriate could be military base housing, prisons, universities, or locations where the public may have regular access for the appropriate exposure period (e.g., a lunch time café or museum for acute exposures). The risk assessor should contact the Air Pollution Control or Air Quality Management District (the District) for guidance about any on-site exposure situations at the emitting facility. These on-site locations should be included in the health risk assessment (HRA). If the facility emits multiple substances from two or more stacks, the acute, 8-hour, chronic, and cancer health impacts at the PMI may be located at different physical locations. The MEIR or MEIW cancer, acute, 8-hour, and chronic receptors may also be at different locations.

The process for determining dose at the receptor location, and ultimately potential health impacts, will likely include air dispersion modeling, and, with less frequency, air monitoring data. Air dispersion modeling combines the facility emissions and release parameters and uses default or site-specific meteorological conditions to estimate downwind, ground-level concentrations at various (user-defined) receptor locations. Air dispersion modeling is described in Chapter 4 and is presented in detail in the *Air Toxics Hot Spots Program Risk Assessment Guidelines; Technical Support Document for Exposure Assessment and Stochastic Analysis (OEHHA, 2012a*).

In summary, the process of using air dispersion modeling results as the basis of an HRA follows these four steps:

- Air dispersion modeling is used to estimate annual average and maximum one-hour ground level concentrations (GLC). The air dispersion modeling results are expressed as an air concentration or in terms of (Chi over Q) for each receptor point. (Chi over Q) is the modeled downwind air concentration (Chi) based on an emission rate of one gram per second (Q). (Chi over Q) is expressed in units of micrograms per cubic meter per gram per second, or ($\mu g/m^3$)/(g/s). (Chi over Q) is sometimes written as (χ/Q) and is sometimes referred to as the dilution factor.

- When multiple substances are evaluated, the χ/Q is normally utilized since it is based on an emission rate of one gram per second. The χ/Q at the receptor point of interest is multiplied by the substance-specific emission rate (in g/s) to yield the substance-specific ground-level concentration (GLC) in units of $\mu g/m^3$. The following equations illustrate this point.

$$\mathbf{GLC} = \left(\frac{\chi}{\mathbf{Q}}\right) \mathbf{x} \left(\mathbf{Q}_{\mathbf{substance}}\right)$$

$$\frac{\chi}{\mathbf{Q}} = \mathbf{(Chi\ \ over\ \ Q)\ in} \left(\frac{\frac{\mu \mathbf{g}}{\mathbf{m}^3}}{\frac{\mathbf{g}}{\mathbf{s}}} \right), \mathbf{\ from\ model\ results\ with\ unit\ emission\ rate}$$

$$\mathbf{Q}_{\mathbf{substance}} = \mathbf{\ substance\ specific\ emission\ rate} \left(\frac{\mathbf{g}}{\mathbf{s}}\right)$$

- The applicable exposure pathways (e.g., inhalation, soil contact, fish consumption) are identified for the emitted substances, and the receptor locations are identified. This determines which exposure algorithms in this chapter are ultimately used to estimate dose. After the exposure pathways are identified, the fate and transport algorithms described in this chapter are used to estimate concentrations in the applicable exposure media (e.g., soil or water) and the exposure algorithms are used to determine the substance-specific dose.

- The dose is used with cancer and noncancer health values to calculate the potential health impacts for the receptor (Chapter 8). An example calculation

using the high-end point-estimates for the inhalation (breathing) exposure pathway can be found in Appendix I. Appendix I and Chapters 5 (this Section) and 8 also contain information on how the annual average and maximum one-hour ground level concentrations are used for chronic, 8-hour, and acute health risk calculations.

The algorithms in this chapter are also used to calculate media concentrations and dose in the rare instance, for the Hot Spots program, when monitoring equipment was used rather than air dispersion modeling to obtain a receptor's substance-specific GLC. One situation that is specific to monitored data is the treatment of results below the sampling method level of detection (LOD). In short, it is standard risk assessment practice when monitoring results are reported both above and below the LOD to use one-half of the LOD for those sample concentrations reported below the LOD. If all testing or monitoring results fall below the LOD, then assessors should contact the District for appropriate procedures. For more information about reporting emissions under the Hot Spots Program, see the ARB's *Emission Inventory Criteria and Guidelines Regulations (Title 17, California Code of Regulations, Sections 93300-93300.5),* and the *Emission Inventory Criteria and Guidelines Report* (EICG Report), which is incorporated by reference therein (ARB, 2007*)*.

The recommended model for calculating and presenting HRA results for the Hot Spots Program is the HARP software, available from the Air Resources Board (ARB). More information on HARP and directions for downloading the software can be found on the ARB's web site at http://www.arb.ca.gov/toxics/harp/downloads.htm.

5.2 Criteria for Exposure Pathway Evaluation

In order to determine total dose to the receptor the applicable pathways of exposure need to be identified. The inhalation pathway must be evaluated for all Hot Spots substances emitted by the facility. A small subset of Hot Spots substances is subject to deposition onto soil, plants, and water bodies. These substances need to be evaluated by the appropriate noninhalation pathways, as well as by the inhalation pathway, and the results must be presented in all HRAs. These substances include semi-volatile organic chemicals and heavy metals. Such substances are referred to as multipathway substances. Two steps are necessary to determine if a substance should be evaluated for multipathway impacts:

1. Determine whether the substance or its group (e.g., dioxins, PAHs) is listed in Table 5.1.
2. Determine if the substance has an oral reference exposure level (REL) listed in Table 6.4, or if it has an oral cancer slope factor listed in Table 7.1. Two other references for checking the presence of oral health factors are OEHHA's website (OEHHA, 2012b) and the *Consolidated Table of OEHHA/ARB Approved Risk Assessment Health Values* on the Air Resources Board website (ARB, 2012). Oral or noninhalation exposure pathways include the ingestion of soil, angler-caught fish, drinking water from surface water sources, mother's milk,

homegrown produce, beef, pork, chicken, eggs and cow's milk. The dermal pathway is also evaluated via contact with contaminated soil.

For all multipathway substances, the minimum exposure pathways that must be evaluated at every residential site (in addition to inhalation) are soil ingestion and dermal exposure. If dioxins, furans, PCBs, PAHs or lead are emitted, then the breast-milk consumption pathway also becomes mandatory. The other exposure pathways (e.g., the ingestion of homegrown produce or angler-caught fish) are evaluated on a site-by-site basis. If the resident can be exposed through an impacted exposure pathway, then it must be included in the HRA. However, if there are no vegetable gardens or fruit trees within the zone of impact for a facility, for example, then the produce pathways need not be evaluated. Note that on-site residential receptors are potentially subject to inhalation and noninhalation exposure pathways. Table 8.2 identifies the residential and worker receptor exposure pathways that are mandatory and those that are dependent on the site-specific decisions. While residents can be exposed though several exposure pathways, worker receptors are only evaluated for inhalation, soil ingestion, and dermal exposure using point estimates.

Table 5.1 shows the multipathway substances that, based on available scientific data, can be considered for each noninhalation exposure pathway. The exposure pathways that are evaluated for a substance depend on two factors: 1) whether the substance is considered a multipathway substance for the Hot Spots Program (Table 5.1), and 2) what the site-specific conditions are. A multipathway substance may be excluded from a particular exposure pathway because its physical-chemical properties can preclude significant exposure via the pathway. For example, some water-soluble substances do not appreciably bioaccumulate in fish; therefore, the fish pathway is not appropriate. In addition, if a particular exposure pathway is not impacted by the facility or is not present at the receptor site, then the pathway is not evaluated. For example, if a fishable water body is not impacted by the facility, or the water source is impacted but no receptor uses it for fishing, then the angler-caught fish pathway is not evaluated.

Table 5.1 Specific Pathways to be Analyzed for Each Multipathway Substance

Substance	Soil Ingestion	Dermal	Meat, Milk & Egg Ingestion	Fish Ingestion	Exposed Vegetable Ingestion	Leafy Vegetable Ingestion	Protected Vegetable Ingestion	Root Vegetable Ingestion	Water Ingestion	Breast Milk Ingestion
Inorganic chemicals										
Arsenic & compounds	X	X	X	X	X	X	X	X	X	
Beryllium & compounds	X	X	X	X	X	X	X	X	X	
Cadmium & compounds	X	X	X	X	X	X	X	X	X	
Chromium VI & compounds	X	X	X[a]	X	X	X	X	X	X	
Fluorides (soluble compounds)	X	X	X		X	X	X	X	X	
Lead & compounds	X	X	X	X	X	X	X	X	X	X
Mercury & compounds	X	X	X	X	X	X	X	X	X	
Nickel & compounds	X	X	X	X	X	X	X	X	X	
Selenium & compounds	X	X	X	X	X	X	X	X	X	
Organic chemicals										
Creosotes	X	X	X	X	X	X			X	X
Diethylhexylphthalate	X	X	X	X	X	X			X	
Hexachlorobenzene	X	X	X	X	X	X			X	
Hexachlorocyclohexanes	X	X	X	X	X	X			X	
4,4'-Methylene dianiline	X	X			X	X			X	
Pentachlorophenol[b]										
PCBs	X	X	X	X	X	X			X	X
Polychlorinated dibenzo-p-dioxins and dibenzofurans	X	X	X	X	X	X			X	X
PAHs	X	X	X	X	X	X			X	X

[a] Cow's milk only; no multipathway analysis for meat and egg ingestion

[b] To be evaluated by pathway in future amendments to the Hot Spots Program

5.3 Estimation of Concentrations in Air, Soil, and Water

Once emissions exit the source, the substances emitted will be dispersed in the air. The substances in the exhaust gas with high vapor pressures will remain largely in the vapor phase, and substances with lower vapor pressures will tend to adsorb to fly ash or other particulate matter. The emission plume may contain both vapor phase substances and particulates. A semivolatile organic toxicant can partition into both vapor and particulate phases. Particulates will deposit on vegetation, on soil, and in water at a rate that is dependent on the particle size. Use the 0.02 m/s deposition rate for emission sources that have verifiable particulate matter control devices or for emission sources that may be uncontrolled but only emit particulate matter that is less than 2.5 microns (e.g., internal combustion engines). The following algorithms are used to estimate concentrations in environmental media including air, soil, water, vegetation, and animal products.

5.3.1 *Air*

The ground level concentration (GLC, or C_{air} as shown in EQ 5.3.1) of a substance in air is a function of the facility emission rate and the dilution factor (χ/Q) at the points under evaluation.

A. Equation 5.3.1: $$C_{air} = Q_{substance} \times \chi/Q$$

1. C_{air} = Ground level concentration ($\mu g/m^3$)
2. $Q_{substance}$ = Substance emission rate (g/sec)
3. χ/Q = Dilution factor provided by dispersion modeling ($\mu g/m^3$/g/sec)

a. Recommended values for EQ 5.3.1:

1. $Q_{substance}$ = Facility-specific, substance emission rate
2. χ/Q = For point of interest, site specific, from dispersion modeling

b. Assumptions for EQ 5.3.1:

1. No plume depletion
2. Emission rate is constant, i.e., assumes steady state

5.3.2 *Soil*

The average concentration of the substance in soil (C_s) is a function of the deposition, accumulation period, chemical specific soil half-life, mixing depth, and soil bulk density. For simplicity and health protection, the Tier 1 default assumes 70-year soil deposition for the accumulation period at end of 70-year facility lifetime. The risk assessor may also choose a supplemental Tier 2 approach, subject to District approval or reviewing authority approval, in which the assessor applies a soil accumulation period based on the facility's start date of operation (e.g., historical date when emissions began), or the current exposure conditions, and the expected duration of operation.

A. Equation 5.3.2 A: $$C_s = Dep \times X / (K_s \times SD \times BD \times T_t)$$

1. C_s = Average soil concentration over the evaluation period ($\mu g/kg$)
2. Dep = Deposition on the affected soil area per day ($\mu g/m^2$-d)
3. X = Integral function for soil accumulation (d), see **EQ 5.3.2 C** below
4. K_s = Soil elimination constant (d^{-1})
5. SD = Soil mixing depth (m)
6. BD = Soil bulk density (kg/m^3)
7. T_t = Soil exposure duration or soil accumulation period (d)

a: Recommended default values for EQ 5.3.2 A:

1. Dep = Calculated in EQ 5.3.2 B
2. X = Calculated in EQ 5.3.2 C
3. K_s = Calculated in EQ 5.3.2 D
4. SD = 0.01 (m) for playground setting (soil ingestion and dermal pathways) and 0.15 (m) for agricultural setting (produce and meat pathways)
5. BD = 1,333 (kg/m^3)
6. T_t = 25,550 (d) = 70 years

b: Assumptions for EQ 5.3.2 A:

1. Substances are uniformly mixed in soil.
2. Substances are not leached or washed away, except where evidence exists to the contrary.
3. It is assumed that toxicants accumulate in the soil for 70 years from deposition over the 70 year lifespan of the facility. Use 70-year soil accumulation (T_t) for Tier 1 estimation of 9-, 30- and 70-year residential exposure, and 25-year off-site worker exposure.
4. For a receptor ingesting mother's milk, the mother is exposed from birth to 25 years of age; the infant is then born and receives mother's milk for one year. Default assumes 70-year soil accumulation for mother's milk pathway. See Table 5.1 for information on which substances or groups of substances must be evaluated by the mother's milk pathway.

B. Equation 5.3.2 B: $$\mathbf{Dep = C_{air} \times Dep\text{-}rate \times 86{,}400}$$

1. C_{air} = Ground level concentration ($\mu g/m^3$)
2. Dep-rate = Vertical rate of deposition (m/sec)
3. 86,400 = Seconds per day conversion factor (sec/d)

a: Recommended default values for EQ 5.3.2 B:

1. C_{air} = Calculated above in EQ 5.3.1 A
2. Dep-rate = Use 0.02 meters/second for controlled sources, or 0.05 meters/second for uncontrolled sources.

b: Assumptions for EQ 5.3.2 B:

1. Deposition rate remains constant. A deposition rate must be used when determining potential noninhalation health impacts. In the absence of facility specific information on the size of the emitted particles, the default values for deposition rate should be used. Currently, the default value of 0.02 meters per second is used for emission sources that have verifiable particulate matter control devices or for emission sources that may be uncontrolled but only emit particulate matter that is less than 2.5 microns

(e.g., internal combustion engines). The 0.05 meters per second default value is used for risk assessment if the emissions are uncontrolled. If other deposition rate factors are used, sufficient support documentation must be included with the HRA.

C. Equation 5.3.2 C: $$X = [\{e^{-Ks * Tf} - e^{-Ks * To}\} / K_s] + T_t$$

1. e = 2.718
2. K_s = Soil elimination constant
3. T_f = End of soil accumulation evaluation period (d)
4. T_o = Beginning of soil accumulation evaluation period (d)
5. T_t = Total days of soil exposure (soil accumulation period) T_f-T_o (d)

a: Recommended default values for EQ 5.3.2 C:

1: K_s = Calculated in EQ 5.3.2 D
2: T_f = 25,550 (d) = 70 years. Total soil exposure time at end of facility operation
3: T_o = 0 (d) The initial time (start period) of soil exposure to all receptors that are impacted by the soil pathway.

Note: Under a Tier 2 scenario, the risk assessor may also adjust T_f and T_t, subject to District approval, to replicate current soil accumulation and expected accumulation at the end of facility operation.

D. Equation 5.3.2 D: $$K_s = 0.693 / t_{1/2}$$

1. 0.693 = Natural log of 2
2. $t_{1/2}$ = Chemical specific soil half-life (d)

a: Recommended default values for EQ 5.3.2 D:

1. $t_{1/2}$ = Chemical-specific. See Table 5.2

5.3.3 *Water*

The water pathway is evaluated if a standing water body (e.g., pond or lake) is impacted by facility emissions and is used as a source for drinking water by food-producing animals or humans, or is a source of angler-caught fish. The average concentration of the substance in water (C_w) is a function of direct deposition and material carried in by surface run-off. However, only the contribution from direct deposition will be considered at this time.

A. Equation 5.3.3 A: $$C_w = C_{depw}$$

1. C_w = Average concentration in water (μg/kg)
2. C_{depw} = Contribution due to direct deposition (μg/kg)

B. Equation 5.3.3 B: $C_{depw} = Dep \times SA \times 365 / (WV \times VC)$

1. Dep = Deposition on water body per day ($\mu g/m^2/d$)
2. SA = Water surface area (m^2)
3. 365 = Days per year (d/yr)
4. WV = Water volume (kg)
5. VC = Number of volume changes per year

a: Recommended default values for EQ 5.3.3 B:

1. Dep = Calculated above in EQ 5.3.2 B
2. SA = Site specific water surface area (m^2)
3. WV = Site specific water volume in (kg) (1L = 1 kg)
4. VC = Site specific number of volume changes per year (SA, WV, and VC values can be obtained from the appropriate Department of Water Resources (DWR) Regional office)

b: Assumptions for EQ 5.3.3 B:

1. With the exception of dilution via number of volume changes per year, all material deposited into the water remains suspended or dissolved in the water column and is available for bioaccumulation in fish.

5.3.4 *Estimation of Concentrations in Vegetation, Animal Products, and Mother's Milk*

Estimates of the concentration of the substance in vegetation, animal products and mother's milk require the use of the results of the air, water, and soil environmental fate evaluation. Plants, animals and nursing mothers will be exposed to the substances at the concentrations previously calculated in Section 5.31 to 5.33 above.

5.3.4.1 Vegetation

The average concentration of a substance in and on vegetation (C_v) is a function of direct deposition of the substance onto the vegetation and of root translocation or uptake from soil contaminated by the substance. We currently recommend root translocation only for the inorganic compounds.

A. Equation 5.3.4.1 A: $C_v = C_{depv} + C_{trans}$

1. C_v = Average concentration in and on specific types of vegetation ($\mu g/kg$)
2. C_{depv} = Concentration due to direct deposition ($\mu g/kg$)
3. C_{trans} = Concentration in vegetation due to root translocation or uptake ($\mu g/kg$) – see EQ 5.3.4.1 C below

B. Equation 5.3.4.1 B: $C_{depv} = [Dep \times IF / (k \times Y)] \times (1 - e^{-kT})$

1. Dep = Deposition on affected vegetation per day ($\mu g/m^2/d$)
2. IF = Interception fraction
3. k = Weathering constant (d^{-1})
4. Y = Yield (kg/m^2)
5. e = Base of natural logarithm (2.718)
6. T = Growth period (d)

a: Recommended default values for EQ 5.3.4.1 B:

1. Dep = Calculated above in EQ 5.3.2 B
2. IF = Crop specific:
    - a: Root crops = 0.0
    - b: Leafy crops = 0.2
    - c: Protected crops = 0.0
    - d: Exposed crops = 0.1
    - e: Pasture = 0.7
3. k = 0.1 (d^{-1})
4. Y = 2 (kg/m^2) for root, leafy, protected, exposed and pasture [CA Department of Food and Agriculture dot maps]
5. T = 45 (d) for leafy crops
   T = 90 (d) for exposed crops

b: Crop-type definitions for EQ 5.3.4.1 B:

1. **Leafy** crop category consists of broad-leafed vegetables in which the leaf is the edible part. Examples include spinach, lettuce, cabbage, and kale.
2. **Root** crop category includes vegetables in which the edible portion is underground. Examples are potato, radish, and carrot.
3. **Exposed** produce category consists of crops with a small surface area subject to air deposition. Examples include strawberries, tomato, cucumber, zucchini, green bean and bell pepper.
4. **Protected** produce category consists of crops in which the edible part is not exposed to air deposition (e.g., the exposed skin of the crop is removed and not eaten). Examples are corn, pea, pumpkin and oranges.

Tables H-9 through H-15 in Appendix H provide more examples of various leafy, root, exposed and protected crop types.

c: Assumptions for EQ 5.3.4.1 B:

1. No deposition on root or protected crops
2. No uptake and translocation of deposited chemicals onto crops

C. Equation 5.3.4.1 C: (for inorganic compounds)

$$C_{trans} = C_s \times UF_2$$

1. C_s = Average soil concentration (μg/kg)
2. UF_2 = Uptake factor based on soil concentration

a: Recommended default values for EQ 5.3.4.1 C:

1. C_s = Calculated above in EQ 5.3.2 A
2. UF_2 = See Table 5.2

D. Equation 5.3.4.1 D: (for organic compounds)

$$UF_2 = [(0.03 \times K_{ow}^{0.77}) + 0.82] / [(K_{oc})(F_{oc})]$$

1. 0.03 = Empirical constant
2. K_{ow} = Octanol:water partition factor
3. 0.77 = Empirical constant
4. 0.82 = Empirical constant
5. K_{oc} = Organic carbon partition coefficient
6. F_{oc} = Fraction organic carbon in soil

a: Recommended default values for EQ 5.3.4.1 D:

1. K_{ow} = Chemical specific, see Table 5.2
2. K_{oc} = Chemical specific, see Table 5.2
3. F_{oc} = 0.1

b: Assumptions for EQ 5.3.4.1 D:

1. OEHHA currently has no recommended root uptake factors for organic compounds listed in Table 5.2. Evidence suggests this route is insignificant compared to airborne deposition. Nevertheless, if it becomes necessary in specific cases to assess root uptake for an organic compound, Equation 5.3.4.1 D would be the algorithm OEHHA recommends using to assess root uptake.

5.3.4.2 Animal Products

The average concentration of the substance in animal products (C_{fa}) depends on which routes of exposure exist for the animals. Animal exposure routes include inhalation, soil ingestion, ingestion of contaminated feed and pasture, and ingestion of contaminated water.

A. Equation 5.3.4.2:

$$C_{fa} = (\text{Inhalation} + \text{Water ingestion} + \text{Feed ingestion} + \text{Pasture/Grazing ingestion} + \text{Soil ingestion}) * Tco$$

1. C_{fa} = Average concentration in farm animals and their products (μg/kg)
2. Inhalation, water ingestion, etc. = Dose through inhalation, water ingestion, etc. (μg/d)
3. Tco = Chemical-specific transfer coefficient of contaminant from diet to animal product (d/kg)

a: Recommended default values for EQ 5.3.4.2:

1. Tco = See Tables 5.3a and 5.3b

b: Assumptions for EQ 5.3.4.2:

1. The Tco for a given chemical is the same for all exposure routes

5.3.4.2.1 Inhalation

A. Equation 5.3.4.2.1: $\text{Inhalation} = BR_a \times C_{air}$

1. Inhalation = Dose through inhalation (μg/d)
2. BR_a = Breathing rate for animal (m^3/d)
3. C_{air} = Ground-level concentration (μg/m^3)

a: Recommended default values for EQ 5.3.4.2.1:

1. BR_a = See Table 5.4
2. C_{air} = Calculated above in EQ 5.3.1 A

b: Assumptions for EQ 5.3.4.2.1:

1. All material inhaled is 100% absorbed

5.3.4.2.2 Water Ingestion

The water ingestion pathway is applied if there are surface water sources of drinking water, such as springs, ponds or lakes, which are exposed to airborne deposition of facility emissions. Due to the site-specific nature for this exposure pathway, OEHHA recommends that the risk assessor conduct a survey at the site to estimate the fraction of contaminated drinking water ingested by the animals, if such sources exist.

A. Equation 5.3.4.2.2: **Water ingestion = $WI_a \times FSW \times C_w$**

1. Water ingestion = Dose through water ingestion (μg/d)
2. WI_a = Water ingestion for animal (kg/d)
3. FSW = Fraction of water ingested from a contaminated body of water (site-specific)
4. C_w = Average concentration in water (μg/kg)
   For water 1 kg = 1 L

a: Recommended default values for EQ 5.3.4.2.2:

1. WI_a = See Table 5.4
2. FSW = Site specific fraction, need to survey water ingestion practices in affected area
3. C_w = Calculated above in EQ 5.3.3 A

5.3.4.2.3 Feed Ingestion

The fraction of feed intake by cattle, pigs and poultry that is contaminated by facility emissions can vary considerably depending on the manner in which the animals are raised. Due to the site-specific nature for this exposure pathway, OEHHA recommends that the risk assessor conduct a survey at the site to estimate the fraction of contaminated feed eaten by the animals. For a Tier 1 assessment, default values are provided by OEHHA (see Table 5.4 and Table 5.4 footnotes) for estimation of exposure to the animals.

Agricultural mixing depth should be used for calculating soil concentration for feed and pasture contamination.

5.3.4.2.3.1 Feed Ingestion

A. Equation 5.3.4.2.3.1: **Feed ingestion = $(1.0 - FG) \times FI \times L \times C_v$**

1. Feed ingestion = Dose through the ingestion of feed (μg/d) that is harvested after it is impacted by source emissions
2. FG = Fraction of diet provided by grazing (site-specific)
3. FI = Feed ingestion rate (kg/d)
4. L = Fraction of locally grown (source impacted) feed that is not pasture (site-specific)
5. C_v = Concentration in feed (μg/kg)

a: Recommended default values EQ 5.3.4.2.3.1:

1. FG = Default values in Table 5.4 footnote b, although a site-specific survey for the fraction of diet provided by grazing is recommended
2. FI = See Table 5.4
3. L = Default values in Table 5.4 footnote b, although a site-specific survey for fraction of locally grown (source impacted) feed that is not pasture is recommended
4. C_v = As calculated above in EQ 5.3.4.1 A

b: Assumptions for EQ 5.3.4.2.3.1:

1. Feed (FI) transported from an off-site location (i.e., not grown locally) is not contaminated by facility emissions.

5.3.4.2.3.2 Pasture/Grazing ingestion

A. Equation 5.3.4.2.3.2: **Pasture/Grazing ingestion = FG × C_v × FI**

1. Pasture/Grazing ingestion = Dose through pasture/grazing (μg/d)
2. FG = Fraction of diet provided by grazing (site-specific)
3. C_v = Concentration in pasture/grazing material (μg/kg)
4. FI = Feed ingestion rate (kg/d)

a: Recommended default values EQ 5.3.4.2.3.2:

1. FG = Default values in Table 5.4 for fraction of diet provided by grazing, although a site-specific survey is recommended
2. C_v = As calculated above in EQ 5.3.4.1 A
3. FI = See Table 5.4

5.3.4.2.4 Soil ingestion

The feeds provided to dairy and beef cattle may contain small quantities of soil. A larger fraction of soil by weight of food is taken up during grazing. Rooting behavior by pigs with access to soil will result in soil ingestion. Likewise, poultry with free access to soil or pasture will also ingest soil. Defaults for soil ingestion are shown in Table 5.4.

A. Equation 5.3.4.2.4 A: **Soil ingestion = SI_a × C_s**

1. Soil ingestion = Dose through soil ingestion (μg/d)
2. SI_a = Soil ingestion rate for animal (kg/d)
3. C_s = Average soil concentration (μg/kg)

a: Recommended default values for EQ 5.3.4.2.4 A:

1. SI_a = Calculated below
2. C_s = Calculated above in EQ 5.3.2 A

B. Equation 5.3.4.2.4 B: $SI_a = [(1 - FG) \times FS_f \times FI] + [FG \times FS_p \times FI]$

1. FG = Fraction of diet provided by grazing
2. FS_f = Soil ingested as a fraction of feed ingested
3. FI = Feed ingestion rate (kg/d)
4. FS_p = Soil ingested as a fraction of pasture ingested

a: Recommended default values for EQ 5.3.4.2.4 B:

1. FG = Site specific fraction of diet provided by grazing
2. FS_f = See Table 5.4
3. FI = See Table 5.4
4. FS_p = See Table 5.4

b: Assumptions for EQ 5.3.4.2.4 B:

1. The transfer coefficient is the same for all exposure routes.
2. Soil ingested in feed (FS_f) transported from an off-site location (i.e., not grown locally) is assumed not to be contaminated by facility emissions.

5.3.4.3 Bioaccumulation in Angler-Caught Fish

The average concentration in fish (C_f) is based on the concentration in water and a chemical-specific bioaccumulation factor.

A. Equation 5.3.4.3: $Ct = Cw \times BAF$

1. Ct = Concentration in wet weight tissue (muscle) of fish (µg/kg)
2. Cw = Concentration in water (µg/kg)
3. BAF = Fish bioaccumulation factor (unitless)

a: Recommended default values for Equation 5.3.4.3:

1. Cw = As calculated above in Equation 5.3.3 A
2. BAF = Chemical-specific; see Table 5.2

b: Assumptions for Equation 5.3.4.3:

1. For conversion of a chemical concentration in a volume of water shown as µg/L, 1 L water = 1 kg water; thus, for concentration of chemical in water, µg/L = µg/kg.
2. For organic chemicals, BAFs lipid-normalized to adult rainbow trout with 4% lipid content in muscle tissue
3. For organic chemicals, BAFs based on the freely dissolved fraction in water under conditions of average particulate organic carbon and dissolved organic carbon in U.S. lakes and other water bodies
4. For inorganic compounds, BAFs based on wet weight muscle tissue concentration and on the total water concentration of the inorganic compound in water.
5. Contaminant concentrations are uniform in water based on dispersion

5.3.4.4 Bioaccumulation in Mother's Milk

The average concentration of a chemical in mother's milk (C_m) is a function of the mother's exposure through all exposure routes (i.e., inhalation, ingestion via food, drinking water, and soil, and dermal absorption via skin contact with soil contaminated with the chemical), the contaminant half-life in the mother's body, and transfer of absorbed chemical to mother's milk. The contaminant half-life in the body and transfer to mother's milk is incorporated in biotransfer coefficients (Tco) in Equation 5.3.4.4. See the TSD (OEHHA, 2012a), Appendix J for details on development of biotransfer factors. The substances assessed by the mother's milk pathway are shown in Table 5.1.

A. Equation 5.3.4.4: $$C_m = [(D_{inder} \times Tco_{m_inder}) + (D_{ing} \times Tco_{m_ing})] \times BW$$

1. C_m = Concentration in mother's milk (mg/kg-milk)
2. D_{inder} = The sum of DOSEair + DOSEdermal through inhalation and dermal absorption (mg/kg-BW-day)
3. D_{ing} = The sum of DOSEfood + DOSEsoil + DOSEwater through ingestion (mg/kg-BW-day)
4. Tco_{m_inder} = Biotransfer coefficient from inhalation and dermal absorption to mother's milk (d/kg-milk)
5. Tco_{m_ing} = Biotransfer coefficient from ingestion to mother's milk (d/kg-milk)
6. BW = Body weight of mother (Kg)

a: Recommended cancer risk default values for EQ 5.3.4.4:

1. D_{ing} = As calculated through ingestion of soil in EQ 5.4.3.1.1 + home-grown produce in EQ 5.4.3.2.1 + home-raised animal products in EQ 5.4.3.2.2 + drinking water in EQ 5.4.3.3.1 + angler-caught fish in EQ 5.4.3.4.1
2. D_{inder} = As calculated through inhalation in EQ 5.4.1.1 + dermal exposure in EQ 5.4.2.1
3. Tco_{m_inder} = See Table 5.5
4. Tco_{m_ing} = See Table 5.5

b: Recommended noncancer risk default values for EQ 5.3.4.4:

1. D_{ing} = As calculated through ingestion of soil in EQ 5.4.3.1.2 + home-grown produce and home-raised animal products in EQ 5.4.3.2.3 + drinking water in EQ 5.4.3.3.2 + angler-caught fish in EQ 5.4.3.4.2
2. D_{inder} = As calculated through inhalation in EQ 5.4.1.1 + dermal exposure in EQ 5.4.2.2
3. Tco_{m_inder} = See Table 5.5
4. Tco_{m_ing} = See Table 5.5

c: Assumptions for EQ 5.3.4.4:

1. Default age of mother at birth is 25 years of age, then nurses the infant for 1 year; Use 16<30 year old high-end (95^{th} percentile) daily breathing rate and intake rates for D_{ing} and D_{inder} for estimating dose to mother.
2. For inhalation dose to mother's milk, it is recommended that the EF variate in EQ 5.4.1.1 is left out for calculation of inhalation dose in the mother's milk pathway.
3. Biotransfer coefficient, Tco_{m_inder}, the same for both inhalation and dermal pathways based on lack of first-pass metabolism through the liver for both of these pathways.
4. Biotransfer coefficient, Tco_{m_ing}, the same for all ingestion pathways based on first-pass metabolism through the liver.
5. For chemicals in Table 5.5 lacking either an oral or inhalation Tco, use the oral Tco for the absent inhalation Tco (i.e., for PCDDs and PCDFs and dioxin-like PCBs), or the inhalation Tco for the absent oral Tco (i.e., for lead) in Equation 5.3.4.4.
6. The concentration in the mother's milk is determined using the derived approach to risk assessment. This method allows use of the high-end dose point estimate for driving exposure pathways and the average dose point estimates for other exposure pathways. See Sections 8.2.6 (cancer) and 8.3.3 (noncancer) for the description of the methodology on how to implement the derived methodology.

Table 5.2a Substance-Specific Default Values for Organic Multipathway Substances

				Root Uptake Factors					
Multipathway Substance	**Log K_{oc}**	**Log K_{ow}**	**Fish BAF**	**Root**	**Leafy**	**Exposed**	**Protected**	**GRAF[2]**	**Soil HalfLife (days)**
Creosotes	NA	NA	$8 \times 10^{+2}$	NA	NA	NA	NA	1.0	$4.3 \times 10^{+2}$
Diethylhexyl-phthalate	5.34[1]	7.63[1]	$4 \times 10^{+1}$	NA	NA	NA	NA	1.0	$1.5 \times 10^{+1}$
Dioxins and Furans	NA	NA	$3 \times 10^{+5}$	NA	NA	NA	NA	0.43	$7.0 \times 10^{+3}$
Hexachlorobenzene	NA	NA	$8 \times 10^{+4}$	NA	NA	NA	NA	1.0	$1.0 \times 10^{+8}$
Hexachlorocyclo-hexanes	NA	NA	$3 \times 10^{+3}$	NA	NA	NA	NA	1.0	$9.4 \times 10^{+1}$
4,4'-Methylene dianiline	2.24[3]	1.59[4]	NA	NA	NA	NA	NA	1.0	$4.6 \times 10^{+2}$
Pentachlorophenol[5]									
Polycyclic Aromatic Hydrocarbons (PAHs)	NA	NA	$8 \times 10^{+2}$	NA	NA	NA	NA	1.0	$4.3 \times 10^{+2}$
Polychlorinated Biphenyls	NA	NA	$2 \times 10^{+6}$	NA	NA	NA	NA	1.0	$3.2 \times 10^{+3}$

(1) Averaged log Kow and Koc values determined by most reliable methods (Staples et al., 1997)

(2) GRAF (Gastrointestinal Relative Absorption Factor). The guidelines allow for adjusting for bioavailability where the evidence warrants. For example, there are good data which indicate that dioxin is not as available to an organism when bound to soil or fly ash matrices relative to when it is in solution or in food. Therefore, a bioavailability factor is incorporated into the model to account for this difference. When information becomes available for other chemicals of concern, this type of bioavailability will be incorporated into the model.

(3) Measured by Hansch et al. (1985)

(4) Estimated according to methodology of Lyman et al. (1990)

(5) To be evaluated for specific default values in future amendments to the Hot Spots Program.

