State of California
AIR RESOURCES BOARD

Final

Assessment of California's Statewide Air Monitoring Network for the Children's Environmental Health Protection Act (SB 25)

October 2003

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TABLE OF CONTENTS

Page

EXECUTIVE SUMMARY.....1

I. PURPOSE OF THE REPORT.....3

II. BACKGROUND.....5

A. Air Quality in California.....5
B. Air Pollutants And Children's Health.....6
C. How We Assess Children's Exposure To Air Pollution.....8
Routine ambient air monitoring.....8
Special purpose air monitoring.....9
Emission inventories.....9
Air quality models.....10
Indoor and personal exposure monitoring.....10
D. SB 25 Review of Pollutants.....11

III. STATEWIDE AIR MONITORING NETWORK.....12

A. Routine Statewide Air Monitoring Network.....14
Criteria pollutant air monitoring.....15
Toxic pollutant air monitoring.....16
B. Special Purpose Monitoring in Six Communities.....19
C. Special Indoor Personal Exposure Study.....23

IV. ADEQUACY OF THE STATEWIDE AIR MONITORING NETWORK.....24

A. What We Learned From the Community Monitoring Sites.....25
B. Evaluation of the Statewide Air Monitoring Network.....27
C. Technical Assessments of the Network for Individual Pollutants.....34
D. Indoor and Personal Eexposure Study.....51

V. CONCLUSIONS AND RECOMMENDATIONS.....53

APPENDICES

A. SENATE BILL 25

B. SUMMARY DATA FOR SIX SB 25 COMMUNITY MONITORING SITES

EXECUTIVE SUMMARY

The Children's Environmental Health Protection Act, Senate Bill 25 (SB 25) (Chapter 731, Escutia, Statutes of 1999), focuses on children's exposure to air pollutants. The Act establishes a number of specific requirements for the California Air Resources Board (ARB or Board). The requirements for ARB include review of the Board's air quality standards from a children's health perspective, evaluation of the statewide air monitoring network, and the development of any additional air toxic control measures needed to protect children's health.

This report addresses the requirement that ARB review the statewide air monitoring network to ensure that children's exposure to air pollutants is adequately characterized. As part of this review, ARB was required to perform special monitoring in six communities around the state. In coordination with air districts and community representatives, ARB has carried out the special monitoring and used the data in the analyses presented in this report. As required by SB 25, the monitoring was done at sites such as schools that are close to sources of air pollution – both industrial and traffic-related sources.

In evaluating the monitoring network, we compared the SB 25 monitoring results with routine network data. The purpose of this analysis was to determine how well network monitoring data represents exposures in nearby communities. We also used a combination of network monitoring data and statistical analyses as another method to evaluate ability of the network data to characterize the air pollution exposure of children.

Based on these analyses, we find that the statewide monitoring network provides the fundamental data needed to determine typical outdoor exposures of children to air pollution in California communities. This includes ozone, particulate matter, carbon monoxide, and nitrogen dioxide (referred to as "criteria pollutants") as well as the most common toxic air contaminants. At the same time, we find that additional methods are needed to assess localized exposures that may occur near specific air pollution sources. The report gives examples of three methods that can be used to estimate such near-source air pollution exposures.

One method uses routine monitoring data in conjunction with special purpose monitoring data collected near air pollution sources in communities. Another combines the use of air quality modeling and network monitoring data. The third example shows how air quality models and emissions information can be used to help identify localized exposures. These assessment tools are being used to supplement the network monitoring data in order to better understand exposures to air pollution in California's communities.

ARB developed three recommendations designed to supplement the air pollution exposure information provided by the statewide monitoring network. We are implementing these recommendations as part of our community health and environmental justice programs. The recommendations are to:

- Use our mobile monitoring capability for short-term special purpose assessments to supplement the statewide monitoring data.

- Improve emission estimates and air quality modeling methods to assess localized exposures near air pollution sources.

- In the 2003 Innovative Clean Air Technologies (ICAT) Program, fund development of lower-cost monitoring methods to provide for expanded community level monitoring in the future.

I. PURPOSE OF THE REPORT

The Children's Environmental Health Protection Act (SB 25) (Chapter 731, Escutia, Statutes of 1999) focuses on children's exposure to air pollutants. The Act establishes a number of specific requirements for the California Air Resources Board (ARB or Board). The requirements for ARB include review of the Board's air quality standards from a children's health perspective, evaluation of the statewide air monitoring network, and the development of any additional air toxic control measures needed to protect children's health.

This report presents the ARB's review of the statewide air monitoring network, its findings, and its recommendations. In evaluating the network, SB 25 requires the ARB to:

(1) Evaluate the adequacy of the statewide air monitoring network for its ability to gather the data necessary to determine the exposure of infants and children to air pollutants including criteria air pollutants and toxic air contaminants;
(2) Identify areas where the exposure of infants and children to air pollutants is not adequately measured by the monitoring network; and
(3) Recommend improvements to the statewide air monitoring network and data collection to more accurately reflect the exposure of infants and children to air pollutants.

SB 25 also requires that the ARB, in coordination with the local air districts, perform supplemental monitoring in six communities and use the monitoring results to help assess the adequacy of the statewide routine monitoring network. In doing so, the ARB should include:

(1) Monitoring during multiple seasons and at multiple locations within each community at schools, day care centers, recreation facilities, and other locations where children spend most of their time; and
(2) Upgrading existing fixed monitoring sites, establishing new fixed monitoring sites, and conducting indoor and outdoor sampling and personal exposure measurements in each community to provide the most comprehensive data possible on the levels of children's exposure to air pollutants and toxic air contaminants.

In response to SB 25, we established a monitoring program to address the question of exposures at the community level and particularly children's exposure. We worked closely with the local air districts, community groups, school districts, and other public agencies in this process. Public workshops were held in June 2000 to discuss the criteria for selecting the six additional communities in which to monitor the air and to solicit input on how best to apply these criteria.

Our goal was to select schools located in communities most likely to be impacted by local air pollution sources and to represent the diversity of California communities to the degree possible. The six communities selected were Barrio Logan (San Diego), Wilmington, Boyle Heights (Los Angeles), Fruitvale (Oakland), Crockett (Contra Costa County), and Fresno (Central Valley). The selection criteria and the six communities are discussed in more detail in Chapter III.

In addition to the data from the six supplemental sites established by this program, we used over 10 million observations from our extensive routine network, and data from other special studies to assess the adequacy of the network. These sources of information provided the data needed to answer questions about the network's adequacy. Specifically, we considered two critical questions:

(1) How well does the statewide monitoring network characterize the typical levels of air pollutants to which children are exposed?
(2) How well does the network characterize exposures when children or others are in close proximity to air pollution sources?

This report is divided into five chapters. Chapter II provides background information on air quality and children's health, including how, in general, we assessed children's exposure to air pollution. Chapter III describes the statewide air monitoring network and the supplemental monitoring conducted in the six communities. Chapter IV discusses ARB's assessment of the statewide air monitoring network, including a discussion of the methodologies used. Chapter V contains ARB's findings and recommendations.

II. BACKGROUND

This section provides background information on air quality in California and the role of the State's air monitoring network in measuring air quality. It also provides an overview of the reasons that children are more susceptible to air pollution than adults and which air pollutants have potentially significant impacts on children's health. Lastly, we discuss how exposure is assessed.

A. Air Quality in California

Air quality in California has improved dramatically in the past 20 years. In 1980, most Californians breathed unhealthy levels of lead, nitrogen dioxide, sulfur dioxide, carbon monoxide, ozone, particulate matter, and/or air toxics. In the South Coast Air Basin, there were over 100 days of Stage 1 health alerts during which ozone levels exceeded 200 parts per billion (ppb) and residents were urged to restrict their activity outdoors. Peak ozone levels reached 490 ppb, 400 ppb above the State standard of 90 ppb.

Today, all of California attains the health based air quality standards for lead, sulfur dioxide, and nitrogen dioxide, and 56 of 58 counties attain the carbon monoxide standards. The South Coast Air Basin has not seen a Stage 1 smog alert for several years and peak ozone concentrations are down over 50 percent. Annual average concentrations of small airborne particles (PM_{10}) have declined over 20 percent and the statewide cancer risk from toxic air pollutants has been reduced by about 50 percent. We are able to document these successes because of the State's extensive network of over 250 air monitoring sites.

Despite these successes, air pollution continues to be a public health issue. Most areas of California continue to exceed health-based state air quality standards for ozone and particulate matter. Federal air quality standards for these pollutants are also exceeded in a number of major urban areas. Air monitoring shows that over 90 percent of Californians still breathe unhealthy levels of one or more air pollutants during some part of the year. And while regional exposure to air toxics is declining, health risk remains too high. Tracking California's progress in improving air quality as we continue to reduce air pollutant emissions is a critical goal of our monitoring network.

In addition to tracking clean air progress, the data collected by the statewide network is used to help determine exposures to sensitive populations, such as children and the elderly. The network helps local air districts protect public health through the announcement of "Spare the Air" days and other health related advisories. The network also provides data that health professionals use to investigate the relationships between air pollution and children's health.

The statewide air monitoring network will continue to be used to track compliance with state and federal health-based ambient air quality standards. The ARB sets

air quality standards at air pollutant levels that are considered safe for the public, including those most sensitive to the effects of air pollution, such as children and the elderly. The ARB has set standards for traditional pollutants such as ozone, particulate matter, carbon monoxide, and nitrogen dioxide. These pollutants are known as "criteria pollutants." Research has connected criteria pollutants with various health effects, including breathing difficulties, increased respiratory illness, lung damage, and premature death. The State's air monitoring network routinely monitors for all criteria pollutants.

In addition to the criteria pollutants, the network monitors toxic air contaminants. ARB identifies pollutants as toxic air contaminants and adopts control measures to reduce public exposure. The State's air quality monitoring network routinely monitors several dozen toxic air pollutants and many more can be measured as part of special monitoring studies.

B. Air Pollutants and Children's Health

Infants and children may be especially vulnerable to adverse health effects from exposure to air pollution for several reasons, as discussed below.

Children's bodies grow and develop from the time they are infants until after adolescence. During this important time of maturation, there are critical periods of development when exposure to pollutants can adversely affect the growth and development of the lungs, heart, and immune system. Some diseases and other conditions may also make children more sensitive to air pollutants. In the United States, about ten percent of the population is affected by asthma, with the majority of cases among children.

Children also can have higher exposures to pollutants compared to adults because, relative to their body size, they breathe more air, eat more food, and drink more water than adults. Consequently, children are potentially exposed to relatively greater amounts of environmental contaminants. Children tend to be more active and breathe more rapidly in comparison to adults. As a result, children breathe more air pollutants as well. Also, children may not limit or alter their activities during times of high air pollution.

Children's exposure to air pollution may have life-long health consequences that we are only beginning to recognize. Severe or chronic health effects may become apparent after years of exposure, and the adverse results of exposures during early life may contribute to longer-term effects. Data now show that exposures during infancy and childhood may lead to ongoing health problems in later life.

Some health effects, such as eye irritation or coughing, can be relatively mild, are reversible, and last a short while. Other effects are more severe and irreversible, including cancer and sudden death. While some of these health effects are

caused by short-term exposures to high concentrations of pollutants over minutes, hours, or days, other health effects result from long-term exposures to low concentration of pollutants over many days, months, or years.

Exposure to ozone, nitrogen dioxide, and small particles has been shown to cause short-term respiratory effects in children, such as difficulty breathing, cough, and temporary reductions in lung function. Lung function reflects a child's ability to inhale or exhale normally. Reductions in lung function may be especially hazardous to asthmatic children who already suffer breathing difficulties. In addition, exposure to these air pollutants may result in inflammation in the lungs that occurs without reducing lung function measurably on a short-term basis. Nevertheless, over the long term, this inflammation and other responses to air pollution can adversely affect children's health by reducing the lung's ability to function normally.

Lasting damage to children's lungs may result from repeated short-term exposures to some air pollutants. Though each short-term exposure may elicit a mild, temporary effect, repeated effects can accumulate and eventually compromise health. Cumulative effects of air pollution may include permanent damage to lung tissues (as shown in animal studies) and increased risk of respiratory diseases, such as bronchitis and pneumonia.

In the Southern California Children's Health Study (CHS), exposure to particulate pollution has been associated with a number of chronic health effects in children. Recent results from the study have associated exposure to particulate matter pollution, nitrogen dioxide, and acid vapors with reduced lung function growth in children. The CHS has also found associations between exposures to particulate matter and increased rates of bronchitis among asthmatic children.

A few recent studies have linked exposure to particulate matter with an increased risk in newborns and infants of death, low birth weight, and premature births. In addition, recent studies have associated exposure to high levels of carbon monoxide and ozone with adverse effects in birth outcomes, including premature births, low birth weight among full-term infants, and heart birth defects.

Finally, many toxic air pollutants have been identified as cancer-causing substances. Recent studies have suggested that children may be at greater risk of cancer since they are at the beginning of their lifetime and therefore have a longer exposure time. In addition, evidence is mounting that there are windows of exposure during a child's development when risk of developing cancer in later childhood or adulthood may be greater than had the same exposure occurred at a different time. This is an area of intensive investigation.

Table 1 lists the major air pollutants, their sources, and their associated health effects.

Table 1. Major air pollutants, their sources, and their associated health effects.

POLLUTANT	HEALTH EFFECTS	EXAMPLES OF SOURCES
Particulate Matter (PM_{10} and $PM_{2.5}$)	▪ Increased respiratory disease ▪ Lung damage ▪ Premature death	▪ Cars and trucks, especially diesels ▪ Fireplaces, woodstoves ▪ Windblown dust, from roadways, agriculture and construction
Ozone	▪ Breathing difficulties ▪ Lung damage	▪ Formed by chemical reactions of air pollutants in the presence of sunlight. Common sources of ozone precursors: motor vehicles, industries, and consumer products
Carbon Monoxide	▪ Chest pain in heart patients ▪ Headaches, nausea ▪ Reduced mental alertness ▪ Death at very high levels (mostly in confined areas)	▪ Any source that burns fuel such as cars, trucks, construction and farming equipment, and residential heaters and stoves
Nitrogen Dioxide	▪ Lung damage	▪ See Carbon Monoxide sources
Toxic Air Contaminants	▪ Cancer ▪ Chronic eye, lung, or skin irritation ▪ Neurological and reproductive disorders	▪ Cars and trucks, especially diesels ▪ Industrial sources ▪ Neighborhood businesses (dry cleaners, chrome plating facilities, etc.) ▪ Building materials and products

C. How We Assess Children's Exposure to Air Pollution

Exposures occur whenever individuals breathe pollutants. The determination of exposure requires measured or estimated levels of pollutants in the air and information regarding how long people are exposed to those levels. While routine ambient monitoring is essential for this purpose, it is not the only way to determine pollutant levels. Special purpose monitoring, emission inventories, air quality models, indoor and personal exposure monitoring and special studies can also help determine the pollutant levels to which individuals are exposed.

In combination, these sources of data allow us to gather the information needed to characterize exposure under most circumstances. Each of the data gathering approaches is discussed below. In Chapter IV, we discuss how these approaches can be used in an overall assessment of exposure to air pollution.

Routine ambient air monitoring

Measurements from the statewide air monitoring network provide information on outdoor pollutant levels. California's air monitoring network was originally

designed for the following tasks: (1) determining whether regions attain ambient air quality standards, (2) supporting preparation of effective plans to improve air quality, (3) determining typical exposures in regions of high population density, and (4) tracking progress toward clean air. Data from the network has served these purposes well for many years. Population exposure is estimated by combining population data with pollutant levels. Population data from the U.S. Census Bureau are available down to individual census tracts including demographic information such as age distributions. Pollutant levels can also be estimated for census tracts based on data from the monitoring network.

Special purpose air monitoring

Special purpose air monitoring can provide first-hand information about a specific question or issue under investigation. These are usually limited-term monitoring studies that are often designed to measure pollution from a specific type of facility or pollution that is impacting a specific community. Pollutant levels measured at the special purpose sites can be combined with information from the routine monitoring network to improve the accuracy of air pollution exposure estimates.

The air monitoring activities in the six communities selected under SB 25 are examples of special purpose monitoring. Other studies that conducted special purpose monitoring relevant to children's environmental health include the Southern California Children's Health Study, the Multiple Air Toxics Exposure Studies, the California Regional Particulate Air Quality Study, the Fresno Asthmatic Children's Environment Study, and the Portable Classrooms Study. Together with other research, these studies produced valuable information concerning children's activity patterns, potential exposures, and resulting health effects.

Emission inventories

An emission inventory is a catalog of the known sources of air pollutants and the amounts produced by each source. Accurate, up-to-date emission inventories can help identify areas of concern that would not be detected through standard monitoring programs. For example, if the inventory shows that air pollution sources are concentrated in a small area, we may expect to find that the area is a "hot spot" with unusually high levels of a pollutant. Hot spots are difficult to locate using routine monitoring efforts, but can be identified with the help of emission inventories. The emission inventory data can be used with air quality models (see below) to estimate the air pollutant levels in the potential hot spot area. Emission inventory data can also be combined with other data to answer questions related to the proximity of schools or day care centers to important sources of air pollution such as freeways, chrome plating facilities, or other major industrial facilities. The ARB maintains a statewide emissions inventory to support a wide range of air quality programs and needs. As part of its ongoing

commitment to make data available to the public, emission inventory data and summaries are available online at *http://www.arb.ca.gov/emisinv/eib.htm*.

Air quality models

Air quality models often play a critical role in estimating exposure to air pollution. These models use information about emissions and meteorology to estimate outdoor air pollution levels. Models can also be used to address questions that cannot be addressed by monitoring alone, such as:

- where is it likely that high air pollution concentrations may occur (to help identify potential air monitoring sites); and
- what are the relative contributions of regional and local sources of air pollution to the overall air pollution levels in a community.

Models can also provide insights into the complex chemistry occurring in the air as well as the dispersion, transport, and deposition of pollutants. The statewide air monitoring network is used in combination with modeling to give a more complete picture of air pollution exposure at the local level.

Indoor and personal exposure monitoring

The ARB, the U.S. Environmental Protection Agency (U.S. EPA), and others have sponsored many studies that measured indoor pollutant levels and exposures in homes, schools, and offices. An important result of this research is the identification of a variety of pollutants for which indoor concentrations are significantly greater than outdoor concentrations. One example is formaldehyde, which is used in many construction materials and furniture products.

Studies in California and across the nation have found that personal exposure to some air pollutants is typically higher than can be accounted for by indoor and outdoor measurements. This is largely because people's activities bring them nearer to sources of pollutants compared to the air monitoring equipment. For example, a study of indoor air pollution might place a monitor in a central location in a home where it characterizes the average pollutant levels. Personal activity, however, may bring individuals near to a stove, consumer products, or other indoor sources that release pollutants in their immediate vicinity.