NA - Data Not Available or Not Applicable

Table 5.2b Substance-Specific Default Values for Inorganic Multipathway Substances

				Root Uptake Factors					
Multipathway Substance	**Log K_{oc}**	**Log K_{ow}**	**Fish BAF**	**Root**	**Leafy**	**Exposed**	**Protected**	**GRAF[1]**	**Soil HalfLife (days)**
Arsenic & Inorganic Compounds	NA	NA	$2 \times 10^{+1}$	8×10^{-3}	1×10^{-2}	2×10^{-2}	7×10^{-2}	1.0	$1.0 \times 10^{+8}$
Beryllium & Compounds	NA	NA	$4 \times 10^{+1}$	5×10^{-3}	2×10^{-4}	8×10^{-3}	3×10^{-4}	1.0	$1.0 \times 10^{+8}$
Cadmium & Compounds	NA	NA	$4 \times 10^{+1}$	8×10^{-2}	1×10^{-1}	2×10^{-2}	1×10^{-2}	1.0	$1.0 \times 10^{+8}$
Chromium VI & Compounds	NA	NA	$2 \times 10^{+1}$	$3 \times 10^{+0}$	3×10^{-1}	2×10^{-2}	7×10^{-2}	1.0	$1.0 \times 10^{+8}$
Fluorides (soluble compounds)	NA	NA	NA	9×10^{-3}	4×10^{-2}	4×10^{-3}	4×10^{-3}	1.0	$1.0 \times 10^{+8}$
Lead & Compounds	NA	NA	$2 \times 10^{+1}$	4×10^{-3}	8×10^{-3}	7×10^{-3}	3×10^{-3}	1.0	$1.0 \times 10^{+8}$
Mercury & Inorganic Compounds[2]	NA	NA	$8 \times 10^{+1}$	2×10^{-2}	2×10^{-2}	9×10^{-3}	1×10^{-2}	1.0	$1.0 \times 10^{+8}$
Nickel and compounds	NA	NA	$2 \times 10^{+1}$	6×10^{-3}	1×10^{-2}	3×10^{-3}	3×10^{-2}	1.0	$1.0 \times 10^{+8}$
Selenium & compounds	NA	NA	$1 \times 10^{+3}$	7×10^{-2}	6×10^{-2}	4×10^{-2}	3×10^{-1}	1.0	$1.0 \times 10^{+8}$

(1) GRAF (Gastrointestinal Relative Absorption Factor). The guidelines allow for adjusting for bioavailability where the evidence warrants. For example, there are good data which indicate that dioxin is not as available to an organism when bound to soil or fly ash matrices relative to when it is in solution or in food. Therefore, a bioavailability factor is incorporated into the model to account for this difference. When information becomes available for other chemicals of concern, this type of bioavailability will be incorporated into the model.

(2) Methyl mercury (MeHg) is not represented in the category “mercury & inorganic compounds”. The BAF for methyl mercury is orders of magnitude higher than for inorganic mercury. Assessment of MeHg for the fish pathway is not directly applicable to the Hot Spots program, as no facilities are known to emit MeHg directly into the air (OEHHA, 2012; OEHHA, 2006), but it may be formed by action of microbes in sediment. Assessing the methylation of mercury deposited into a water body is difficult, and is also very water body-specific. At this time OEHHA cannot address this issue in the Hot Spots program, but will consider addressing this problem in future amendments of the Guidance.

NA - Data Not Available or Not Applicable.

Table 5.3a Animal Transfer Coefficients for Persistent Organic Chemicals

Organic Chemical	Tco (d/kg)[a]				
	Cow's Milk	Chicken Egg	Chicken Meat	Cattle Meat	Pig Meat
Diethylhexylphthalate	9×10^{-5}	0.04	0.002	6×10^{-4}	5×10^{-4}
Hexachlorobenzene	0.02	20	10	0.2	0.08
Hexachlorocyclohexanes	0.01	7	5	0.2	0.09
PAHs	0.01	0.003	0.003	0.07	0.06
Polychlorinated biphenyls					
Congener 77	0.001	6	4	0.07	0.4
81	0.004	10	7	0.2	0.4
105	0.01	10	7	0.6	0.7
114	0.02	10	7	0.9	0.7
118	0.03	10	7	1	0.7
123	0.004	10	7	0.2	0.7
126	0.04	10	7	2	0.7
156	0.02	10	8	0.9	2
157	0.01	10	8	0.5	2
167	0.02	10	8	1	2
169	0.04	10	8	2	2
189	0.005	10	8	0.2	1
Unspeciated (PCB 126)[b]	0.04	10	7	2	0.7
PCDD/Fs					
Congener 2,3,7,8-TCDD	0.02	10	9	0.7	0.1
1,2,3,7,8-PeCDD	0.01	10	9	0.3	0.09
1,2,3,4,7,8-HxCDD	0.009	10	6	0.3	0.2
1,2,3,6,7,8-HxCDD	0.01	10	6	0.4	0.1
1,2,3,7,8,9-HxCDD	0.007	7	3	0.06	0.02
1,2,3,4,6,7,8-HpCDD	0.001	5	2	0.05	0.2
OCDD	0.0006	3	1	0.02	0.1
2,3,7,8-TCDF	0.004	10	6	0.1	0.02
1,2,3,7,8-PeCDF	0.004	30	10	0.1	0.01
2,3,4,7,8-PeCDF	0.02	10	8	0.7	0.09
1,2,3,4,7,8-HxCDF	0.009	10	5	0.3	0.1
1,2,3,6,7,8-HxCDF	0.009	10	6	0.3	0.09
2,3,4,6,7,8-HxCDF	0.008	5	3	0.3	0.06
1,2,3,7,8,9-HxCDF	0.009	3	3	0.3	0.03
1,2,3,4,6,7,8-HpCDF	0.002	3	1	0.07	0.06
1,2,3,4,7,8,9-HpCDF	0.003	3	1	0.1	0.02
OCDF	0.002	1	0.6	0.02	0.03
Unspeciated (2,3,7,8-TCDD)[b]	0.02	10	9	0.7	0.1

[a] All Tco values were rounded to the nearest whole number.

[b] For unspeciated mixtures, use PCB 126 Tcos to represent the class of PCBs, and 2378-TCDD Tcos to represent the class of PCDDs/Fs.

Table 5.3b Animal Transfer Coefficients for Inorganic Chemicals

Inorganic Metals and Chemicals	Tco (d/kg)[a]				
	Cow's Milk	Chicken Egg	Chicken Meat	Cattle Meat	Pig Meat
Arsenic	5×10^{-5}	0.07	0.03	2×10^{-3}	0.01[b]
Beryllium	9×10^{-7}	0.09	0.2	3×10^{-4}	0.001
Cadmium	5×10^{-6}	0.01	0.5	2×10^{-4}	0.005
Chromium (VI)	9×10^{-6}	NA[c]	NA	NA	NA
Fluoride	3×10^{-4}	0.008	0.03	8×10^{-4}	0.004[b]
Lead	6×10^{-5}	0.04	0.4	3×10^{-4}	0.001[b]
Mercury	7×10^{-5}	0.8	0.1	4×10^{-4}	0.002[b]
Nickel	3×10^{-5}	0.02	0.02	3×10^{-4}	0.001
Selenium	0.009	3	0.9	0.04	0.5

[a] All Tco values were rounded to the nearest whole number.

[b] The meat Tco was estimated using the metabolic weight adjustment ratio of 4.8 from cattle to pig

[c] NA – no data available or was not applicable

Table 5.4 Point Estimates for Animal Pathway

Parameter	Beef Cattle	Lactating Dairy Cattle	Pigs	Meat Poultry	Egg-laying Poultry
BW (body weight in kg)	533	575	55	1.7	1.6
BR_a (inhalation rate in m^3/d)	107	115	7	0.4	0.4
WI_a (water consumption in kg/d)	45	110	6.6	0.16	0.23
FI (Food Intake in kg/d) DMI[a] and/or pasture grazing[b]	9	22	2.4	0.13	0.12
FS_f (soil fraction of feed)	0.01	0.01	NA	NA	NA
FS_p (soil fraction of pasture)	0.05	0.05	0.04	0.02	0.02

[a] Dry matter intake

[b] For beef and dairy cattle, pasture grazing is assumed to be leafy vegetation (grasses, including greenchop) and accounts for half of the cattle's diet (FG=0.5 in Section 5.3.4.2.3). The default assumes on-site pasture grazing contaminated by facility emissions. Fraction of feed or dry matter intake (e.g., hay, grain) grown on-site is assumed to be contaminated by facility emissions and fraction of feed that is grown off-site is not assumed to be contaminated. A default may be used that assumes all feed is grown off-site (L=0 in Section 5.3.4.2.3), but a survey is recommended to verify the fractions of feed grown on-site and off-site.

For pigs with access to soil, but usually confined to a pen, default assumes no pasture grazing (FG=0 in Section 5.3.4.2.3). For feed, estimated intake consists of equal portions of all plant types including exposed, leafy, protected and root in which 10% (L=0.1 in Section 5.3.4.2.3) of the diet is homegrown and contaminated by facility emissions. The fraction of feed that was transported from an off-site location is assumed not to be contaminated by facility emissions.

For poultry including egg-laying and broiler chickens that have access to soil, default assumes no pasture grazing (FG=0 in Section 5.3.4.2.3). Estimated feed intake is composed of equal proportions of all plant types with 5% (L=0.05 in Section 5.3.4.2.3) homegrown and contaminated by facility emissions. The fraction of feed grown off-site and transported to the receptor was not contaminated by facility emissions.

NA - Not applicable. Assume FS_f is equal to zero.

Table 5.5 Mother's Milk Transfer Coefficients (Tco_m)[a]

Chemical/chem. group	Tco_m (day/kg-milk)
PCDDs - oral[b]	3.7
PCDFs - oral[b]	1.8
Dioxin-like PCBs - oral[b]	1.7
PAHs – inhalation[c]	1.55
PAHs – oral	0.401
Lead - inhalation[d]	0.064

[a] These compound classes represent the chemicals of greatest concern for the mother's milk pathway under the Hot Spots program. It is expected that additional transfer coefficients will be developed for other multipathway chemicals in the Hot Spots Program as data becomes available and is reviewed.

[b] Use the oral Tco_m for the inhalation and dermal pathways. The PCDD, PCDF and dioxin-like PCB Tcos were derived using a Random-effects model from individual Tco_m estimates for 7 PCDDs, 9 PCDFs and 12 dioxin-like PCBs (See OEHHA, 2012, Appendix J).

[c] Use the inhalation Tco_m for the dermal pathway

[d] Use the inhalation Tco_m for the ingestion and dermal pathways

5.4 Estimation of Dose

Once the concentrations of substances are estimated in air, soil, water, plants, and animal products, they are used to evaluate estimated exposure to people. Exposure is evaluated by calculating the daily dose in milligrams per kilogram body weight per day (mg/kg/d). The following algorithms calculate this dose for exposure through inhalation, dermal absorption, and ingestion pathways. All chemicals must be assessed for exposure through inhalation. If there are emissions of one or more of the subset of semi- or non-volatile multipathway substances, the soil ingestion pathway and the dermal soil exposure pathway are also assessed. The mother's milk pathway may also be a mandatory pathway depending on the multipathway substance released (See Table 5.1). The other exposure pathways may also need to be assessed if a survey of the exposure site shows they are present (e.g., ingestion of water, home-grown crops, home-raised animal products, and angler-caught fish).

This section contains average and high-end point estimates and data distributions for adults and children for many exposure pathways. The point-estimates and data distributions for children fall within the 3rd trimester, 0<2, 2<9, and 2<16 year age groupings. The point-estimates and data distributions for adults fall within the 16<30 and 16-70 year age groupings. When evaluating 9-, 30-, and 70-year exposure durations for cancer risk assessment, assessors will use distributions starting at the third trimester.

Workers are assessed for cancer risk as adults using 8-hour breathing rate point estimates (See Table 5.8). Point estimates for workers are listed under "offsite worker." OEHHA has not developed stochastic distributions for worker exposure. Therefore, there is no Tier 3 stochastic approach for offsite worker cancer risk assessment.

5.4.1 *Estimation of Exposure through Inhalation*

The dose through the inhalation route is estimated for cancer risk assessment and noncancer hazard assessment. Both residential and offsite worker exposures are considered. Since residential exposure includes near-continuous long-term exposure at a residence and workers are exposed only during working hours (i.e., 8 hours/day), different breathing rate distributions are used.

5.4.1.1 Residential Inhalation Dose for Cancer Risk Assessment

Exposure through inhalation is a function of the breathing rate, the exposure frequency, and the concentration of a substance in the air. For residential exposure, the breathing rates are determined for specific age groups, so inhalation dose (Dose-air) is calculated for each of these age groups, 3rd trimester, 0<2, 2<9, 2<16, 16<30 and 16-70 years. OEHHA used the mother's breathing rates to estimate dose for the 3rd trimester fetus assuming the dose to the fetus during the 3rd trimester is the same as the mother's dose. These age-specific groupings are needed in order to properly use the age sensitivity factors for cancer risk assessment (see Chapter 8). A Tier 1 evaluation uses the high-end point estimate (i.e., the 95th percentiles) breathing rates for the inhalation

pathway in order to avoid underestimating cancer risk to the public, including children. A possible exception for using high-end breathing rates are when there is exposure to multipathway substances and two of the non-inhalation pathways drive the risk, rather than the inhalation pathway (see Chapter 8).

A. Equation 5.4.1.1: $$\text{Dose-air} = C_{air} \times \{BR/BW\} \times A \times EF \times 10^{-6}$$

1. Dose-air = Dose through inhalation (mg/kg/d)
2. C_{air} = Concentration in air ($\mu g/m^3$)
3. {BR/BW} = Daily Breathing rate normalized to body weight (L/kg body weight - day)
4. A = Inhalation absorption factor (unitless)
5. EF = Exposure frequency (unitless), days/365 days
6. 10^{-6} = Micrograms to milligrams conversion, liters to cubic meters conversion

a: Recommended default values for EQ 5.4.1.1:

1. {BR/BW} = Daily breathing rates by age groupings, see As supplemental information, the assessor may wish to evaluate the inhalation dose by using the mean point estimates in Table 5.6 to provide a range of breathing rates for cancer risk assessment to the risk manager.
2. Table (point estimates) and Table 5.7 (parametric model distributions for Tier III stochastic risk assessment). For Tier 1 residential estimates, use 95th percentile breathing rates in Table 5.6.
3. A = 1
4. EF = 0.96 (350 days/365 days in a year for a resident)

b: Assumption for EQ 5.4.1.1:

1. The fraction of chemical absorbed (A) is the same fraction absorbed in the study on which the cancer potency or Reference Exposure Level is based.

As supplemental information, the assessor may wish to evaluate the inhalation dose by using the mean point estimates in Table 5.6 to provide a range of breathing rates for cancer risk assessment to the risk manager.

Table 5.6 Point Estimates of Residential Daily Breathing Rates for 3rd trimester, 0<2, 2<9, 2<16, 16<30 and 16-70 years (L/kg BW-day)

	3rd Trimester[a]	0<2 years	2<9 years	2<16 years	16<30 years	16<70 years
	L/kg-day					
Mean	225	658	535	452	210	185
95th Percentile	361	1090	861	745	335	290

[a] 3rd trimester **breathing rates** based on breathing rates of pregnant women using the assumption that the dose to the fetus during the 3rd trimester is the same as that to the mother.

Table 5.7 Daily Breathing Rate Distributions by Age Group for Residential Stochastic Analysis (L/kg BW-day)

	3rd Trimester	0<2 years	2<9 years	2<16 years	16<30 years	16-70 years
Distribution	Max extreme	Max extreme	Max extreme	Log-normal	Logistic	Logistic
Minimum	78	196	156	57	40	13
Maximum	491	2,584	1,713	1,692	635	860
Scale	59.31	568.09	125.59		40.92	36.19
Likeliest	191.50	152.12	462.61			
Location				-144.06		
Mean	225	658	535	452	210	185
Std Dev	72	217	168	172	75	67
Skewness	0.83	2.01	1.64	1.11	0.83	1.32
Kurtosis	3.68	10.61	7.88	6.02	5.17	10.83
Percentiles						
5%	127	416	328	216	96	86
10%	142	454	367	259	118	104
25%	179	525	427	331	161	141
50%	212	618	504	432	207	181
75%	260	723	602	545	252	222
80%	273	758	631	572	261	233
90%	333	934	732	659	307	262
95%	361	1090	861	745	335	290
99%	412	1430	1140	996	432	361

5.4.1.2 Offsite Worker (MEIW) Inhalation Dose for Cancer Risk Assessment

For worker exposure, the default assumes working age begins at 16 years, and that exposures to facility emissions occur during the work shift, typically up to 8 hours per day during work days. Breathing rates that occur over an 8-hour period vary depending on the intensity of the activity (See Table 5.8), and are used to estimate the inhalation dose. The 8-hour breathing rates may also be useful for cancer risk assessment of children and teachers exposed at schools during school hours.

Another risk management consideration for the offsite worker scenario for cancer assessment of a Hot Spots facility is whether there are women of child-bearing age at the MEIW location and whether the MEIW has a daycare center. Since the third trimester is only a short segment of the 25 year exposure duration used for the MEIW, the resulting risk estimate would not differ significantly. An exception to this assumption is high exposure to carcinogens over a short period, as might occur during short-term projects (see Section 8.2.10). In this case, risk assessment during the third trimester may be warranted. However, if there is onsite daycare at the MEIW, then the risks to the children will be underestimated using the offsite adult worker scenario due to increased exposure (per kg body weight) and increased sensitivity to carcinogen exposure (see Section 8.2.1). In this case, the Districts may wish to include a calculation of inhalation dose for the children in the onsite daycare, assuming they could be there from 0 to age 6 years.

Exposed workers may be engaged in activities ranging from desk work, which would reflect breathing rates of sedentary/passive or light activities, to farm worker activities, which would reflect breathing rates of moderate intensity (See Table 5.9). OEHHA recommends default (Tier 1) point estimate 8-hour breathing rates in L/kg-8-hrs based on the mean and 95th percentile of moderate intensity activities, 170 and 230 L/kg-8-hrs, respectively, for adults 16-70 years old.

Many facilities operate non-continuously, as in only 8-10 hours per day, but the air dispersion modeling is performed as if the emissions were uniformly emitted over 24 hours a day, 7 days per week. The air dispersion computer model used, including AERMOD and other models, typically calculate an annual average air concentration based on actual operating conditions but also include the hours of nonoperation in the average concentration.

Therefore, there are two components that determine the worker exposure to facility emissions:

1) What is the estimated concentration the worker is exposed to (i.e., breathes), during the work shift, and

2) What is the amount of time the offsite worker's schedule overlaps with the facility's emission schedule?

There are two approaches to estimating the modeled concentration the worker is breathing during the work shift. The first approach uses a worker adjustment factor (i.e.,

the WAF) to approximate what the worker is breathing based on the modeling run used for residential receptors. The second approach uses a special modeling run with the hourly raw results from an air dispersion analysis and is described in Appendix M.

The first and more basic approach is to obtain the long term average concentration as you would for modeling a residential receptor, then adjusting this exposure concentration using the calculated WAF (EQ 5.4.1.2 B) to estimate the concentration the offsite worker is exposed to during the work shift (shown as (C_{air} × WAF) in EQ 5.4.1.2 A). This method is characteristic of a default approach used in a Tier 1 assessment. Once the exposure concentration is determined, the worker's inhalation dose (Dose-air) can be calculated as shown in EQ 5.4.1.2 A.

The second approach for determining the air concentration the worker is exposed to uses a refined modeling run where the hourly raw dispersion model output are post processed to examine the hourly concentrations that fall within the offsite worker's shift. This method provides a more representative estimate of the air concentration, but is more complex, and time consuming than the first method. See Appendix M for information on how to simulate the long term concentration for the offsite worker that can be used to estimate inhalation cancer risk.

The HARP software has the ability to calculate worker impacts using an approximation factor and, in the future, it will have the ability to post process refined worker concentrations using the hourly raw results from an air dispersion analysis.

If the off-site worker's shift does not completely overlap the emission schedule of the facility, then a Discount Factor (DF) may be applied to the WAF. Calculation of the DF is shown in EQ 5.4.1.2 C. The default assumption is that the offsite worker's shift falls completely within the emission schedule of the facility, in which case DF=1. Use of a DF less than 1 requires a survey at the MIEW to verify that some portion of the off-site worker shift is not subject to the facility emissions.

A. Equation 5.4.1.2 A: $\textbf{Dose-air} = (C_{air} \times WAF) \times \{BR/BW\} \times A \times EF \times 10^{-6}$

1. Dose-air = Dose through inhalation (mg/kg/d)
2. C_{air} = Annual average concentration in air ($\mu g/m^3$)
3. WAF = Worker air concentration adjustment factor (unitless)
4. {BR/BW} = Eight-hour breathing rate normalized to body weight (L/kg body weight - day)
5. A = Inhalation absorption factor (unitless)
6. EF = Exposure frequency (unitless), days/365 days)
7. 10^{-6} = Micrograms to milligrams conversion, Liters to cubic meters conversion

a: Recommended default values for EQ 5.4.1.2 A:

1. WAF = See EQ. 5.4.1.2 B for formula to calculate WAF, or App. M for refined post-processing modeling to calculate WAF.
2. {BR/BW} = For workers, use age16-70 year, 95th percentile, moderate intensity 8-hour point estimate breathing rates (see Table 5.8). No worker breathing rate distributions exist for stochastic risk assessment.
3. A = 1
4. EF = 0.68 (250 days / 365 days). Equivalent to working 5 days/week, 50 weeks/year.

b: Assumption for EQ 5.4.1.2 A:

1. The fraction of chemical absorbed (A) through the lungs is the same fraction absorbed in the study on which the cancer potency factor is based.
2. The source emits during the daylight hours. Calculate WAF (EQ 5.4.1.2 B) if a special post-processing modeling run described in App. M was not completed. For nighttime emissions and exposure scenarios, see Appendix N.

B. Equation 5.4.1.2 B: $$WAF = (H_{res} / H_{source}) \times (D_{res} / D_{source}) \times DF$$

1. WAF = Worker adjustment factor (unitless)
2. H_{res} = Number of hours per day the annual average residential air concentration is based on (always 24 hours)
3. H_{source} = Number of hours the source operates per day
4. D_{res} = Number of days per week the annual average residential air concentration is based on (always 7 days)
5. D_{source} = Number of days the emitting source operates per week
6. DF = Discount factor, for when the offsite worker's schedule partially overlaps the source's emission schedule

b: Recommended default values for EQ 5.4.1.2 B:

1. DF = 1 for offsite worker's schedule occurring within the source's emission schedule. A site-specific survey may be used to adjust the DF using EQ 5.4.1.2 C.

C. Equation 5.4.1.2 C: $$DF = (H_{coincident} / H_{worker}) \times (D_{coincident} / D_{worker})$$

1. $H_{coincident}$ = Number of hours per day the offsite worker's schedule and the source's emission schedule coincide
2. H_{worker} = Number of hours the offsite worker works per day
3. $D_{coincident}$ = Number of days per week the offsite worker's schedule and the source's emission schedule coincide
4. D_{worker} = Number of days the offsite worker works per week

Tier 2 adjustments for EQ 5.4.1.2 A-C may be used for:

1. Eight-hour breathing rate. Point estimates in Table 5.8 for lower breathing rates of sedentary/passive and light intensity work activities may be substituted in site-specific Tier 2 scenarios. Table 5.9 can be used to estimate breathing rate intensities for various job activities. Use of different breathing rates requires a survey of the exposed workplace and approval by Air District, ARB and OEHHA.
2. Discount Factor (DF) in EQ 5.4.1.2 C. If a site-specific survey of the offsite worker schedule only partially overlaps with the source's emission schedule, then a DF less than 1 may be calculated. Use of a DF less than 1 requires a survey of the exposed workplace and approval by the Air District or ARB.

The 8-hour breathing rates are based on minute ventilation rates derived by U.S. EPA (2009). U.S. EPA employed a metabolic equivalent (METS) approach for estimating breathing rates. This method determines daily time-weighted averages of energy expenditure (expressed as multipliers of the basal metabolic rate) across different levels of physical activity. The 8-hour breathing rates shown in Table 5.8 are divided into three categories:

Sedentary & Passive Activities (METS $\leq$ 1.5)

Light Intensity Activities (1.5 < METs $\leq$ 3.0)

Moderate Intensity Activities (3.0 < METs $\leq$ 6.0)

For example, a METS = 1 is roughly equivalent to energy expenditure during sleep and is close to the basal metabolic rate. A METS activity that is two to three times greater (METS = 2 to 3) is characteristic of light intensity activities, such as administrative office work or sales work as shown in Table 5.9.

Under a Tier 1 scenario, the risk assessor may simply use the 95th percentile breathing rate for moderate intensity activities of 230 L/kg-8 hrs in Eq. 5.4.1.2 A to calculate the daily dose via the inhalation route to the worker. In an example of a Tier 2 scenario, the risk assessor surveys the workplace and determines that the worker(s) at the MEIW receptor are primarily sitting at a desk performing administrative-type work on a computer. Referring to Table 5.9, this activity corresponds most closely to "administrative office work" with a mean activity level of 1.7 and a SD = 0.3. This level of activity is considered "light intensity activity" (i.e., 1.5 < METs $\leq$ 3.0). With the prior approval of the Air District or ARB, the risk assessor may then use the 95th percentile breathing rate of 100 L/kg-8 hr for light intensity activities in Equation 5.4.1.2 A.

Table 5.8. Eight-Hour Breathing Rate (L/kg per 8 Hrs) Point Estimates for Males and Females Combined[a,b]

	0<2 years	2<9 years	2<16 years	16<30 years	16-70 years
	Sedentary & Passive Activities (METS $\leq$ 1.5)				
Mean	200	100	80	30	30
95th Percentile	250	140	120	40	40
	Light Intensity Activities (1.5 < METs $\leq$ 3.0)				
Mean	490	250	200	80	80
95th Percentile	600	340	270	100	100
	Moderate Intensity Activities (3.0 < METs $\leq$ 6.0)				
Mean	890	470	380	170	170
95th Percentile	1200	640	520	240	230

[a] For pregnant women, OEHHA recommends using the mean and 95th percentile 8-hour breathing rates based on moderate intensity activity of 16<30 year-olds for 3rd trimester.
[b.] Breathing rates in the table may be used for worker, school, or residential exposures

Table 5.9. METS Distributions for Workplace and Home Activities

Activity Description	Mean	Median	SD	Min	Max
Workplace Activities					
Administrative office work	1.7	1.7	0.3	1.4	2.7
Sales work	2.9	2.7	1.0	1.2	5.6
Professional	2.9	2.7	1.0	1.2	5.6
Precision/production/craft/repair	3.3	3.3	0.4	2.5	4.5
Technicians	3.3	3.3	0.4	2.5	4.5
Private household work	3.6	3.5	0.8	2.5	6.0
Service	5.2	5.3	1.4	1.6	8.4
Machinists	5.3	5.3	0.7	4.0	6.5
Farming activities	7.5	7.0	3.0	3.6	17.0
Work breaks	1.8	1.8	0.4	1.0	2.5
Household/Neighborhood Activities					
Sleep or nap	0.9	0.9	0.1	0.8	1.1
Watch TV	1.0	1.0	-	1.0	1.0
General reading	1.3	1.3	0.2	1.0	1.6
Eat	1.8	1.8	0.1	1.5	2.0
Do homework	1.8	1.8	-	1.8	1.8
General personal needs and care	2.0	2.0	0.6	1.0	3.0
Indoor chores	3.4	3.0	1.4	2.0	5.0
Care of plants	3.5	3.5	0.9	2.0	5.0
Clean house	4.1	3.5	1.9	2.2	5.0
Home repairs	4.7	4.5	0.7	4.0	6.0
General household chores	4.7	4.6	1.3	1.5	8.0
Outdoor chores	5.0	5.0	1.0	2.0	7.0
Walk/bike/jog (not in transit) age 20	5.8	5.5	1.8	1.8	11.3
Walk/bike/jog (not in transit) age 30	5.7	5.7	1.2	2.1	9.3
Walk/bike/jog (not in transit) age 40	4.7	4.7	1.8	2.3	7.1

Table 5.10 lists some WAFs for a few typical scenarios. For example, if the source is continuously emitting, then the offsite worker is assumed to breathe the long-term annual average concentration during their work shift. The WAF then becomes one and no concentration adjustments are necessary in this situation when estimating the inhalation cancer risk. If the source is non-continuously emitting for 8 hours/day, 5 days/week and the offsite worker's shift completely overlaps the emitting facility's operating schedule, then the WAF would be 4.2:

$$(24 \text{ hrs/day} / 8 \text{ hrs/day}) \times (7 \text{ days/week} / 5 \text{ days/week}) = 4.2$$

If the offsite worker's 8 hour/day shift only overlaps the emitting facility's operation schedule for 4 hrs/day, then the WAF is 2.1 because the DF = 0.5 will reduce the WAF by half: DF = (4 hrs/day / 8 hrs/day) x (5 days/week / 5 days/week) = 0.5

Table 5.10: Example Worker Adjustment Factors (WAF) to Convert a Long-Term Daily Average Emission Concentration to an Off-Site Worker Receptor Exposure

Off-Site Workers' Shift Overlap with Facility's Emission Schedule[a]	Facility Operating Schedule	Adjustment Factor
8 hrs/day, 5 days/week	Continuous (24 hrs/7 days/week)	1.0
8 hrs/day, 5 days/week[b]	Non-continuous (8 hrs/5 days/week)	4.2
4 hrs/day, 5 days/week	Non-continuous (8 hrs/5 days/week)	2.1

[a] Worker works 8 hours per day, 5 days per week
[b] Workers' work hours completely overlap the facilities operating hours

5.4.1.3 Inhalation Dose for Children at Schools and Daycare Facilities for Cancer Risk Assessment

The 8-hour breathing rates and inhalation dose equations (EQ 5.4.1.2 A-C) may also be used to estimate risk to children when exposures occur while at school or at day care facilities. Breathing rate point estimates to use in Table 5.8 depend on the ages of the children at the exposed schools and day cares. As a Tier 1 default, moderate intensity breathing rates are recommended. Equations 5.4.1.2 A-C is used in the same way to estimate dose in children as it is for workers.

5.4.1.4 Non-Cancer Inhalation Exposure for Workers and Residents

For typical daily work shifts of 8-9 hours, acute, 8-hour and chronic Reference Exposure Levels (RELs) described in Chapter 8 are used in health risk assessments to characterize the noncancer risks using the Hazard Index approach described in Chapter 8 and in OEHHA (2008). Uncertainty factors are already incorporated into the RELs used to assess noncancer risk, as explained in Chapter 8, so all that is needed to evaluate the noncancer hazard is the air concentration that the worker is exposed to. The modeled maximum 1-hour air concentration is determined for acute hazard assessment and the annual average air concentration is determined for chronic hazard assessment. The modeled average air concentration during a work shift is determined for 8-hour hazard assessment using the adjusted annual average air concentration described below.

The 8-hour RELs are primarily designed to address offsite worker inhalation exposure at the MEIW because they better characterize the daily intermittent exposures of workers than the chronic RELs do. They are used in estimating the 8 hour Hazard Index for offsite workers. The 8-hour RELs should be used for typical daily work shifts of 8-9 hours. For further questions, assessors should contact OEHHA, the District, or reviewing authority to determine if the 8-hour RELs should be used in your HRA. Any discussions or directions to exclude the 8-hour REL evaluation should be documented in the HRA.

Note, however, there are only a handful of 8-hour RELs currently adopted for use in the Hot Spots program. Therefore, we also recommend performing chronic noncancer exposure assessment for the offsite worker (MEIW) based on the annual average air concentration at the MEIW. Evaluation of the chronic Hazard Index should help protect workers who routinely work longer than 8 hour shifts. Exposure to multipathway substances also requires noncancer hazard assessment for the dermal and oral soil exposure pathways for offsite workers. Because there are few 8-hour RELs currently available, hazard assessment for the noninhalation pathways for multipathway substances is only applied when estimating the chronic Hazard Index.

In addition, the Districts may wish to determine if there is an onsite daycare at the MEIW and include a calculation of the chronic and 8-hour inhalation dose for children, although onsite hazard assessment is not a requirement for a Hot Spots risk assessment.

As explained in Section 5.4.1.2 for cancer risk, the modeled annual average air concentration is adjusted to the air concentration that the worker is actually exposed to if the facility operates non-continuously. The typical method for this adjustment is by calculating the Worker Adjustment Factor (WAF) shown in EQ 5.4.1.4 B and multiplying this value by the annual average air concentration (C_{air}, in $\mu g/m^3$) in EQ 5.4.1.4 A.

Unlike cancer risk assessment, no discount factor (DF) is applied in noncancer assessment for partial overlap between the worker's schedule and the source's emission schedule. Adjustments for worker vacations, work shifts for shortened weeks (e.g., 1 - 4 days), and worker time away on weekends are also not appropriate.

An alternative refined post-processing method, described in Appendix M, may be used to estimate the air concentration the worker is exposed to during their work schedule. OEHHA may be consulted about the particular chemical involved if it is important to make a more refined analysis.

The equation to adjust the annual average air concentration to a worker 8-hour exposure concentration (i.e., the adjusted annual average ground level concentration) is expressed as:

A. Equation 5.4.1.4 A: $$\text{Adjusted } C_{air} \ (\mu g/m^3) = C_{air} \times WAF$$

Where WAF is determined as:

B. Equation 5.4.1.4 B: $$WAF = (H_{res} / H_{source}) \times (D_{res} / D_{source})$$

a: Assumptions for EQ 5.4.1.4 B:

1. No adjustment of the WAF allowed for partial overlap of the worker's schedule and the source's emission schedule.

Alternatives for calculating off-site worker Adjusted C_{air} in EQ 5.4.1.4 A-B:

1. Rather than calculate the WAF for a non-continuous emitting facility, a post-processing of the hourly raw dispersion model output and examination of the hourly concentrations that fall within the offsite worker's shift can be conducted to estimate the air concentration the worker is exposed to. This method is a more refined, complex, and time consuming approach, but should result in a more representative exposure concentration. See Appendix M for information on how to simulate the exposure concentration for the off-site worker.
2. For continuously-emitting facilities (i.e., 24 hrs/day, 7 days/week), if an assessor does not wish to assume the worker breathes the long-term annual average concentration during the work shift, then a refined concentration can also be post-processed as described in Appendix M. All alternative assumptions should be approved by the reviewing authority and supported in the presentation of results.

For residential exposure to non-continuously operating facilities, the modeled maximum 1-hour and chronic air concentrations at the MEIR are determined for noncancer hazard assessment. Hazard assessment for repeated 8-hour exposure at the MEIR is not required. Chronic exposure assessment based on the annual average air concentration should adequately protect individuals, in part because residents are considered to be present at the MEIR at or near 24 hrs per day. Many facilities operate for periods longer than 8 hours per day and the hazards are better characterized based on chronic exposure. Nevertheless, differences between 8-hour and chronic exposures (i.e., higher daily 8-hour exposures vs. lower longer daily exposure 24 hrs/day) may result in different toxicological responses including potentially greater toxicological responses with either 8-hour or chronic exposure. There may also be cases such as special meteorological situations (e.g., significant diurnal-nocturnal meteorological differences) where the 8-hour REL will be more protective than the chronic REL. Thus, the air districts may also elect to have an 8-hour hazard assessment performed at the MEIR, using daily 8 hour exposures and the 8 hr RELs.