D. SB 25 Review of Pollutants

SB 25 requires the Office of Environmental Health Hazard Assessment (OEHHA) to develop a list of toxic air contaminants that may cause children to be more susceptible to illness. The initial list of toxic air contaminants identified by OEHHA may contain up to five substances, and additional substances may be added when the list is updated on an annual basis beginning in 2005.

In September 2001, OEHHA identified the following toxic pollutants as those that may cause children to be more susceptible to illness: acrolein, particulate emissions from diesel-fueled engines (diesel PM), dioxins, lead, and polycyclic organic matter (POM). The OEHHA report and the selection of these substances were reviewed and endorsed by the Scientific Review Panel, an appointed committee of independent scientists.

The ARB's toxics monitoring network already routinely monitors for lead and constituents of POM as well as many of the toxic pollutants evaluated by OEHHA for special consideration with respect to children's health. Dioxins, which are among the most potent toxics, are currently being monitored as part of a special monitoring effort called the California Ambient Dioxin Air Monitoring Program (CADAMP). The monitors in this program also measure lead and some key components of POM such as furans and dioxin-like polychlorinated biphenyls. The CADAMP study includes nine locations in northern and southern California - five in the San Francisco Bay area and four in the Los Angeles area. This is a limited-term monitoring study to assess dioxin exposures.

ARB is also developing a monitoring method for acrolein since there is no reliable method available in the ambient air. In addition, there is also no method to measure diesel PM as an independent constituent in the ambient air. Diesel PM is currently measured as part of the PM_{10} and $PM_{2.5}$ values. We also use a variety of methods to estimate diesel particulate exposure based on measured carbon levels, emissions information, and other data. Though not an ideal marker, elemental carbon was measured at most of the SB 25 sites.

Due to the lack of a measurement technique for diesel PM, previous efforts relied on emission inventories to estimate statewide population-weighted, annual average outdoor diesel PM concentrations; these concentrations are a major contributor to cancer risk from urban toxic air pollutants. Currently, the ARB staff combines ambient PM_{10} data (collected from special studies and the routine monitoring network), PM_{10} emission inventories, and the results from receptor modeling to estimate statewide outdoor concentrations of diesel PM.

As OEHHA continues to update the list of toxic air contaminants identified as making infants and children more susceptible to illness, the ARB will assess the feasibility of adding those substances to those routinely monitored, or determine if a special study may be needed to determine exposures.

III. STATEWIDE AIR MONITORING NETWORK

In the previous Chapter, we described the general data gathering approaches that can be used to collect data for assessing exposure. In this Chapter, we describe the routine statewide air monitoring network; the six special purpose monitoring sites established for this evaluation; and the study of indoor and personal exposures.

California deserves its reputation as a leader in monitoring air quality. The statewide network of air monitors is extensive and measures a wide spectrum of pollutants using up-to-date technologies. Our monitoring network is the primary source of the data needed to conduct exposure assessments. It is important to understand the characteristics of this network before we can conclude how well it does in characterizing children's exposure.

Exposure to air pollution has been linked to a wide variety of adverse health effects and it is an ARB priority to protect public health by reducing the exposure to unhealthy levels of air pollution. The U.S. EPA sets national ambient air quality standards and the ARB sets state standards. The goal of our air pollution control program is to meet both State and federal standards as expeditiously as possible. SB 25 required ARB, with OEHHA, to review the existing air quality standards to determine whether they adequately protect the health of infants and children. The report on the review of the standards is available at *http://www.arb.ca.gov/research/aaqs/caaqs/ad-aaqs/ad-aaqs.htm*.

In California, the State standards are generally more protective than the federal standards. Two of the most critical air pollutants for children's health are ozone and particulate matter. Ozone is a pollutant that forms in the air from the chemical reactions of other pollutants such as organic gases and nitrogen oxides, which are called ozone precursors. Ozone takes time to form, so ozone levels are often highest some distance downwind from where the precursors were emitted into the air. Ozone and its sources are widespread and localized ozone hot spots in neighborhoods are not likely. The statewide network established to measure ozone takes into account its ubiquitous nature, and monitors are located throughout California.

State standards cover two sizes of particulate matter, PM_{10} and $PM_{2.5}$. PM_{10} is airborne particulate matter that has an aerodynamic diameter of 10 microns or less. $PM_{2.5}$ is a subset of PM_{10} that has an aerodynamic diameter of 2.5 microns or less. $PM_{2.5}$ is often formed in the air as the result of chemical reactions of other pollutants. Like ozone, the highest levels may be found downwind of the location where precursors are emitted into the air, and neighborhood levels are likely to be similar to the levels in the surrounding area unless there are nearby sources directly emitting particulate matter. ARB has monitored for PM_{10} since the mid-1980s. However, with adoption of federal standards and State (annual)

standards for $PM_{2.5,}$ ARB has deployed a number of $PM_{2.5}$ monitors over the last few years.

Toxic air contaminants are formally identified by the ARB under a state law (H&SC 39650 et-seq.) that established a Toxic Air Contaminant Identification and Control Program. As part of the identification process, ARB is required to develop exposure assessments using monitoring data to detect and determine ambient levels of toxic air contaminants. Air toxics monitors have been established at sites throughout California to support this program and are operated by the ARB and local air districts.

It is important to note that the data collected from the State's extensive air monitoring network directly or indirectly serves several important purposes, including:

- Documenting population exposures;
- Determining which areas of the State meet the health-based State and national ambient air quality standards;
- Providing information on air quality trends that track progress towards attainment of the ambient air quality standards;
- Identifying locations in the State where there may be high levels of toxic air contaminants;
- Supporting determination of the types of emissions control programs and regional strategies needed to achieve healthy air and reduce exposure;
- Supporting epidemiological health studies; and
- Determining the different stages of health-protective advisories issued in different areas of the State.

As part of its ongoing commitment to provide up-to-date information to the public, the ARB makes data from the statewide air monitoring network available in a number of ways and formats. The ARB publishes and updates annually the California Almanac of Emissions & Air Quality, and also publishes a compact disc (CD) of air quality data. Both are available online at *http://www.arb.ca.gov/aqd/order/orderform.htm*. In addition, the public may access air quality data online from the ARB's California Air Quality Data web page *http://www.arb.ca.gov/aqd/aqd.htm*.

Below, we describe the statewide air monitoring network along with the six special purpose monitoring sites, the indoor monitoring, and the personal exposure monitoring required and implemented pursuant to the Children's Environmental Health Protection Act. The discussion includes descriptions of how indoor and personal exposures are measured. Though technically not part of the statewide air monitoring network, personal exposure measurements are an important component of overall assessments of air pollution exposure.

A. Routine Statewide Air Monitoring Network

The statewide air monitoring network is the primary tool for measuring outdoor pollution levels and for tracking progress towards clean air. California's extensive ambient air quality monitoring network has evolved substantially since the 1970s, and currently consists of over 250 monitoring sites employing over a thousand air pollution measuring devices. The 250 sites measure one or more criteria pollutants. Additionally, about 40 sites measure toxic air contaminants. The air monitoring network is continuously reviewed and adjusted as needed. For example, new pollutants are added to the statewide network as we become aware of their health effects and their presence in California.

Some monitoring stations measure many pollutants, while others may focus on a smaller number of pollutants depending on the need and objective of the monitoring site. A list of criteria and toxic pollutants measured in the California statewide network is provided in Table 2. It is important to note that measuring an air pollutant involves more than just plugging in the equipment and flipping a switch. Most continuous air pollution monitors, such as those used for ozone, are delicate scientific instruments that require a secure, temperature-controlled environment and regular calibrations to ensure that they are operating properly. For other pollutants, such as particulates, the sample is collected on a filter that must be picked up by a technician and sent to the laboratory for analysis. This can often add a month or longer before the data are available.

California's air monitoring network was originally designed for the following objectives: (1) determining whether regions attain ambient air quality standards, (2) supporting preparation of effective plans to improve air quality, (3) determining typical exposures in regions of high population density, and (4) tracking progress toward clean air. Data from the network has served these purposes well for many years.

The following monitoring objectives, the first four of which are specified in federal regulations, helped guide the development of California's network:

- General background levels;
- Highest levels in the area;
- Representative levels in densely populated areas;
- Impacts of major emission sources;
- New or existing program needs; and
- Impacts of population growth.

Criteria pollutant air monitoring

The Statewide air monitoring network for criteria pollutants has grown and matured significantly over the last 30 years. Figures 1 and 2 show the current locations of gaseous and particulate monitors. Of the 250 sites, approximately 190 stations measure ozone, 120 stations measure NO_2, and 100 stations measure CO. Approximately 230 monitors measure particulate matter, including about 150 that measure PM_{10} and 80 that measure $PM_{2.5}$. Continuous hourly average PM_{10} levels are collected at 12 sites, and 11 sites gather hourly average $PM_{2.5}$ values. Data for gaseous and particulate pollutants are reviewed annually to determine which areas of the State attain established air quality standards.

Figure 1. Statewide Network: Monitors measuring criteria gases.

Figure 2. Statewide Network: Monitors measuring particulate matter.

The ARB began a routine seasonal sampling program in 1989 to gather information about organic gases that play an important role in smog formation. Beginning in 1994, federal regulations required states to establish photochemical assessment monitoring stations (PAMS) as part of their State Implementation Plans in ozone nonattainment areas. Figure 3 shows the locations of PAMS sites in California. The PAMS program is intended to supplement ozone monitoring and add detailed sampling of precursors. There are seven ozone nonattainment areas subject to the (PAMS) regulation in California. The local air districts in the affected areas are full participants in the PAMS monitoring activities.