Eight-hour exposure assessment is not recommended for continuously emitting sources for residential receptors. In this situation it is only necessary to estimate chronic exposure based on the annual average concentration. However, there may be situations where the air district may wish to assess an 8-hour residential exposure to continuously operating facilities, for example, where there are significant differences in modeled concentration of emissions during the day due to diurnal wind patterns.

For estimating the air concentration from non-continuously operating facilities, EQ 5.4.1.4.A is also used to adjust the annual average concentration to what the residents are exposed to. This is the air concentration that the 8-hour REL will be compared to as discussed in Chapter 8. The alternative refined post-processing method described in Appendix M may also be used to estimate residential exposure.

In summary, the requirements for noncancer hazard assessment using the Hazard Index approach at the MEIW and MEIR are as follows.

For offsite worker exposure:

- Acute hazard assessment based on the maximum 1-hour air concentrations and 1-hour RELs
- Eight-hour hazard assessment based on daily average 8-hour exposure (estimated using adjusted annual average air concentration in EQ 5.4.1.4 A and B or by post-processing method in App. M) for those substances with 8-hour RELs
- Chronic hazard assessment based on annual average exposure and chronic RELs, and oral chronic RELs for noninhalation routes of multipathway substances

For residential exposure:

- Acute hazard assessment based on the maximum 1-hour air concentration and 1-hour RELs
- Eight-hour hazard assessment based on daily average 8-hour exposure not required, but can be performed at the discretion of the air districts for exposure to non-continuously operating facilities based on the adjusted annual average air concentration (EQ 5.4.1.4 A and B or method in App. M). Eight-hour assessments not recommended for exposure to continuously operating facilities
- Chronic hazard assessment based on annual average exposure and chronic RELs, and oral chronic RELs for noninhalation routes of multipathway substances

5.4.1.5 Exposure Frequency and Age Groupings for Noncancer Hazard Assessment

For cancer risk, the basic assumption is that risk is associated with cumulative dose of carcinogen. Thus, the dose used to estimate cancer risk can be adjusted for exposure frequency, as well as time spent within the MEIR or MEIW location. Chronic RELs are not necessarily related to cumulative dose. Thus, adjusting the estimated dose used to calculate hazard index for exposure frequency or time away from the MEIR or MEIW is not appropriate.

The average daily dose for chronic noncancer assessment is based on exposure beginning at birth to 70 years of age, necessitating calculation of a time-weighted average for age 0-2, 2-16 and 16-70 years. Since we are not applying Age Sensitivity Factors for assessing non-cancer hazard, the 3rd trimester is not explicitly called out for determining dose, as it is for cancer risk assessment. Rather adult exposure is considered, which would include pregnant women in any trimester. Both inhalation and oral RELs incorporate safety factors to protect sensitive human populations.

5.4.2 *Estimation of Exposure through Dermal Absorption*

Exposure through dermal absorption (dose-dermal) is a function of the soil or dust loading of the exposed skin surface, the amount of skin surface area exposed, and the concentration and availability of the substance. In the previous edition of OEHHA's

exposure guidelines document (OEHHA, 2000), we recommended using specified average and high-end point estimate values for four of the variates (body weight, exposed surface area of skin, soil load on skin and frequency of exposure) in the stochastic analysis for dermal dose. This equation required multiplying values together, which could lead to overly conservative exposure estimates when high-end values were used. By combining information from the four variates into one composite distribution, over-conservatism may be avoided.

To this end, OEHHA created a new variate, "annual dermal load", or ADL, which is a composite of the body surface area (BSA) per kg body weight, exposure frequency, and soil adherence variates. Point estimates from the composite "annual dermal load" can be used for point estimate assessments while parameters and information on the type of distribution (e.g., lognormal) can be used for Tier III stochastic risk assessments. For details on the development of the ADL, refer to the Technical Support Document for Exposure and Stochastic Analysis (OEHHA, 2012).

5.4.2.1 Dermal Dose for Cancer Risk Assessment

The dose through residential dermal exposure to contaminated soil varies by age and is calculated for each age group (e.g., 3rd trimester, 0<2 yrs, 2<9 yrs, 2<16 yrs, 16<30 and 16-70 yrs). These age-specific groupings are needed in order to properly use the age sensitivity factors for cancer risk assessment (see Chapter 8). This pathway is also assessed for exposure to offsite workers; a separate ADL for offsite workers is presented in Table 5.11. Children at a MEIW daycare, if present, may also be assessed for exposure if the District deems it advisable.

A. Equation 5.4.2.1: $$\mathbf{Dose_{dermal} = ADL \times Cs \times ABS \times 10^{-9} / 365}$$

1. $Dose_{dermal}$ = Exposure dose through dermal absorption (mg/kg-d)
2. ADL = Annual dermal load (mg soil/kg BW-yr)
3. C_s = Average soil concentration (μg/kg)
4. ABS = Fraction absorbed across skin (unitless)
5. 10^{-9} = Conversion factor for chemical & soil (μg to mg, mg to kg)
6. 1/365 = Conversion factor for ADL from yrs to days

a: Recommended default values for EQ 5.4.2.1:

1. ADL = See Table 5.11 (point estimates) & Table 5.12 a-d (distributions)
2. C_s = Calculated above in EQ 5.3.2 A
3. ABS = See Table 5.13

b: Assumption for EQ 5.4.2.1:

1. The ADL for the third trimester of the fetus is based on the ADL of the mother; when normalized to body weight, we assume that exposure to the

mother and the fetus will be the same. The mother's exposure is based on that of adults 16-30 years of age in Table 5.11 and 5.12d.

2. Exposure frequency (EF) for vacation time spent away from exposure does not appear as a variate in EQ 5.4.2.1, as it is incorporated in the ADL and includes a 2-week vacation per year away from dermal soil exposure for both residents and offsite workers.

Climate will strongly influence people's choice of clothing. Due to California's varied climatic regions and existing data on clothing choices at different temperatures, three levels of climatic conditions, warm, mixed, and cold, are used to describe California's climate regions:

1. A warm climate is characteristic of Southern California areas such as Los Angeles, which can have warm to hot temperatures throughout the year.
2. A "mixed" climate is one that has warm-to-hot temperatures during much of the year (daily highs over 80 degrees are common), roughly from April to October, and cold temperatures (lows near or below freezing) during the remainder of the year. The mountains and central valley are examples of a mixed climate.
3. A cold climate is representative of San Francisco, Eureka, and other northern coastal communities, which have cool temperatures (daily highs of less than 65 degrees) for the majority of the year and can receive a considerable amount of fog and rainfall.

OEHHA recommends consulting the local air district for assistance on selecting the most appropriate climate.

Table 5.11 Recommended Annual Dermal Load Point Estimates (in mg/kg-yr) for Dermal Exposure

	3rd Trimester[a]	Children 0<2 yrs	Children 2<9 yrs	Children 2<16 yrs	Adults[b]	Offsite Worker[c]
Warm climate						
Mean	1.2×10^3	3.6×10^3	7.5×10^3	6.4×10^3	1.2×10^3	2.6×10^3
95th percentile	2.6×10^3	4.3×10^3	9.1×10^3	8.5×10^3	2.6×10^3	5.0×10^3
Mixed climate						
Mean	1.1×10^3	2.2×10^3	6.6×10^3	5.7×10^3	1.1×10^3	2.6×10^3
95th percentile	2.4×10^3	2.9×10^3	8.7×10^3	8.1×10^3	2.4×10^3	5.0×10^3
Cold climate						
Mean	0.7×10^3	1.2×10^3	3.1×10^3	2.8×10^3	0.7×10^3	2.6×10^3
95th percentile	2.1×10^3	1.9×10^3	5.2×10^3	5.1×10^3	2.1×10^3	5.0×10^3

[a] The ADL for the 3rd trimester of the fetus is based on the ADL of the mother; when normalized to body weight, we assume that exposure to the mother and the fetus will be the same

[b] Residential adult ADLs are for both 16<30 and 16-70 year age groups

[c] Assumes exposure only to face, hands and forearms regardless of climate region

Tables 5.12a - d Annual Dermal Load Distributions by Age Group and Climate for Stochastic Analysis

Table 5.12a Annual Dermal Load (mg/kg-yr) Distributions for the 0<2 Year Age Group

Climate Type	Warm climate	Mixed climate	Cold climate
Distribution	Student's t	Logistic	Triangular
Minimum			0.2×10^3
Likeliest			0.7×10^3
Maximum			2.6×10^3
Scale	0.41	0.28	
Deg. freedom	3		
Midpoint	3.6×10^3		
Mean	3.6×10^3	2.2×10^3	1.2×10^3
50th percentile	3.6×10^3	2.2×10^3	0.9×10^3
90th percentile	4.1×10^3	2.8×10^3	1.9×10^3
95th percentile	4.3×10^3	2.9×10^3	1.9×10^3
99th percentile	4.7×10^3	3.1×10^3	2.1×10^3

Table 5.12b Annual Dermal Load (mg/kg-yr) Distributions for the 2<9 Year Age Group

Climate Type	Warm climate	Mixed climate	Cold climate
Distribution	Min extreme	Min extreme	Triangular
Minimum			0.4×10^3
Likeliest	8.0×10^3	7.3×10^3	1.9×10^3
Maximum			6.9×10^3
Scale	0.1	1.3	
Mean	7.5×10^3	6.6×10^3	3.1×10^3
50th percentile	7.7×10^3	6.5×10^3	2.3×10^3
90th percentile	8.7×10^3	8.4×10^3	5.1×10^3
95th percentile	9.1×10^3	8.7×10^3	5.2×10^3
99th percentile	9.7×10^3	9.4×10^3	5.7×10^3

Table 5.12c Annual Dermal Load (mg/kg-yr) Distributions for the 2<16 Year Age Group

Climate Type	Warm climate	Mixed climate	Cold climate
Distribution	Min extreme	Logistic	Triangular
Minimum			0.3×10^3
Likeliest	7.2×10^3		1.6×10^3
Maximum			6.9×10^3
Scale	1.29	0.91	
Mean	6.4×10^3	5.7×10^3	2.8×10^3
50th percentile	6.6×10^3	5.7×10^3	2.2×10^3
90th percentile	8.1×10^3	7.7×10^3	4.8×10^3
95th percentile	8.5×10^3	8.1×10^3	5.1×10^3
99th percentile	9.3×10^3	8.9×10^3	5.6×10^3

Table 5.12d Annual Dermal Load (mg/kg-yr) Distributions for Residential Adults (Age 16-30 and 16-70 Years)[a] and Offsite Workers

Receptor	Residential Adult			Offsite Worker
Climate Type	Warm	Mixed	Cold	All Climates[b]
Distribution	Beta	Beta	Gamma	Lognormal
Minimum	0.2×10^3	0.02×10^3		
Maximum	3.3×10^3	0.3×10^3		
Scale			0.07	
Mean	1.2×10^3	1.1×10^3	0.7×10^3	2.6×10^3
50th percentile	1.2×10^3	1.0×10^3	0.5×10^3	2.3×10^3
90th percentile	2.4×10^3	2.1×10^3	1.6×10^3	4.5×10^3
95th percentile	2.6×10^3	2.4×10^3	2.1×10^3	5.0×10^3
99th percentile	2.9×10^3	2.6×10^3	2.3×10^3	6.4×10^3

[a] The ADL distribution for the 3rd trimester is based on the ADL distribution of the mother; we assume the same ADL distribution for residential adult (the mother) and the fetus

[b] Face, hands and forearms are exposed only, regardless of climate

Table 5.13 Dermal Absorption Fraction Factors (ABS) as Percent from Soil for Semi-Volatile and Solid Chemicals under the OEHHA "Hot Spots" Program

Chemical	ABS
Inorganic chemicals	
Arsenic	6
Beryllium	3
Cadmium	0.2
Chromium (VI)	2
Fluorides (soluble compounds)	3
Lead	3
Mercury	4
Nickel	2
Selenium	3
Organic chemicals	
Creosotes	13
Diethylhexylphthalate	9
Hexachlorobenzene	4
Hexachlorocyclohexanes	3
4,4'methylene dianiline	10
Pentachlorophenol	[a]
Polychlorinated biphenyls	14
Polychlorinated dibenzo-p-dioxins and dibenzofurans	3
Polycyclic aromatic hydrocarbons	13

[a] To be determined in future amendments to the Hot Spots Program

Skin permeability is related to the solubility or strength of binding of the chemical in the delivery matrix (soil or other particles) versus the receptor matrix, the skin's stratum corneum. Fractional dermal absorption point estimate values were derived by OEHHA from available literature sources for the semi-volatile and nonvolatile chemicals in the "Hot Spots" program. The rationale for the chemical-specific dermal absorption fraction values, and the use of default values in cases where sufficient data are lacking, can be found in Appendix F of the Technical Support Document for Exposure and Stochastic Analysis (OEHHA, 2012).

5.4.2.2 Chronic Noncancer Dermal Dose

Dermal exposure, and thus annual dermal load (ADL), varies by age group. Therefore, a time-weighted average ADL for age 0-70 years (0-2, 2-16, and 16-70 years) is estimated for chronic residential exposure using ADL values in Table 5.12. This exposure pathway is also assessed for offsite workers using the offsite worker ADL values in Table 5.12d. Children at a MEIW daycare, if present, may also be assessed for exposure if the District deems it advisable. The contribution to the dermal dose is determined for each age group in EQ 5.4.2.2:

A. Equation 5.4.2.2: $\mathbf{Dose_{dermal} = ADL \times Cs \times ABS \times 10^{-9} \times ED/AT \times (1/350)}$

1. $Dose_{dermal}$ = Exposure dose through dermal absorption (mg/kg/d)
2. ADL = Annual dermal load (mg/kg-yr), age-specific
3. Cs = Average soil concentration (μg/kg)
4. ABS = Fraction absorbed across skin (unitless)
5. 10^{-9} = Conversion factor for chemical & soil (μg to mg, mg to kg)
6. 1/350 = Conversion factor for ADL from yrs to days (Note: this conversion is needed to remove EF, expressed as 350 days/365 days, from the ADLs in Table 5.12a-d)
7. ED = Exposure duration for specified age groups: 2 yrs for 0<2, 14 yrs for 2<16, 54 yrs for 16-70 for residential exposure,
8. AT = Averaging time for residential exposure – 70 yrs

a: Recommended default values for EQ 5.4.2.2:

1. ADL = See Table 5.11 for point estimates by age group, climate region and receptor type (resident or worker)
2. Cs = Calculated above in EQ 5.3.2 A
3. ABS = See Table 5.13

b: Recommended off-site worker default modifications to EQ 5.4.2.2:

1. Chronic dermal dose to the off-site worker assumes only adult exposure and is incorporated into the off-site worker ADL in Table 5.12d.
2. A time-weighted average estimate of dose is not necessary and the ED and AT variates are left out of EQ 5.4.2.2 for dermal dose to the worker.

c: Recommended nursing mother default modifications to EQ 5.4.2.2:

1. For dermal dose to mother's milk, use the ADL for age 16-30 years in Table 5.12d.
2. The ED and AT variates in EQ 5.4.2.2 are left out for dermal dose in the mother's milk pathway.

d: Assumptions for EQ 5.4.2.2:

1. For cancer risk assessment, Exposure Frequency (EF) for vacation time away from exposure is incorporated into the ADLs shown in Tables 5.11 and 5.12 using the basic assumption that cancer risk is associated with cumulative dose of carcinogen. The dose used to estimate cancer risk can be adjusted for EF, and for time spent within the MEIR or MEIW location. Chronic RELs are not necessarily related to cumulative dose. Thus, adjusting the estimated dose for EF at the MEIR or MEIW is not appropriate, and the unadjusted daily rate is used in EQ 5.4.2.2.
2. For worker exposure, the annual average concentration should not be adjusted to account for worker and facility emission schedules, as done for

inhalation cancer risk assessment. The pollutant will be deposited and accumulate in the soil in the absence or presence of the worker; therefore, the total deposition and soil concentration will be dependent on the annual average air concentration.

For residential chronic exposure, the dermal dose contribution for each age group is summed together to obtain the time-weighted average daily dermal dose for chronic hazard assessment:

(ADL age 0<2 × Cs × ABS × 10^{-9} × 2 / 70 × (1/350)) +

(ADL age 2<16 × Cs × ABS × 10^{-9} × 14 / 70 × (1/350)) +

(ADL age 16-70 × Cs × ABS × 10^{-9} × 54 / 70 × (1/350)) = Chronic $Dose_{dermal}$

5.4.3 *Estimation of Exposure through Ingestion*

Exposure through ingestion is a function of the concentration of the substance in the ingested soil, water, and food, the gastrointestinal absorption of the substance, and the amount ingested.

5.4.3.1 Exposure through Ingestion of Soil

There are no distributions for soil ingestion currently recommended. Tier III stochastic risk assessments should include a high-end point estimate of soil ingestion, soil loading, exposure frequency and soil area.

5.4.3.1.1 Soil Ingestion Dose for Cancer Risk

The exposure dose through residential soil ingestion varies by age and is calculated for each age group ((e.g., 3rd trimester, 0<2 yrs, 2<9 yrs, 2<16 yrs, 16<30 and 16-70 yrs). These age-specific groupings are needed in order to properly use the age sensitivity factors for cancer risk assessment (see Chapter 8). This pathway is also assessed for exposure to off-site workers. Children at a MEIW daycare, if present, may also be assessed for exposure if the District deems it advisable. The dose from inadvertent soil ingestion can be estimated by the point estimate approach using the following general equation:

A. Equation 5.4.3.1.1: $DOSE_{soil} = C_{soil} \times GRAF \times SIR \times 10^{-9} \times EF$

1. $DOSE_{soil}$ = Dose from soil ingestion (mg/kg BW-day)
2. 10^{-9} = Conversion factor (μg to mg, mg to kg)
3. C_{soil} = Concentration of contaminant in soil (μg/kg)
4. GRAF = Gastrointestinal relative absorption fraction, chemical-specific (unitless)
5. SIR = Soil ingestion rate (mg/kg BW-day)
6. EF = Exposure frequency (unitless), (days/365 days)

a: Recommended default values for EQ 5.4.3.1.1:

1. C_{soil} = Calculated above in EQ 5.3.2 A
2. GRAF = See Table 5.2
3. SIR = See Table 5.14
4. EF = 350 d/year resident, 250 d/year worker

In this approach, it is assumed that the soil ingested contains a representative concentration of the contaminant(s) and the concentration is constant over the exposure period.

The term **GRAF**, or gastrointestinal relative absorption factor, is defined as the fraction of contaminant absorbed by the GI tract relative to the fraction of contaminant absorbed from the matrix (feed, water, other) used in the study(ies) that is the basis of either the cancer potency factor (CPF) or the Reference Exposure Level (REL). If no data are available to distinguish absorption in the toxicity study from absorption from the environmental matrix in question (i.e., soil), then GRAF = 1. The GRAF allows for adjustment for absorption from a soil matrix if it is known to be different from absorption across the GI tract in the study used to calculate the CPF or REL. In most instances, the GRAF will be 1.

Table 5.14 Recommended Soil Ingestion Rate (SIR) Estimates for Adults and Children (mg/kg-day)*

Age Groups (years)	Mean (mg/kg-day)	95th % (mg/kg-day)
3rd Trimester[a]	0.7	3
0<2	20	40
2<9	5	20
2<16	3	10
16<30	0.7	3
16 to 70	0.6	3
PICA adult	NR	-

[a] Assumed to be the mother's soil ingestion rate (adult age 16 <30)
* Soil includes outdoor settled dust
NR = No recommendation

5.4.3.1.2 Chronic Noncancer Dose for Soil Ingestion

The soil ingestion rate varies by age. A time-weighted average approach is used to combine soil intake rates of the age groupings (i.e., 0<2 yrs, 2<16 yrs, and 16-70 yrs) to determine the residential soil ingestion dose for chronic noncancer hazard assessment. This pathway is also assessed for exposure to offsite workers using the adult intake values for age 16-70 years in Table 5.14. Children at a MEIW daycare, if present, may also be assessed for exposure if the District deems it advisable. The contribution to the soil ingestion dose by each age group is determined in EQ 5.4.3.1.2:

A. Equation 5.4.3.1.2: $$DOSE_{soil} = C_{soil} \times GRAF \times SIR \times 10^{-9} \times ED/AT$$

1. $DOSE_{soil}$ = Dose from soil ingestion (mg/kg BW-day)
2. 10^{-9} = Conversion factor (μg to mg, mg to kg)
3. C_{soil} = Concentration of contaminant in soil (μg/kg)
4. GRAF = Gastrointestinal relative absorption fraction, unitless; chemical-specific
5. SIR = Soil ingestion rate (mg/kg BW-day)
6. ED = Exposure duration for a specified age group: 2 yrs for 0<2, 14 yrs for 2<16, 54 yrs for 16-70
7. AT = Averaging time for lifetime exposure – 70 yrs

a: Recommended default values for EQ 5.4.3.1.2:

1. C_{soil} = Calculated above in EQ 5.3.2 A
2. GRAF = See Table 5.2
3. SIR = See Table 5.14; use 16-70 age group SIR for workers

b: Recommended off-site worker default modifications to EQ 5.4.3.1.2:

1. A time-weighted average estimate of dose is not necessary and the ED and AT variates are left out of EQ 5.4.3.1.2 for oral soil dose to the worker.

c: Recommended nursing mother default modifications to EQ 5.4.3.1.2:

1. For mother's ingested soil dose to milk, use the SIR for age 16-30 years in Table 5.14.
2. The ED and AT variates in EQ 5.4.3.1.2 are left out for soil ingestion dose in the mother's milk pathway.

d: Assumptions for EQ 5.4.3.1.2:

1. For worker exposure, the annual average concentration should not be adjusted to account for overlap of worker and facility emission schedules. The pollutant will be deposited and accumulate in the soil in the absence or presence of the worker; therefore, the total deposition and soil concentration will be dependent on the annual average air concentration.

For residential exposure, the soil ingestion dose contribution for each age group is summed together to obtain the time-weighted average daily soil intake dose for chronic hazard assessment:

(SIR for age 0<2 yrs × C_{soil} × GRAF × 10^{-9} × 2 / 70) +

(SIR for age 2<16 yrs × C_{soil} × GRAF × 10^{-9} × 14 / 70) +

(SIR for age 16-70 yrs × C_{soil} × GRAF × 10^{-9} × 54 / 70) = Chronic $Dose_{soil}$

5.4.3.2 Exposure through Ingestion of Food

The exposure through food ingestion can be through ingestion of home-grown plant products (categorized as leafy, protected, exposed and root produce), home-raised animals (categorized as meat, cow's milk and eggs), angler-caught fish and mother's milk. When a specific food pathway is a dominant pathway (e.g., homegrown produce), and multiple pathways such as home raised meat, milk, and eggs categories all need to be assessed, the 95th percentile default consumption rate for the driving exposure pathway is used, while the mean consumption values for the remaining exposure pathways (i.e., food categories) are used. See Section 8.2.6 for a complete discussion of the methodology on how to implement the derived methodology.

5.4.3.2.1 Dose for Cancer Risk from Home-Grown Produce

Exposure through ingesting home-grown produce (DOSEp) is a function of the type of crop (i.e., exposed, leafy, protected, root), gastrointestinal relative absorption factor, bioavailability and the fraction of plant ingested that is homegrown. The calculation is done for each type of crop, then summed to get total dose for this pathway. The

exposure dose through ingestion of home-grown produce varies by age and is calculated for each age group (e.g., 3rd trimester, 0<2 yrs, 2<9 yrs, 2<16 yrs, 16<30 and 16-70 yrs). These age-specific groupings are needed in order to properly use the age sensitivity factors for cancer risk assessment (see Chapter 8).

A. Equation 5.4.3.2.1: $$DOSEp = C_v \times IP \times GRAF \times L \times EF \times 10^{-6}$$

1. DOSEp = Exposure dose through ingestion of home-grown produce (mg/kg/d)
2. C_v = Concentration in specific type of crop, i.e., exposed, leafy, protected, root (μg/kg)
3. IP = Consumption of specific type of crop (g/kg BW*day)
4. GRAF = Gastrointestinal relative absorption factor (unitless)
5. L = Fraction of plant type consumed that is home-grown or locally grown (unitless)
6. EF = Exposure frequency (unitless, days/365 days)
7. 10^{-6} = Conversion factors (μg/kg to mg/g)

a: Recommended default values for Equation 5.4.3.2.1:

1. C_v = Calculated above in EQ 5.3.4.1 A
2. IP = See Table 5.15 (point estimates) and 5.16a-e (distributions)
3. GRAF = See Table 5.2
4. L = Site-specific survey is recommended. Otherwise, see Table 5.17 for Tier I default values
5. EF = 0.96 (350 d/365 d in a yr)

Once the dose for each type of crop that applies is calculated (See Section 5.3.4.1 for definition of crops types), the doses are summed to get the total dose for the home-grown produce pathway:

Total DOSEp = DOSEp (leafy) + DOSEp (root) + DOSEp (exposed) + DOSEp (protected)

The total home-grown produce dose will need to be calculated for each age group that applies.

5.4.3.2.2 Dose for cancer risk from home-raised meat, eggs, and cow's milk

Exposure through ingesting home-raised or farm animal products ($DOSE_{fa}$) is a function of the type of food (meat, eggs and cow's milk), gastrointestinal relative absorption factor, bioavailability and the fraction of food ingested that is home-raised. The only meat sources considered here are beef, pork and poultry. Unlike the home-grown produce pathway, the dose is calculated and presented separately for each type of home-raised food. The age-specific groupings to determine dose (3rd trimester, 0<2 yrs, 2<9 yrs, 2<16 yrs, 16<30 yrs or 16-70 yrs) is needed in order to properly use the age sensitivity factors for cancer risk assessment (see Chapter 8).

A. Equation 5.4.3.2.2: $DOSE_{fa} = C_{fa} \times I_{fa} \times GRAF \times L \times EF \times 10^{-6}$

1. $DOSE_{fa}$ = Exposure dose through ingestion of home-raised animal product (mg/kg/d)
2. C_{fa} = Concentration in animal product, e.g., beef, pork, poultry, dairy, eggs (μg/kg)
3. I_{fa} = Consumption of animal product (g/kg BW-day)
4. GRAF = Gastrointestinal relative absorption factor (unitless)
5. L = Fraction of animal product consumed that is home-raised or locally produced (unitless)
6. EF = Exposure frequency (unitless, days/365 days)
7. 10^{-6} = Conversion factors (μg/kg to mg/g)

a: Recommended default values for EQ 5.4.3.2.2:

1. C_{fa} = Calculated above in EQ 5.3.4.2 A
2. I_{fa} = See Table 5.15 (point estimates) and Table 5.16a-e (distributions)
3. GRAF = See Table 5.2
4. L = Site-specific survey is recommended. Otherwise, see Table 5.17 for Tier I default values
5. EF = 0.96 (350 days / 365 days in a year)

5.4.3.2.3 Chronic Noncancer Dose for Ingestion of Food

For oral noncancer hazard assessment, a time-weighted average approach is used to combine food ingestion rates for the age groups (i.e., 0<2, 2<16 and 16-70 yrs) to estimate the chronic dose for residential exposure. The equation used to estimate dose through home-grown produce and home-raised meat/eggs/cow's milk is similar and is shown below in one equation. Similar to the cancer risk dose calculation, home-grown produce is presented as a total dose for all types of crops (See Section 5.4.3.2.1) and home-raised animal product dose is presented separately for each type of animal product that applies (See Section 5.4.3.2.2).

The contribution to the food intake dose is determined for each age group in EQ 5.4.3.2.3:

A. Equation 5.4.3.2.3: $\mathbf{DOSE_{food} = C_{food} \times I_{food} \times GRAF \times L \times 10^{-6} \times ED/AT}$

1. $DOSE_{food}$ = Exposure dose through ingestion of home-grown produce or home-raised animal product (mg/kg/d)
2. C_{food} = Concentration (μg/kg) in produce (e.g., exposed, leafy, protected, root) or animal product (e.g., beef, pork, poultry, dairy, eggs)
3. I_{food} = Consumption of produce or animal product (g/kg BW-day)
4. GRAF = Gastrointestinal relative absorption factor (unitless)
5. L = Fraction of produce or animal product consumed that is home-grown (unitless)
6. 10^{-6} = Conversion factors (μg/kg to mg/g)
7. ED = Exposure duration for a specified age group (2 yrs for 0<2, 14 yrs for 2<16, 54 yrs for 16-70
8. AT = Averaging time for lifetime exposure: 70 yrs

a: Recommended default values for EQ 5.4.3.2.3:

1. C_{food} = Calculated above in EQ 5.3.4.1 A (for home-grown produce) or EQ 5.3.4.2 A (for home-raised animal products)
2. I_{food} = Age-specific, see Table 5.15 for point estimates
3. GRAF = See Table 5.2
4. L = Site-specific survey is recommended. Otherwise, see Table 5.17 for Tier I default values

b: Recommended nursing mother default modifications to EQ 5.4.3.2.3:

1. For the mother's dose to milk through ingested food, use the food intake rates for age 16-30 years in Table 5.15 and 5.16d.
2. The ED and AT variates in EQ 5.4.3.2.3 are left out for ingested food dose in the mother's milk pathway.

Following calculation of the intake dose contributions for each age group, the intake rates for home-grown produce and the intake rates for home-raised animal products are summed separately to obtain the residential time-weighted average intake dose for chronic residential exposure to home-grown produce and to home-raised animal products:

(I_{food} for age 0<2 yrs × C_{food} × GRAF × L × 10^{-6} × 2 / 70) +

(I_{food} for age 2<16 yrs × C_{food} × GRAF × L × 10^{-6} × 14 / 70) +

(I_{food} for age 16-70 yrs × C_{food} × GRAF × L × 10^{-6} × 54 / 70) = Chronic $Dose_{food}$

Table 5.15 Recommended Average and High End Point Estimate Values for Home Produced Food Consumption (g/kg-day)

Food Category	Third Trimester		Ages 0<2		Ages 2<9	
Produce	Avg.	High End	Avg.	High End	Avg.	High End
Exposed	1.9	5.9	11.7	30.2	7.4	21.7
Leafy	0.9	3.2	3.8	10.8	2.5	7.9
Protected	1.7	5.8	5.9	17.5	4.7	13.3
Root	1.7	4.6	5.7	15.3	3.9	10.8
Meat						
Beef	2.0	4.8	3.9	11.3	3.5	8.6
Poultry	0.9	2.9	2.9	10.5	2.2	7.8
Pork	1.8	4.7	4.5	11.4	3.7	9.0
Milk	5.4	15.9	50.9	116	23.3	61.4
Eggs	1.6	4.2	6.1	15.0	3.9	9.4
	Ages 2>16		Ages 16<30		Ages 16-70	
Produce	Avg.	High End	Avg.	High End	Avg.	High End
Exposed	1.9	5.9	1.9	5.9	1.8	5.6
Leafy	0.9	3.2	0.9	3.2	1.1	3.4
Protected	1.7	5.8	1.7	5.8	1.6	5.2
Root	1.7	4.6	1.7	4.6	1.5	4.2
Meat						
Beef	2.0	4.8	2.0	4.8	1.7	4.4
Poultry	0.9	2.9	0.9	2.9	0.9	2.8
Pork	1.8	4.7	1.8	4.7	1.5	3.8
Milk	5.4	15.9	5.4	15.9	4.3	13.2
Eggs	1.6	4.2	1.6	4.2	1.3	3.4

[a] Food consumption values for 3rd trimester calculated by assuming that the fetus receives the same amount of contaminated food on a per kg BW basis as the mother (adult age 16 to less than 30).

Table 5.16a - e Parametric Models of Per Capita Food Consumption by Age Group for Stochastic Analysis

Table 5.16a Per Capita Food Consumption (g/kg-day) for Ages 0<2

Food Category	Distrib. Type	Anderson-Darling Statistic	Mean	Std. Dev	Location	Scale	Shape	Like-liest
Produce								
Exposed	Gamma	60			0.01	6.56	0.830	
Leafy	Gamma	167			0.01	3.30	1.161	
Protected	LogN	67	6.03	7.31				
Root	Gamma	83			0.06	4.44	1.28	
Meat								
Beef	LogN	16	1.97	1.73				
Poultry	LogN	58	4.5	4.08				
Pork	LogN	230	3.00	4.46				
Dairy	Max Ext.	169				27.82		33.79
Eggs	LogN	172	6.11	4.21				

Table 5.16b Per Capita Food Consumption (g/kg-day) for Ages 2<9

Food Category	Distribution Type	Anderson-Darling Statistic	Mean	Std. Dev	Location	Scale	Shape	Rate
Produce								
Exposed	Exponential	206						0.14
Leafy	LogN	127	2.64	3.89				
Protected	Weibull	68			0.02	4.76	1.063	
Root	LogN	60	3.95	3.85				
Meat								
Beef	LogN	35	3.55	2.79				
Poultry	LogN	17	3.71	2.67				
Pork	LogN	66	2.25	2.84				
Milk	LogN	12	23.4	20.78				
Eggs	LogN	38	3.93	3.00				

Table 5.16c Per Capita Food Consumption (g/kg-day) for Ages 2<16

Food Category	Distribution Type	Anderson-Darling Statistic	Mean	Std. Dev	Location	Scale	Shape
Produce							
Exposed	Gamma	60			0.01	6.54	0.8325
Leafy	LogN	68	1.83	2.91			
Protected	Gamma	47			0.00	3.69	0.9729
Root	LogN	51	3.10	3.44			
Meat							
Beef	LogN	10	2.96	2.49			
Poultry	LogN	27	2.98	2.52			
Pork	LogN	48	1.84	2.79			
Milk	LogN	35	16.8	19.2			
Eggs	LogN	71	3.16	2.95			

Table 5.16d Per Capita Food Consumption (g/kg-day) for Ages 16-30[a]

Food Category	Distribution Type	Anderson-Darling Statistic	Mean	Std. Dev	Location	Scale	Shape
Produce							
Exposed	Gamma	70			0.01	2.05	0.9220
Leafy	Weibull	191			0.00	0.88	0.8732
Protected	LogN	93	1.81	3.31			
Root	LogN	43	1.69	1.69			
Meat							
Beef	LogN	26	1.98	1.54			
Poultry	LogN	26	1.80	1.42			
Pork	LogN	242	1.01	1.74			
Milk	Gamma	22			0.02	5.66	0.9421
Eggs	LogN	29	1.55	1.36			

[a] These distributions are also recommended for the third trimester. Food consumption values for 3rd trimester are calculated by assuming that the fetus receives the same amount of contaminated food on a per kg BW basis as the mother (adult age 16<30).

Table 5.16e Per Capita Food Consumption (g/kg-day) for Ages 16-70

Food Category	Distribution Type	Anderson-Darling Statistic	Mean	Std. Dev	Location	Scale	Shape
Produce							
Exposed	Gamma	148			0.01	2.07	0.8628
Leafy	Gamma	83			0.00	1.15	0.9713
Protected	Gamma	78			0.01	1.90	0.8325
Root	Gamma	14			0.00	1.28	1.166
Meat							
Beef	LogN	20	1.75	1.40			
Poultry	LogN	18	1.53	1.18			
Pork	LogN	190	0.97	1.59			
Milk	Gamma	20			0.00	4.50	0.9627
Eggs	LogN	30	1.3	1.01			

Table 5.17 Default Values for L in EQs 5.4.3.2.1., 5.4.3.2.2 and 5.4.3.2.3: Fraction of Food Intake that is Home-Produced

Food Type	Households that Garden[a]	Households that Farm[a]
Avg. Total Veg & Fruits	0.137	0.235
	Households that Garden/Hunt[b]	**Households that Farm[b]**
Beef	0.485	0.478
Pork	0.242	0.239
Poultry	0.156	0.151
Eggs	0.146	0.214
Total Dairy (Cow's milk)	0.207	0.254

[a] As a default for home-produced leafy, exposed, protected and root produce, OEHHA recommends 0.137 as the fraction of produce that is home-grown. The households that grow their own vegetables and fruits are the population of concern. In rural situations where the receptor is engaged in farming, OEHHA recommends 0.235 as the default value for fraction of leafy, exposed, protected and root produce that is home-grown.

[b] OEHHA recommends the fraction home-raised under "Households that raise animals/hunt" (for beef, pork, poultry (chicken), eggs and dairy (cow's milk), with the exception of rural household receptors engaged in farming. OEHHA recommends that the fractions listed under "Households that farm" be used for the rural household receptors.

5.4.3.3 Exposure through Ingestion of Water

Intake of drinking water varies by age on a ml per kg body weight per day basis resulting in differences in exposure dose by age. The age-specific groupings to determine dose are needed in order to properly use the age sensitivity factors for

cancer risk assessment (see Chapter 8) and to calculate a time-weighted average dose for chronic noncancer assessment.

5.4.3.3.1 Dose for Cancer Risk through Ingestion of Water

$DOSE_{water}$ is calculated for each age group (i.e., 3rd trimester, 0<2 yrs, 2<9 yrs, 2<16 yrs, 16<30 yrs and 16-70 yrs), then incorporated into EQ 8.2.5 in Chapter 8 to determine cancer risk through exposure in drinking water.

A. Equation 5.4.3.3.1: $$\mathbf{DOSE_{water} = C_w \times WIR \times ABS_{wa} \times Fdw \times EF \times 10^{-6}}$$

1. $DOSE_{water}$ = Exposure dose through ingestion of water (mg/kg BW/d)
2. C_w = Water concentration (μg/L)
3. WIR = Water ingestion rate (ml/kg BW-day)
4. ABS_{wa} = Gastrointestinal relative absorption factor (unitless)
5. Fdw = Fraction of drinking water from contaminated source
6. EF = Exposure frequency (unitless, days/365 days)
7. 10^{-6} = Conversion factors (mg/μg)(L/ml)

a: Recommended default values for EQ 5.4.3.3.1:

1. C_w = Calculated above 5.3.3 A
2. WIR = See 5.18 (point estimates) and Table 5.19 (distributions)
3. ABS_{wa} = Default set to 1
4. Fdw = Default set to 1, although a site-specific survey is recommended for this variate
5. EF = 0.96 (350 days/365 days in a year)

5.4.3.3.2 Chronic Noncancer Dose through Ingestion of Water

Because water intake varies by age group, a time-weighted average intake approach is used to determine the daily water ingestion dose for chronic residential exposure. The contribution to the water ingestion dose is determined for each age group (i.e., 0<2, 2<16 and 16-70 yrs) in EQ 5.4.3.3.2.

A. Equation 5.4.3.3.2:

$$\mathbf{DOSE_{water} = C_w \times WIR \times ABS_{wa} \times Fdw \times 10^{-6} \times ED/AT}$$

1. $DOSE_{water}$ = Exposure dose through ingestion of water (mg/kg BW/d)
2. C_w = Water concentration (μg/L)
3. WIR = Water ingestion rate (ml/kg BW-day)
4. ABS_{wa} = Gastrointestinal absorption factor
5. Fdw = Fraction of drinking water from contaminated source (site-specific)
6. 10^{-6} = Conversion factors (mg/μg)(L/ml)
7. ED = Exposure duration for a specified age group: 2 yrs for 0<2, 14 yrs for 2<16, 54 yrs for 16-70
8. AT = Averaging time for residential exposure: 70 yrs

a: Recommended default values for EQ 5.4.3.3.2:

1. C_w = Calculated above in 5.3.3 A
2. WIR = See 5.18 (point estimates)
3. ABS_{wa} = Default set to 1
4. Fdw = Default set to 1, although a site-specific survey is recommended for this variate

b: Recommended nursing mother default modifications to EQ 5.4.3.3.2:

1. For the dose to mother's milk through water ingestion, use the WIR for age 16-30 years in Table 5.18.
2. The ED and AT variates in EQ 5.4.3.3.2 are left out for ingested water dose in the mother's milk pathway.

The water intake dose contribution for each age group is summed together to obtain the time-weighted average daily residential water ingestion dose:

(WIR for age 0<2 yrs × C_w × ABS_{wa} × Fdw × 10^{-6} × 2 / 70) +

(WIR for age 2<16 yrs × C_w × ABS_{wa} × Fdw × 10^{-6} × 14 / 70) +

(WIR for age 16-70 yrs × C_w × ABS_{wa} × Fdw × 10^{-6} × 54 / 70) = Chronic $Dose_{water}$

Table 5.18 Recommended Point Estimate Tap Water Intake Rates (ml/kg-day)

Point Estimates				
Using Mean Values	**For the Age Period**	**9-year scenario**	**30-year scenario**	**70-year scenario**
	3rd trimester	18	18	18
	0<2 years	113	113	113
	2<9 years	26	-	-
	2<16 years	-	24	24
	16-30 years	-	18	-
	16-70 years	-	-	18
Using 95th-percentile values	**For the Age Period**	**9-year scenario**	**30-year scenario**	**70-year scenario**
	3rd trimester	47	47	47
	0<2 years	196	196	196
	2<9 years	66	-	-
	2<16 years	-	61	61
	16-30 years	-	47	-
	16-70 years	-	-	45

Table 5.19 Recommended Distributions of Tap Water Intake Rates (ml/kg-day) for Stochastic Risk Assessment

	9-year scenario	**30-year scenario**	**70-year scenario**
0<2 years	**Max Extreme** Likeliest = 93 Scale = 35	**Max Extreme** Likeliest = 93 Scale = 35	**Max Extreme** Likeliest = 93 Scale = 35
2<9 years	**Weibull** Location = 0.02 Scale = 29 Shape = 1.3		
2<16 years		**Gamma** Location = 0.19 Scale = 15.0 Shape = 1.6	**Gamma** Location = 0.19 Scale = 15.0 Shape = 1.6
16-30 years		**Gamma** location=0.49 scale=13.6 shape=1.26	
16-70 years			**Beta** min=0.17 max=178 alpha=1.5 beta= 12.9

5.4.3.4 Exposure through Ingestion of Angler-caught Fish

Exposure through ingestion of angler-caught fish ($DOSE_{fish}$) is a function of the fraction of fish ingested that is caught in the exposed water body, which differs for each age grouping, and the gastrointestinal absorption factor. Ingestion of angler-caught fish on a mg/kg body weight per day basis varies by age resulting in differences in exposure dose by age. The age-specific groupings to determine dose is needed primarily to properly use the age sensitivity factors for cancer risk assessment (see Chapter 8) and to calculate a time-weighted average dose for chronic noncancer assessment.

5.4.3.4.1 Cancer Risk Dose via Ingestion of Angler-Caught Fish

$DOSE_{fish}$ is calculated for each age group separately (i.e., 3rd trimester, 0<2 yrs, 2<9 yrs, 2<16 yrs, 16<30 yrs and 16-70 yrs), then incorporated into EQ 8.2.5 in Chapter 8 to determine cancer risk through exposure to angler-caught fish.

A. Equation 5.4.3.4.1: $$DOSE_{fish} = C_t \times I_{fish} \times Gf \times L \times EF \times 10^{-6}$$

1. $DOSE_{fish}$ = Dose via ingestion of angler-caught fish (mg/kg BW-day)
2. C_t = Concentration in fish muscle tissue (μg/kg)
3. I_{fish} = Angler-caught fish ingestion rate (g/kg BW per day)
4. Gf = Gastrointestinal absorption factor (unitless)
5. L = Fraction of fish caught at exposed site (unitless)
6. EF = Exposure frequency (days/365 days)
7. 10^{-6} = Conversion factor (mg/μg, kg/g)

a: Recommended default values for Equation 5.4.3.4.1:

1. C_t = Calculated above in Equation 5.3.4.7
2. I_{fish} = See Table 5.20 (point estimates) and Table 5.21 (distributions)
3. Gf = Default set to 1
4. L = Default set to 1 for fraction of fish caught locally, although a site-specific survey is recommended for this variate
5. EF = 0.96 (350 days/365 days in a yr)

5.4.3.4.2 Chronic Noncancer Dose via Ingestion of Angler-Caught Fish

Angler-caught fish consumption varies by age group. A time-weighted average intake for residential consumption over 70 years is used to determine dose for average and high-end exposure. The contribution to the angler-caught fish consumption dose is determined for each age group in EQ 5.4.3.4.2:

A. Equation 5.4.3.4.2: $\mathbf{DOSE_{fish} = C_t \times I_{fish} \times Gf \times L \times 10^{-6} \times ED/AT}$

1. $DOSE_{fish}$ = Dose via ingestion of angler-caught fish (mg/kg BW-day)
2. C_t = Concentration in fish muscle tissue (μg/kg)
3. I_{fish} = Angler-caught fish ingestion rate (g/kg BW per day)
4. Gf = Gastrointestinal absorption factor (unitless)
5. L = Fraction of fish caught at exposed site (unitless)
6. 10^{-6} = Conversion factor (mg/μg, kg/g)
7. ED = Exposure duration for a specified age group: 2 yrs for 0<2, 14 yrs for 2<16 and 54 yrs for 16-70
8. AT = Averaging time for chronic exposure – 70 yrs

a: Recommended default values for Equation 5.4.3.4.2:

1. C_t = Calculated above in Equation 5.3.4.7
2. I_{fish} = See Table 5.20 (point estimates)
3. Gf = Default set to 1
4. L = Default set to 1 for fraction of fish caught locally, although a site-specific survey is recommended for this variate

b: Recommended nursing mother default modifications to EQ 5.4.3.4.2:

1. For the dose to mother's milk through fish consumption, use the I_{fish} for age 16-30 years in Table 5.20.
2. The ED and AT variates in EQ 5.4.3.4.2 are left out for the dose via fish consumption in the mother's milk pathway.

Following calculation of the angler-caught fish consumption dose contribution for each age group, 0<2 yr, 2<16 yr and 16-70 yr fish consumption doses are summed together to obtain the residential chronic dose:

(I_{fish} for age 0<2 yrs × C_t × Gf × L × 10^{-6} × 2 / 70) +

(I_{fish} for age 2<16 yrs × C_t × Gf × L × 10^{-6} × 14 / 70) +

(I_{fish} for age 16-70 yrs × C_t × Gf × L × 10^{-6} × 54 / 70) = Chronic $Dose_{fish}$

Table 5.20 Point Estimate Values for Angler-Caught Fish Consumption (g/kg-day) by Age Group

	Third Trimester	0 <2 Years	2<9 Years	2<16 Years	16<30 Years	16-70 Years
Mean	0.38	0.18	0.36	0.36	0.38	0.36
95th Percentile	1.22	0.58	1.16	1.16	1.22	1.16

Table 5.21 Empirical Distribution for Angler-Caught Fish Consumption (g/kg-day)

Mean	Percentile									
	10th	20th	30th	40th	50th	60th	70th	80th	90th	95th
Third trimester, 2<9, 2<16, 16<30 and 16-70-year age groups										
0.36	0.06	0.09	0.12	0.16	0.21	0.27	0.36	0.50	0.79	1.16
0<2-year age group										
0.18	0.03	0.05	0.06	0.08	0.11	0.14	0.18	0.25	0.40	0.58

5.4.3.5 Mother's Milk

Exposure through mother's milk ingestion (Dose-Im) is a function of the average concentration of the substance in mother's milk and the amount of mother's milk ingested. The minimum pathways that the nursing mother is exposed to include inhalation, soil ingestion, and dermal, since the chemicals evaluated by the mother's milk pathway are multipathway chemicals. Other pathways may be appropriate depending on site conditions (e.g., the presence of vegetable gardens or home grown chickens). The compounds currently considered for the mother's milk pathway are:

1. Dioxins and Furans (PCDDS and PCDFs)
2. Polychlorinated biphenyls (PCBs)
3. Polycyclic Aromatic Hydrocarbons (PAHs), including creosotes
4. Lead

These compound classes represent the chemicals of greatest concern for the mother's milk pathway under the Hot Spots program, and for which data are available to estimate transfer coefficients. It is expected that additional transfer coefficients will be developed for other multipathway chemicals in the Hot Spots Program as data becomes available and is reviewed. The nursing mother in the mother's milk pathway is not herself subject to the mother's milk pathway. The summed average daily dose (mg/kg BW-day) from all pathways is calculated for the nursing mother using the equations that follow.

5.4.3.5.1 Cancer Risk Dose to Infant via Mother's Milk

A. Equation 5.4.3.5.1: $$\textbf{Dose-Im} = C_m \times BMI_{bw} \times EF \times 10^{-3}$$

1. Dose-Im = Dose to infant through ingestion of mother's milk (mg/kg BW per day)
2. C_m = Concentration of contaminant in mother's milk (mg/kg milk)
3. BMI_{bw} = Daily breast-milk ingestion rate (g/kg BW-day)
4. EF = Frequency of exposure (days / 365 days)
5. 10^{-3} = Conversion factor (kg to g)

a: Recommended default values for EQ 5.4.3.5.1:

1. C_m = See EQ 5.3.4.8
2. BMI_{bw} = See Table 5.22 for point estimates. For distribution (parametric model) for Tier 3 stochastic risk assessments see Table 5.23.
3. EF = 1 (all 365 days of the first year of birth)

b: Assumptions for EQ 5.4.3.5.1:

1. For the MEIR, mother is exposed from birth up to 25 years of age when the infant is born. The exposed infant is then fully breastfed only during the first year of life.
2. For cancer risk assessment, exposure of breast-feeding infants to contaminants in breast milk applies only to the first year of the 0<2 yr age group for calculation of risk to this group, which then can be summed with the risk calculated for the other age groups (See Chapter 8).

5.4.3.5.2 Chronic Noncancer Dose to Infant via Mother's Milk

For oral noncancer hazard assessment, exposure of the infant through mother's milk ingestion occurs during the first year of life. After one year of age, the mother's milk pathway is not a factor for noncancer assessment.

A. Equation 5.4.3.5.2: $\text{Dose-Im} = C_m \times BMI_{bw} \times 10^{-3}$

1. Dose-Im = Dose to infant through ingestion of mother's milk (mg/kg BW/d)
2. C_m = Concentration of contaminant in mother's milk (mg/kg milk)
3. BMI_{bw} = Daily breast-milk ingestion rate (g/kg BW-day)
4. 10^{-3} = Conversion factor (kg to g)

a: Recommended default values for EQ 5.4.3.5.2:

1. C_m = See EQ 5.3.4.8
2. BMI_{bw} = See Table 5.22 for point estimates

Table 5.22 Default Point Estimates for Breast Milk Intake (BMI_{bw}) for Breastfed Infants

Infant Group	Intake (g/kg-day)
Fully breastfed over the first year (i.e., fed in accordance with AAP recommendations)	
Mean	101
95th percentile	139

Table 5.23 Recommended Distribution of Breast Milk Intake Rates Among Breastfed Infants for Stochastic Assessment* (Averaged Over an Individual's First Year of Life)

	Mean (SD)	Percentile							
		5	10	25	50	75	90	95	99
Intake (g/kg-day)	101 (23)	62	71	85	101	116	130	139	154

* For stochastic analysis, the mother's milk data are normally distributed.

5.5 References

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6 - Dose-Response Assessment for Noncarcinogenic Endpoints

6.1 Derivation of Toxicity Criteria for Noncancer Health Effects

Dose-response assessment describes the quantitative relationship between the amount of exposure to a substance (the dose) and the incidence or occurrence of an adverse health impact (the response). Dose-response information for noncancer health effects is used to determine Reference Exposure Levels (RELs). Inhalation RELs are air concentrations or doses at or below which adverse noncancer health effects are not expected even in sensitive members of the general population under specified exposure scenarios. The acute RELs are for infrequent 1 hour exposures that occur no more than once every two weeks in a given year, although this time frame of exposure does not necessarily apply to chemicals that can bioaccumulate (e.g., dioxins and furans, PCBs, and various metals). The chronic RELs are for 24 hour per day exposures for at least a significant fraction of a lifetime, defined as about 8 years (≥12 percent of a 70-year lifespan). The 8-hour RELs are for repeated 8-hour exposures for a significant fraction of a lifetime such as the exposures that offsite workers might typically receive. Eight-hour RELs are only available for 10 chemicals at present, but OEHHA will develop 8-hour RELs as we re-evaluate our existing RELs to ensure they are protective of children's health, and as we develop RELs for new chemicals. There are oral chronic RELs for some chemicals in the Hot Spots program that are semivolatile or nonvolatile and thus subject to deposition and oral ingestion or dermal exposure. The methodology for developing RELs is similar to that used by U.S. EPA in developing the inhalation Reference Concentrations (RfCs) and oral Reference Doses (RfDs).

Review and revision of RELs to take into account new information and sensitive subpopulations including infants and children is an ongoing process. All draft RELs for individual chemicals revised under the current noncancer methodology will undergo public comment and peer review, as mandated by the Hot Spots Act. .

The first step in determining an acute, 8-hour, or chronic REL is to determine a point of departure. The point of departure is preferably determined by the benchmark concentration procedure applied to human or animal studies, but if this method of calculation cannot be used with a particular data set, a no observed adverse effect level (NOAEL) or lowest observed adverse effect level (LOAEL) may be used as the point of departure. The benchmark concentration method (also referred to as the benchmark dose method for oral exposures) is a preferred method to estimate a point of departure because it takes all of the available dose-response data into account to statistically estimate, typically, a 5 percent response rate.

Dosimetric or toxicokinetic adjustments are often made to the point of departure to adjust for differences in dosimetry or kinetics across species or among humans. Time adjustments are generally applied to adjust experimental exposure to the exposure of

interest for the REL (e.g., 1 hour for acute, continuous for chronic). A modified Haber's equation is used where needed to adjust studies with different exposure times to the one-hour period needed for acute RELs. A simple Haber's law (C x T) adjustment for exposure period duration is used for most 8-hour and chronic RELs.

The time and dosimetry adjusted point of departure is divided by uncertainty factors that reflect the limitations in the current toxicology of the chemical. For example, an interspecies uncertainty factor is applied to account for the differences between humans and animals when an animal study is used. An intraspecies uncertainty factor is usually included to account for differences in susceptibility among the human population. In addition, where benchmark dose modeling is not suitable and a NOAEL is not available, a LOAEL to NOAEL uncertainty factor may be applied when the LOAEL serves as the point of departure. If a chronic study is not available to serve as a basis for a chronic REL, then a subchronic uncertainty factor (for chronic and 8-hour RELs only) may also be applied. Finally, if there are data deficiencies, for example, lack of a developmental toxicity study for a chemical, then a database deficiency factor may be applied. The individual uncertainty factors, which range from 2 to 10 depending on the limitations in the data, are multiplied together for a total uncertainty factor. The point of departure is then divided by the total UF to obtain the REL.

The most sensitive toxicological end point is selected as the basis for the REL when there are multiple adverse health effects. The selection of the most sensitive endpoint as the basis for a REL helps ensure that the REL is protective for all health effects. The use of uncertainty factors helps ensure that the REL is protective for nearly all individuals, including sensitive subpopulations, within the limitations of current scientific knowledge. For detailed information on the methodology and derivations for RELs, including guidance on selection of uncertainty factors, see the Air Toxics Hot Spots Risk Assessment Guidelines Technical Support Document for the Derivation of Noncancer Reference Exposure Levels (OEHHA, 2008).

It should be emphasized that exceeding the acute or chronic REL does not necessarily indicate that an adverse health impact will occur. The REL is not the threshold where population health effects would first be seen. However, levels of exposure above the REL have an increasing but undefined probability of resulting in an adverse health impact, particularly in sensitive individuals (e.g., depending on the toxicant, the very young, the elderly, pregnant women, and those with acute or chronic illnesses). The significance of exceeding the REL is dependent on the seriousness of the health endpoint, the strength and interpretation of the health studies, the magnitude of combined safety factors, and other considerations. In addition, there is a possibility that a REL may not be protective of certain small, unusually sensitive human subpopulations. Such subpopulations can be difficult to identify and study because of their small numbers, lack of knowledge about toxic mechanisms, and other factors. It may be useful to consult OEHHA staff when a REL is exceeded (hazard quotient or hazard index is greater than 1.0). Chapter 8 discusses the methods used for determining potential noncancer health impacts and Appendix I presents example calculations used to determine a hazard quotient (HQ) and hazard indices (HI).

Tables 6.1 through 6.3 list the currently adopted acute, 8-hour, and chronic inhalation RELs. Some substances that pose a long-term inhalation hazard may also present a chronic hazard via non-inhalation (oral, dermal) routes of exposure. The oral RELs for these substances are presented in Table 6.3. Appendix L provides a consolidated listing of all the acute, 8-hour, and chronic RELs with the respective target organs that are approved for use by OEHHA and ARB for the Hot Spots Program. Periodically, new or updated RELs are adopted by OEHHA and these guidelines will be updated to reflect those changes. See OEHHA's web site at *www.oehha.ca.gov* (look under "Air", then select "Hot Spots Guidelines") to determine if any new or updated RELs have been adopted since the last guideline update.

6.2 Acute Reference Exposure Levels

OEHHA developed acute RELs for assessing potential noncancer health impacts for short-term, one-hour peak exposures to facility emissions (OEHHA, 2008; http://www.oehha.ca.gov/air/allrels.html). By definition, an acute REL is an exposure that is not likely to cause adverse health effects in a human population, including sensitive subgroups, exposed to that concentration (in units of micrograms per cubic meter or $\mu g/m^3$) for the specified exposure duration on an intermittent basis.

The target organ systems and the acute RELs for each substance are presented in Table 6.1. Many acute RELs are based on mild adverse effects, such as mild irritation of the eyes, nose, or throat, or may result in other mild adverse physiological changes. For most individuals, it is expected that the mild irritation and other adverse physiological changes will not persist after exposure ceases. For RELs that have been recently developed or revised, the notation "sensory irritation" has been added in parenthesis in Table 6.1 for those chemicals that have an acute REL based on sensory irritation of the respiratory system (i.e., nose , throat) and/or eyes.

Other acute RELs are based on reproductive/developmental endpoints, such as teratogenicity or fetotoxicity, which are considered severe adverse effects. The inhalation pathway is the only pathway to assess for acute exposure. Other non-inhalation pathways of exposure are evaluated for worker and residential scenarios where the exposures are chronic or repeated daily in nature. The oral RELs are used to evaluate the non-inhalation pathways of exposure. Noninhalation (oral) RELs are discussed in Section 6.5. Chapter 8 discusses the methods used for determining noncancer acute health impacts. Appendix I presents an example calculation used to determine an HQ and HI.

Table 6.1 Acute Inhalation Reference Exposure Levels (RELs) and Acute Hazard Index Target Organ System(s)

Substance	Chemical Abstract Service Number (CAS)	Acute Inhalation REL ($\mu g/m^3$)	Acute Hazard Index Target Organ Systems(s)
Acetaldehyde	75-07-0	$4.7 \times 10^{+2}$	Eyes; Respiratory System (sensory irritation)
Acrolein	107-02-8	$2.5 \times 10^{+0}$	Eyes; Respiratory System (sensory irritation)
Acrylic Acid	79-10-7	$6.0 \times 10^{+3}$	Eyes; Respiratory System
Ammonia	7664-41-7	$3.2 \times 10^{+3}$	Eyes; Respiratory System
Arsenic and Inorganic Arsenic Compounds (including arsine)	7440-38-2	2.0×10^{-1}	Development; Cardiovascular System; Nervous System
Benzene	71-43-2	$2.7 \times 10^{+1}$	Reproductive/Developmental; Immune System; Hematologic System
Benzyl Chloride	100-44-7	$2.4 \times 10^{+2}$	Eyes; Respiratory System
1,3-Butadiene	106-99-0	$6.6 \times 10^{+2}$	Development
Caprolactam	105-60-2	$5.0 \times 10^{+1}$	Eyes (sensory irritation)
Carbon Disulfide	75-15-0	$6.2 \times 10^{+3}$	Nervous System; Reproductive/Developmental
Carbon Monoxide [a]	630-08-0	$2.3 \times 10^{+4}$	Cardiovascular System
Carbon Tetrachloride	56-23-5	$1.9 \times 10^{+3}$	Alimentary System (Liver); Nervous System Reproductive/Developmental
Chlorine	7782-50-5	$2.1 \times 10^{+2}$	Eyes; Respiratory System
Chloroform	67-66-3	$1.5 \times 10^{+2}$	Nervous System; Respiratory System; Reproductive/Developmental
Chloropicrin	76-06-2	$2.9 \times 10^{+1}$	Eyes; Respiratory System
Copper and Compounds	7440-50-8	$1.0 \times 10^{+2}$	Respiratory System
1,4-Dioxane	123-91-1	$3.0 \times 10^{+3}$	Eyes; Respiratory System
Epichlorohydrin	106-89-8	$1.3 \times 10^{+3}$	Eyes; Respiratory System
Ethylene Glycol Monobutyl Ether	111-76-2	$1.4 \times 10^{+4}$	Eyes; Respiratory System
Ethylene Glycol Monoethyl Ether	110-80-5	$3.7 \times 10^{+2}$	Reproductive/Developmental
Ethylene Glycol Monoethyl Ether Acetate	111-15-9	$1.4 \times 10^{+2}$	Nervous System; Reproductive/Developmental
Ethylene Glycol Monomethyl Ether	109-86-4	$9.3 \times 10^{+1}$	Reproductive/Developmental
Formaldehyde	50-00-0	$5.5 \times 10^{+1}$	Eyes (sensory irritation)
Hydrogen Chloride	7647-01-0	$2.1 \times 10^{+3}$	Eyes; Respiratory System
Hydrogen Cyanide	74-90-8	$3.4 \times 10^{+2}$	Nervous System
Hydrogen Fluoride	7664-39-3	$2.4 \times 10^{+2}$	Eyes; Respiratory System
Hydrogen Selenide	7783-07-5	$5.0 \times 10^{+0}$	Eyes; Respiratory System
Hydrogen Sulfide [a]	7783-06-4	$4.2 \times 10^{+1}$	Nervous System
Isopropanol	67-63-0	$3.2 \times 10^{+3}$	Eyes; Respiratory System
Mercury and Inorganic Mercury Compounds	7439-97-6	6.0×10^{-1}	Nervous System; Development
Methanol	67-56-1	$2.8 \times 10^{+4}$	Nervous System
Methyl Bromide	74-83-9	$3.9 \times 10^{+3}$	Nervous System; Respiratory System; Reproductive/Developmental

Substance	Chemical Abstract Service Number (CAS)	Acute Inhalation REL ($\mu g/m^3$)	Acute Hazard Index Target Organ Systems(s)
Methyl Chloroform	71-55-6	$6.8 \times 10^{+4}$	Nervous System
Methyl Ethyl Ketone	78-93-3	$1.3 \times 10^{+4}$	Eyes; Respiratory System
Methylene Chloride	75-09-2	$1.4 \times 10^{+4}$	Nervous System; Cardiovascular System
Nickel and Nickel Compounds	7440-02-0	2.0×10^{-1}	Immune System
Nitric Acid	7697-37-2	$8.6 \times 10^{+1}$	Respiratory System
Nitrogen Dioxide [a]	10102-44-0	$4.7 \times 10^{+2}$	Respiratory System
Ozone [a]	10028-15-6	$1.8 \times 10^{+2}$	Eyes; Respiratory System
Perchloroethylene (Tetrachloroethylene)	127-18-4	$2.0 \times 10^{+4}$	Eyes; Nervous System; Respiratory System
Phenol	108-95-2	$5.8 \times 10^{+3}$	Eyes; Respiratory System
Phosgene	75-44-5	$4.0 \times 10^{+0}$	Respiratory System
Propylene Oxide	75-56-9	$3.1 \times 10^{+3}$	Eyes; Respiratory System; Reproductive/Developmental
Sodium Hydroxide	1310-73-2	$8.0 \times 10^{+0}$	Eyes; Skin; Respiratory System
Styrene	100-42-5	$2.1 \times 10^{+4}$	Eyes; Respiratory System; Reproductive/Developmental
Sulfates [a]	N/A	$1.2 \times 10^{+2}$	Respiratory System
Sulfur Dioxide [a]	7446-09-5	$6.6 \times 10^{+2}$	Respiratory System
Sulfuric Acid and Oleum	7664-93-9 8014-95-7	$1.2 \times 10^{+2}$	Respiratory System
Tetrachloroethylene (Perchloroethylene)	127-18-4	$2.0 \times 10^{+4}$	Eyes; Nervous System; Respiratory System
Toluene	108-88-3	$3.7 \times 10^{+4}$	Nervous System; Respiratory System; Eyes; Reproductive/Developmental
Triethylamine	121-44-8	$2.8 \times 10^{+3}$	Nervous System; Eyes
Vanadium Pentoxide	1314-62-1	$3.0 \times 10^{+1}$	Eyes; Respiratory System
Vinyl Chloride	75-01-4	$1.8 \times 10^{+5}$	Nervous System; Eyes; Respiratory System
Xylenes (m,o,p-isomers)	1330-20-7	$2.2 \times 10^{+4}$	Eyes; Respiratory System; Nervous System

[a] California Ambient Air Quality Standard

6.3 8-hour Reference Exposure Levels

OEHHA has developed 8-hour RELs for assessing potential noncancer health impacts for exposures to the general public that occur on a recurrent basis, but only during a portion of each day (OEHHA, 2008; http://www.oehha.ca.gov/air/allrels.html). Eight-hour RELs are compared to air concentrations that represent an average (daily) 8-hour exposure. They were designed to address off-site worker exposure at the MEIW, but may also be used at the Districts' discretion to characterize 8-hour residential noncancer exposures, particularly for non-continuous facility operations where exposure is based on air concentrations during facility operation (i.e., the zero emission hours are not included) rather than averaged over 24-hours/day, 7 days/week as assessed for chronic exposure. The 8-hour RELs can also be used to assess exposure of students and teachers while at school (OEHHA, 2008). These RELs were developed because of concerns that applying the chronic REL in some scenarios was

overly conservative. By definition, an 8-hour REL is an exposure that is not likely to cause adverse health effects in a human population, including sensitive subgroups, exposed to that concentration (in units of micrograms per cubic meter or $\mu g/m^3$) for an 8-hour exposure duration on a regular (including daily) basis.

The RELs, target organ systems, and the averaging time for substances that can present a potential hazard from inhalation for 8 hours on a daily basis are presented in Table 6.2. Chapter 8 discusses the methods used for determining noncancer 8-hour health impacts. Appendix I presents an example calculation used to determine an HQ and HI.

Any substances in Table 6.2 with Development or Reproductive System as a target organ system are represented in HARP and in the Appendix L REL tables under the single endpoint "Reproductive/Development".

Table 6.2 Eight-Hour Inhalation Reference Exposure Levels (RELs) and 8-Hour Hazard Index Target Organ System(s)

Substance	Chemical Abstract Service Number (CAS)	Chronic Inhalation REL ($\mu g/m^3$)	Chronic Inhalation Hazard Index Target Organ System(s)
Acetaldehyde	75-07-0	$3.0 \times 10^{+2}$	Respiratory System
Acrolein	107-02-8	7.0×10^{-1}	Respiratory System
Arsenic & Inorganic Arsenic Compounds	7440-38-2	1.5×10^{-2}	Cardiovascular System; Development; Nervous System; Respiratory System; Skin
Benzene	71-43-2	$3.0 \times 10^{+0}$	Hematologic System
1,3-Butadiene	106-99-0	$9.0 \times 10^{+0}$	Reproductive System
Caprolactam	105-60-2	$7.0 \times 10^{+0}$	Respiratory System
Formaldehyde	50-0-0	$9.0 \times 10^{+0}$	Respiratory System
Manganese & Manganese Compounds	7439-96-5	1.7×10^{-1}	Nervous System
Mercury & Inorganic Mercury Compounds	7439--97-6	6.0×10^{-2}	Nervous System; Development; Kidney
Nickel & Nickel Compounds	7440-02-0	6.0×10^{-2}	Respiratory System; Immune System

6.4 Chronic Reference Exposure Levels

OEHHA has developed chronic RELs for assessing noncancer health impacts from long-term exposure. (OEHHA, 2008; see also http://www.oehha.ca.gov/air/allrels.html) A chronic REL is a concentration level (expressed in units of micrograms per cubic meter ($\mu g/m^3$) for inhalation exposure and in a dose expressed in units of milligrams per kilogram-day (mg/kg-day) for oral exposures) at or below which no adverse health effects are anticipated following long-term exposure. Long-term exposure for these purposes has been defined by U.S. EPA as at least 12% of a lifetime, or about eight years for humans. Table 6.3 lists the chronic noncancer RELs that should be used in

the assessment of chronic health effects from inhalation exposure. Appendix L provides a consolidated listing of all the acute, 8-hour and chronic RELs and target organs that are approved for use by OEHHA and ARB for the Hot Spots Program. Periodically, new or updated RELs are adopted by OEHHA. See OEHHA's web site http://www.oehha.ca.gov/air/allrels.html to determine if any new or updated RELs have been adopted since the last guideline update.

The organ system(s) associated with each chronic REL are also presented in Table 6.3. Any substances in Table 6.3 with Development or Reproductive System as a target organ system are represented in HARP and in the Appendix L REL tables under the single endpoint "Reproductive/Development". Chapter 8 discusses the methods used for determining potential noncancer health impacts and Appendix I presents example calculations used to determine a HQ and HI.