Measurements made at the PAMS sites include ozone, oxides of nitrogen, 56 target hydrocarbons, at least two carbonyls (formaldehyde and acetaldehyde), and surface and upper air meteorology. Most PAMS sites obtain measurements on a 3-hour basis during the summer ozone season.

Toxic pollutant air monitoring

The ARB established a network to measure toxic air pollutants in the mid-1980s in response to State law (H&SC 39650 et-seq.) which established the Toxic Air Contaminant Identification and Control Program. This law requires the ARB to identify and control toxic air pollutants in the ambient air and to develop exposure assessments. In doing so, the identification and exposure assessments must rely on monitoring data to detect and determine ambient levels of air toxics. The data are also used to track changes in air toxics levels in response to regulations limiting emissions.

Therefore, the ARB established a statewide air monitoring network to measure concentrations of a full spectrum of air toxics. The data collected by this network are used to assess general population exposures and evaluate public health risks to these pollutants.

The current network includes approximately 40 stations that measure toxics, including the short-term sites required by SB 25 and the PAMS sites. The non-PAMS sites are shown in Figure 4 and represent areas in the South Coast Air Basin, San Diego County, the San Francisco Bay Area Air Basin, Santa Barbara County, Mojave Desert Air Basin, Ventura County, and the Sacramento and San Joaquin Valleys. About half of these monitors measure an extensive set of toxic compounds routinely, including 1,3-butadiene, benzene, hexavalent chromium, polycyclic aromatic hydrocarbons (PAHs), and lead along with other toxic metals.

The ARB operates half of the 40 toxics monitors in California. The primary objective of the ARB toxics monitoring network is to collect sufficient samples to estimate annual average concentrations in those areas with the greatest potential for elevated public exposure. In addition to the network operated by ARB, local air districts such as the Bay Area Air Quality Management District (BAAQMD) and the South Coast Air Quality Management District (SCAQMD) operate supplemental monitoring networks. The BAAQMD operates toxics monitors at more than 15 locations (see Figure 4). In order to take maximum advantage of data from the supplemental sites, the ARB, BAAQMD, and SCAQMD continue to work closely together to develop and implement procedures to ensure data compatibility.

Figure 3. PAMS sites in California (2002)

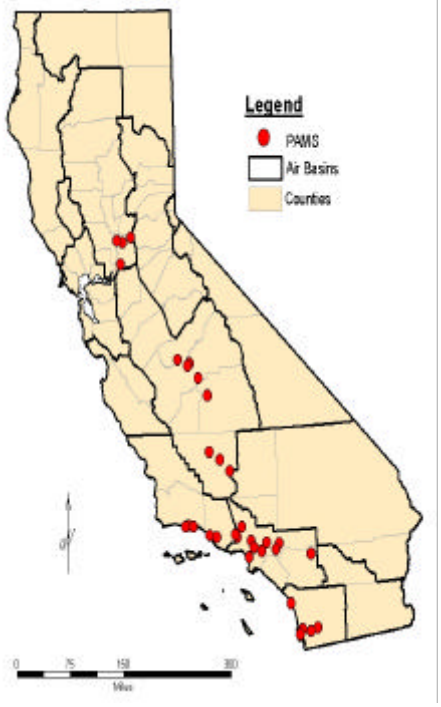


Figure 4. Toxics sites in California (2002)

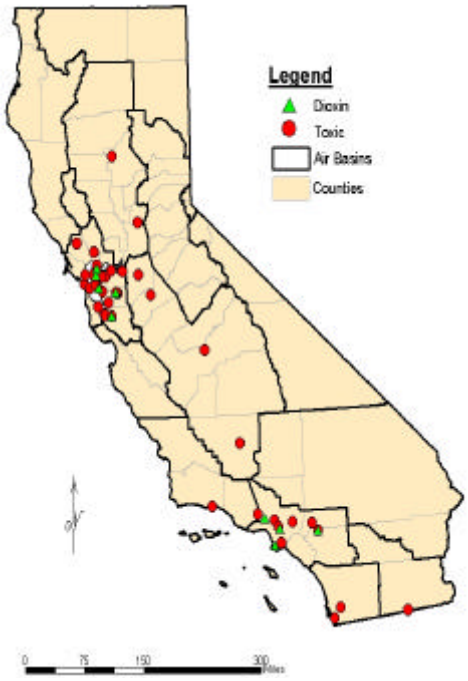


Table 2. Criteria and toxic pollutants routinely monitored in the statewide air monitoring network

Measured Pollutants[1]	
Gaseous Criteria Pollutants	
Ozone	Nitrogen Dioxide
Carbon Monoxide	Sulfur Dioxide
Particulate Matter	
PM_{10}	Elemental Carbon
$PM_{2.5}$	Black Carbon
Carbonyl Compounds	
Formaldehyde	Methyl Ethyl Ketone
Acetaldehyde	
Polycyclic Aromatic Hydrocarbons (PAH)	
Benzo(b)fluoranthene	Dibenz(a,h)anthracene
Benzo(k)fluoranthen	Benzo(g,h,i)perylene
Benzo(a)pyrene	Indeno(1,2,3-c,d)pyrene
Halogenated Organic Compounds	
Bromomethane	Carbon Tetrachloride
Perchloroethylene	Chloroform
Trichloroethylene	*cis-, trans-* Dichloropropene
Trichloroethane	Dichloromethane
Aromatics	
Benzene	*o-,m-,p*-Xylene
Toluene	*o-,p*-Dichlorobenzene
Ethyl Benzene	Styrene
Dienes	
1,3-Butadiene	
Oxygenates	
Methyl tertiary-Butyl Ether	
Metals	
Chromium VI	Other Metals[2]
Ions	
Sulfate, Nitrate, Chloride, Ammonium, Potassium	

[1] CS2, Dioxins, NMHC and H2S measured at selected SB25 sites.

[2] Aluminum, Arsenic, Silicon, Phosphorus, Sulfur, Chlorine, Potassium, Calcium, Titanium, Vanadium, Chromium, Manganese, Iron, Cobalt, Nickel, Copper, Zinc, Selenium, Bromine, Rubidium, Strontium, Yttrium, Zirconium, Molybdenum, Tin, Antimony, Barium, Mercury, Lead, Uranium

B. Special Purpose Monitoring in Six Communities

To help assess the adequacy of the statewide air monitoring network in determining children's exposure, SB 25 required the ARB to expand the network into six communities in non-attainment areas. Local air districts played a major role in selecting the locations and operating the monitors for this special-purpose study in the six selected communities.

In selecting the six sites, we looked for locations within communities where localized impacts from emission sources might occur. We used ARB's comprehensive databases on industrial facilities and geographic information systems to identify schools and neighborhoods near emission sources such as industry or freeways. Local air districts and community representatives provided recommendations and information that aided in the selection process.

We also looked at the available information on cumulative air quality impacts by using the U.S.EPA's ASPEN model. ASPEN is a computer model that can estimate the cumulative health risk from all sources of air pollution at the census tract level. Cumulative air pollution health risk maps generated by the ASPEN model were used to help focus our search for the six special air monitoring sites.

The site selection process was presented during public workshops in Fresno, Los Angeles, Oakland, and Sacramento in June 2000. In addition to the workshops, ARB staff visited many communities throughout California and spoke with community representatives. Community input in identifying schools in areas of concern was very helpful in making the selections.

The six sites selected were Barrio Logan (San Diego), Boyle Heights (Los Angeles), Wilmington (Los Angeles County), Crockett (Contra Costa County), Fruitvale (Oakland), and Fresno (San Joaquin Valley). The six sites are described below in more detail. These sites are quite diverse in terms of weather, geography, and air pollution sources – including diesel exhaust, automobiles, neighborhood sources, refineries, and other sources.

Barrio Logan (San Diego)

Barrio Logan is a small community located in San Diego near the shipyards and the Coronado Bridge. Barrio Logan was selected because it has industrial areas intermixed with residential areas and because this low-income, largely Latino community has had long-standing concerns about the effects of air pollution on children's health in the community. Major sources of air pollution in and near Barrio Logan include shipyards, major freeways, industrial sources, automotive repair facilities, chrome plating and metal refinishing operations. The community is also part of the ARB's Neighborhood Assessment Program, which involves detailed emission inventory preparation and a modeling analysis in addition to the special monitoring program required by SB 25.

The primary monitoring site in the Logan Heights/Barrio Logan area of San Diego was Memorial Academy. In the summer of 1999, an ambient air monitoring station was installed on school property at 2850 Logan Avenue , just east of I-5, a heavily traveled freeway. Measurements of selected pollutants were taken at several additional locations in Barrio Logan. The Memorial Academy site began collecting ambient air quality data in October 1999. Summary results and a more complete description and analysis of the data collected is available at the following site: *http://www.arb.ca.gov/ch/aq_result/barriologan/barriologan.htm*.

Supplementing the overall monitoring effort, the ARB established satellite monitors on a residential street where homes and two chrome platers are located. The purpose of this additional effort was to better understand the impact of the chrome plating facilities on the community. Although these monitors were initially set up as satellite sites, this effort became an extensive special monitoring study that identified very high levels of hexavalent chromium at residences in the community. This special study ran from December 2001 through May 2002. Summary results are included later in this report but a more complete description and analysis of the data collected will be published later this year.