Table 6.3 Chronic Inhalation Reference Exposure Levels (RELs) and Chronic Hazard Index Target Organ System(s)

Substance	Chemical Abstract Service Number (CAS)	Chronic Inhalation REL ($\mu g/m^3$)	Chronic Inhalation Hazard Index Target Organ System(s)
Acetaldehyde [a]	75-07-0	$1.4 \times 10^{+2}$	Respiratory System
Acrolein	107-02-8	3.5×10^{-1}	Respiratory System
Acrylonitrile	107-13-1	$5.0 \times 10^{+0}$	Respiratory System
Ammonia	7664-41-7	$2.0 \times 10^{+2}$	Respiratory System
Arsenic & Inorganic Arsenic Compounds	7440-38-2	1.5×10^{-2}	Cardiovascular System; Development; Nervous System; Respiratory System; Skin
Benzene	71-43-2	$3.0 \times 10^{+0}$	Hematologic System
Beryllium and Beryllium Compounds	7440-41-7	7.0×10^{-3}	Immune System; Respiratory System
1,3-Butadiene	106-99-0	$2.0 \times 10^{+0}$	Reproductive System
Cadmium and Cadmium Compounds	7440-43-9	2.0×10^{-2}	Kidney; Respiratory System
Caprolactam	105-60-2	$2.2 \times 10^{+0}$	Respiratory System
Carbon Disulfide	75-15-0	$8.0 \times 10^{+2}$	Nervous System; Reproductive System
Carbon Tetrachloride	56-23-5	$4.0 \times 10^{+1}$	Alimentary System (Liver); Development; Nervous System
Chlorine	7782-50-5	2.0×10^{-1}	Respiratory System
Chlorine Dioxide	10049-04-4	6.0×10^{-1}	Respiratory System
Chlorinated Dibenzo-*p*-dioxins [b]			
2,3,7,8-Tetrachlorodibenzo-*p*-dioxin [b]	1746-01-6	4.0×10^{-5}	Alimentary System (Liver); Development; Endocrine System; Hematologic System; Reproductive System; Respiratory System
1,2,3,7,8-Pentachlorodibenzo-*p*-dioxin [b]	40321-76-4	4.0×10^{-5}	
1,2,3,4,7,8-Hexachlorodibenzo-*p*-dioxin [b]	39227-28-6	4.0×10^{-4}	
1,2,3,6,7,8-Hexachlorodibenzo-*p*-dioxin [b]	57653-85-7	4.0×10^{-4}	
1,2,3,7,8,9-Hexachlorodibenzo-*p*-dioxin [b]	19408-74-3	4.0×10^{-4}	
1,2,3,4,6,7,8-Heptachlorodibenzo-*p*-dioxin [b]	35822-46-9	4.0×10^{-3}	
1,2,3,4,6,7,8,9-Octachlorodibenzo-*p*-dioxin [b]	3268-87-9	1.3×10^{-1}	

Table 6.3 Chronic Inhalation Reference Exposure Levels (RELs) and Chronic Hazard Index Target Organ System(s)

Substance	Chemical Abstract Service Number (CAS)	Chronic Inhalation REL ($\mu g/m^3$)	Chronic Inhalation Hazard Index Target Organ System(s)
Chlorinated Dibenzofurans [b]			
2,3,7,8-Tetrachlorodibenzofuran [b]	5120-73-19	4.0×10^{-4}	Alimentary System (Liver); Development; Endocrine System; Hematologic System; Reproductive System; Respiratory System
1,2,3,7,8-Pentachlorodibenzofuran [b]	57117-41-6	1.3×10^{-3}	
2,3,4,7,8-Pentachlorodibenzofuran [b]	57117-31-4	1.3×10^{-4}	
1,2,3,4,7,8-Hexachlorodibenzofuran [b]	70648-26-9	4.0×10^{-4}	
1,2,3,6,7,8-Hexachlorodibenzofuran [b]	57117-44-9	4.0×10^{-4}	
1,2,3,7,8,9-Hexachlorodibenzofuran [b]	72918-21-9	4.0×10^{-4}	
2,3,4,6,7,8-Hexachlorodibenzofuran [b]	60851-34-5	4.0×10^{-4}	
1,2,3,4,6,7,8-Heptachlorodibenzofuran [b]	67562-39-4	4.0×10^{-3}	
1,2,3,4,7,8,9-Heptachlorodibenzofuran [b]	55673-89-7	4.0×10^{-3}	
1,2,3,4,6,7,8,9-Octachlorodibenzofuran [b]	39001-02-0	1.3×10^{-1}	
Chlorobenzene	108-90-7	$1.0 \times 10^{+3}$	Alimentary System (Liver); Kidney; Reproductive System
Chloroform	67-66-3	$3.0 \times 10^{+2}$	Alimentary System (Liver); Development; Kidney
Chloropicrin	76-06-2	4.0×10^{-1}	Respiratory System
Chromium VI & Soluble Chromium VI Compounds (except chromic trioxide)	18540-29-9	2.0×10^{-1}	Respiratory System
Chromic Trioxide (as chromic acid mist)	1333-82-0	2.0×10^{-3}	Respiratory System
Cresol Mixtures	1319-77-3	$6.0 \times 10^{+2}$	Nervous System
1,4-Dichlorobenzene	106-46-7	$8.0 \times 10^{+2}$	Alimentary System (Liver); Kidney; Nervous System; Respiratory System
1,1-Dichloroethylene (Vinylidene Chloride)	75-35-4	$7.0 \times 10^{+1}$	Alimentary System (Liver)
Diesel Exhaust [a]	N/A	$5.0 \times 10^{+0}$	Respiratory System
Diethanolamine	111-42-2	$3.0 \times 10^{+0}$	Hematologic System; Respiratory System
N,N-Dimethylformamide	68-12-2	$8.0 \times 10^{+1}$	Alimentary System (Liver); Respiratory System
1,4-Dioxane	123-91-1	$3.0 \times 10^{+3}$	Alimentary System (Liver); Cardiovascular System; Kidney
Epichlorohydrin	106-89-8	$3.0 \times 10^{+0}$	Eyes; Respiratory System
1,2-Epoxybutane	106-88-7	$2.0 \times 10^{+1}$	Cardiovascular System; Respiratory System
Ethylbenzene	100-41-4	$2.0 \times 10^{+3}$	Alimentary System (Liver); Kidney; Development; Endocrine System
Ethyl Chloride	75-00-3	$3.0 \times 10^{+4}$	Alimentary System (Liver); Development
Ethylene Dibromide	106-93-4	8.0×10^{-1}	Reproductive System
Ethylene Dichloride	107-06-2	$4.0 \times 10^{+2}$	Alimentary System (Liver)
Ethylene Glycol	107-21-1	$4.0 \times 10^{+2}$	Development; Kidney; Respiratory System
Ethylene Glycol Monoethyl Ether	110-80-5	$7.0 \times 10^{+1}$	Hematologic System; Reproductive System
Ethylene Glycol Monoethyl Ether Acetate	111-15-9	$3.0 \times 10^{+2}$	Development

Table 6.3 Chronic Inhalation Reference Exposure Levels (RELs) and Chronic Hazard Index Target Organ System(s)

Substance	Chemical Abstract Service Number (CAS)	Chronic Inhalation REL ($\mu g/m^3$)	Chronic Inhalation Hazard Index Target Organ System(s)
Ethylene Glycol Monomethyl Ether	109-86-4	$6.0 \times 10^{+1}$	Reproductive System
Ethylene Glycol Monomethyl Ether Acetate	110-49-6	$9.0 \times 10^{+1}$	Reproductive System
Ethylene Oxide	75-21-8	$3.0 \times 10^{+1}$	Nervous System
Fluorides (except hydrogen fluoride)	N/A	$1.3 \times 10^{+1}$	Bone and Teeth; Respiratory System
Formaldehyde	50-00-0	$9.0 \times 10^{+0}$	Respiratory System
Glutaraldehyde	111-30-8	8.0×10^{-2}	Respiratory System
Hexane (n-)	110-54-3	$7.0 \times 10^{+3}$	Nervous System
Hydrazine	302-01-2	2.0×10^{-1}	Alimentary System (Liver); Endocrine System
Hydrogen Chloride	7647-01-0	$9.0 \times 10^{+0}$	Respiratory System
Hydrogen Cyanide	74-90-8	$9.0 \times 10^{+0}$	Cardiovascular System; Endocrine System; Nervous System
Hydrogen Fluoride	7664-39-3	$1.4 \times 10^{+1}$	Bone and Teeth; Respiratory System
Hydrogen Sulfide	7783-06-4	$1.0 \times 10^{+1}$	Respiratory System
Isophorone	78-59-1	$2.0 \times 10^{+3}$	Alimentary System (Liver); Development
Isopropanol	67-63-0	$7.0 \times 10^{+3}$	Development; Kidney
Maleic Anhydride	108-31-6	7.0×10^{-1}	Respiratory System
Manganese & Manganese Compounds	7439-96-5	9.0×10^{-2}	Nervous System
Mercury & Inorganic Mercury Compounds	7439-97-6	3.0×10^{-2}	Nervous System; Development; Kidney
Methanol	67-56-1	$4.0 \times 10^{+3}$	Development
Methyl Bromide	74-83-9	$5.0 \times 10^{+0}$	Development; Nervous System; Respiratory System
Methyl Chloroform	71-55-6	$1.0 \times 10^{+3}$	Nervous System
Methyl Isocyanate	624-83-9	$1.0 \times 10^{+0}$	Reproductive System; Respiratory System
Methyl tertiary-Butyl Ether	1634-04-4	$8.0 \times 10^{+3}$	Alimentary System (Liver); Eyes; Kidney
Methylene Chloride	75-09-2	$4.0 \times 10^{+2}$	Cardiovascular System; Nervous System
4,4'-Methylene Dianiline (& its dichloride)	101-77-9	$2.0 \times 10^{+1}$	Alimentary System (Liver); Eyes
Methylene Diphenyl Isocyanate	101-68-8	7.0×10^{-1}	Respiratory System
Naphthalene	91-20-3	$9.0 \times 10^{+0}$	Respiratory System
Nickel & Nickel Compounds (except nickel oxide)	7440-02-0	1.4×10^{-2}	Hematologic System; Respiratory System
Nickel Oxide	1313-99-1	2.0×10^{-2}	Respiratory System
Perchloroethylene (Tetrachloroethylene)[a]	127-18-4	$3.5 \times 10^{+1}$	Alimentary System (Liver); Kidney
Phenol	108-95-2	$2.0 \times 10^{+2}$	Alimentary System (Liver); Cardiovascular System; Kidney; Nervous System
Phosphine	7803-51-2	8.0×10^{-1}	Alimentary System (Liver); Hematologic System; Kidney; Nervous System; Respiratory System

Table 6.3 Chronic Inhalation Reference Exposure Levels (RELs) and Chronic Hazard Index Target Organ System(s)

Substance	Chemical Abstract Service Number (CAS)	Chronic Inhalation REL ($\mu g/m^3$)	Chronic Inhalation Hazard Index Target Organ System(s)
Phosphoric Acid	7664-38-2	$7.0 \times 10^{+0}$	Respiratory System
Phthalic Anhydride	85-44-9	$2.0 \times 10^{+1}$	Respiratory System
Polychlorinated biphenyls (PCBs)[b]			
3,3',4,4'-Tetrachlorobiphenyl (77) [b]	35298-13-3	4.0×10^{-1}	Alimentary System (Liver); Developmental; Endocrine System; Hematologic System; Reproductive System; Respiratory System
3,4,4',5-Tetrachlorobiphenyl (81) [b]	70362-50-4	1.3×10^{-1}	
2,3,3',4,4'- Pentachlorobiphenyl (105) [b]	32598-14-4	$1.3 \times 10^{+0}$	
2,3,4,4'5- Pentachlorobiphenyl (114) [b]	74472-37-0	$1.3 \times 10^{+0}$	
2,3'4,4',5- Pentachlorobiphenyl (118) [b]	31508-00-6	$1.3 \times 10^{+0}$	
2',3,4,4',5- Pentachlorobiphenyl (123) [b]	65510-44-3	$1.3 \times 10^{+0}$	
3,3',4,4',5- Pentachlorobiphenyl (126) [b]	57465-28-8	4.0×10^{-4}	
2,3,3',4,4',5-Hexachlorobiphenyl (156) [b]	38380-08-4	$1.3 \times 10^{+0}$	
2,3,3',4,4',5'-Hexachlorobiphenyl (157) [b]	69782-90-7	$1.3 \times 10^{+0}$	
2,3',4,4',5,5'-Hexachlorobiphenyl (167) [b]	52663-72-6	$1.3 \times 10^{+0}$	
3,3',4,4'5,5'- Hexachlorobiphenyl (169) [b]	32774-16-6	1.3×10^{-3}	
2,3,3'4,4',5,5'-Heptachlorobiphenyl (189) [b]	39635-31-9	$1.3 \times 10^{+0}$	
Propylene	115-07-1	$3.0 \times 10^{+3}$	Respiratory System
Propylene Glycol Monomethyl Ether	107-98-2	$7.0 \times 10^{+3}$	Alimentary System (Liver)
Propylene Oxide	75-56-9	$3.0 \times 10^{+1}$	Respiratory System
Selenium and Selenium compounds (other than Hydrogen Selenide)	7782-49-2	$2.0 \times 10^{+1}$	Alimentary System (Liver); Cardiovascular System; Nervous System
Silica (crystalline, respirable)	N/A	$3.0 \times 10^{+0}$	Respiratory System
Styrene	100-42-5	$9.0 \times 10^{+2}$	Nervous System
Sulfuric Acid	7664-93-9	$1.0 \times 10^{+0}$	Respiratory System
Toluene	108-88-3	$3.0 \times 10^{+2}$	Development; Nervous System; Respiratory System
2,4-Toluene Diisocyanate	584-84-9	7.0×10^{-2}	Respiratory System
2,6-Toluene Diisocyanate	91-08-7	7.0×10^{-2}	Respiratory System
Trichloroethylene [a]	79-01-6	$6.0 \times 10^{+2}$	Eyes; Nervous System
Triethylamine	121-44-8	$2.0 \times 10^{+2}$	Eyes
Vinyl Acetate	108-05-4	$2.0 \times 10^{+2}$	Respiratory System
Xylenes (m, o, p-isomers)	1330-20-7	$7.0 \times 10^{+2}$	Nervous System; Respiratory System; Eyes

[a] These peer-reviewed values were developed under the Toxic Air Contaminant (TAC) Program mandated by AB1807 (California Health and Safety Code Sec. 39650 *et seq*.).

[b] The OEHHA has adopted the World Health Organization Toxicity Equivalency Factor (TEF) scheme for evaluating the cancer risk and noncancer hazard due to exposure to samples containing mixtures of polychlorinated dibenzo-*p*-dioxins (PCDD) (also referred to as chlorinated dioxins and dibenzofurans), polychlorinated dibenzofurans (PCDF) and polychlorinated biphenyls (PCBs). The TEF values are revised from time to time to reflect new data and increased scientific knowledge. Currently OEHHA recommends use of the 2005 revision to the WHO TEF values (WHO_{05}-TEF). See Appendix E for more information about the scheme and for the methodology for calculating 2,3,7,8-tetrachlorodibenzo-*p*-dioxin (TCDD) equivalents for PCDD and PCDFs. For

convenience, OEHHA has calculated chronic REL values for speciated PCDDs, PCDFs and PCBs based on the WHO_{05} TEF values and the chronic REL for 2,3,7,8-TCDD using the procedure discussed in Appendix E. The chronic REL values can be used to calculate a hazard index when the mixtures are speciated from individual congener ground level concentrations. In those cases where speciation of dioxins and furans has not been performed, then 2,3,7,8-TCDD serves as the surrogate for dioxin and furan emissions.

N/A Not Applicable

6.5 Chronic Oral (Noninhalation) Reference Exposure Levels

As specified throughout the guidelines, estimates of long-term exposure resulting from facility air emissions of specific compounds must be analyzed for both inhalation and noninhalation (multipathway) pathways of exposure for humans. Facilities often emit substances under high temperature and pressure in the presence of particulate matter. While some of these substances are expected to remain in the vapor phase, other substances such as metals and semi-volatile organics can be either emitted as particles, form particles after emission from the facility, or adhere to existing particles. Some substances will partition between vapor and particulate phases. Substances in the particulate phase can be removed from the atmosphere by settling and, thus, potentially present a significant hazard via noninhalation pathways.

Particulate-associated chemicals can be deposited directly onto soil, onto the leaves or fruits of crops, or onto surface waters. Exposure via the oral route is the predominant noninhalation pathway, resulting in the noninhalation RELs being referred to as 'oral RELs' in this document. The oral RELs are used for both ingestion and dermal exposures, and are applied using the chronic non-inhalation exposures in the residential scenario and the worker scenarios. The oral RELs are expressed as doses in milligrams of substance (consumed and dermally absorbed) per kilogram body weight per day (mg/kg-day).

Table 6.4 lists the chronic noncancer RELs to be used in the assessment of chronic health effects from noninhalation pathways of exposure. Any substances in Table 6.4 with Development or Reproductive System as a target organ system are represented in HARP and in the Appendix L REL tables under the single endpoint "Reproductive/Development". Appendix L provides a consolidated listing of all chronic RELs and target organs that are approved for use by OEHHA and ARB for the Hot Spots Program. Periodically, new or updated RELs are adopted by OEHHA and these guidelines will be updated to reflect those changes. See OEHHA's web page at http://www.oehha.ca.gov/air/allrels.html to determine if any new or updated RELs have been adopted since the last guideline update. Chapter 8 discusses the methods used for determining potential noncancer health impacts and Appendix I presents example calculations used to determine a HQ and HI.

Table 6.4 Chronic Noninhalation 'Oral' Reference Exposure Levels (RELs) and Chronic Hazard Index Target Organ System(s)

Substance	Chemical Abstract Service No. (CAS)	Chronic Oral REL (mg/kg-day)	Chronic Oral Hazard Index Target Organ System(s)
Arsenic & Inorganic Arsenic Compounds	7440-38-2	3.5×10^{-6}	Development; Nervous System; Respiratory System; Cardiovascular System; Skin
Beryllium and Beryllium Compounds	7440-41-7	2.0×10^{-3}	Alimentary System (Gastrointestinal Tract)
Cadmium and Cadmium Compounds	7440-43-9	5.0×10^{-4}	Kidney
Chlorinated Dibenzo-*p*-dioxins [a]			
2,3,7,8-Tetrachlorodibenzo-*p*-dioxin [a]	1746-01-6	1.0×10^{-8}	Alimentary System (Liver); Developmental; Endocrine System; Hematologic System; Reproductive System; Respiratory System
1,2,3,7,8-Pentachlorodibenzo-*p*-dioxin [a]	40321-76-4	1.0×10^{-8}	
1,2,3,4,7,8-Hexachlorodibenzo-*p*-dioxin [a]	39227-28-6	1.0×10^{-7}	
1,2,3,6,7,8-Hexachlorodibenzo-*p*-dioxin [a]	57653-85-7	1.0×10^{-7}	
1,2,3,7,8,9-Hexachlorodibenzo-*p*-dioxin [a]	19408-74-3	1.0×10^{-7}	
1,2,3,4,6,7,8-Heptachlorodibenzo-*p*-dioxin [a]	35822-46-9	1.0×10^{-6}	
1,2,3,4,6,7,8,9-Octachlorodibenzo-*p*-dioxin [a]	3268-87-9	3.3×10^{-5}	
Chlorinated Dibenzofurans [a]			
2,3,7,8-Tetrachlorodibenzofuran [a]	5120-73-19	1.0×10^{-7}	Alimentary System (Liver); Development; Endocrine System; Hematologic System; Reproductive System; Respiratory System
1,2,3,7,8-Pentachlorodibenzofuran [a]	57117-41-6	3.3×10^{-7}	
2,3,4,7,8-Pentachlorodibenzofuran [a]	57117-31-4	3.3×10^{-8}	
1,2,3,4,7,8-Hexachlorodibenzofuran [a]	70648-26-9	1.0×10^{-7}	
1,2,3,6,7,8-Hexachlorodibenzofuran [a]	57117-44-9	1.0×10^{-7}	
1,2,3,7,8,9-Hexachlorodibenzofuran [a]	72918-21-9	1.0×10^{-7}	
2,3,4,6,7,8-Hexachlorodibenzofuran [a]	60851-34-5	1.0×10^{-7}	
1,2,3,4,6,7,8-Heptachlorodibenzofuran [a]	67562-39-4	1.0×10^{-6}	
1,2,3,4,7,8,9-Heptachlorodibenzofuran [a]	55673-89-7	1.0×10^{-6}	
1,2,3,4,6,7,8,9-Octachlorodibenzofuran [a]	39001-02-0	3.3×10^{-5}	
Chromium VI & Soluble Chromium VI Compounds (including chromic trioxide)	18540-29-9	2.0×10^{-2}	Hematologic System
Fluorides (including hydrogen fluoride)	7664-39-3	4.0×10^{-2}	Bone and Teeth
Mercury & Mercury Inorganic Compounds	7439-97-6	1.6×10^{-4}	Kidney; Nervous System; Development
Nickel & Nickel Compounds (including nickel oxide)	7440-02-0	1.1×10^{-2}	Development
Polychlorinated biphenyls (PCBs) (speciated)[a]			
3,3',4,4'-Tetrachlorobiphenyl (77)[a]	35298-13-3	1.0×10^{-4}	Alimentary System (Liver); Developmental; Endocrine System; Hematologic System; Reproductive System; Respiratory System
3,4,4',5-Tetrachlorobiphenyl (81)[a]	70362-50-4	3.3×10^{-5}	
2,3,3',4,4'- Pentachlorobiphenyl (105)[a]	32598-14-4	3.3×10^{-4}	
2,3,4,4'5- Pentachlorobiphenyl (114)[a]	74472-37-0	3.3×10^{-4}	
2,3'4,4',5- Pentachlorobiphenyl (118)[a]	31508-00-6	3.3×10^{-4}	
2',3,4,4',5- Pentachlorobiphenyl (123)[a]	65510-44-3	3.3×10^{-4}	
3,3',4,4',5- Pentachlorobiphenyl (126)[a]	57465-28-8	1.0×10^{-7}	
2,3,3',4,4',5-Hexachlorobiphenyl (156)[a]	38380-08-4	3.3×10^{-4}	
2,3,3',4,4',5'-Hexachlorobiphenyl (157)[a]	69782-90-7	3.3×10^{-4}	
2,3',4,4',5,5'-Hexachlorobiphenyl (167)[a]	52663-72-6	3.3×10^{-4}	
3,3',4,4'5,5'- Hexachlorobiphenyl (169)[a]	32774-16-6	3.3×10^{-7}	
2,3,3'4,4',5,5'- Heptachlorobiphenyl (189)[a]	39635-31-9	3.3×10^{-4}	

Table 6.4 Chronic Noninhalation 'Oral' Reference Exposure Levels (RELs) and Chronic Hazard Index Target Organ System(s)

Substance	Chemical Abstract Service No. (CAS)	Chronic Oral REL (mg/kg-day)	Chronic Oral Hazard Index Target Organ System(s)
Selenium and Selenium Compounds (other than hydrogen selenide)	7782-49-2	5.0×10^{-3}	Alimentary System (Liver); Cardiovascular System; Nervous System

a The OEHHA has adopted the World Health Organization Toxicity Equivalency Factor (TEF) scheme for evaluating the cancer risk and noncancer risk due to exposure to samples containing mixtures of polychlorinated dibenzo-*p*-dioxins (PCDD) (also referred to as chlorinated dioxins and dibenzofurans), polychlorinated dibenzofurans (PCDF), and polychlorinated biphenyls (PCBs). The TEF values are revised from time to time to reflect new data and increased scientific knowledge. Currently OEHHA recommends use of the 2005 revision to the WHO TEF values (WHO_{05}-TEF). See Appendix E for more information about the scheme and for the methodology for calculating 2,3,7,8-equivalents for PCDD and PCDFs. For convenience, OEHHA has calculated chronic 'oral' REL values for speciated PCDDs, PCDFs, and PCBs based on the WHO_{05} TEF values and the chronic 'oral' REL for 2,3,7,8-tetrachlorodibenzo-*p*-dioxin using the procedure discussed in Appendix E. The chronic 'oral' REL values can be used to calculate a hazard index when the mixtures are speciated from individual congener ground level concentrations. In those cases where speciation of dioxins and furans has not been performed, then 2,3,7,8-TCDD serves as the surrogate for dioxin and furan emissions.

6.6 References

OEHHA, 2008. Air Toxics Hot Spots Risk Assessment Guidelines Technical Support Document for the Derivation of Noncancer Reference Exposure Levels. Available online at: http://www.oehha.ca.gov

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7 - Dose-Response Assessment for Carcinogens

7.1 Introduction

Dose-response assessment characterizes the quantitative relationship between the amount of exposure to a substance (the dose) and the incidence or occurrence of injury (the response). The process often involves establishing a toxicity value or criterion to use in assessing potential health risk. The toxicity criterion, or health guidance value, for carcinogens is the cancer potency slope (potency factor), which describes the potential risk of developing cancer per unit of average daily dose over a 70-year lifetime. Cancer inhalation and oral potency factors have been derived by the Office of Environmental Health Hazard Assessment (OEHHA) or by the United States Environmental Protection Agency (U.S. EPA) and approved by the State's Scientific Review Panel on Toxic Air Contaminants. They are available for many of the substances listed in Appendix A (List of Substances) as carcinogens. Table 7.1 and Appendix L list the inhalation and oral cancer potency factors that should be used in multipathway health risk assessments (HRAs) for the Hot Spots Program.

The details on the methodology of dose-response assessment for carcinogens and the approved cancer potency factors are provided in the Air Toxics Hot Spots Risk Assessment Guidelines. Part II. Technical Support Document for Cancer Potency Factors: Methodologies for derivation, listing of available values, and adjustments to allow for early life stage exposures. May, 2009. (OEHHA, 2009; see http://www.oehha.ca.gov/air/hot_spots/tsd052909.html).

7.2 Carcinogenic Potency

Cancer potency factors used for both the inhalation and oral routes in the Hot Spots program are generally the 95% upper confidence limits (UCL) on the modeled dose-response slope at the low dose range. The cancer slope factor assumes continuous lifetime exposure to a substance, and is expressed in units of inverse dose [i.e., $(mg/kg/day)^{-1}$]. Another common potency expression is in units of inverse concentration [$(\mu g/m^3)^{-1}$)] when the slope is based on exposure concentration rather than dose; this is termed the unit risk factor. To accommodate the use of age-specific exposure variates, the Hot Spots program has translated the unit risk factors based on concentration to units of inverse dose. This allows calculation of risk for age groupings, as exposure varies with age. It also allows for application of Age Sensitivity Factors for early life exposures.

It is assumed in cancer risk assessments that risk is directly proportional to dose and that, for most carcinogens, there is no threshold for carcinogenesis. The derivation of inhalation and oral cancer potency factors takes into account information on pharmacokinetics, when available, and on the mechanism of carcinogenic action.

Table 7.1 and Appendix L list inhalation and oral cancer potency factors that should be used in risk assessments for the Hot Spots Program. Chapter 8 describes procedures for use of potency factors in estimating potential cancer risk.

7.2.1 *Inhalation Cancer Potency Factors*

The risk assessment methodology and algorithms presented in Chapter 8 express the inhalation cancer slope factors in units of inverse dose (i.e., $(mg/kg/day)^{-1}$). Breathing rates, expressed in units of liters per kilogram of body weight-day (L/kg-day), are multiplied with the air concentrations, coupled with the appropriate unit conversion factor, to estimate dose in mg/kg-day. This allows estimation of average and high-end cancer risk point estimates. Estimation of a distribution of cancer risk based on variability in breathing rate can be obtained by Monte Carlo methods using the distributions of breathing rates in L/kg-day, which can then be converted to a dose distribution in mg/kg BW based on the intake rate. Unit risk factors [in the units of inverse concentration (i.e., $(\mu g/m^3)^{-1}$], which were used in previous guidelines for the Hot Spots program, are still listed in the TSD (OEHHA, 2009) and may prove useful in other risk assessment applications.

The average daily inhalation dose (mg/kg-day) multiplied by the cancer potency factor $(mg/kg\text{-}day)^{-1}$ will give the inhalation cancer risk (unitless), which is an expression of the chemical's cancer risk during a 70-year lifespan of exposure. For example, an inhalation cancer risk of 5×10^{-6} is the same as stating that an individual has an estimated probability of developing cancer from their exposure of 5 chances per million people exposed. A more complete description of how potential cancer risk is calculated from the exposure dose and cancer potency factors is provided in Chapter 8. Appendix I presents an example calculation for determining cancer risk.

A list of current inhalation potency factors is provided in Table 7.1. Periodically, new or revised cancer potency factors will be peer reviewed by the State's Scientific Review Panel on Toxic Air Contaminants (SRP) and adopted by the Director of OEHHA. For new or updated numbers, consult the OEHHA web site at (http://www.oehha.ca.gov/air/hot_spots/tsd052909.html) to determine if any new or updated cancer potency factors have been adopted since this guideline update. New cancer potency factors that have been approved by the SRP and adopted by the Director of OEHHA should be incorporated into Hot Spots risk assessment for facilities that emit those chemicals.

7.2.2 *Oral Cancer Potency Factors*

Under the Hot Spots Program, a few substances are evaluated for exposure and risk from non-inhalation pathways – these are referred to as multipathway substances. Multipathway substances have the potential to impact a receptor through inhalation and noninhalation (oral and dermal) exposure routes. These substances include heavy metals and semi-volatile organic substances such as dioxins, furans, and polycyclic aromatic hydrocarbons (PAHs). These substances commonly exist in the particle

phase or partially in the particle phase when emitted into the air. They can therefore be deposited onto soil, vegetation, and water. Noninhalation exposure pathways considered under the Hot Spots Program include the ingestion of soil, homegrown produce, meat, milk, surface water, breast milk, and fish as well as dermal exposure to contaminants deposited in the soil. See Table 5.1 for a list of the multipathway substances.

Table 7.1 and Appendix L list oral cancer potency factors in units of $(mg/kg\text{-}day)^{-1}$ that should be used for assessing the potential cancer risk for these substances through noninhalation exposure pathways. The cancer risk from these individual pathways is calculated by multiplying the dose (mg/kg-day) times the oral cancer potency factor $(mg/kg\text{-}day)^{-1}$ to yield the potential cancer risk (unitless) from non-inhalation exposures. Chapter 5 provides all of the algorithms to calculate exposure dose through all of the individual exposure pathways. Appendix I provides a sample calculation for dose and cancer risk using the inhalation exposure pathway.

Three carcinogens (cadmium, beryllium, and nickel), although subject to deposition, are only treated as carcinogenic by the inhalation route and not by the oral route. Therefore, there are no oral cancer potency factors for these substances. However, the oral doses of these substances need to be estimated because of their noncancer toxicity. See Chapters 6 and 8, and Appendices I and L for dose-response factors, and calculations to address these substances.

Table 7.1 Inhalation and Oral Cancer Potency Factors

Substance	Chemical Abstract Service Number (CAS)	Inhalation Potency Factor $(mg/kg\text{-}day)^{-1}$	Oral Slope Factor $(mg/kg\text{-}day)^{-1}$
Acetaldehyde	75-07-0	1.0×10^{-2}	
Acetamide	60-35-5	7.0×10^{-2}	
Acrylamide	79-06-1	$4.5 \times 10^{+0}$	
Acrylonitrile	107-13-1	$1.0 \times 10^{+0}$	
Allyl chloride	107-05-1	2.1×10^{-2}	
2-Aminoanthraquinone	117-79-3	3.3×10^{-2}	
Aniline	62-53-3	5.7×10^{-3}	
Arsenic (inorganic)	7440-38-2	$1.2 \times 10^{+1}$	$1.5 \times 10^{+0}$
Asbestos [#]	1332-21-4	$2.2 \times 10^{+2}$ [#]	
Benz[*a*]anthracene [BaP]	56-55-3	3.9×10^{-1}	$1.2 \times 10^{+0}$
Benzene	71-43-2	1.0×10^{-1}	
Benzidine	92-87-5	$5.0 \times 10^{+2}$	
Benzo[*a*]pyrene	50-32-8	$3.9 \times 10^{+0}$	$1.2 \times 10^{+1}$
Benzo[*b*]fluoranthrene [BaP]	205-99-2	3.9×10^{-1}	$1.2 \times 10^{+0}$
Benzo[*j*]fluoranthrene [BaP]	205-82-3	3.9×10^{-1}	$1.2 \times 10^{+0}$
Benzo[*k*]fluoranthrene [BaP]	207-08-9	3.9×10^{-1}	$1.2 \times 10^{+0}$
Benzyl chloride	100-44-7	1.7×10^{-1}	
Beryllium	7440-41-7	$8.4 \times 10^{+0}$	
Bis(2-chloroethyl) ether	111-44-4	$2.5 \times 10^{+0}$	
Bis(chloromethyl)ether	542-88-1	$4.6 \times 10^{+1}$	
1,3-Butadiene	106-99-0	6.0×10^{-1}	
Cadmium (and compounds)	7440-43-9	$1.5 \times 10^{+1}$	
Carbon tetrachloride	56-23-5	1.5×10^{-1}	
Chlorinated Dibenzo-p-dioxins [A]			
2,3,7,8-Tetrachlorodibenzo-*p*-dioxin	1746-01-6	$1.3 \times 10^{+5}$	$1.3 \times 10^{+5}$
1,2,3,7,8-Pentachlorodibenzo-*p*-dioxin	40321-76-4	$1.3 \times 10^{+5}$	$1.3 \times 10^{+5}$
1,2,3,4,7,8-Hexachlorodibenzo-*p*-dioxin	39227-28-6	$1.3 \times 10^{+4}$	$1.3 \times 10^{+4}$
1,2,3,6,7,8-Hexachlorodibenzo-*p*-dioxin	57653-85-7	$1.3 \times 10^{+4}$	$1.3 \times 10^{+4}$
1,2,3,7,8,9-Hexachlorodibenzo-*p*-dioxin	19408-74-3	$1.3 \times 10^{+4}$	$1.3 \times 10^{+4}$
1,2,3,4,6,7,8-Heptachlorodibenzo-*p*-dioxin	35822-46-9	$1.3 \times 10^{+3}$	$1.3 \times 10^{+3}$
1,2,3,4,,6,7,8,9-Octachlorodibenzo-*p*-dioxin	3268-87-9	$3.9 \times 10^{+1}$	$3.9 \times 10^{+1}$
Chlorinated Dibenzofurans [A]			
2,3,7,8-Tetrachlorodibenzofuran	5120-73-19	$1.3 \times 10^{+4}$	$1.3 \times 10^{+4}$
1,2,3,7,8-Pentachlorodibenzofuran	57117-41-6	$3.9 \times 10^{+3}$	$3.9 \times 10^{+3}$
2,3,4,7,8-Pentachlorodibenzofuran	57117-31-4	$3.9 \times 10^{+4}$	$3.9 \times 10^{+4}$
1,2,3,4,7,8-Hexachlorodibenzofuran	70648-26-9	$1.3 \times 10^{+4}$	$1.3 \times 10^{+4}$
1,2,3,6,7,8-Hexachlorodibenzofuran	57117-44-9	$1.3 \times 10^{+4}$	$1.3 \times 10^{+4}$
1,2,3,7,8,9-Hexachlorodibenzofuran	72918-21-9	$1.3 \times 10^{+4}$	$1.3 \times 10^{+4}$
2,3,4,6,7,8-Hexachlorodibenzofuran	60851-34-5	$1.3 \times 10^{+4}$	$1.3 \times 10^{+4}$

Table 7.1 Inhalation and Oral Cancer Potency Factors

Substance	Chemical Abstract Service Number (CAS)	Inhalation Potency Factor $(mg/kg\text{-}day)^{-1}$	Oral Slope Factor $(mg/kg\text{-}day)^{-1}$
1,2,3,4,6,7,8-Heptachlorodibenzofuran	67562-39-4	$1.3 \times 10^{+3}$	$1.3 \times 10^{+3}$
1,2,3,4,7,8,9-Heptachlorodibenzofuran	55673-89-7	$1.3 \times 10^{+3}$	$1.3 \times 10^{+3}$
1,2,3,4,,6,7,8,9-Octachlorodibenzofuran	39001-02-0	$3.9 \times 10^{+1}$	$3.9 \times 10^{+1}$
Chlorinated paraffins	108171-26-2	8.9×10^{-2}	
Chloroform	67-66-3	1.9×10^{-2}	
4-Chloro-*o*-phenylenediamine	95-83-0	1.6×10^{-2}	
p-Chloro-*o*-toluidine	95-69-2	2.7×10^{-1}	
Chromium (hexavalent)	18540-29-9	$5.1 \times 10^{+2}$	5×10^{-1}
Chrysene [BaP]	218-01-9	3.9×10^{-2}	1.2×10^{-1}
Creosote	8001-58-9	*	
p-Cresidine	120-71-8	1.5×10^{-1}	
Cupferron	135-20-6	2.2×10^{-1}	
2,4-Diaminoanisole	615-05-4	2.3×10^{-2}	
2,4-Diaminotoluene	95-80-7	$4.0 \times 10^{+0}$	
Dibenz[*a,h*]acridine [BaP]	226-36-8	3.9×10^{-1}	$1.2 \times 10^{+0}$
Dibenz[*a,j*]acridine [BaP]	224-42-0	3.9×10^{-1}	$1.2 \times 10^{+0}$
Dibenz[*a,h*]anthracene [BaP]	53-70-3	$4.1 \times 10^{+0}$	$4.1 \times 10^{+0}$
Dibenzo[*a,e*]pyrene [BaP]	192-65-4	$3.9 \times 10^{+0}$	$1.2 \times 10^{+1}$
Dibenzo[*a,h*]pyrene [BaP]	189-64-0	$3.9 \times 10^{+1}$	$1.2 \times 10^{+2}$
Dibenzo[*a,l*]pyrene [BaP]	189-55-9	$3.9 \times 10^{+1}$	$1.2 \times 10^{+2}$
Dibenzo[*a,l*]pyrene [BaP]	191-30-0	$3.9 \times 10^{+1}$	$1.2 \times 10^{+2}$
7H-Dibenzo[*c,g*]carbazole [BaP]	194-59-2	$3.9 \times 10^{+0}$	$1.2 \times 10^{+1}$
1,2-Dibromo-3-chloropropane	96-12-8	$7.0 \times 10^{+0}$	
1,4-Dichlorobenzene	106-46-7	4.0×10^{-2}	
3,3'-Dichlorobenzidine	91-94-1	$1.2 \times 10^{+0}$	
1,1-Dichloroethane	75-34-3	5.7×10^{-3}	
Diesel exhaust [B]	NA	$1.1 \times 10^{+0}$	
Diethylhexylphthalate	117-81-7	8.4×10^{-3}	8.4×10^{-3}
p-Dimethylaminoazobenzene	60-11-7	$4.6 \times 10^{+0}$	
7,12-Dimethylbenz[*a*]anthracene [BaP]	57-97-6	$2.5 \times 10^{+2}$	$2.5 \times 10^{+2}$
1,6-Dinitropyrene [BaP]	42397-64-8	$3.9 \times 10^{+1}$	$1.2 \times 10^{+2}$
1,8-Dinitropyrene [BaP]	42397-65-9	$3.9 \times 10^{+0}$	$1.2 \times 10^{+1}$
2,4-Dinitrotoluene	121-14-2	3.1×10^{-1}	
1,4-Dioxane	123-91-1	2.7×10^{-2}	
Epichlorohydrin	106-89-8	8.0×10^{-2}	
Ethyl benzene	100-41-4	8.7×10^{-3}	1.1×10^{-2}
Ethylene dibromide	106-93-4	2.5×10^{-1}	
Ethylene dichloride	107-06-2	7.2×10^{-2}	
Ethylene oxide	75-21-8	3.1×10^{-1}	

Table 7.1 Inhalation and Oral Cancer Potency Factors

Substance	Chemical Abstract Service Number (CAS)	Inhalation Potency Factor $(mg/kg\text{-}day)^{-1}$	Oral Slope Factor $(mg/kg\text{-}day)^{-1}$
Ethylene thiourea	96-45-7	4.5×10^{-2}	
Formaldehyde	50-00-0	2.1×10^{-2}	
Hexachlorobenzene	118-74-1	$1.8 \times 10^{+0}$	
Hexachlorocyclohexanes (technical grade)	608-73-1	$4.0 \times 10^{+0}$	$4.0 \times 10^{+0}$
Hydrazine	302-01-2	$1.7 \times 10^{+1}$	$3.0 \times 10^{+0}$
Indeno[1,2,3-*cd*]pyrene [BaP]	193-39-5	3.9×10^{-1}	$1.2 \times 10^{+0}$
Lead and lead compounds	7439-92-1	4.2×10^{-2}	8.5×10^{-3}
Lindane	58-89-9	$1.1 \times 10^{+0}$	$1.1 \times 10^{+0}$
Methyl tertiary-butyl ether	1634-04-4	1.8×10^{-3}	
3-Methylcholanthrene [BaP]	56-49-5	$2.2 \times 10^{+1}$	$2.2 \times 10^{+1}$
5-Methylchrysene [BaP]	3697-24-3	$3.9 \times 10^{+0}$	$1.2 \times 10^{+1}$
4, 4'-Methylene bis(2-chloroaniline) (MOCA)	101-14-4	$1.5 \times 10^{+0}$	
Methylene chloride	75-09-2	3.5×10^{-3}	
4,4'-Methylenedianiline	101-77-9	$1.6 \times 10^{+0}$	$1.6 \times 10^{+0}$
Michler's ketone	90-94-8	8.6×10^{-1}	
Naphthalene	91-20-3	1.2×10^{-1}	
Nickel (and compounds)	7440-02-0	9.1×10^{-1}	
5-Nitroacenaphthene [BaP]	602-87-9	1.3×10^{-1}	1.3×10^{-1}
6-Nitrochrysene [BaP]	7496-02-8	$3.9 \times 10^{+1}$	$1.2 \times 10^{+2}$
2-Nitrofluorene [BaP]	607-57-8	3.9×10^{-2}	1.2×10^{-1}
1-Nitropyrene [BaP]	5522-43-0	3.9×10^{-1}	$1.2 \times 10^{+0}$
4-Nitropyrene [BaP]	57835-92-4	3.9×10^{-1}	$1.2 \times 10^{+0}$
N-Nitroso-n-butylamine	924-16-3	$1.1 \times 10^{+1}$	
N-Nitroso-N-methylethylamine	10595-95-6	$2.2 \times 10^{+1}$	
N-Nitrosodi-*n*-propylamine	621-64-7	$7.0 \times 10^{+0}$	
N-Nitrosodiethylamine	55-18-5	$3.6 \times 10^{+1}$	
N-Nitrosodimethylamine	62-75-9	$1.6 \times 10^{+1}$	
N-Nitrosodiphenylamine	86-30-6	9.0×10^{-3}	
p-Nitrosodiphenylamine	156-10-5	2.2×10^{-2}	
N-Nitrosomorpholine	59-89-2	$6.7 \times 10^{+0}$	
N-Nitrosopiperidine	100-75-4	$9.4 \times 10^{+0}$	
N-Nitrosopyrrolidine	930-55-2	$2.1 \times 10^{+0}$	
Pentachlorophenol	87-86-5	1.8×10^{-2}	
Perchloroethylene	127-18-4	2.1×10^{-2}	5.1×10^{-2}
Polychlorinated biphenyls (PCBs) (unspeciated mixture)	1336-36-3		
(high risk) [P1]		$2.0 \times 10^{+0}$	$2.0 \times 10^{+0}$
(low risk) [P2]		4.0×10^{-1}	4.0×10^{-1}
(lowest risk) [P3]		7.0×10^{-2}	7.0×10^{-2}

Table 7.1 Inhalation and Oral Cancer Potency Factors

Substance	Chemical Abstract Service Number (CAS)	Inhalation Potency Factor $(mg/kg\text{-}day)^{-1}$	Oral Slope Factor $(mg/kg\text{-}day)^{-1}$
Polychlorinated biphenyls[P4] (PCBs) (speciated)			
3,3',4,4'-Tetrachlorobiphenyl (77)	35298-13-3	$1.3 \times 10^{+1}$	$1.3 \times 10^{+1}$
3,4,4',5-Tetrachlorobiphenyl (81)	70362-50-4	$3.9 \times 10^{+1}$	$3.9 \times 10^{+1}$
2,3,3',4,4'- Pentachlorobiphenyl (105)	32598-14-4	$3.9 \times 10^{+0}$	$3.9 \times 10^{+0}$
2,3,4,4'5- Pentachlorobiphenyl (114)	74472-37-0	$3.9 \times 10^{+0}$	$3.9 \times 10^{+0}$
2,3'4,4',5- Pentachlorobiphenyl (118)	31508-00-6	$3.9 \times 10^{+0}$	$3.9 \times 10^{+0}$
2',3,4,4',5- Pentachlorobiphenyl (123)	65510-44-3	$3.9 \times 10^{+0}$	$3.9 \times 10^{+0}$
3,3',4,4',5- Pentachlorobiphenyl (126)	57465-28-8	$1.3 \times 10^{+4}$	$1.3 \times 10^{+4}$
2,3,3',4,4',5-Hexachlorobiphenyl (156)	38380-08-4	$3.9 \times 10^{+0}$	$3.9 \times 10^{+0}$
2,3,3',4,4',5'-Hexachlorobiphenyl (157)	69782-90-7	$3.9 \times 10^{+0}$	$3.9 \times 10^{+0}$
2,3',4,4',5,5'-Hexachlorobiphenyl (167)	52663-72-6	$3.9 \times 10^{+0}$	$3.9 \times 10^{+0}$
3,3',4,4'5,5'- Hexachlorobiphenyl (169)	32774-16-6	$3.9 \times 10^{+3}$	$3.9 \times 10^{+3}$
2,3,3'4,4',5,5'- Heptachlorobiphenyl (189)	39635-31-9	$3.9 \times 10^{+0}$	$3.9 \times 10^{+0}$
Potassium bromate	7758-01-2	4.9×10^{-1}	
1,3-Propane sultone	1120-71-4	$2.4 \times 10^{+0}$	
Propylene oxide	75-56-9	1.3×10^{-2}	2.4×10^{-1}
1,1,2,2-Tetrachloroethane	79-34-5	2.0×10^{-1}	
Thioacetamide	62-55-5	$6.1 \times 10^{+0}$	
2,4-Toluene diisocyanate	584-84-9	3.9×10^{-2}	
2,6-Toluene diisocyanate	91-08-7	3.9×10^{-2}	
1,1,2-Trichloroethane (vinyl trichloride)	79-00-5	5.7×10^{-2}	
Trichloroethylene	79-01-6	7.0×10^{-3}	1.5×10^{-2}
2,4,6-Trichlorophenol	88-06-2	7.0×10^{-2}	
Urethane	51-79-6	$1.0 \times 10^{+0}$	
Vinyl chloride	75-01-4	2.7×10^{-1}	

Notes for Table 7.1

Asbestos: [100 PCM fibers/m^3]$^{-1}$ A unit risk factor of 2.7 x 10^{-6} ($\mu g/m^3$)$^{-1}$ and an inhalation cancer potency factor of 2.2 x 10^{+2} (mg/kg BW*day)$^{-1}$ are available (see Appendix C for explanation).

BaP PAHs and PAH Derivatives: Many have potency equivalency factors relative to benzo[*a*]pyrene (see Appendix G). For multipathway chemicals, including PAHs, the oral slope factor is considered the same as the inhalation potency factor unless otherwise noted in the Table.

A Polychlorinated Dibenzo-*p*-dioxins, Polychlorinated Dibenzofurans and speciated poly chlorinated biphenyls: (see Appendix E). For convenience, OEHHA has calculated cancer potency factors for speciated polychlorinated dibenzo-*p*-dioxin, polychlorinated dibenzofuran and polychlorinated biphenyl congeners using the procedure in Appendix E.

B Diesel Exhaust is listed as a Toxic Air Contaminant by the Air Resources Board as "Particulate Matter from Diesel-Fueled Engines". (See Appendix D)

***** Creosote: Can be calculated using Potency Equivalency Factors contained in the benzo[*a*]pyrene Toxic Air Contaminant document and in Appendix G of these guidelines.

P1 Polychlorinated Biphenyls (PCBs): High Risk is for use in cases where congeners with more than four chlorines do not comprise less (are greater) than one-half percent of total PCBs. The high risk number is the default for unspeciated PCB mixtures.

P2 The low risk number is generally not applicable to the Hot Spots program. The Hot Spots program addresses PCBs emitted by stationary facilities. It cannot be assumed that such emissions would occur by simple evaporation. There is a dermal absorption factor applied in evaluation of the dermal pathway for PCBs so the medium risk would not apply to dermal exposure (OEHHA, 2009). The water pathway does not include an assumption that PCB isomers are water soluble, so the medium number would not apply to the water pathway.

P3 Polychlorinated Biphenyls (PCBs): Lowest Risk is for use in cases where congeners with more than four chlorines comprise less than one-half percent of total PCBs. In order for the low number to be used, scientific justification needs to be presented.

P4 Number in parentheses is the IUPAC #, the PCB nomenclature is IUPAC. For multipathway chemicals, including PCBs, the oral slope factor is considered the same as the inhalation potency factor unless otherwise noted in the Table.

7.3 References

OEHHA, 2009. Air Toxics Hot Spots Risk Assessment Guidelines. Part II. Technical Support Document for Cancer Potency Factors: Methodologies for derivation, listing of available values, and adjustments to allow for early life stage exposures. May, 2009. Available online at: http://www.oehha.ca.gov/air/hot_spots/tsd052909.html

8 - Risk Characterization for Carcinogens and Noncarcinogens and the Requirements for Hot Spots Risk Assessments

8.1 Introduction

Risk characterization is the final step of the health risk assessment (HRA). In this step, information developed through the exposure assessment is combined with information from the dose-response assessment to characterize risks to the general public from emissions. In the Hot Spots program, OEHHA conducts the dose-response assessment during the development of cancer potency factors and Reference Exposure Levels. These are used in conjunction with the exposure estimates to estimate cancer risk and evaluate hazard from noncancer toxicity of emitted chemicals. Under the Air Toxics Hot Spots (Hot Spots) Act, risk characterizations should present both individual and population-wide health risks (Health and Safety Code Section (HSC) 44306). Persons preparing HRAs for the Hot Spots Program should consult the local Air Pollution Control or Air Quality Management District (District) to determine if the District has special guidelines to assist with HRA format or other requirements of the Hot Spots Program.

OEHHA is recommending that a 30-year exposure duration be used as the basis for estimating cancer risk at the maximum exposed individual resident (MEIR) in the Hot Spots Program. This exposure duration represents the time of residency for 90 to 95% of Californians at a single location and should provide adequate public health protection against individual risk. We also recommend including the 9 and 70-year cancer risk at the MEIR as supplemental information. Note that a 70-year exposure duration is required to estimate cancer burden or provide an estimate of population-wide risk.

This chapter provides guidance on how to evaluate the risk characterization component of risk assessments required by the Hot Spots Program. A general summary of the risk characterization components includes the following items and information.

- The locations of the point of maximum impact (PMI), the MEIR, and the maximum exposed individual worker (MEIW) are to be identified. The PMI, MEIW, and MEIR for cancer risk and for noncancer hazard indices (averaging times for acute 1-hour, repeated 8-hour, and chronic hazard indices) may not be the same location; all should be identified.

- The location of any specified sensitive receptors (e.g., schools, hospitals, daycare, or eldercare facilities - contact the District or reviewing authority for more information) should be identified

- Estimates of population-wide cancer risk and noncancer hazard

This information must be clearly presented in cross-referenced text, tables, figures, and maps. Chapter 9 provides an outline that specifies the content and recommended format of HRA results. The HARP software is the recommended model for calculating HRA results for the Hot Spots Program. Information on obtaining the HARP software can be found under the Air Toxics Program on the ARB's web site at *www.arb.ca.gov*.

8.1.1 *Tiered Approach to Risk Assessment*

The tiered approach for risk assessment that is presented in detail in the TSD (OEHHA, 2012) and summarized here should be reviewed prior to conducting the health risk assessment. The tiered approach to risk assessment and the health impacts evaluation described here are included in the HARP software.

The tiered approach provides a risk assessor with flexibility and allows consideration of site-specific differences (Table 8.1). The four-tiered approach to risk assessment is intended to primarily apply to residential cancer risk assessment, both for inhalation and noninhalation pathways. Risk assessors can tailor the level of effort and refinement of an HRA by using either the point estimate exposure assumptions as the basis of the exposure and risk assessment, or both the point estimate and a stochastic treatment of exposure factor distributions.

Table 8.1 The Tiered Approach to Risk Assessment

Tier	Description	When Applied
Tier 1	Utilizes OEHHA default point estimates of exposure variates	All risk assessments must include a Tier 1 assessment
Tier 2	Utilizes site-specific point estimates for exposure variates (justified, and approved by OEHHA)	A Tier 2 approach may be presented in addition to Tier 1
Tier 3	Utilizes OEHHA distributions of exposure variates	A Tier 3 approach may be presented in addition to Tier 1
Tier 4	Utilizes site-specific distributions of exposure variates (justified, and approved by OEHHA)	A Tier 4 approach may be presented in addition to Tier 1

Tier 1 is a standard point estimate approach that uses the recommended exposure variate (e.g., breathing or water ingestion rate) point estimates presented in this document. Derivations of these values are described in detail in OEHHA (2012). The results of the Tier 1 evaluations are required to be presented in the risk characterization section for all HRAs prepared for the Hot Spots Program. Thus, persons preparing an HRA using Tier 2 through Tier 4 evaluations must also include the risk characterization results of a Tier 1 evaluation in the HRA.

As discussed in OEHHA (2012), if the risk characterization results from a Tier 1 assessment are above a regulatory level of concern, the risk assessor may want to proceed with more site-specific analysis as described in Tier 2, or use a more resource-intensive stochastic modeling effort described in Tier 3 and Tier 4 (for cancer risk). While further evaluation may provide more information to the risk manager on which to base decisions, the Tier 1 evaluation is useful in comparing risks among a large number of facilities and must be included in all HRAs.

Tier 2 analysis allows the use of available and justifiable site-specific exposure variates (e.g., fish consumption), when presenting the potential health impacts. The site-specific information applied in a Tier 2 assessment must be adequately justified and approved by OEHHA and the District. In Tier 3, a stochastic approach to exposure assessment is taken using the distributions for the exposure pathways presented in the TSD (OEHHA, 2012) and in Chapter 5 of this Guidance Manual. The exposure distributions apply only to a residential receptor and are used only for the determination of cancer risk. OEHHA has not developed exposure intake distributions for workers to use in the offsite worker exposure scenario. Tier 4 is also a stochastic approach for the residential exposure scenario but allows for utilization of site-specific exposure variate distributions if they are justifiable and more appropriate for the site under evaluation than those derived in OEHHA (2012). Alternative site-specific distributions must be approved by OEHHA and the District. For an off-site worker cancer risk evaluation, Tiers 3 and 4 do not apply. Tier 3 and Tier 4 analyses show what a distribution of potential cancer risk may be to an individual or population based on a distribution of exposure inputs (e.g., water ingestion rate) rather than specific point estimates of exposure.

Table 8.2 summarizes OEHHA's recommendations for use of the four Tiers in cancer and noncancer risk assessment.

Table 8.2 Tiers for Residential and Offsite Worker Cancer and Noncancer Hot Spots Risk Assessments

Tier	Cancer		Non Cancer Chronic and 8-Hour	
	Inhalation	Noninhalation	Inhalation	Noninhalation
Tier-1	X	X	X	X
Tier-2	X	X		X[b]
Tier-3	X[a]	X[a]		
Tier-4	X[a]	X[a]		

[a] Applies to residential exposure scenario only
[b] Applies to chronic noncancer exposure only

OEHHA has not developed a stochastic approach (Tier 3 or 4) for estimating noncancer health impacts using acute, 8-hour, and chronic Reference Exposure Levels (RELs). Tier 1 is the only option for determining noncancer health impacts from inhalation exposure since calculating the hazard quotient involves dividing the ground level air concentrations for the specified exposure duration by the appropriate RELs. However, chronic noninhalation noncancer risks involve a calculation of dose from oral or dermal pathways to which site-specific evaluations could be considered under a Tier 2 approach.

Small foot-print facilities – Tier 2 or Tier 4

Some facilities subject to the Air Toxics Hot Spots Act (e.g., some in the industry-wide categories such as gas stations or dry cleaners) have very small zones of impact. In some of these instances, there will be very few receptors within the zone of impact. It isn't possible to develop special recommendations for exposure variates for all possible exposure scenarios. Alternative breathing rates (point estimates or distributions) may be used as part of Tier 2 or Tier 4 risk assessments with appropriate supporting justification in the case of a very small zone of impact. OEHHA is willing to work with risk managers at ARB and the Districts on this issue.

8.2 Risk Characterization for Carcinogens

Cancer risk is calculated by multiplying the daily inhalation or oral dose (calculated in Chapter 5), by a cancer potency factor, the age sensitivity factor, the frequency of time spent at home (for residents only), and the exposure duration divided by averaging time, to yield the excess cancer risk (see section 8.2.4). As described below, the excess cancer risk is calculated separately for each age grouping and then summed to yield cancer risk at the receptor location. A brief description of the age sensitivity factors, exposure duration, and frequency of time spent at home are included in Sections 8.2.1 to 8.2.3 below. These factors are discussed in detail in OEHHA (2009) and OEHHA (2012).

8.2.1 *Adjustment for Early Life Stage Exposures to Carcinogens*

Studies have shown that young animals are more sensitive than adult animals to exposure to many carcinogens (OEHHA, 2009). Therefore, OEHHA developed age sensitivity factors (ASFs) to take into account the increased sensitivity to carcinogens during early-in-life exposure (Table 8.3). These factors were developed and described in detail in OEHHA (2009). In the absence of chemical-specific data, OEHHA recommends a default ASF of 10 for the third trimester to age 2 years, and an ASF of 3 for ages 2 through 15 years to account for potential increased sensitivity to carcinogens during childhood.

Table 8.3 Age Sensitivity Factors by Age Group for Cancer Risk Assessment

Age Group	Age Sensitivity Factor (unitless)
3rd Trimester	10
0<2 years	10
2<9 years	3
2<16 years	3
16<30 years	1
16-70 years	1

For specific carcinogens where data indicate enhanced sensitivity during life stages other than the immediate postnatal and juvenile periods, or for which data demonstrate ASFs different from the default ASFs, the chemical-specific data should be used in order to adequately protect public health.

The risk assessments generated under the Air Toxics Hot Spots Act are reviewed by OEHHA. If a risk assessor had data indicating there are no windows of susceptibility early in life or that a different ASF should be used for a specific carcinogen and wanted to use these data, OEHHA would review the material as part of the review of the risk assessment.

8.2.2 *Fraction of Time Spent at Home for Cancer Risk Assessment*

OEHHA and ARB evaluated information from activity patterns databases to estimate the fraction of time at home (FAH) during the day (OEHHA, 2012). This information can be used to adjust exposure duration and cancer risk from a specific facility's emissions, based on the assumption that exposure to the facility's emissions are not occurring away from home. From the third trimester to age <2 years, 85% of time is spent at home (Table 8.4). From age 2 through <16 years, 72% of time is spent at home. From age 16 years and greater, 73% of time is spent at home. Facilities with any school within the 1×10^{-6} (or greater) isopleth should use FAH = 1 for the child age groups (3rd Trimester, 0<2 years, and 2<16 years). See Appendix I for an example calculation using the FAH.

Table 8.4 Recommendations for Fraction of Time at Home (FAH) for Evaluating Residential Cancer Risk

Age Range	Fraction of Time at Residence
3rd Trimester, and 0<2 years	0.85[1]
2<16 years[2]	0.72[1]
16-70 years[3]	0.73

[1] Use FAH = 1 if a school is within the 1×10^{-6} (or greater) cancer risk isopleth

[2] Also use FAH = 0.72 for 2<9 yr age group.
[3] Also use FAH = 0.73 for 16<30 yr age group.

The FAH is calculated based on a diary of trips taken over a 24-hour period on the survey day. Ninety-five percent of the diary days were on weekdays. Participants can select "vacation" as one of their trips. However, vacation time represented only a fraction (0.68%) of the over 175,000 trips recorded in the survey. Because much of these vacation trips were presumed to be within-day trips and were only a small fraction of total trips, there is likely little overlap with the Exposure Frequency (EF) variate used in the dose equations in Chapter 5.

8.2.3 *Exposure Duration for Estimating Cancer Risk to Residents and Off-Site Workers*

OEHHA recommends that an exposure duration (residency time) of 30 years be used to estimate individual cancer risk for the maximally exposed individual resident (MEIR) (Table 8.5). OEHHA also recommends that the 30-year exposure duration be used as the basis for public notification and risk reduction audits and plans. The Districts, however, may opt to use the 70 year cancer risk for notification and risk reduction audits and plans.

Note that the 30-year exposure duration starts in the third trimester to accommodate the increased susceptibility of exposures in early life (OEHHA, 2009), and would apply to both the point estimate and stochastic approaches.

Table 8.5 Summary of Recommendations for Exposure Duration for Individual Cancer Risk at the MEIR and MEIW

Receptor	***Recommendation***
Resident (MEIR)	30 years
Resident (supplemental Information)	9 years for central tendency; 70 years for maximum (lifetime)
Worker (MEIW)	25 years

Exposure durations of 9-years and 70-years are also recommended to be evaluated for the MEIR to show the range of cancer risk based on residency periods. If a facility is notifying the public regarding cancer risk, the 9- and 70-year cancer risk estimates are useful for people who have resided in their current residence for periods shorter and longer than 30 years.

The 9-, 30-, and 70-year exposures are chosen to coincide with U.S. EPA's estimates of the average (9 years), high-end estimates (30-years) of residence time, and a lifetime residency (70 years). These estimates are also consistent with what is known about residence time in California. Together, the 9-, 30-, and 70-year cancer risk calculations provide a useful presentation of cancer risk and the relationship to duration of residency and, thus, exposure to a facility's emissions.

For the maximally exposed individual worker (MEIW), OEHHA recommends using an exposure duration of 25 years to estimate individual cancer risk for the off-site worker scenario (Table 8.5). This duration represents approximately the 95th percentile of job tenure with the same employer in the U.S.

8.2.4 *Calculating Residential and Offsite Worker Inhalation Cancer Risk*

Residential Receptors

For residential inhalation exposure, cancer risk must be separately calculated for specified age groups (Eq. 8.2.4A, see Section 8.2.1), because of age differences in sensitivity to carcinogens and age differences in intake rates (per kg body weight). Separate risk estimates for these age groups provide a health-protective estimate of cancer risk by accounting for greater susceptibility in early life, including both age-related sensitivity and amount of exposure. The following equation illustrates the formula for calculating residential inhalation cancer risk. See Appendix I for a detailed example calculation.

A. Equation 8.2.4 A: $$RISK_{inh\text{-}res} = DOSE_{air} \times CPF \times ASF \times ED/AT \times FAH$$

7. $RISK_{inh\text{-}res}$ = Residential inhalation cancer risk
8. $DOSE_{air}$ = Daily inhalation dose (mg/kg-day)
9. CPF = Inhalation cancer potency factor ($mg/kg\text{-}day^{-1}$)
10. ASF = Age sensitivity factor for a specified age group (unitless)
11. ED = Exposure duration (in years) for a specified age group
12. AT = Averaging time for lifetime cancer risk (years)
13. FAH = Fraction of time spent at home (unitless)

a: Recommended default values for EQ 8.2.4 A:

5. $DOSE_{air}$ = Calculated for each age group from Eq. 5.4.1
6. CPF = Substance-specific (see Table 7.1)
7. ASF = See Section 8.2.1
8. ED = 0.25 years for 3rd trimester, 2 years for 0<2, 7 years for 2<9, 14 years for 2<16, 14 years for 16<30, 54 years for 16-70
9. AT = 70 years*
10. FAH = See Table 8.4

*Although AT actually sums to 70.25 years when the 3rd trimester (0.25 years) is included, OEHHA recommends rounding AT = 70 years (and rounding residential exposure durations at 9- and 30-years rather than 9.25- and 30.25-years) to simplify the calculation without causing a significant adjustment. Note that the dose for the 3rd trimester is based on the breathing rate of pregnant women using the assumption that the dose to the fetus during the 3rd trimester is the same as that to the mother.

Cancer risks calculated above for individual age groups are summed to estimate cancer risk for 9-, 30- and 70-year exposures as shown below. Note that this example includes the Fraction of Time Spent at Home (FAH) for each age grouping.

Calculation of Inhalation Cancer Risk from the Third Trimester to Age Nine:

$$RISK_{inh\text{-}res} = (DOSE_{air}\ third\ trimester \times CPF \times 10 \times 0.25/70\ years \times FAH_{3rd\ tri\ <2}) + (DOSE_{air}\ age\ 0<2 \times CPF \times 10 \times 2/70 \times FAH_{3rd\ tri\ <2}) + (DOSE_{air}\ age\ 2<9 \times CPF \times 3 \times 7/70\ years \times FAH_{2<9})$$

Calculation of Inhalation Cancer Risk from Third Trimester to Age 30:

$$RISK_{inh\text{-}res} = (DOSE_{air}\ third\ trimester \times CPF \times 10 \times 0.25/70\ years \times FAH_{3rd\ tri\ <2}) + (DOSE_{air}\ age\ 0<2 \times CPF \times 10 \times 2/70 \times FAH_{3rd\ tri\ <2}) + (DOSE_{air}\ age\ 2<16 \times CPF \times 3 \times 14/70 \times FAH_{2<16}) + (DOSE_{air}\ age\ 16<30 \times CPF \times 1 \times 14/70\ years \times FAH_{16\text{-}30})$$

Calculation of Inhalation Cancer Risk from Third Trimester to Age 70:

$$RISK_{inh\text{-}res} = (DOSE_{air}\ third\ trimester \times CPF \times 10 \times 0.25/70\ years \times FAH_{3rd\ tri\ <2}) + (DOSE_{air}\ age\ 0<2 \times CPF \times 10 \times 2/70 \times FAH_{3rd\ tri\ <2}) + (DOSE_{air}\ age\ 2<16 \times CPF \times 3 \times 14/70 \times FAH_{2<16}) + (DOSE_{air}\ age\ 16<70 \times CPF \times 1 \times 54/70\ years \times FAH_{16\text{-}70})$$

Expressing cancer risk in "chances per million" is useful as a risk communication tool for the public, but cancer risk can also be expressed in other ways, such as "chances per 100,000" (cancer risk × 10^5) or "chances per 10 million" (cancer risk × 10^7). To convert the resulting cancer risk estimate to chances of developing cancer per million individuals exposed, multiply the cancer risk by 10^6:

$$Cancer\ risk \times 10^6 = chances\ per\ million$$

For exposure to multiple carcinogenic substances, Table 8.7 and Table I.5 in Appendix I are examples of how cancer risks of individual substances are summed to determine the total cancer risk.

Worker Receptors

For assessment of off-site worker cancer risk at the MEIW, the default assumes working age begins at 16 years. Note that the residential FAH factor in Eq. 8.2.4.A above does not apply for workers. The daily inhalation dose ($DOSE_{air}$) (as calculated in Chapter 5, EQ 5.4.1.2) is based on the adjusted 8-hour concentration at the MEIW (for non-continuous sources) and amount of time the offsite worker's schedule overlaps with the facility's emission schedule. The duration of exposure at the MEIW receptor is 25 years, as discussed in the TSD (OEHHA, 2012).

B. Equation 8.2.4 B: $RISK_{inh\text{-}work} = DOSE_{air} \times CPF \times ASF \times ED/AT$

1. $RISK_{inh\text{-}work}$ = Worker inhalation cancer risk

a: Recommended default values for EQ 8.2.4 B:

1. $DOSE_{air}$ = Calculated for workers in Eq. 5.4.1.2
2. CPF = Substance specific (see Table 7.1)
3. ASF = 1 for working age 16-70 yrs (See Section 8.2.1)
4. ED = 25 years
5. AT = 70 yrs for lifetime cancer risk

Work Locations with Daycare Facilities:

An additional risk management consideration for offsite worker cancer risk assessment of a Hot Spots facility is whether there are women of child bearing age at the MEIW location and whether the MEIW has a daycare center. In the case of women of child-bearing age at the MEIW, the Districts may wish to treat the off-site MEIW in the same way as the residential scenario to account for the higher susceptibility during the third trimester of pregnancy (i.e., use of an ASF=10 for third trimester exposure). If there is onsite daycare at the MEIW, then the risks to the children will be underestimated using the offsite adult worker scenario. In this case, the Districts may wish to include a cancer risk assessment for the children in the onsite daycare, assuming they could be there from 0 to age 6 years (ED = 6 years) and using the appropriate exposure factors to calculate $DOSE_{air}$, fraction of time at worksite (e.g., hrs at daycare per 24 hrs), and ASFs in EQ 8.2.4 B to account for the higher susceptibility of infants and children to carcinogens.

Children at a MEIW daycare may also be assessed for noninhalation exposures. Typically, soil ingestion and dermal exposure will be the most common noninhalation pathways. However, all pathways that are present at the daycare should be included. See section 8.2.6 for more discussion of multipathway risk assessment methods.

8.2.5 *Calculation of Noninhalation Cancer Risk*

A small subset of Hot Spots substances is subject to deposition onto the soil, plants, and water bodies (see Table 5.1). These substances need to be evaluated by the appropriate noninhalation pathways, as well as by the inhalation pathway, and the risk characterization results must be presented in all HRAs. These substances include semi-volatile organic chemicals and heavy metals.

For all multipathway substances, the exposure pathways that must be evaluated at every residential and worker site (in addition to inhalation) are soil ingestion and dermal exposure. If PAHs (and creosotes), lead, dioxins, furans, or PCBs are emitted, then the breast-milk consumption pathway becomes mandatory for residential receptors. OEHHA has developed transfer coefficients for these chemicals from the mother to breast milk (see OEHHA, 2012 for details). The other exposure pathways (e.g.,

ingestion of homegrown produce or fish) are only evaluated for residential receptors if the facility impacts that exposure medium and the receptor under evaluation can be exposed to that medium or pathway. For example, if the facility does not impact a fishable body of water within the isopleth of the facility, or the impacted water body does not sustain fish that are consumed by fishers, then the fish pathway will not be considered for that facility or receptor.

Table 8.6 identifies the residential receptor exposure pathways that are mandatory and those that are dependent on the available routes of exposure. Table 8.6 also identifies the three exposure pathways that are relevant for a worker receptor. The cancer risk estimates should be presented in the risk characterization section of the risk assessment for all the appropriate pathways.