Boyle Heights (Los Angeles)

Boyle Heights is located in central Los Angeles County, a few miles southeast of downtown Los Angeles. Boyle Heights was chosen because of its proximity to mobile source emissions and because many children live in the community. This low-income, largely Latino community has 16 schools and childcare centers that operate between four major freeways – state routes 60 and 101, and Interstate Highways 5 and 10. A large number of heavy-duty-duty diesel trucks exit the freeways in this area, resulting in many diesel trucks operating on local streets. In addition to mobile sources, significant pollutant sources in the community include printing services, auto refinishing facilities, trucking operations, large-scale boilers, textile facilities, dry cleaners, and service stations.

The primary monitoring site in the Boyle Heights community was Hollenbeck Middle School, located at 2510 East 6th Street about one-half mile downwind of the convergence of the four freeways. Hollenbeck School has 2,200 students, and Theodore Roosevelt Senior High School, across from Hollenbeck, is a large high school with enrollment over 5,000. Data collection at Hollenbeck, began in March 2001 and ended in May 2002, and represents typical pollutant levels for the Boyle Heights community. Air monitoring was also conducted at the two satellite sites in the Boyle Heights community – Soto Street Elementary School and the East Los Angeles Science Center from March 2001 through October 2001. The East Los Angeles Mathematics, Science and Technology Center, was also one of nine sites chosen for the California Ambient Dioxin Air Monitoring Program (CADAMP).

Wilmington (Los Angeles County)

The Wilmington community is in southern Los Angeles County near the ports of Los Angeles and Long Beach. The community is also part of the Neighborhood Assessment Program, which involves detailed emission inventory preparation and a modeling analysis in addition to the special monitoring program required by SB 25.

Wilmington was chosen because a number of air pollution sources are concentrated in the community and near schools in the area. Community members had long-standing concerns about diesel emissions from trucks, trains and ships serving the ports of Los Angeles and Long Beach as well as emissions from three local oil refineries. This low-income, largely Latino community has approximately 12 schools, and several childcare facilities operating in the area.

The primary monitor in the Wilmington community was installed at Mahar House, 1115 Mahar Avenue, across the street from Wilmington Park Elementary School and the Wilmington Park Children's Center. The Children's Center site was also selected for the CADAMP network which measured urban dioxin levels. Monitoring at Mahar House began in May 2001 and ended in July 2002. An additional satellite monitor was placed at Hawaiian Elementary School, 540 Hawaiian Avenue, near the I-110 freeway. SCAQMD also conducted additional monitoring at the Hawaiian School.

Crockett (Contra Costa County)

The city of Crockett is located in Contra Costa County where I-80 crosses the Carquinez Strait. Crockett was chosen because of its proximity to large industrial facilities and mobile source emissions. Several oil refineries and storage facilities are located in upwind cities. Air quality models indicated that Crockett was likely to be impacted strongly by emissions from local refineries, with special focus on hydrogen sulfide (H_2S) and carbon disulfide (CS_2). Community groups in the Contra Costa County area have repeatedly expressed concerns about the effects of toxic air pollution from local refineries on children. Crockett is also the location of a major food processing operation and a heavy-rail transfer facility.

The primary site in this community was John Swett High School. In October 2001, an ambient air monitoring station began collecting data at the school, which is located at 1098 Pomona Street. Approximately 650 students attend John Swett High School and 500 students attend Carquinez Middle School across Pomona Street. The monitoring is expected to continue until Spring 2003. John Swett High School in central Crockett is also one of nine sites chosen for the California Ambient Dioxin Air Monitoring Program (CADAMP).

Fruitvale (Oakland)

The Fruitvale community is located in Oakland near the intersection of Fruitvale Avenue and International Blvd. Fruitvale, a culturally diverse low-income community, was chosen because its air quality is affected by several categories of pollutant emissions and because the area has a large high school-age population. Two major freeways are significant sources of vehicular emissions, and the area is downwind of several industrial sources of criteria pollutants and air toxic emissions, including potential sources of dioxins. In addition, Oakland International Airport, less than five miles away, is a source of aircraft and ground-vehicle emissions. During the community selection process, a key consideration was concerns from the community regarding a nearby medical waste incinerator. This facility has now been closed. Lockwood Elementary, Havenscourt Middle School, and the child development center have a combined enrollment of over 1,800 students. Twenty more public schools are in the Fruitvale area between High Street and 98th Avenue.

The primary monitoring site was at Lockwood Elementary School, located at 6701 International Boulevard (at 69th Avenue). The educational complex, between the 580 and 880 freeways and two miles from an industrial area, also includes Havenscourt Middle School and a child development center. Collection of ambient air quality data at Lockwood Elementary School began in November 2001 and is expected to continue until Spring 2003. Monitoring for the California Ambient Dioxin Air Monitoring Program (CADAMP) in the Fruitvale area of Oakland is being conducted at Lockwood Elementary School.

Fresno (San Joaquin Valley)

The Fresno site offered an opportunity to leverage our efforts with the Fresno Asthmatic Children's Environment Study (FACES). FACES is a multiyear study of Fresno school children that will investigate the relationship between air pollution and asthma in children. The Fresno school system is the fourth largest in California, with over 800,000 students in 61 elementary schools, 16 middle schools, and nine comprehensive high schools.

The primary monitoring site in Fresno is Fremont Elementary School, located at 1005 W. Weldon approximately one-half mile east of State Route 99. The site began collecting air quality data in June 2002 and data collection will continue until Fall 2003. As noted above, the Fresno site is closely allied with other major monitoring and health studies, including FACES. The combination of information from the special monitoring and from FACES will greatly expand our understanding of factors that contribute to the exacerbation (triggering) and progression of asthma. It will also help define the type of monitoring that is needed to protect children afflicted with respiratory problems. In addition, the special monitoring site in Fresno is situated just a short distance from the

Fresno–1st Street monitoring station operated by the ARB. Monitoring activities at this site have been expanded significantly in recent years with funds from the U.S.EPA. The Fresno Supersite, as it is called, will provide a rich database that may be used to augment the analyses of the data collected under SB 25.

C. Special Indoor Personal Exposure Study

SB 25 also requires monitoring of indoor and personal exposures. Because indoor environments are more-or-less isolated from the surrounding area, they are examples of micro-environments, and indoor exposures are sometimes called micro-environmental exposures. The indoor and personal monitoring will provide additional data to help us understand the levels of children's exposure to air pollutants both indoors and outdoors.

The ARB contracted with the University of California, Los Angeles to measure pollutants inside school classrooms, at one location on the school grounds, and in a few residences. These measurements were taken at Hollenbeck Middle School in Boyle Heights, Wilmington Park Elementary School in Wilmington, and John Swett High School in Crockett.

Measured pollutants included toxic gases, particulate matter, and formaldehyde and related compounds. A subset of students was equipped with monitoring badges to measure their personal 48-hour exposure to hydrocarbons, including a number of toxic gases. The contractor also administered a health status survey to students in the monitored classrooms to determine the incidence of asthma and allergies. Additionally, information on ways to reduce exposures to indoor and outdoor contaminants was developed and distributed.

The study of indoor pollutant levels and personal exposures started in the fall of 2001. Field measurements were completed at the end of the school year in June 2002 and data analysis is underway. The study results will provide valuable information that will help the ARB identify differences between pollutant levels measured at network monitoring sites and children's indoor and personal exposures to air pollutants. The personal monitoring data will provide insight to children's actual exposures to toxic air pollutants. The micro-environmental monitoring data collected at locations where children spend most of their time - at school and at home - will expand our knowledge of how indoor sources contribute to children's exposures. Finally, this information will be useful in identifying additional pollutant sources that may require emission reductions in the future.

IV. ADEQUACY OF THE STATEWIDE AIR MONITORING NETWORK

In this Chapter, we present our evaluation of how well the statewide network characterizes the air that children breathe in their communities. Using the air monitoring data collected at the community sites described in Chapter III and data from the routine monitoring network, we conducted several analyses to answer questions regarding the network's adequacy. Based on these analyses, we found that the statewide air monitoring network reflects typical outdoor levels of pollutants fairly well at the community level. This finding is not surprising since the network is designed for this purpose. However, we also found that additional approaches are needed to evaluate more localized air pollution impacts that may occur.

For example, the statewide network may not capture an elevated pollutant exposure occurring near an emission source such as a freeway or industrial facility. In this context, an elevated exposure would be one substantially higher than what is measured at the nearest network monitor. To characterize pollutant levels near significant emission sources, additional information such as emission inventories, air quality models, and special-purpose monitoring may be needed. ARB is developing technical protocols for such analyses and funding projects to help commercialize low-cost, community oriented monitoring methods to supplement the statewide monitoring network.

The PM monitoring data for the community monitoring sites includes diesel particulate matter as a component – it is reflected in both PM_{10} and $PM_{2.5}$ data. However, there is no analytical method to measure diesel particulate as an independent constituent. Therefore, from a toxics risk standpoint, the monitoring results in this report do not include diesel particulate. Apart from this monitoring report, we use a variety of methods to estimate diesel particulate exposure based on measured carbon levels, emissions information, and other data. These exposure estimates are used in ARB's diesel risk reduction program and to characterize the contribution of diesel particulate to air toxics risk.

This Chapter starts with a broad overview in Section A of what we learned at the six community sites established by SB 25. In Section B, we discuss the methods we used to evaluate the adequacy of the network or to enhance the network's performance. These methods use data from the SB 25 community sites along with monitoring data from the routine network and other studies. We divide the methods into two groups - those that are used to assess the adequacy of the network, and those that are used to fill in gaps that the routine network does not completely capture. Section C follows with a discussion of individual pollutant assessments used to evaluate the adequacy of the network.

A. What We Learned From the Community Monitoring Sites

One goal of the special community monitoring program was to determine whether or not pollutant levels were similar to levels measured by the routine monitoring network. We used the air monitoring data collected at these sites in our analyses of network adequacy. Although the analyses of air monitoring data is not entirely complete; the data are sufficient to assess network adequacy for all but the Fresno site. In Fresno, the start of the program was delayed to coincide with the ARB's childhood asthma study (FACES). A year or more of monitoring was conducted at all the sites. We plan to produce a final report for each community that includes all the data collected at that site together with our findings.

The location of the six community sites and the reasons for selecting them are included in Chapter III. The six sites were selected with the anticipation that we would find higher levels of pollution than found at nearby routine monitoring sites. This was because we selected monitoring locations downwind of areas with high concentrations of emission sources. We took this approach to maximize the possibility of finding exposure differences between individual communities and typical regional exposures. In general, we found that levels of air pollution at the six sites were quite similar to the levels found at the nearby routine monitors.

San Diego Area

When data from Logan Memorial Academy in Barrio Logan are compared to typical data for a nearby routine site, San Diego – 12th Avenue, the number of days exceeding the state ozone standard was the same – one day during the 2000 summer ozone season. For PM_{10}, Logan Memorial Academy exceeded the state standard on two more days than did San Diego – 12th Avenue – six days compared to four days.

The toxics levels measured at Logan Memorial were slightly higher for the key motor vehicle pollutants, benzene and 1,3-butadiene. However, the total health risk level from a combination of measured air toxics was not statistically different from the risk found at Chula Vista, the nearest routine site that measures toxics.

Los Angeles Area

At Hollenbeck School in Boyle Heights, the number of days exceeding the ozone standard was half that at a nearby routine site, Los Angeles – N. Main Street – five days compared to 12 days over the summer 2001 ozone season. For PM_{10}, 20 days exceeded the standard at Hollenbeck School and 16 exceeded the standard at Los Angeles – N. Main Street.

All of the measured toxics showed levels nearly identical to the levels at the nearest toxics site, also at Los Angeles – N. Main St., including benzene and 1,3-butadiene.

At the monitoring site for Wilmington Park School in Wilmington, there were no days that exceeded the ozone standard, while the nearest routine site at North Long Beach typically exceeds the standard on two days per year. For PM_{10}, 14 days exceeded the standard at Wilmington Park School and 10 days typically exceed the standard at North Long Beach. Average levels of PM_{10}, $PM_{2.5}$, and NO_2 were very similar in both places. The toxics levels at the nearest routine site, also at North Long Beach, were the same or greater than the levels found at Wilmington Park School.

San Francisco Bay Area

At John Swett High School in Crockett, the ozone and PM_{10} levels never exceeded the state standards. These standards were exceeded at other locations in the Bay Area. At the nearest routine site, Vallejo – Tuolumne Street, PM_{10} levels typically exceed the standard on two days per year. Average levels of PM_{10} and NO_2 in Vallejo were very similar to the average levels from the available data in Crockett. For toxics that represent the greatest risk, the levels were lower at Crockett than the levels routinely found at Vallejo or at another nearby routine site in San Pablo.

For Lockwood Elementary School in Fruitvale, the nearest routine site is Oakland – Alice Street, which is five miles away. That site measures a subset of the pollutants measured at Lockwood School. For ozone and CO, the two pollutants measured at both sites, average levels were similar at both sites and never exceeded the air quality standards.

Some distance from Fruitvale, the routine monitor at Fremont – Chapel Way measured all of the criteria pollutants (ozone, CO, PM_{10}, $PM_{2.5}$, and NO_2). For these pollutants, the average levels and the number of days above state standards were comparable at Lockwood School and Fremont – Chapel Way. Toxics are also measured at Fremont – Chapel Way, where the total risk from several major toxics was not statistically different compared to the total risk at Lockwood School.

Fresno Area

Insufficient data have been collected from the SB 25 site in Fresno (Fremont School) to present results in this report. SB 25 monitoring at Fremont School was delayed in order to coincide with the ARB's childhood asthma study (FACES).This will greatly increase the value of the resulting data. A final report on the Fresno data will be prepared following completion of the study.

Supplemental "Satellite Sites"

In addition to the primary SB 25 monitoring sites, we established satellite sites near emission sources within some of the communities. These satellite sites allowed us to measure the impact of being very close (within meters) of an emission source.

The first satellite sites were placed in Barrio Logan, where we set up monitors near a chrome plating operation, a source of hexavalent chromium, a potent cancer-causing pollutant. In Boyle Heights, we set up a satellite monitor at Soto Street School adjacent to a major freeway. In each case, the pollution levels were significantly higher than the levels measured at the primary community site or at the nearest routine monitoring site.

One of the satellite sites in Barrio Logan showed unexpectedly high hexavalent chromium levels but they were very localized – within meters of the source. Because these levels were many times higher than those measured at the primary site, we continued monitoring at this site until the data were sufficient for local officials to take formal action to resolve the issue. (The facility that was in question has now been shut down. This site became the subject of a major special study and those results can be found at the following: *http://www.arb.ca.gov/ch/communities/studies/barriologan/barriologan_chromium.htm*.)

The satellite site in Boyle Heights measured PM_{10} at Soto Street. Compared to the primary site, the PM_{10} levels were systematically higher. On average, PM_{10} levels at Soto Street were 35 percent higher than the levels measured at Hollenbeck School and there were more days that exceeded the state standard – 28 days compared to nine days. These results are used later in this report as an example showing how network data can be supplemented with special monitoring studies.

A complete summary of the monitoring results for the six SB 25 community sites is included in Appendix B.

B. Evaluation of the Statewide Air Monitoring Network

In addition to the special community monitoring studies discussed above, the Children's Environmental Health Protection Act (SB 25) requires an assessment of the adequacy of the statewide air monitoring network focused on children's exposures to air pollutants. The central issue in this assessment is whether the network adequately determines the outdoor pollutant exposures of children. In this section, we discuss the methods used to evaluate the network's adequacy as well as methods that could enhance exposure assessments.

We discuss six different methods, divided into two groups of three. The first three methods (numbers 1 through 3) assess the ability of the network to characterize typical community levels of criteria and toxic pollutants that are considered widespread in nature. The remaining three methods (numbers 4 through 6) illustrate alternative ways to estimate possible elevated levels of pollutants near emission sources that the routine network does not sufficiently capture.

In the outdoor air, some pollutant exposures are considered “widespread” while others are more "localized." A widespread pollutant exposure can be characterized as the typical level found in an urbanized area and results from emission sources that are distributed across a region. Widespread exposures are common for most of the criteria pollutants, such as ozone, particulate matter, carbon monoxide, and nitrogen dioxide. Some important toxic pollutants, such as diesel PM, benzene, 1,3-butadiene, formaldehyde, and acetaldehyde are also widespread because they are emitted, directly or indirectly, by motor vehicles. The level of widespread pollutants tends to be fairly uniform throughout a region.

In the case of localized exposures, there may be relatively higher levels of some pollutants near sources such as freeways or some facilities. Such “localized” pollutant exposures reflect the impact of one or more emission sources in a defined area. The size of the impacted area can be affected by the specific emission characteristics of nearby sources as well as local weather patterns.

In general, there were minimal differences between the community monitoring results and the network data. However, the localized impacts of the chrome plater in Barrio Logan and the freeway impacts in Boyle Heights demonstrate the need to supplement the monitoring network in some cases. The network is not the only tool available to address children's exposures to outdoor air pollution. Other approaches are available to help better understand near-source exposures. This includes special purpose monitoring, emissions information, and air quality modeling.

Below we describe the methods we used to assess the monitoring network. Section C then follows with pollutant-by-pollutant discussions based on the six methods.

Methods used to assess network adequacy

The following three methods were used to assess the ability of the network to characterize typical community levels of air widespread pollutants. All three methods were applied to data collected in the six SB 25 communities. The first method was applied to data from selected monitors in the statewide network that were near the six SB 25 communities. The second and third methods were applied to data collected by many network monitors throughout California.

1. Community-to-Community Comparison of Monitoring Data - Criteria and Toxic Pollutants

This method assesses network adequacy by comparing general air quality characteristics in pairs of communities near to each other. In each pair, a monitor in the routine network will represent one community, while a special monitor represents the community in the surrounding area. If the data for each pair of communities match reasonably closely, one can conclude that the network monitors represent their surrounding areas.

This method is simple and direct. It is often useful for general comparisons of air quality in different areas, and we have used it in this report to provide an overview of the results from the SB 25 special study. The general characteristics of air quality that we compared include the frequency with which pollutants exceeded their respective standards, along with average, minimum, and maximum pollutant levels. We used this method in Section A to examine the statewide network's ability to match the typical community levels of pollutants in the six communities selected for the SB 25 special monitoring study.

We also applied this method when comparing the composite cancer-risk due to several air toxics in the six communities and in nearby communities in which routine monitors measure air toxics. For this purpose, we converted the average level for each pollutant into its equivalent "cancer risk" level and added the results to determine the composite risk. In communities near each other, the composite risk tended to be similar. This pattern was also found for the pairs of communities included in the second Multiple Air Toxics Exposure Study (MATES II) conducted in the Los Angeles area. Section C includes an extended discussion of our results.