Table 8.6 Mandatory and Site/Route Dependent Exposure Pathways

Mandatory Exposure Pathways	Site/Route Dependent Exposure Pathways
• Inhalation[w] • Soil Ingestion[w] • Dermal Exposure to Contaminated Soil[w] • Breast Milk Consumption[*]	• Homegrown Produce Ingestion • Angler-Caught Fish Ingestion • Drinking Water Ingestion • Home-Raised Animal Product Ingestion (Dairy (Cow's) Milk, Meat (Beef, Pork, Chicken) and Egg).

(w) Identifies the appropriate exposure pathways that should be evaluated for a worker. These pathways are inhalation, dermal exposure, and the soil ingestion pathway.

(*) If PAHs (including creosotes), lead, dioxins, furans, or PCBs are emitted, then the breast-milk consumption pathway becomes mandatory.

The noninhalation residential cancer risk is calculated using the same steps as inhalation cancer risk described in Section 8.2.4. A dose (see Chapters 4 and 5) from the pathway under evaluation (e.g., soil ingestion) is multiplied by the substance-specific oral slope factor, expressed in units of inverse dose (i.e., $(mg/kg/day)^{-1}$) (Table 7.1), the appropriate age sensitivity factor (ASF), and exposure duration divided by averaging time to yield the cancer risk for a specified age grouping. Cancer risk for each age group is summed as appropriate for the exposure duration. The FAH factor is relevant only to the inhalation pathway and is not appropriate to use in the noninhalation pathways.

Equation 8.2.5 illustrates the formula for calculating noninhalation cancer risk. Details (data, algorithms, and guidance) for each exposure pathway are presented in Chapter 5 and in OEHHA (2012).

A. Equation 8.2.5: $RISK_{noninh} = DOSE_{noninh} \times CPF_{oral} \times ASF \times ED/AT$

1. $RISK_{noninh}$ = Noninhalation pathway cancer risk
2. $DOSE_{noninh}$ = Daily dose (mg/kg-day) for a specified non-inhalation pathway for each age group
3. CPF_{oral} = Oral cancer potency (slope) factor (mg/kg-day^{-1})
4. ASF = Age sensitivity factor for a specified age group (unitless)
5. ED = Exposure duration (in years) for a specified age group
6. AT = Averaging time for lifetime cancer risk

a: Recommended default values for EQ 8.2.5:

1. $DOSE_{noninh}$ = Calculated in Chapter 5 dose algorithms for each age group and for each noninhalation route in Table 8.6 the receptor is exposed to
2. CPF_{oral} = Substance-specific (see Table 7.1)
3. ASF = See Section 8.2.1
4. ED = Residents: 0.25 years for 3rd trimester, 2 years for 0<2, 7 years for 2<9, 14 years for 2<16, 14 years for 16<30, 54 years for 16-70
   = Offsite worker: 25 yrs
5. AT = 70 years

Estimating cancer risk for 9-, 30- and 70-years by summing the individual age-group cancer risks is the same as that shown for the inhalation route in Section 8.2.4. The exception is that the FAH variate is only appropriate for the residential inhalation pathway and is not a factor for oral and dermal exposure pathways.

Calculation of Noninhalation Cancer Risk from Third Trimester to Age 30:

$RISK_{noninh\text{-}res}$ = ($DOSE_{noninh}$ third trimester × CPF × 10 × 0.25/70 years) + ($DOSE_{noninh}$ age 0<2 × CPF × 10 × 2/70) + ($DOSE_{noninh}$ age 2<16 × CPF × 3 × 14/70) + ($DOSE_{noninh}$ age 16<30 × CPF × 1 × 14/70 years)

To convert this estimated probability of risk to chances per million of developing cancer, multiply the estimated cancer risk for each noninhalation exposure route by 10^6. This result is useful communication tool to compare risks for each pathway of exposure.

$$\text{Cancer risk} \times 10^6 = \text{cancer risk expressed as chances per million}$$

For assessment of the offsite worker the typical noninhalation pathways that apply for worker cancer risk are the dermal exposure pathway and the soil ingestion pathway.

Children at a MEIW daycare may also be assessed for noninhalation exposures. Typically, soil ingestion and dermal exposure will be the most common noninhalation pathways. However, all pathways that are present at the daycare should be included.

8.2.6 *Multipathway Cancer Risk Methodology*

Under a Tier 1 assessment, it is necessary to calculate the total cancer risk from both inhalation and noninhalation exposures if multipathway substances are emitted from the facility. The calculation of cancer risk that includes exposure to a multipathway substance or substances has three steps:

1) Calculate cancer risk for the inhalation pathway (EQ 8.2.4 A for residents, EQ 8.2.4 B for off-site workers) for all substances, and the noninhalation pathways that apply (EQ 8.2.5) for all multipathway substances, using high-end point estimates of intake rates.
2) For each multipathway substance, identify the two exposure pathways with the highest risk. These are the dominant pathways that are to be assessed using high-end point estimates of intake rates for the total cancer risk. For all other pathways, the average point estimate of intake rates may be used to calculate the pathway cancer risk (See OEHHA (2012) for more information).
3) To calculate total cancer risk, all inhalation and noninhalation pathways are summed together for all substances.

The final cancer risk calculation using a combination of high-end and average exposure parameters is referred to as the derived risk in the HARP software. This is described in Chapter 1, Section 1.4.1 of OEHHA (2012). The inhalation route is almost always one of the two dominant pathways in a multipathway cancer risk assessment. Therefore, in most cases only one noninhalation pathway would be calculated using a high-end dose point estimate. For all other pathways, the average point estimate may be used to calculate the pathway cancer risk.

For example, if dermal exposure and soil ingestion risks are calculated, then the cancer risks from these pathways would be summed along with the inhalation cancer risks to give the total cancer risk for the single multipathway substance:

Cancer Risk (inhalation) + Cancer Risk (dermal) + Cancer Risk (soil) = Total Risk

The mother's milk pathway also becomes a mandatory pathway to assess risk in nursing infants if the mother is exposed to specific substances (see Table 5.1).

Many facilities will emit multiple carcinogenic substances. If multiple substances are emitted, the substance-specific cancer risks for all exposure pathways are summed to give the (total) multipathway cancer risk at the receptor location. The HARP software will display not only the multipathway risk for each carcinogenic substance, but also show a breakdown of the cancer risk from each exposure pathway. Table 8.7 shows the results of a multipathway risk assessment for a hypothetical facility. While not presented in the following table, it is critical to identify the driving exposure pathways and the driving substances in a multipathway cancer risk assessment when summarizing and presenting the HRA results. See Chapter 9 for more information.

Table 8.7 Multipathway Assessment of a Hypothetical Facility 30-Year Cancer Risk

Substance	Cancer Risk[a]	Cancer risk[b] (chances per million)
Arsenic	1.1×10^{-5} (i) 3×10^{-7} (ni)	11 (i) 0.3 (ni)
Benzene	2.92×10^{-4} (i)	292 (i)
2,3,7,8-TCDD (dioxin)	1.06×10^{-4} (i) 5.7×10^{-5} (ni)	106 (i) 57 (ni)
1,3-Butadiene	6.0×10^{-6} (i)	6 (i)
Total Facility Cancer Risk	**4.723×10^{-4}**	**472**

[a] As calculated in EQ 8.2.4 A or EQ 8.2.5
[b] Calculated as: cancer risk × 10^6 = chances per million
i = inhalation pathway contribution
ni = noninhalation pathway contribution

Cancer risk in Table 8.7 for the multipathway substances, arsenic and 2,3,7,8-TCDD, is arranged by the inhalation pathway risk and the sum of all noninhalation pathway risks. The total facility multipathway cancer risk is the sum of all inhalation and noninhalation pathways.

Cancer risks from different substances are treated additively in risk assessment generally, and in the Hot Spots Program in part because many carcinogens act through the common mechanism of DNA damage. The additive assumption is reasonable from a public health point of view. Other possible interactions of multiple carcinogens include synergism (effects are greater than additive) or antagonism (effects are less than additive). The type of interaction is both chemical and dose dependent and in most cases the data are not available to adequately characterize these interactions.

8.2.7 *Multipathway Cancer Risk for Infant Exposure to Mother's Milk*

The mother' milk pathway becomes mandatory if the nursing mother is exposed to one or more of the following multipathway substances: dioxins and furans, PCBs, PAHs including creosotes, and lead. The default assumption inherent in the intake rate is that the infant's only source of food is breast for the first year (e.g., is fully breastfed, see OEHHA, 2012, for details), which is one-half of the 0<2 year age group used in the Hot Spots program. Thus, the cancer risk by the mother's milk pathway will need to be calculated with a modified cancer risk equation using a different exposure duration:

A. Equation 8.2.7: $\mathbf{RISK_{mm} =}$ Dose-Im $\mathbf{\times CPF_{oral} \times ASF \times ED/AT}$

1. $RISK_{mm}$ = Infant cancer risk via mother's milk pathway
2. Dose-Im = Daily dose (mg/kg-day) to infant from mother's milk
3. CPF_{oral} = Oral cancer slope factor (mg/kg-day^{-1})
4. ASF = Age sensitivity factor for infant (unitless)
5. ED = Exposure duration (in years) for infant
6. AT = Averaging time for lifetime cancer risk

a: Recommended default values for EQ 8.2.7:

6. Dose-Im = Calculated from EQ 5.4.3.5.2, dose to infant via mother's milk
7. CPF_{oral} = Substance-specific (see Table 7.1)
8. ASF = 10 (See Section 8.2.1)
9. ED = 1 yr (1st yr of 0<2 yr age group)
10. AT = 70 years

Once the cancer risk is determined for the mother's milk pathway for each applicable substance, the pathway risk is summed with other pathway risks.

For Tier 1, the derived approach for cancer risk assessment should be used if the mother's milk pathway applies. As outlined in Section 8.2.6, the two dominant pathways will be calculated using high-end point estimates of intake rates; all additional pathways may be calculated using average point estimates of intake rates. There will be four mandatory pathways to assess (inhalation, mother's milk, soil ingestion and dermal exposure) for cancer risk when exposure to dioxins/furans, PCBs, PAHs including creosotes, and/or lead occurs. Therefore, if the infant is exposed to no other additional site-specific noninhalation pathway(s), only the two dominant pathways among the four will be assessed for cancer risk using high-end point estimates of intake rates; and the others would be assessed using the average point estimate of intake rate.

In short, multipathway cancer risk for a substance is estimated by summing the potential inhalation and noninhalation cancer risks for the receptor location of interest. See the discussion of Tier 1 in Section 8.2.6 or the TSD for more information on the method used to determine the multipathway cancer risk.

8.2.8 *Cancer Risk Characterization for Stochastic Risk Assessment*

Risk characterization for a stochastic risk assessment is similar to that described for the point-estimate approach. However, the stochastic risk assessment produces a distribution of risk that accounts for some of the natural variability in exposure-related factors, such as breathing rates or water intake. The cancer risk distribution for inhalation cancer risk, for example, is generated by multiplying randomly selected values from the breathing rate distribution by the ground level air concentration, and the cancer potency factor. A variation of the Monte Carlo method called Latin hypercube sampling is the method by which the values from the breathing rate distribution are

selected. If noninhalation pathways need to be evaluated, the same process is followed for each pathway and the risk is summed to give an overall inhalation and noninhalation cancer risk distribution. Further, the specification of Age Sensitivity Factors and the need to separately calculate risks require that a Monte Carlo sampling be conducted for each age group and the cancer risk distributions are then summed across age groups.

The HARP software will perform an HRA using a Monte Carlo analysis with either OEHHA-provided or user-provided data distributions and will include the statistics for the distributions. In risk assessments that have chosen to use the distribution of exposure variates, the cancer risk distribution for a 30-year residential exposure duration (MEIR) should be presented in the risk characterization section We also recommend including the 9 and 70-year cancer risk at the MEIR as supplemental information. Note that a 70-year exposure duration is required to estimate cancer burden or provide an estimate of population-wide risk. A stochastic approach has not been developed for acute, 8-hour, and chronic noncancer health impacts or worker (MEIW) exposures.

8.2.9 *Use of Individual Cancer Risk and Population-wide Cancer Risk*

Cancer risk for an individual receptor and a representation of population-wide cancer risk are both important components of a risk assessment. The individual receptor approach reflects the exposures that may occur to an individual receptor over a period of time at a specific location. The individual cancer risk approach has some inherent limitations in terms of illustrating and potentially protecting population-based public health. For example, a facility with a small emissions footprint may impact a few individuals with a high individual potential cancer risk; whereas, a facility with a larger emission footprint may have a lower potential cancer risk for an individual receptor but expose many more people to those levels. Since this larger emitting facility can impact many more people, the population-wide health impacts are magnified due to the larger number of people exposed to the facility's emissions. This potential for higher population impacts is not captured by the individual receptor risk methodology. Therefore, the individual and population-wide heath impacts should be presented for all facilities to provide a more complete illustration of the facility's health impacts.

8.2.9.1 Population Risk

For facilities with large emission footprints (e.g., refineries, ports, or rail yards, etc.), population-based health impacts are critical to provide a better illustration of the potential impacts of emissions since large numbers of people may be exposed to the emissions. The individual cancer risk approach has some inherent limitations in terms of protecting public health. A small facility with a single stack can impact a few individuals with an individual cancer risk that is unacceptable, whereas a large facility may have an individual cancer risk that is below the acceptable limit for individual risk but exposes many more people. Thus, the population-wide impacts are larger for the large facility. Population-wide risk is independent of individual risk, and assumes that a population (not necessarily the same individuals) will live in the impacted zone over a

70-year period. Thus, a 70-year exposure duration is required for estimates of population-wide risks.

To evaluate population risk, one method that regulatory agencies have used is the cancer burden method to account for the number of excess cancer cases that could occur in a population.

Cancer Burden

The cancer burden can be calculated by multiplying the cancer risk at a census block centroid by the number of people who live in the census block, and adding up the estimated number of potential cancer cases across the zone of impact. The result of this calculation is a single number that is intended to estimate of the number of potential cancer cases within the population that was exposed to the emissions for a lifetime (70 years).

The cancer burden is calculated on the basis of lifetime (70-year) risks (whereas individual cancer risk at the MEIR is based on 30-year residential exposure). Cancer burden is independent of how many people move in or out of the vicinity of an individual facility. For example, if 10,000 people are exposed to a carcinogen at a concentration with a 1×10^{-5} cancer risk for a lifetime the cancer burden is 0.1, and if 100,000 people are exposed to a 1×10^{-5} risk the cancer burden is 1.

Estimate of Population Wide Risk

An estimate of the number of people exposed at various cancer risk levels can provide perspective on the magnitude of the potential public health threat posed by a facility. This approach is intended as a replacement for or addition to the cancer burden calculation used by some Districts in the past. The new approach provides a much easier way for the general public to interpret results when compared to cancer burden estimates. A facility in a sparsely populated area can have a public health impact different from the same facility in a highly populated area; however, under the cancer burden method, those differences may not be seen. Some suggested approaches and methods for performance of a screening or refined population exposure analyses are provided in Section 4.6.

The District or reviewing authority should be consulted before beginning the population exposure estimates and, as results are generated, further consultation may be necessary. Note that a 70-year exposure duration is required to estimate cancer burden or provide an estimate of population-wide risk.

The zone of impact for estimating the number of persons exposed to a cancer risk from facility emissions should be set at a minimum of a 10^{-6} cancer risk level (see Section 4.6.1). Some Districts may prefer to use a cancer risk of 10^{-7} to define the carcinogenic zone of impact. The total number of persons exposed to a series of potential risk levels can be presented to aid risk managers in understanding the magnitude of the potential public health impacts.

The HARP software can provide population-level risk estimates as cancer burden or as the number of persons exposed to a selected (user-identified) cancer risk level at block level centroids.

8.2.9.2 Population Estimates for Noncancer Health Impacts

A noncancer chronic, 8-hour, and acute population estimate of the number of people exposed to acute, 8-hour, and chronic HQs or HIs exceeding 0.5 or 1.0, in increments of 1.0, should also be presented. For example, a facility with a maximum chronic HI of 4.0 would present the number of people exposed to a chronic HI of 0.5, 1.0, 2.0, 3.0, and 4.0. The isopleths used in this determination should be drawn using the smallest feasible grid size. The same methods that are described in Chapter 4 and Section 8.2.9 (for the population exposure estimate for cancer risk) should be used in the chronic, 8-hour and acute population estimates. Population estimates for acute, 8-hour, and chronic health impacts should be presented separately.

8.2.9.3 Factors That Can Impact Population Risk – Cumulative Impacts

Although the Hot Spots program is designed to address the impacts of single facilities and not aggregate or cumulative impacts, there are a number of known factors that influence the susceptibility of the exposed population and thus may influence population risk. Socioeconomic status influences access to health care, nutrition, and outcome after cancer diagnosis. Community unemployment can affect exposure and residency time near a facility. Factors that affect the vulnerability of the population are discussed in the report *Cumulative Impacts: Building a Scientific Foundation* (OEHHA, 2010). Information on many of these factors is relatively easy to obtain at the census tract level. The OEHHA recommends that these types of factors be considered by the risk manager, along with the quantitative measures of population risk. OEHHA is in the process of developing guidance on quantification of the impact of these factors.

8.2.10 *Cancer Risk Evaluation of Short Term Projects*

The local air pollution control districts sometimes use the risk assessment guidelines for the Hot Spots program in permitting decisions for short-term projects such as construction or waste site remediation. Frequently, the issue of how to address cancer risks from short-term projects arises.

Cancer potency factors are based on animal lifetime studies or worker studies where there is long-term exposure to the carcinogenic agent. There is considerable uncertainty in trying to evaluate the cancer risk from projects that will only last a small fraction of a lifetime. There are some studies indicating that dose rate changes the potency of a given dose of a carcinogenic chemical. In others words, a dose delivered over a short time period may have a different potency than the same dose delivered over a lifetime.

The OEHHA's evaluation of the impact of early-in-life exposure has reduced some of the uncertainty in evaluating the cancer risk to the general population for shorter-term exposures, as it helps account for susceptibility to carcinogens by age at exposure (OEHHA, 2009).

Due to the uncertainty in assessing cancer risk from very short-term exposures, we do not recommend assessing cancer risk for projects lasting less than two months at the MEIR. We recommend that exposure from projects longer than 2 months but less than 6 months be assumed to last 6 months (e.g., a 2-month project would be evaluated as if it lasted 6 months). Exposure from projects lasting more than 6 months should be evaluated for the duration of the project. In all cases, for assessing risk to residential receptors, the exposure should be assumed to start in the third trimester to allow for the use of the ASFs (OEHHA, 2009). Thus, for example, if the District is evaluating a proposed 5-year mitigation project at a hazardous waste site, the cancer risks for the residents would be calculated based on exposures starting in the third trimester through the first five years of life.

For the MEIW, we recommend using the same minimum exposure requirements used for the residential receptor (i.e., no evaluation for projects less than 2 months; projects longer than 2 months but less than 6 months are assumed to last 6 months; projects longer than 6 months would be evaluated for the duration of the project). Although the off-site worker scenario assumes that the workers are 16 years of age or older with an Age-Sensitivity Factor of 1, another risk management consideration for short-term project cancer assessment is whether there are women of child bearing age at the worksite and whether the MEIW receptor has a daycare center. In this case, the Districts may wish to treat the off-site MEIW in the same way as the residential scenario to account for the higher susceptibility during the third trimester of pregnancy, and for higher susceptibility of infants and children.

Finally, the risk manager may want to consider a lower cancer risk threshold for risk management for very short-term projects. Typical District guidelines for evaluating risk management of Hot Spots facilities range around a cancer risk of 1 per 100,000 exposed persons as a trigger for risk management. Permitting thresholds also vary for each District. There is valid scientific concern that the rate of exposure may influence the risk – in other words, a higher exposure to a carcinogen over a short period of time may be a greater risk than the same total exposure spread over a much longer time period. In addition, it is inappropriate from a public health perspective to allow a lifetime acceptable risk to accrue in a short period of time (e.g., a very high exposure to a carcinogen over a short period of time resulting in a 1×10^{-5} cancer risk). Thus, consideration should be given for very short term projects to using a lower cancer risk trigger for permitting decisions.

8.3 Noncancer Acute, 8-Hour, and Chronic Inhalation Health Impacts – the Hazard Index Approach

All substances in the Hot Spots Program that have noncancer health impacts at a receptor must be evaluated through the inhalation pathway. Estimates of noncancer inhalation health impacts are determined by dividing an airborne concentration at the receptor by the appropriate Reference Exposure Level (REL). This is termed the Hazard Index Approach. A REL is used as an indicator of potential noncancer health impacts and is defined as the concentration at which no adverse noncancer health effects are anticipated. When a health impact calculation is performed for a single substance, then it is called the hazard quotient (HQ). Each REL for a substance will have one or more target organ systems (e.g., respiratory system, nervous system, etc.) where the substance can have a noncancer health impact. Thus, all HQs have specified target organ systems associated with them. The sum of the Hazard Quotients of all chemicals emitted that impact the same target organ is termed the Hazard Index. Inhalation RELs for noncancer health impacts have been developed for acute, 8-hour, and chronic exposures to a number of Hot Spots substances. Acute RELs are designed to protect against the maximum 1-hour ground level concentration at the receptor. Eight-hour RELs are designed to protect people with daily 8-hour schedules, such as offsite workers, in an impacted zone. The 8-hour RELs should be used for typical daily work shifts of 8-9 hours. For further questions, assessors should contact OEHHA, the District, or reviewing authority to determine if the 8-hour RELs should be used in your HRA. Any discussions or directions to exclude the 8-hour REL evaluation should be documented in the HRA. Chronic RELs protect against long-term exposure to the annual average air concentration spread over 24 hours/day, 7 days/week.

OEHHA has added 8-hour RELs to the set of noncancer RELs that were previously comprised of acute and chronic RELs (OEHHA, 2008). Specifically, 8-hour RELs are air concentrations at or below which health impacts would not be expected even for sensitive subpopulations in the general population with repeated daily 8-hour exposures over a significant fraction of a lifetime. The 8-hour RELs can be used to evaluate the potential for health impacts (including effects of repeated exposures) in offsite workers, and to children and teachers exposed during school hours. Although not required in the HRA, they could also be applied by the Districts to a residential scenario where a facility operates only a portion of the day and exposure to residences is not adequately reflected by averaging concentrations over a 24 hour day. The number of chemicals with 8-hour RELs will increase as OEHHA re-evaluates RELs for chemicals under SB-25 to ensure that they are protective of children's health.

Acute, 8-hour, and chronic RELs are needed because the dose metrics and even the health impact endpoints may be different with the different exposure durations of acute, daily 8-hour, and chronic exposures. Also, although chronic REL values are lower or set the same as 8-hour RELs, there are some cases such as special meteorological situations (e.g., significant diurnal-nocturnal meteorological differences) or intermittent exposures where the 8-hour REL may be more protective than the chronic REL.

Chapter 4 describes air dispersion modeling and both Chapter 6 and Appendix L list the needed dose-response information to evaluate non-cancer hazards. Appendix I presents sample calculations for determining acute HQs and HIs, 8-hour HQs and HIs, and chronic multipathway HQs and HIs. Chapter 9 provides an outline of information required for risk characterization. The HARP software will calculate the HQ and HI for Hot Spots risk assessments.

8.3.1 *Calculation of Noncancer Inhalation Hazard Quotient and Hazard Index*

To calculate the acute HQ, the maximum 1-hour ground level concentration (in $\mu g/m^3$) of a substance at a receptor is divided by the acute 1-hour REL (in $\mu g/m^3$) for the substance:

$$\text{Acute Hazard Quotient} = \frac{\text{1-Hour Max Concentration } (\mu g/m^3)}{\text{Acute REL } (\mu g/m^3)}$$

To calculate the chronic HQ, the annual average ground level concentration of a substance is divided by the chronic REL for the substance:

$$\text{Chronic Hazard Quotient} = \frac{\text{Annual Average Concentration } (\mu g/m^3)}{\text{Chronic REL } (\mu g/m^3)}$$

To calculate the 8-hour HQ, the adjusted annual average ground level concentration of a substance (represented as "Adjusted C_{air}" in EQ 5.4.1.4 A) is divided by the 8-hour REL for the substance:

$$\text{8-hour Hazard Quotient} = \frac{\text{Adjusted Annual Average Concentration } (\mu g/m^3)}{\text{8-hour REL } (\mu g/m^3)}$$

The daily 8-hour average ground level concentrations used for calculating the 8-hour HQs are derived as described in Chapter 4.

An HQ of 1.0 or less indicates that adverse health effects are not expected to result from exposure to emissions of that substance. As the HQ increases above one, the probability of human health effects increases by an undefined amount. However, it should be noted that a HQ above one is not necessarily indicative of health impacts due to the application of uncertainty factors in deriving the RELs.

If a receptor is exposed to multiple substances that target the same organ system, then the HQs for the individual substances are summed to obtain a Hazard Index (HI) for that target organ.

Table 8.8 is an example of an HRA spreadsheet showing acute inhalation HQs arranged by target organ system for several substances. The bottom row shows the summed HQs by target organ system to derive the HIs.

Table 8.8 Individual Hazard Quotients and Total Hazard Index for Acute Inhalation Exposure

Substance	Reproductive/ Developmental	Nervous System	Cardiovascular System	Respiratory System	Eye
Ammonia				0.6	0.6
Arsenic	0.2	0.2	0.2		
Benzene	0.02				
Chlorine				0.7	0.7
Total Hazard Index	**0.22**	**0.2**	**0.2**	**1.3**	**1.3**

A more detailed example of calculating HQs and HIs and of determining noncancer health impacts is shown in Appendix I.

Hazard quotients or HIs for different target organs are not summed together (e.g., do not add the impacts for the eye to the cardiovascular system). Chapter 6 and Appendix L have lists of the organ systems affected by each substance. Unlike the cancer risk algorithms, no exposure duration adjustment (e.g., 9 yrs / 70 yrs) should be made for noncancer assessments.

There are limitations to this method of assessing cumulative noncancer health impacts. The impact on organ systems may not be additive if health effects occur by different mechanisms. However, the impact on organ systems could also be synergistic. An analysis by a trained health professional familiar with the substance's toxicological literature is usually needed to determine the public health significance of an HQ or HI above one. It is recommended that the Air District contact OEHHA if this situation presents itself. For assessing the noncancer health impacts of lead, different procedures are used; please see Appendix F.

8.3.2 *Calculating Noninhalation (oral) Noncancer Hazard Quotient and Hazard Index*

Similar to the situation with multipathway carcinogenic substances, multipathway substances that present a noncancer hazard are assessed by noninhalation routes of exposure (see Table 8.6). Noninhalation routes of exposure are assessed only for chronic exposure. There are no oral acute RELs since it is generally anticipated that health effects from a single exposure via the oral route at typical environmental levels resulting from deposition of facility emissions would be insignificant relative to the inhalation route. The multipathway substances with noninhalation RELs, called chronic oral RELs, are shown in Table 6.4. Similar to inhalation exposure, the hazard quotient

for a noninhalation pathway is obtained by dividing the dose in milligrams per kilogram-day (mg/kg-day) by the oral REL also expressed in units of mg/kg-day:

$$\text{Chronic Non-inhalation HQ} = \frac{\text{Chronic Noninhalation Dose (mg/kg-day)}}{\text{Chronic Oral REL (mg/kg-day)}}$$

The calculated chronic oral HQs are combined with the chronic inhalation HQs for determining the chronic HIs for each affected target organ (see Section 8.3.4). The point estimates and algorithms for calculating the oral dose for all applicable exposure pathways and receptors (e.g., workers or residents) are explained in Chapter 5.

The chronic oral dose calculated in mg/kg-day is based on a time-weighted average 70-year residential exposure combining the 0<2, 2<16 and 16-70 year age groups. Unlike the assessment of cancer risk, no exposure duration adjustment should be made when estimating HQs. In other words, the variates ED and AT in the cancer risk EQ 8.2.5 in Section 8.2.5 are not used for estimating the noncancer HQs. See Appendix I for an example calculation.

8.3.3 *Multipathway Noncancer Risk Methodology*

To determine multipathway chronic noncancer health impacts, it is necessary to calculate the total hazard index from both inhalation and noninhalation exposures. The calculation of HIs has several steps:

1) First, the inhalation HQ is calculated for each substance emitted (Section 8.3.1).
2) Second, if the substance has an oral REL, then the non-inhalation HQ is calculated as shown above using high-end point-estimates for intake rates for each noninhalation pathway that applies.
3) Third, if there are more than two noninhalation pathways to consider for a multipathway substance, then the oral HQ is calculated using high-end point estimates in the dose equation for the two dominant pathways. For any additional noninhalation pathways, the HQs are calculated using average point estimates in the dose equation. This step applies only to residential receptors.
4) Fourth, all noninhalation pathway HQs for a multipathway substance are then summed together by target organ to obtain the total noninhalation HQ for a multipathway substance.
5) The final step is to sum the inhalation and noninhalation HQs together by target organ to determine the HIs. This step is displayed in Table 8.9. If there is only one substance, then the multipathway HQ is the same as the HI.

Table 8.9 Substance-Specific Chronic Inhalation and Noninhalation Hazard Quotients and the Hazard Index by Target Organ System

Substance	Respiratory System	Hematologic System	Alimentary System	Endocrine System	Development	Reproductive System	Nervous System	Cardiovascular System	Skin
Ammonia	0.8								
Arsenic					0.04(i) 0.1(ni)		0.04(i) 0.1(ni)	0.04(i) 0.1(ni)	0.04(i) 0.1(ni)
Benzene		0.08			0.08		0.08		
2,3,7,8-TCDD (dioxin)	0.1(i) 0.2(ni)	0.1(i) 0.2(ni)	0.1(i) 0.2(ni)	0.1(i) 0.2(ni)	0.1(i) 0.2(ni)	0.1(i) 0.2(ni)			
Nickel	0.4(i)	0.4(i)	0.1(ni)						
Hazard Index	**1.50**	**0.78**	**0.40**	**0.3**	**0.52**	**0.30**	**0.22**	**0.14**	**0.14**

i = inhalation pathway contribution

ni = noninhalation pathway contribution

Table 8.9 shows the calculated chronic HIs by combining the chronic inhalation HQs and chronic oral HQs. The HQs or HIs for different target organs are not added together (e.g., do not add the impacts for the respiratory system to the nervous system). The noninhalation pathways for TCDD and arsenic in Table 8.9 have all the noninhalation pathways that apply incorporated into their HQ values. For example, the noninhalation value for arsenic (HQs = 0.1) includes at least the soil ingestion and dermal soil pathways in the HQs because these are the mandatory noninhalation pathways to take into account with exposure to a multipathway substance. For TCDD, the mother's milk pathway is an additional mandatory noninhalation pathway to take into account (See Table 5.1). If there are exposures to any of the site-specific pathways, then these would be included too. A more detailed example calculation of HIs is shown in Appendix I.

When exposure to more than two noninhalation pathways occur, using the high-end point estimates of intake rates for only the two dominant noninhalation pathways will lessen the issue of compounding high-end exposure estimates, while retaining a health-protective approach for the more important exposure pathways. It is unlikely that an individual receptor would be on the high-end of exposure for all the non-inhalation intake parameters (exposure pathways).

8.3.4 *Summary - Acute, 8-Hour and Chronic Hazard Index Calculation at the MEIR and MEIW*

Eight-hour RELs were developed principally for exposure of individuals during 8-hour work schedules. The 8-hour RELs should be used for typical daily work shifts of 8-9 hours. For further questions, assessors should contact OEHHA, the District, or reviewing authority to determine if the 8-hour RELs should be used in your HRA. Any discussions or directions to exclude the 8-hour REL evaluation should be documented in the HRA. There are currently only a limited number of substances with an 8-hour inhalation REL. Over time as the science supporting REL values for individual substances is reviewed and the RELs are revised by OEHHA, more 8-hour RELs will be developed.

Therefore, for the MEIR, we recommend:

- Estimating the acute Hazard Index based on the maximum 1-hour air concentration and 1-hour RELs
- Estimating the chronic Hazard Index based on the annual average air concentration and the chronic RELs, and the oral RELs for multipathway substances

An 8-hour hazard index based on the daily average 8-hour exposure is not required for the MEIR, but can be performed at the discretion of the District for exposure to non-continuously operating facilities using the adjusted annual average air concentration (See EQ 5.4.1.4 A and B or method in App. M). Eight-hour hazard assessments are not recommended for exposure to continuously operating facilities.

For the MEIW, we recommend:

- Estimating the acute Hazard Index based on the maximum 1-hour air concentration and 1-hour RELs
- Estimating the 8-hour Hazard Index based on daily average 8-hour exposure for those chemicals with 8-hour RELs
- Estimating the chronic Hazard Index based on the annual average air concentration and chronic RELs, and oral RELs for multipathway substances

Until there are 8-hour RELs for many of the Hot Spots substances that have a chronic REL value, we recommend determining the chronic HI for the MEIW to adequately protect the offsite worker.

8.3.5 *Evaluation of Background Criteria Pollutants*

The District should be contacted to determine if the contribution of background criteria pollutants to respiratory health effects is required to be included in an HRA for the Hot Spots Program. If inclusion is required, the methods for calculating the health impact from acute and chronic exposure (respiratory endpoint) is the standard HI approach (see Sections 8.3.1 and 8.3.4). There are currently no 8-hour RELs for criteria

pollutants, so 8-hour health impacts from criteria pollutants are not assessed in HRAs. The background criteria pollutant contribution should be calculated if the HI from the facility's emissions exceeds 0.5 in either the acute or chronic assessment for the respiratory endpoint.

The most recent criteria pollutant concentration data should be obtained from the ARB's ambient air monitoring network and can be found in the *California Almanac of Emissions and Air Quality* on their web site at www.arb.ca.gov. For determining the criteria pollutant contribution in HI calculations, the annual average concentration data should be taken from a monitoring site near the facility. If background contributions are unavailable, the District may direct the risk assessor to make an alternative assumption. The criteria pollutants that should be included in acute and chronic assessments for the respiratory endpoint are ozone, nitrogen dioxide, sulfur dioxide, sulfates, and hydrogen sulfide.

8.4 Uses of Exposure Duration Adjustments for Onsite Receptors

Onsite workers are protected by CAL OSHA and typically are not evaluated under the Hot Spots program. Exceptions may include a worker who also lives on the facility property such as at prisons, military bases, and universities that have worker housing within the facility. Another scenario where the District may require assessment of on-site worker exposure and risk is when a facility (e.g., airport) has multiple businesses owned by different entities within the facility/property (e.g., rental car agencies, restaurants, etc.). In these situations the evaluation of onsite cancer risks, and/or acute, 8-hour, and chronic noncancer hazard indices is appropriate under the Hot Spots program. If the onsite receptor under evaluation can be exposed through a noninhalation exposure pathway, then that exposure pathway must also be included. When a receptor lives and works on the facility, site, or property, then these receptors should be evaluated and reported under both residential and worker scenarios and the one that is most health-protective should be used for risk management decisions.

The cancer risk estimates for the on-site residents may use a 30-year exposure duration while the 25-year exposure duration is used for a worker. Under a Tier 2 analysis, alternate exposure durations may be evaluated and presented with all assumptions supported. See section 8.2.10 for more discussion of short-term exposures.