Judging whether risk levels in one community are similar or dissimilar to risk levels in another is not always a simple task. In many cases, differences are less than 10 percent and most would agree that the levels are similar. When the measured differences are larger, however, we need to characterize the degree of difference taking into account the natural variability of monitoring data. In our analyses, we looked for differences in annual averages in terms of both location and time, and considered the variability typical with routine monitoring data.

In applying method 1, "Community-to-Community Comparisons", to toxics, we examined the natural differences in annual average levels of risk that occur from one community to another nearby

community or from one time to another. For this purpose, we looked at data from the SB 25 special monitoring study, data from the routine network, and data from the MATES II project in the South Coast Air Basin. Our analyses indicate that the differences in pollutant levels between the six SB 25 communities and nearby monitors in the routine network were not unusual. Appendix B includes a comprehensive summary of these comparisons.

Analyses using this method suggest the routine network is able to characterize the typical community levels of criteria pollutants and composite risk from the most common air toxics because comparisons for selected communities near one another are generally similar.

2. Measured Versus Estimated Levels – Criteria Pollutants

This method assesses network adequacy by comparing measured and estimated levels of widespread criteria pollutants. We applied this method to data from the six SB 25 communities and from the routine statewide network.

Widespread criteria pollutants include ozone, PM_{10}, $PM_{2.5}$, CO, and NO_2. A large number of monitors in the routine network measure these pollutants. For example, approximately 190 monitors measure ozone, while 150 monitors measure PM_{10} in California. To evaluate the network's ability to determine on a daily basis the typical community levels of these pollutants in communities throughout the State, we conducted an extensive study of data from the routine network. We also applied this method to the data from the SB 25 communities and used these results to illustrate network adequacy for each of the five pollutants.

We analyzed five years of daily data for ozone, PM_{10}, $PM_{2.5}$, CO, and NO_2, a total of almost one million observations. Each daily value measured at each monitor was compared to an estimate for that same location based on same-day measurements at the closest six monitors in the routine network. The data from the six monitors influenced the estimates more or less depending on their distance from the monitor that measured the values being estimated. In this way, measurements from close monitors affected the estimates more strongly than did measurements from more distant monitors.

If estimated values are close enough to the measured values, one can conclude that the routine network can also estimate daily pollutant levels in communities between the monitors in the routine

network. Despite the fact that California's routine network of air monitors is among the most extensive in the world, most communities in the State lie between monitors. When we applied this method throughout the State, we found that measured and estimated pollutant levels were almost always close to each other.

Analyses using this method show that data from the routine network can be used to determine the typical community levels of ozone, PM_{10}, $PM_{2.5}$, CO, and NO_2 on almost all days in almost all communities in California, even those communities with no monitor. Results for each pollutant are shown in Section C.

3. Measured Versus Estimated Levels – Toxics Pollutants

This method assesses network adequacy by comparing measured and estimated values for typical community levels of widespread toxic pollutants.

Some widespread pollutants are measured at relatively few sites. In some cases, however, the levels of pollutant "A," which is measured at relatively few sites, are closely related to the levels of pollutant "B," which is measured at many additional sites. If the relationship is strong enough, the levels of pollutant "B" can be used to estimate the levels of pollutant "A" at the many additional sites. We developed Method 2 for this purpose.

We used Method 2 to assess the network's ability to determine typical levels of benzene and 1,3-butadiene in California communities. We studied five years of data for benzene and 1,3-butadiene from 21 routine sites that measured toxic pollutants. These sites also measured the levels of CO. From day to day, the levels of benzene and 1,3-butadiene were closely related to the levels of CO. This result is expected because all three pollutants are primarily produced by motor vehicle activity. We then tested the relationships found at the 21 routine sites for their ability to estimate benzene and 1,3-butadiene at monitors where CO alone is measured.

We applied the relationships (linear equations) developed at each of the 21 routine monitors to the nearest of the 20 other monitors. To do this, the daily CO levels measured at monitor "B" were plugged into the equations from monitor "A" to produce daily estimates of benzene and 1,3-butadiene at monitor "B." We then compared the estimated and the measured levels of benzene and 1,3-butadiene at monitor "B." Since benzene, 1,3-butadiene, and CO were all measured during the SB 25 special monitoring

program, we applied the same procedure to these communities to show the ability of the routine network to characterize the average levels of benzene and 1,3-butadiene in the SB 25 communities.

At the present time, benzene, 1,3-butadiene, and CO are all measured routinely at about forty monitors in California. We can use the data from these sites to determine relationships between CO and the two toxic compounds. Then, we can use these relationships to estimate the outdoor levels of benzene and 1,3-butadiene with adequate accuracy at 100 additional sites that measure CO but not toxics. These two pollutants are important contributors to health risk from measured air toxics throughout California.

Analyses using this method show that the toxics monitors and criteria pollutant monitors in the routine network can be used to determine typical levels of the key air toxics benzene and 1,3-butadiene in almost all California communities. Individual results for these pollutants are shown in Section C.

Methods used to address near-source pollution levels

The following three methods are used to illustrate alternative ways to estimate near-source pollution levels that might not be captured by the routine monitoring network. Any of the three methods might be used to enhance exposure estimates depending upon the circumstances, available information, and resources.

4. Special-Purpose and Network Monitors

This method of addressing near-source pollution levels uses special-purpose monitors and network monitors to estimate levels of pollutants near sources within communities.

Pollutant levels at some locations close to sources may be higher than typical for the community or region. By itself, the routine network rarely captures the impacts of particular air pollution sources. Nevertheless, measurements from the routine network in conjunction with measurements from special-purpose monitors can be used to better estimate exposures near sources.

Air pollution sources, such as cars, can be concentrated in limited areas. Freeways, for example, often carry large volumes of motor vehicles that lead to higher levels of pollutants in nearby areas. We illustrate this approach using PM_{10} data from the Boyle Heights

community of Los Angeles gathered during the SB 25 special monitoring study.

The PM_{10} data gathered in Boyle Heights showed that PM_{10} near the freeway was 35 percent higher compared to PM_{10} several hundred meters away from the freeway. From day to day, this proportional relationship was very stable. Since Method 1 can be used to estimate the typical community levels of PM_{10} on a daily basis, the daily levels of PM_{10} near the freeway can also be estimated routinely by applying the proportional factor to the estimated typical levels. For other pollutants and other circumstances, data from special monitoring studies can provide the basis for developing similar procedures.

This method shows how routine network data, in conjunction with special monitoring data, can be used to estimate near source exposures more effectively.

5. Air Quality Models and Network Monitors

This method of addressing near-source pollution levels uses air quality models and network monitors to estimate elevated levels of pollutants near sources within communities.

Whereas the previous method, (method 4) combines measured data from network monitors and special-purpose monitors, this method combines measured data from network monitors with simulated data from air quality models to estimate pollutant levels near sources within a community.

By the term "model," we mean computer-based systems that include three components: emissions data, meteorological data, and procedures that use these data to estimate the resulting pollutant levels in the air. At this time, satisfactory models are available for some but not all pollutants or all areas.

We illustrate this approach using benzene data from the Barrio Logan community of San Diego. In this SB 25 community, benzene levels were measured at the central site established at Memorial Academy. A relatively simple model worked with information on freeway traffic, emissions characteristics, and meteorological conditions to estimate benzene concentrations around the I-5 freeway due to motor vehicle activity. The model, however, did not include the urban background levels of benzene that prevail in and around Barrio Logan. The urban background levels, however, are included in the data measured at Memorial Academy. Therefore,

the modeled benzene and the monitored benzene can be combined to estimate the benzene levels near the freeway with better accuracy. Details are provided in Section C.

This method shows how the routine network data in conjunction with an air quality model may better estimate exposures near sources.

6. Air Quality Models with Local Emissions Information

This method of addressing near-source pollution levels uses air quality models with emissions information to estimate the elevated levels of localized pollutants near sources.

This method might apply when community or regional pollutant levels are relatively low but a source may cause relatively high exposures at a specific location. Examples might include hexavalent chromium from chrome-plating facilities and lead from battery recycling operations. Based on the Barrio Logan study results, we found that even with many routine monitors in place high concentrations would not necessarily be detected. Additional information such as localized modeling can help pinpoint areas of impacts. As modeling methods continue to improve, we expect this method to become increasingly useful.

We illustrate this method using a study of hexavalent chromium emitted from chrome-plating operations in the Barrio Logan neighborhood of San Diego. In the study, modeling was only used to locate places where relatively high levels of hexavalent chromium were expected. The estimated concentrations were not used directly in that study. Nevertheless, the example shows how computer models might be used in the future to determine pollutant levels in localized “hot spots” when these levels would almost certainly escape the notice of routine monitors.

This example shows how air quality models may be used to help identify localized exposures not captured by the routine monitoring network.

C. Technical Assessments of the Network for Individual Pollutants

In this section, we evaluate the adequacy of the network for selected pollutants. Using methods 1, 2, and 3 described above, we assess the accuracy with which typical levels of various pollutants within communities can be estimated using information from the routine network. In addition, methods 4, 5, and 6 are applied to illustrate how near-source levels of some pollutants may be estimated.

Ozone

Ozone is a widespread pollutant measured hourly by more than 190 monitors around the State. When compared using method 1, "Community-to-Community Comparisons", measured levels of PM in the six SB 25 communities were similar to the levels measured at nearby monitors in the routine network (see Section A and Appendix B).