Other situations that may require on-site receptor assessment include the presence of locations where the public may have regular access for the appropriate exposure period (e.g., a lunchtime café, store, or museum for acute exposures). The District or reviewing authority should be consulted on the appropriate evaluations for the risk for all onsite receptors.

8.5 References

ERG, 2008. Summary Report of the Peer Review Meeting: EPA's Draft Framework for Determining a Mutagenic Mode of Action for Carcinogenicity. Final Report. Submitted to Risk Assessment Forum, Office of the Science Advisor, U.S. Environmental Protection Agency, Washington, DC., by Eastern Research Group. May 23, 2008.

OEHHA, 2010. *Cumulative Impacts: Building a Scientific Foundation*. Available online at: http://www.oehha.ca.gov

OEHHA, 2008. *Air Toxics Hot Spots Program Risk Assessment Guidelines*. Technical Support Document for Deriving Noncancer Refernce Exposure Levels. Office of Environmental Health Hazard Assessment, California Environmental Protection Agency. Available online at: http://www.oehha.ca.gov

OEHHA, 2009. *Air Toxics Hot Spots Program Risk Assessment Guidelines. Technical Support Document for Cancer Potency Factors: Methodologies for derivation, listing of available values, and adjustments to allow for early life stage exposures*. Office of Environmental Health Hazard Assessment, California Environmental Protection Agency. May 2009. Available online at: http://www.oehha.ca.gov

OEHHA, 2012. *Air Toxics Hot Spots Program Risk Assessment Guidelines; Technical Support Document for Exposure Assessment and Stochastic Analysis*. Office of Environmental Health Hazard Assessment, California Environmental Protection Agency. Available online at http://www.oehha.ca.gov

U.S. EPA, 2005a. Supplemental Guidance for Assessing Susceptibility from Early-Life Exposure to Carcinogens EPA/630/R-03/003F March 2005.

U.S.EPA, 2005b. Guidelines for Carcinogen Risk Assessment. Risk Assessment Forum, Washington, DC. EPA/630/P-03/001F.

9 - Summary of the Requirements for a Modeling Protocol and a Health Risk Assessment Report

The AB 2588 program is a community right-to-know act. Although risk assessment is a technical field, AB 2588 risk assessments need to be clear and understandable to the educated lay person. An Executive Summary that explains the process and the results of the risk assessment in lay terms is necessary. Clear risk communication is imperative in situations where the facility is required to notify the surrounding community. In addition, the risk assessment is by law reviewed by the local Air Pollution Control or Air Quality Management District (District) and OEHHA in order to ensure that AB 2588 risk assessment procedures have been followed. This chapter clarifies the type of information that is needed for District and OEHHA review of modeling protocols and health risk assessments (HRAs).

The material presented here is intended to promote transparent, consistent presentation and efficient review of the modeling protocol and the health risk assessment report (products). We recommend that persons preparing these products consult with the local District to determine if the District has modeling or HRA guidelines that supersede these products. If the District does not have guidelines for these products, then we recommend Section 9.1 be used for modeling protocols and Section 9.2 be used for the presentation of HRAs. Persons preparing modeling protocols and HRAs should specify the guidelines that were used to prepare their products.

9.1 Submittal of a Modeling Protocol

It is strongly recommended that a modeling protocol be submitted to the District for review and approval prior to extensive analysis with an air dispersion model. The modeling protocol is a plan of the steps to be taken during the air dispersion modeling and risk assessment process. We encourage people who are preparing protocols to take advantage of the protocol step and fully discuss anticipated methodologies for any portion of your project that may need special consideration. Below, we have provided an example of the format that may be followed in the preparation of the modeling protocol. **Consult with the District to confirm format and content requirements or to determine the availability of District modeling guidelines before submitting the protocol.**

9.1.1 *Outline for a Modeling Protocol*

I. Introduction

Include the facility name, address, and a brief overview describing the facility's operations.

- Provide a description of the terrain and topography surrounding the facility and potential receptors.

- Indicate the format in which data will be provided. Ideally, the report and summary of data will be on paper and all data and model input and output files will be provided electronically (e.g., compact disk or CD).

- Identify the guidelines used to prepare the protocol (e.g., District Guidelines).

II. Emissions

For each pollutant and process whose emissions are required to be quantified in the HRA, list the annual average emissions (pounds/year and grams/second) and the maximum one-hour emissions (pounds/hour and grams/second)[1]. Maximum 1-hour emissions are used for acute noncancer health impacts while annual emissions are used for chronic exposures (i.e., chronic and 8-hour noncancer health impacts or cancer risk assessment).

- Identify the reference and method(s) used to determine emissions (e.g., source tests, emission factors, etc.). Clearly indicate any emission data that are not reflected in the previously submitted emission inventory report. In this event, a revised emission inventory report will need to be submitted to the District.

- Identify if this will be a multipathway assessment based on emitted substances.

[1] Except radionuclides, for which annual and hourly emissions are reported in Curies/year and millicuries/hour, respectively.

III. Models / Modeling Assumptions

Specify the model and modeling assumptions

- Identify the model(s) to be used, including the version number.
- Identify the model options that will be used in the analysis.
- Identify the modeling domain(s) and the spacing of receptor grid(s). Grid spacing should be sufficient in number and detail to capture the concentration at all of the receptors of interest.
- Indicate complex terrain options that may be used, if applicable.
- Identify the source type(s) that will be used to represent the facility's operations (e.g., point, area, or volume sources, flare options or other).
- Indicate the preliminary source characteristics (e.g., stack height, gas temperature, exit velocity, dimensions of volume source, etc.).
- Identify and support the use of urban or rural dispersion coefficients for those models that require dispersion coefficients. For other models, identify and support the parameters required to characterize the atmospheric dispersion due to land characteristics (e.g., surface roughness, Monin-Obukhov length).

IV. Meteorological Data

Specify the type, source, and year(s) of hourly meteorological data (e.g., hourly surface data, upper air mixing height information).

- State how the data are representative for the facility site.
- Describe QA/QC procedures.
- Identify any gaps in the data; if gaps exist, describe how the data gaps are filled.

V. Deposition

- Specify the method to calculate deposition (if applicable).

VI. Receptors

Specify the type and location of receptors. Include all relevant information describing how the individual and population-related receptors will be evaluated.

- Identify and describe the location(s) of known or anticipated potential sensitive receptors, the point of maximum impact (PMI), the maximum exposed individual residential (MEIR), and worker (MEIW) receptors. Identify any special considerations or grids that will be used to model these receptors. This information should correspond with information provided in Section III (e.g., fine receptor spacing of 20 meters at the fence line and centered on the maximum impacts; coarse receptor spacing of 100 meters out to 2,000 meters; extra coarse spacing of 1,000 meters out to 20,000 meters).

- Identify if spatial averaging will be used. Include necessary background information on each receptor including how the domain and spacing will be determined for each receptor or exposure pathway.

- Describe how the cancer burden or population impact estimates are calculated. Clarify the same information for the presentation of noncancer population impacts (e.g., centroids of the census tracts in the area within the zone of impact).

- Specify that actual UTM coordinates and the block/street locations (i.e., north side of 3,000 block of Smith Street), where possible, will be provided for specified receptor locations.

- Identify and support the use of any exposure adjustments (e.g., time at location, diurnal).

- Include the list of anticipated exposure pathways that will be included and indicate which substance will be evaluated in the multipathway assessment. Identify if sensitive receptors are present and which receptors will be evaluated in the HRA.

VII. Maps

Identify how the information will be graphically presented.

- Indicate which cancer risk isopleths will be plotted for the cancer zone of impact (e.g., 10^{-7}, 10^{-6} see Section 4.6.1).

- Indicate the hazard quotients or hazard indices to be plotted for the noncancer acute, 8 hour, and chronic zones of impact (e.g., 0.5, 1.0, etc.).

9.2 Health Risk Assessment Report

The purpose of this section is to provide an outline to assist with the preparation and review of HRAs. This outline specifies the key components that should be included in HRAs. All information used for the report must be presented in the HRA. Ideally, the HRA report and a summary of data used in the HRA will be on paper and all data and model input and output files will be provided electronically (e.g., CD). Persons preparing HRAs for the Hot Spots Program should consult the District to determine if HRA guidelines or special formats are to be followed when preparing and presenting the HRA's results.

If District guidelines or formats do not exist that supersede this outline, then the HRA should follow the format presented here. If the HRA is prepared for other programs, the reviewing authority should be consulted for clarification of format and content. We recommend that those persons preparing HRAs specify the guidelines that were used to prepare their product. **The HRA may be considered deficient by the reviewing authority if components that are listed here are not included**.

9.2.1 *Outline for the Health Risk Assessment Report*

I. Table of Contents

- Section headings with page numbers indicated.
- Tables of tables and Table of figures with page numbers indicated.
- Appendices with page numbers indicated.

II. Executive Summary

Overview of all relevant information regarding the project or facility.

- Facility identifier number (consult the District).

- Description of facility operations and a list identifying emitted substances including table of maximum 1-hour emissions, and annual average emissions.

- Provide a brief description of acute, 8-hour, chronic, and cancer health impacts of the emitted substances, based on OEHHA's descriptions in the appropriate Technical Support Documents.

- Text presenting overview of dispersion modeling and exposure assessment.

- Text describing estimated cancer risk for carcinogens, noncancer Hazard Quotients and Hazard Indices and a table showing target organ systems by substance for noncancer impacts.

- Summarize the individual and population-wide health impacts including the driving substance(s) and the driving exposure pathways:

    - Location (block/street location; e.g., north side of 3,000 block of Smith Street) and description of the off-site point of maximum impact (PMI), maximum exposed individual resident (MEIR), and maximum exposed individual worker (MEIW).

    - Location (block/street location; e.g., north side of 3,000 block of Smith Street) and description of any on-site receptors that were evaluated at the facility (consult District or agency).

    - Location (block/street location; e.g., north side of 3,000 block of Smith Street) and description of any sensitive receptors that are required by the district or reviewing authorities (consult District or agency).

      NOTE: When presenting information described in the following bullets, cancer risk should be presented separately for a residential 30-year, Tier–1 analysis. Results of other exposure assumptions (e.g., 9 or 70-year) or other tier evaluations should also be presented, and must be clearly labeled. For the Hot Spots Program, while the 30-year exposure duration is recommended as the basis for public notification and risk reduction audits and plans, the District has discretion to use the 70 year exposure scenario for its decisions. In addition, the 70 year cancer risk must be calculated to estimate population-wide impacts.

    - Text presenting an overview of the total cancer risk (including multipathway substances, if present) at the PMI, MEIR, MEIW, and sensitive receptors. Provide a table of cancer risk by substance for the MEIR and MEIW (if applicable). Include a statement indicating which of the substances appear to contribute most to (drive) the potential health impacts. In addition, identify the exposure pathways evaluated in the HRA.

    - Provide a map of the facility and surroundings and identify the location of the MEIR, MEIW, PMI, and other locations or receptors of interest.

    - Provide a map of 30-year and 70-year cancer risk zone of impact(s), if applicable.

    - Text presenting an overview of the acute and chronic noncancer hazard quotients and the (total) hazard indices for the PMI, MEIR, MEIW, and sensitive receptors. Additionally, include 8-hour hazard quotients and hazard indices for the MEIW. Include separate statements (for acute, 8-hour, and chronic exposures) indicating which

of the substances appear to drive the potential health impacts. In addition, clearly identify the primary target organ(s) that are impacted from acute, 8-hour, and chronic exposures.

- Identify any sensitive subpopulations (e.g., child daycare facilities, schools, nursing homes) of concern.

- Table and text presenting an overview of estimates of population exposure (e.g., cancer burden or population estimates from HARP) (consult District or agency) (see Section 8.4).

- Version of the Risk Assessment Guidelines and computer program(s) used to prepare the risk assessment (e.g., HARP).

III. Risk Assessment Procedures

A. Hazard identification

- Table and text identifying all substances emitted from the facility, plus any other substances required by the District or reviewing authority. Include the CAS number of the substance and the physical form of the substance if possible. [The Hot Spots substances are listed in Appendix A, and also in the ARB's Emission Inventory Criteria and Guidelines Regulations (Title 17, California Code of Regulations, Sections 93300-93300.5), and the Emission Inventory Criteria and Guidelines Report (EICG Report), which is incorporated by reference therein (ARB, 1997)].

- Table and text identifying all substances that are evaluated for cancer risk and/or noncancer acute, 8-hour, and chronic health impacts. In addition, identify any multipathway substances that present a cancer risk or chronic noncancer hazard via noninhalation routes of exposure.

- Describe the types and amounts of continuous or intermittent predictable emissions from the facility that occurred during the reporting year. As required by statute, releases from a facility include spilling, leaking, pumping, pouring, emitting, emptying, discharging, injecting, escaping (fugitive), leaching, dumping, or disposing of a substance into ambient air. Include the substance(s) released and a description of the processes that resulted in long-term and continuous releases.

B. Exposure Assessment

This section describes the information related to the air dispersion modeling process that needs to be reported in the risk assessment; the information is also presented in Chapter 4 (see Section 4.15). The District may have specific requirements regarding format and content (see Section 4.14). Sample calculations should be provided at each step to indicate how reported emissions

data were used. Reviewing agencies must receive input, output, and supporting files of various model analyses on computer-readable media (e.g., CD).

1. Information on the Facility and its Surroundings

Report the following information regarding the facility and its surroundings:

- Facility Name
- Location (UTM coordinates and street address)
- Land use type (see Section 2.4)
- Local topography
- Facility plot plan identifying:
  - source locations
  - property line
  - horizontal scale
  - building heights
  - emission sources

2. Source and Emission Inventory Information

a. Release Parameters

Report the following information for each release location in table format:

- Release location identification number
- Release name
- Release type (e.g., point, volume, area, line, pit, etc.)
- Source identification number(s) used by the facility for sources that emit out of this release location
- Release location using UTM coordinates
- Release parameters by release type (e.g., shown for point source):
- Stack height (m), stack diameter (building dimensions for downwash, exhaust gas exit velocity (m/s), exhaust gas volumetric flow rate (ACFM), exhaust gas exit temperature (K), etc.

b. Source Description and Operating Schedule

The description and operating schedule for each source should be reported in table form including the following information:

- Source identification number used by the facility
- Source name
- Number of operating hours per day and per year (e.g., 0800-1700, 2700 hr/yr)
- Number of operating days per week (e.g., Mon-Sat)

- Number of operating days or weeks per year (e.g., 52 wk/yr excluding major holidays)
- Release point identification number(s) for where source emissions are released
- Fraction of source emissions emitted at each release point by release point ID number

c. *Emission Control Equipment and Efficiency*

- Report emission control equipment and efficiency by source and by substance

d. *Emissions Data Grouped By Source*

Report emission rates for each toxic substance, grouped by source (i.e., emitting device or process identified in Inventory Report), in table form including the following information:

- Source name
- Source identification number
- Substance name and CAS number (from Inventory Guidelines)
- Annual average emissions for each substance (lb/yr)
- Hourly maximum emissions for each substance (lb/hr)

e. *Emissions Data Grouped by Substance*

Report facility total emission rate by substance for all emitted substances listed in the Air Toxics “Hot Spots” Program including the following information:

- Substance name and CAS number (from Inventory Guidelines)
- Annual average emissions for each substance (lb/yr)
- Hourly maximum emissions for each substance (lb/hr)

f. *Emission Estimation Methods*

Report the methods used in obtaining the emissions data indicating whether emissions were measured or estimated. Clearly indicate any emission data that are not reflected in the previously submitted emission inventory report and submit a revised emission inventory report to the district. A reader should be able to reproduce the risk assessment without the need for clarification.

g. List of Substances

Include tables listing all "Hot Spots" Program substances which are emitted, plus any other substances required by the District. Indicate substances to be evaluated for cancer risks and noncancer effects.

h. Exposed Population and Receptor Location

Report the following information regarding exposed population and receptor locations:

- Description of zone of impact including map showing the location of the facility, boundaries of zone of impact, census tracts, emission sources, sites of maximum exposure, and the location of all appropriate receptors. This should be a true map (one that shows roads, structures, etc.), drawn to scale, and not just a schematic drawing. USGS 7.5 minute maps or GIS based maps are usually the most appropriate choices. (If significant development has occurred since the user's survey, this should be indicated.)

- Separate maps for the cancer risk zone of impact and the hazard index (noncancer) zone of impact(s). The cancer zone of impact should include isopleths down to at least the 1/1,000,000 risk level. Because some districts use a level below 1/1,000,000 to define the zone of impact, the District should be consulted. For the noncancer zone of impact, three separate isopleths (to represent chronic, 8-hour, and acute HI) should be created to define the zone of impact for the hazard index from both inhalation and noninhalation pathways greater than or equal to 0.5. The point of maximum impact (PMI), maximum exposed individual at a residential receptor (MEIR), and maximum exposed individual worker (MEIW) for both cancer and noncancer risks should be located on the maps.

- Tables identifying population units and sensitive receptors (UTM coordinates, receptor IDs or index from the modeling, and street addresses of specified receptors)

- Heights or elevations of the receptor points.

- **Spatial averaging**: For each receptor type (e.g., PMI, MEIR, and MEIW, or other location of interest) that will utilize spatial averaging, the domain size and grid resolution must be clearly identified. If another domain or grid resolution other than 20 meters by 20 meters with 5-meter grid spacing will be used for a receptor, then care should be taken to determine the proper domain size and grid resolution that should be used. For a worker, the HRA shall support all assumptions used, including, but not limited to, documentation for all workers

showing the area where each worker routinely performs their duties. The final domain size should not be greater than the smallest area of worker movement. Other considerations for determining domain size and grid spacing resolution may include an evaluation of the concentration gradients across the worker area. The grid spacing used within the domain should be sufficient in number and detail to obtain a representative concentration across the area of interest. When spatial averaging over the deposition area of a pasture, garden, or water body, care should be taken to determine the proper domain size to make sure it includes all reasonable areas of potential deposition. The size and shape of the pasture, garden, or water body of interest should be identified and used for the modeling domain. The grid spacing or resolution used within the domain should be sufficient in detail to obtain a representative deposition concentration across the area of interest. One way to determine the grid resolution is to include an evaluation of the concentration gradients across the deposition area. The HRA shall support all assumptions used, including, but not limited to, documentation of the deposition area (e.g., size and shape of the pasture or water body, maps, representative coordinates, grid resolution, concentration gradients, etc.). The use or spatial averaging is subject to approval by the reviewing authority. This includes the size of the domain and grid resolution that is used for spatial averaging of a worksite or multipathway deposition area.

3. Meteorological Data

If meteorological data were not obtained directly from the District, then the report must clearly indicate the data source and time period used. Meteorological data not obtained from the District must be submitted in electronic form along with justification for their use including information regarding representativeness and quality assurance.

The risk assessment should indicate if the District required the use of a specified meteorological data set. All memos indicating the District's approval of meteorological data should be attached in an appendix.

4. Model Selection and Modeling Rationale

The report should include an explanation of the model chosen to perform the analysis and any other decisions made during the modeling process. The report should clearly indicate the name of the models that were used, the level of detail (screening or refined analysis) and the rationale behind the selection.

Also report the following information for each air dispersion model used:

- Version number
- Selected options and parameters in table form

- Identify the modeling domain(s) and the spacing of receptor grid(s). Grid spacing should be sufficient in number and detail to capture the concentration at all receptors of interest.

5. Air Dispersion Modeling Results

The report should include tables, text, and appendices that clearly present all of the following information

- Maximum hourly and annual average concentrations of chemicals at appropriate receptors such as the residential and worker MEI receptors

- Annual average and maximum one-hour (and 30-day average for lead only) concentrations of chemicals at appropriate receptors listed and referenced to computer printouts of model outputs

- Model printouts (numbered), annual concentrations, maximum hourly concentrations

- Disk with input/output files for air dispersion program (e.g., the AERMOD input file containing the regulatory options and emission parameters, receptor locations, meteorology, etc.)

- Include tables that summarize the annual average concentrations that are calculated for all the substances at each site. The use of tables that present the relative contribution of each emission point to the receptor concentration is recommended. (These tables should have clear reference to the computer model which generated the data. It should be made clear to any reader how data from the computer output were transferred to these tables.) [As an alternative, the above two tables could contain just the values for sites of maximum impact (i.e., PMI, MEIR and MEIW), and sensitive receptors, if required. All the values would be found in the Appendices.]

C. ***Health Values Used in Dose-Response and Dose Estimates***

- Provide tables of the acute, 8-hour and chronic inhalation RELs, chronic oral RELs (if applicable), and cancer potency factors for each substance that is quantified in the HRA.

- Identify the guidelines (title and date) that were used to obtain these factors, or indicate whether newly approved values obtained from the OEHHA website were used.

- Provide a table of target organ systems for each noncancer substance, including acute (1 hour), 8-hour, and chronic inhalation, and chronic oral (if applicable).

- Include tables of the estimated dose for each substance by each exposure pathway at the PMI, MEIR, MEIW, and at any sensitive receptor locations (required by the District).

D. ***Risk Characterization***

The Hot Spots Analysis and Reporting Program (HARP) will generate the risk characterization data needed for the outline below. Any data needed to support the risk characterization findings should be clearly presented and referenced in the text and appendices. A listing of HARP output files that meet these HRA requirements is provided in this outline under the section entitled "Appendices". All HARP files should be included in the HRA. Ideally, the HRA report and a summary of data used in the HRA will be on paper and all data and model input and output files will be provided electronically (e.g., CD). Information on obtaining copies of HARP is available on the California Air Resources Board's Internet web site under the Air Toxics Program at *www.arb.ca.gov.*

NOTE: The cancer risk for the PMI, MEIR, and sensitive receptors of interest must be presented in the HRA's text, tables, and maps. OEHHA recommends that cancer risk for a 30-year exposure duration be presented for the MEIR, and that cancer risk for 9-year and 70-year exposure durations for the MEIR be presented to provide the risk managers with supplemental information. Note that the assessment of population impacts must be based on a 70-year exposure duration; thus all risk assessments need to estimate cancer risk for a 70-year exposure duration in order to report the number of individuals residing in the risk isopleths, or to calculate cancer burden if the District so requires. In addition, some Districts may opt to make risk management decisions based on a 70-year exposure duration. The MEIW location should use a 25-year exposure period.

All HRAs must include the results of a Tier-1 exposure assessment (see Chapter 2 and 8, or the 2012 TSD). If the reviewing authority specifies that additional exposure periods should be presented, or if persons preparing the HRA would like to present additional information (i.e., exposure duration adjustments or the inclusions of risk characterizations using Tier-2 through Tier-4 exposure data), then this information should be presented in separate, clearly titled, sections, tables, and text.

The following information should be presented in this section of the HRA. If not fully presented here, then by topic, clearly identify the section(s) and pages within the HRA where this information is presented.

- Description of receptors to be quantified.

- Table and text providing the location [UTM coordinates, receptor ID number or index from the modeling, and the block/street address

(e.g., north side of 3,000 block of Smith Street)] and description of the PMI, MEIR, and MEIW for both cancer and noncancer risks.

- Separate tables and text providing description of the PMI and MEIR for 30-year cancer risk, and 9- or 70-year cancer risk.

- Tables and text describing MEIW 25-year cancer risk.

- Table and text providing the location [UTM coordinates, receptor ID number or index from the modeling, and the block/street address (e.g., north side of 3,000 block of Smith Street)] and description of any sensitive receptor that is of interest to the District or reviewing authorities (consult District or agency).

- Provide any exposure information that is used for risk characterization (e.g., concentrations at receptors, emissions information, census information, figures, zone of impact maps, etc.). If multipathway substances are emitted, identify the site/route dependent exposure pathways (e.g., water ingestion) for the receptor(s), where appropriate (e.g., MEIR).

- Provide a summary of the site-specific inputs used for each exposure pathway (e.g., water or grazing intake assumptions). This information may be presented in an appendix with the information clearly presented and cross-referenced to the text. In addition, provide reference to the appendix (section and page number) that contains the modeling (i.e., HARP/dispersion modeling) files that show the same information.

- If any exposure parameters were used other than those provided in the Air Toxics Risk Assessment Guidelines: Technical Support Document for Exposure Assessment and Stochastic Analysis (2012), they must be presented in detail. The derivation and data used must be presented so that it is clear to the reviewer. The justification for using site-specific exposure parameters must be clearly presented.

- Table and text presenting the potential multipathway cancer risk by substance, by pathway, and total, at the PMI, MEIR, MEIW, and sensitive receptor locations (required by the District).

- Table and text presenting the acute (inhalation only) and chronic noncancer (inhalation and oral) hazard quotients (by substance, exposure pathways, and target organs) and the (total) hazard indices by substance and target organs for the PMI, MEIR, MEIW, and sensitive receptors. For 8-hour exposure at the MEIW (inhalation only), table and text presenting hazard quotients (by substance, exposure pathways, and target organs) and the (total) hazard indices by substance and target organs. Note:

Chronic noncancer results should be shown with inhalation and oral contributions (shown separately) and for the combined (multipathway) impact.

- Identify any sensitive subpopulations (e.g., child daycare facilities, schools, nursing homes) of concern.

- Table and text presenting estimates of population exposure (e.g., population exposure estimates or cancer burden from HARP) (consult District or agency). Tables should indicate the number of persons exposed to a (total) cancer risk greater than 10^{-7}, 10^{-6}, 10^{-5}, 10^{-4}, etc., and total hazard quotient or hazard index greater than 0.5, 1.0, 2.0, and 3.0, etc. Provide a table that shows excess cancer burden for each population unit and the total excess cancer burden, if cancer burden calculation is required.

- Provide maps that illustrate the HRA results for the three sub-bullet points below. These maps should be an actual street map of the area impacted by the facility with elevation contours and actual UTM coordinates, and the facility boundaries clearly labeled. In some cases the elevation contours will make the map too crowded and should therefore not appear. This should be a true map (one that shows roads, structures, etc.), drawn to scale, and not just a schematic drawing. USGS 7.5-minute maps are usually the most appropriate choice (see Section 4.6).

    - The facility (emission points and boundaries), the locations of the PMI, MEIR, MEIW, and sensitive receptors.

    - Maps of the cancer zone of impacts (e.g., 10^{-6} or 10^{-7} levels - consult District or Agency). The map should clearly identify the zone of impact for the inhalation pathway, the minimum exposure pathways (soil ingestion, dermal exposure, and breast-milk consumption) if multipathway substances are emitted, and the zone of impact for all the applicable exposure pathways (minimum exposure pathways plus any additional site/route specific pathways) for multipathway analyses. Two maps may be needed to accomplish this. The legend of these maps should state the level(s) used for the zone of impact and identify the exposure pathways that were included in the assessment.

    - Maps of the noncancer hazard index (HI) zone of impacts (e.g., 0.5 or 1.0 - consult District or Agency). The noncancer maps should clearly identify the noncancer zones of impact. These include the acute (inhalation), 8-hour (inhalation), chronic (inhalation), and chronic (multipathway) zones of impact. For clarity, presentation of the noncancer zones of impact may require two or more maps. The

legend of these maps should state the level(s) used for the zone of impact and identify the exposure pathways.

- The risk assessor may want to include a discussion of the strengths and weaknesses of the risk analyses and associated uncertainty directly related to the facility HRA.

- If appropriate, comment on the possible alternatives for control or remedial measures. How do the risks compare?

- If possible, identify any community concerns that influence public perception of risk.

- Sample calculations may be needed for all analyses in the HRA if proprietary software other than HARP was used. The District should be consulted. These calculations should be clearly presented and referenced to the findings they are supporting in the HRA text.

- Version of the Risk Assessment Guidelines and computer program used to prepare the risk assessment.

- If software other than HARP is used for the health assessment modeling, all supporting material must be included with the HRA (e.g., all algorithms and parameters used in a clear, easy to review format).

E. ***References***

Include any references used for the HRA in this section.

F. ***Appendices***

The appendices should contain all data, sample calculations, assumptions, and all modeling and risk assessment files that are needed to reproduce the HRA results. Ideally, a summary of data used in the HRA will be on paper and all data and model input and output files will be provided electronically (e.g., CD), unless otherwise specified by the district or reviewing authority. All appendices and the information they contain should be referenced, clearly titled, and paginated.

Potential Appendix Topics (if not presented elsewhere in the HRA report):

- List of all receptors locations (UTM coordinates, receptor ID number or index from the modeling, and the block/street address (e.g., north side of 3,000 block of Smith Street)) for the PMI, MEIR, MEIW, and sensitive receptors.
- List of all emitted substances.
- All emissions files.

- List of dose-response factors (Reference Exposure Levels and cancer potency factors).
- All air dispersion modeling input and output files. Detailed discussions of meteorological data, regulatory options, emission parameters, receptor locations, etc.
- Census data.
- Maps.
- Identify the site/route dependent exposure pathways for the receptor(s), where appropriate (e.g., MEIR). Provide a summary of the site-specific inputs used for each pathway (e.g., water or grazing intake assumptions) and the data to support them.
- All calculations used to determine emissions, concentrations, and potential health impacts at the PMI, MEIR, MEIW, and sensitive receptors.
- All HRA model input and output (HARP) files for receptors of concern.
- (Total) cancer and noncancer impacts by receptor, substance, and exposure pathway (by endpoint for noncancer) at all receptors.
- Presentation of alternate risk assessment methods (e.g., alternate exposure durations, or Tier-2 to Tier-4 evaluations with supporting information).

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List of Abbreviations

A - Area
AB2588 - Air Toxics “Hot Spots” Information and Assessment Act, 1987
ACFM - Actual Cubic Feet per Minute
ADL - Annual Dermal Load
AQMD - Air Quality Management District (District)
ARB - Air Resources Board
ASF - Age Sensitivity Factor
AT - Average Time for Lifetime Cancer Risk
BAF - Bioaccumulation Factor
BG - Urban Block Groups
BLP - Buoyant Line and Point Source Dispersion Model
BMI - Breast Milk Intake
BPIP - Building Profile Input Program
BPIPPRM - Building Profile Input Program for PRIME
BSA - Body Surface Area
BW - Bodyweight
C_{air} - annual average air concentration
CALMPRO - Calms processor program
CAPCOA - California Air Pollution Control Officer’s Association
CAS - Chemical Abstracts Service
CERCLA - Comprehensive Environmental Response, Compensation and Liability Act
C_f - Average concentration of a substance in fish
C_m - Average concentration of a substance in mother’s milk (mislabeled on 114 as Cf)
C_{fa} - Average concentration of a substance in animal products
CONST2 - Constant in the Briggs’ stable plume rise equation using BLP
CONST3 - Constant in the Briggs’ neutral plume rise equation using BLP
CPF - Cancer Potency Factor
CRIT - Convergence criterion for the line source calculations using BLP
Cs - Concentration of Substance in the Soil
CTDMPLUS - Complex Terrain Dispersion Model
CTSCREEN - Complex Terrain Screening Model
Cv - Average concentration of a substance in and on vegetation
Cw - Concentration of a Substance in the Water
DECFAC - Pollutant decay factor for use with BLP
DF - Discount Factor
$DOSE_{air}$ - Daily inhaled dose
$DOSE_{fa}$ - Exposure through ingesting home-raised or farm animal products
$DOSE_{fish}$ - Exposure through ingestion of angler-caught fish
Dose-Im - Exposure through mother’s milk ingestion
$DOSE_p$ - Exposure through ingesting home-grown produce
$DOSE_{water}$ - Exposure through ingesting water

DTHTA - Vertical potential temperature gradient
DTSC - Department of Toxic Substance Control
EASA - Exposure Assessment and Stochastic Analysis
ED - Rural Enumeration Districts or Exposure Duration (in years)
EF - Exposure Frequency
EICG - Emission Inventory Criteria and Guidelines
EPA - Environmental Protection Agency
EQ - Equation
F - Fahrenheit
FAH - Fraction of Time at Home
FG - Fraction of diet provided by grazing
GIS - Geographic Information Systems
GLC - Ground-Level Concentrations
GRAF - Gastrointestinal Relative Absorption Factor
HARP - Hot Spots Analysis and Reporting Program
HESIS - Hazard Evaluation System and Information Service
HI - Hazard Index
HQ - Hazard Quotient
HRA - Health Risk Assessment
HSC - Health and Safety Code
IARC - International Agency for Research on Cancer
IDELS - Maximum variation in number of stability classes per hour (BLP option)
ISCST3 - Industrial Source Complex Short Term
IUPAC - International Union of Pure and Applied Chemistry
K - Kelvin
L - Fraction of locally-grown (source-impacted) feed that is not pasture (site-specific)
LOAEL - Lowest Observed Adverse Effects Level
LOD - Level of Detection
LSHEAR - Plume rise wind shear (BLP option)
LTRANS - Transitional point source plume rise (BLP option)
MAXIT - Maximum iterations allowed for line source calculations (BLP option)
MEIR - Maximally Exposed Individual Resident
MEIW - Maximally Exposed Individual Worker
METDB - Meteorological Database
METS - Metabolic Equivalents
MPRM - Meteorological Processor for Regulatory Models
MWAF - Molecular Weight Adjustment Factor
NAS - National Academy of Sciences
NCDC - National Climatic Data Center
NOAEL-No Observed Adverse Effects Level
NTP - National Toxicology Program
NWS - National Weather Station
OCD - Offshore and Coastal Dispersion Model
OEHHA - Office of Environmental Health Hazard Assessment
p - Population density
PAH - Polycyclic Aromatic Hydrocarbons

PCB - Polychlorinated Biphenyl
PCDD - Polychlorinated dibenzo-p-dioxins
PCDF - Polychlorinated dibenzofurans
PEXP - Vertical wind speed power law profile exponents
PM2.5 - Particulate Matter less than 2.5 microns in diameter
PM10 - Particulate Matter less than 10 microns in diameter
PMI - Point of Maximum Impact
QA - Quality Assurance
QC - Quality Control
RCRA - Resource Conservation and Recovery Act
REL - Reference Exposure Level
RfC - Reference Concentration
RfD - Reference Dose
SCRAM - Support Center for Regulatory Air Models
SDM - Shoreline Dispersion Model
SIR - Soil Ingestion Rate
SMAQMD - Sacramento Metropolitan Air Quality Management District
SRP - Scientific Review Panel
TAC - Toxic Air Contaminant
Tco – Biotransfer coefficient
TEF - Toxic Equivalency Factor
TERAN – Terrain option in BLP
TSD - Technical Support Document
TSP - Total Suspended Particulates
UCL - Upper Confidence Limits
USGS - U.S. Geological Survey
UTM - Universal Transvers Mercator
WAF - Worker Adjustment Factor
WHO - World Health Organization

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Index of Selected Terms and Acronyms

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LEED ND: Plan | v4 - LEED v4

Certified green building

Required

Glossary

Intent

To encourage the design, construction, and retrofit of buildings using green building practices.

Requirements

Design, construct, or retrofit one whole building within the project to be certified through a LEED rating system (if LEED for Commercial Interiors, 75% of the total building floor area must be certified), or through a green building rating system requiring review by independent, impartial, third-party certifying bodies that have been accredited by an IAF-accredited body to ISO/IEC Guide 65 or, when available, ISO/IEC 17065.