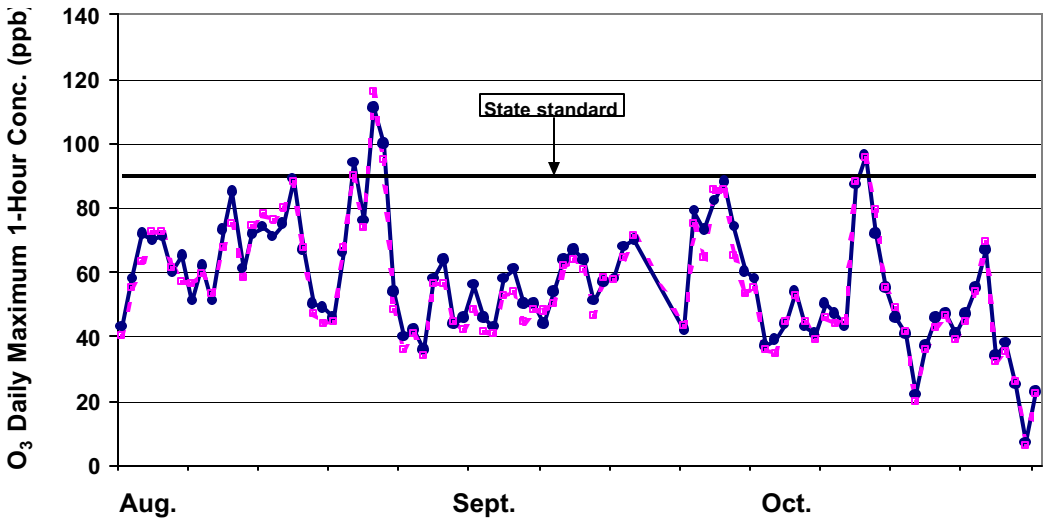
When we applied method 2, "Measured Versus Estimated Levels – Criteria Pollutants", to five years of data from the monitors in the routine network, we found that daily maximum ozone levels in almost all California communities could be estimated reasonably well based on the network data. Those communities least likely to be well represented tend to lie outside of those metropolitan areas where routine monitors operate.

We used data from the Boyle Heights community in Los Angeles to illustrate the accuracy with which the network can estimate typical levels of ozone on a daily basis. Boyle Heights does not have its own routine monitor for ozone. However, during the yearlong special monitoring study, ozone levels were measured in Boyle Heights at Hollenbeck Middle School. This allowed us the opportunity to use the routine network to predict the daily ozone levels values at Hollenbeck School and then to compare the estimates to the actual measurements from the special monitor located at the school.

Figure 5 shows the relationship between the predicted and the measured levels of ozone at Hollenbeck School. The solid line connects the observed ozone levels and the dashed line connects the levels predicted at Hollenbeck by the routine network. In many places, the two lines coincide so closely they cannot be distinguished from each other. For readability, the figure is limited to August – October 2001, a period when relatively high ozone levels occurred. The differences between the observed and predicted levels were remarkably close, within 10 ppb during this time. The same accuracy was found for the other SB 25 communities for which data were available. In general, the ozone levels in the SB 25 communities were similar to the levels measured at routine monitors in nearby communities.

While this analysis uses Hollenbeck as the example, we repeated this type of comparison for about 150 of the 190-plus ozone monitors that operate throughout the State. We found that predicted and observed values differed by less than 20 ppb on almost all days.

Figure 5. Measured ozone (solid line) at Hollenbeck School in Boyle Heights compared to ozone predicted by the routine network (dashed line) from August through October 2001.



Particulate Matter (PM_{10} and $PM_{2.5}$)

Particles in the air occur in a wide range of sizes. The large particles usually settle out of the air after a short period of time, a few minutes to a few hours. Smaller particles, however, can remain airborne for days. These small particles are a significant health risk because they penetrate deep into our lungs where they can cause serious adverse health effects, including premature death.

Two sizes of small airborne particles, called PM_{10} and $PM_{2.5}$, are widespread in most areas of California and are measured by many monitors. A particle's size is given in terms of "aerodynamic diameter" because that property determines how a particle behaves in the air. A particle with an aerodynamic diameter of 10 μm (microns, or millionths of a meter) floats in the air like a tiny sphere with this diameter and a standard density. Such particles vary in shape, size, and composition. PM_{10} samples include particles of 10 μm or less, while $PM_{2.5}$ samples are limited to particles of 2.5 μm or less. The smaller particles are of special interest because they can penetrate deeper into the lungs.

PM_{10} and $PM_{2.5}$ are widespread pollutants measured at many locations in the State. PM_{10} has been monitored in California since the mid-1980s. The statewide air monitoring network includes approximately 150 monitors measuring daily average levels of PM_{10}. Extensive monitoring for $PM_{2.5}$ began in 1998, and approximately 80 monitors in the routine network now measure 24-hour average levels of $PM_{2.5}$, though not necessarily on a daily sampling schedule.

When compared using method 1, "Community-to-Community Comparisons of Monitoring Data", measured levels of PM in the six SB 25 communities were similar to the levels measured at nearby monitors in the routine network (see Section A and Appendix B).

We also applied method 2, “Measured Versus Estimated Levels – Criteria Pollutants”, to PM_{10} and $PM_{2.5}$ data from 1996 through 2000 for the monitors in the routine network. The results show the routine network can estimate daily levels of PM_{10} and $PM_{2.5}$ with reasonable accuracy.

We used data from the special monitoring program in Barrio Logan and Fruitvale to illustrate the ability of the routine network to determine the levels of PM_{10} and $PM_{2.5}$ in communities without monitors. These two communities do not have routine monitors for PM_{10} and $PM_{2.5}$, but these pollutants were measured during the special monitoring study. Figure 6 shows the observed and predicted levels for daily PM_{10} at Barrio Logan during a period when relatively high levels occurred. Similarly, Figure 7 shows the observed and predicted levels for daily $PM_{2.5}$ at Fruitvale.

Both examples show how closely the predicted and observed values match. Comparisons of this nature throughout the State show similar results, suggesting that PM_{10} and $PM_{2.5}$ can be adequately predicted for neighborhoods that do not have monitors.

Figure 6. Measured PM_{10} (solid line) at Memorial Academy in Barrio Logan compared to PM_{10} predicted by the routine network (dashed line) from October 21 through December 14, 2001. The horizontal line is the state 24-hour standard.

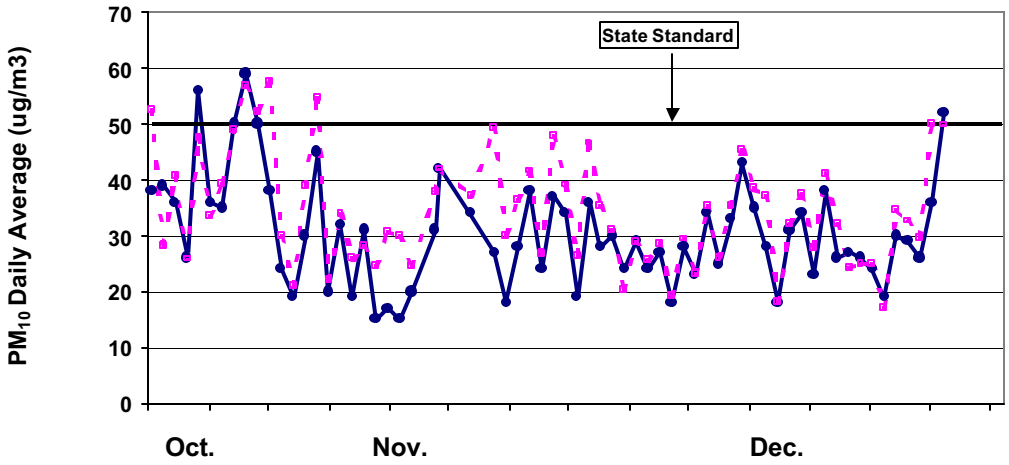
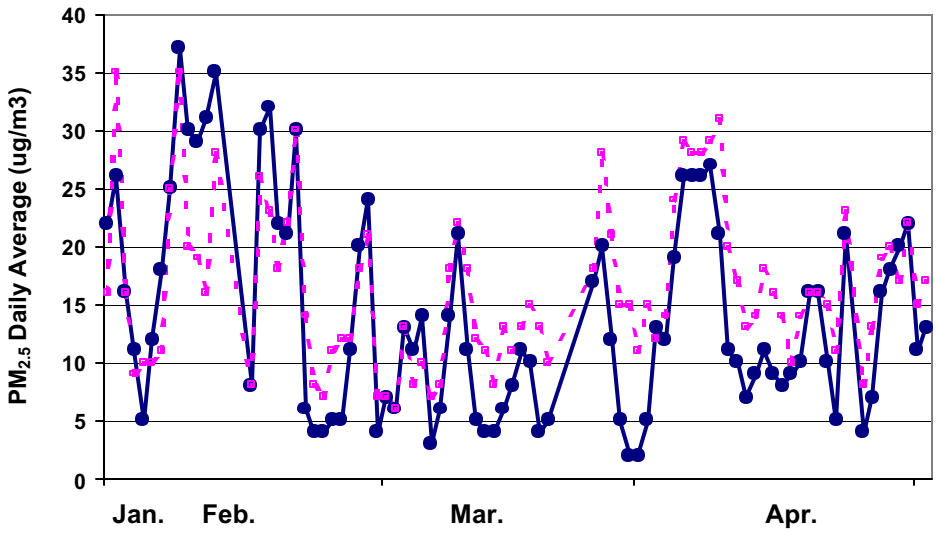


Figure 7. Measured $PM_{2.5}$ (solid line) at Lockwood School in Fruitvale compared to $PM_{2.5}$ predicted by the routine network (dashed line) from January 24 through April 24, 2002. No state standard shown because none has been established at this time.

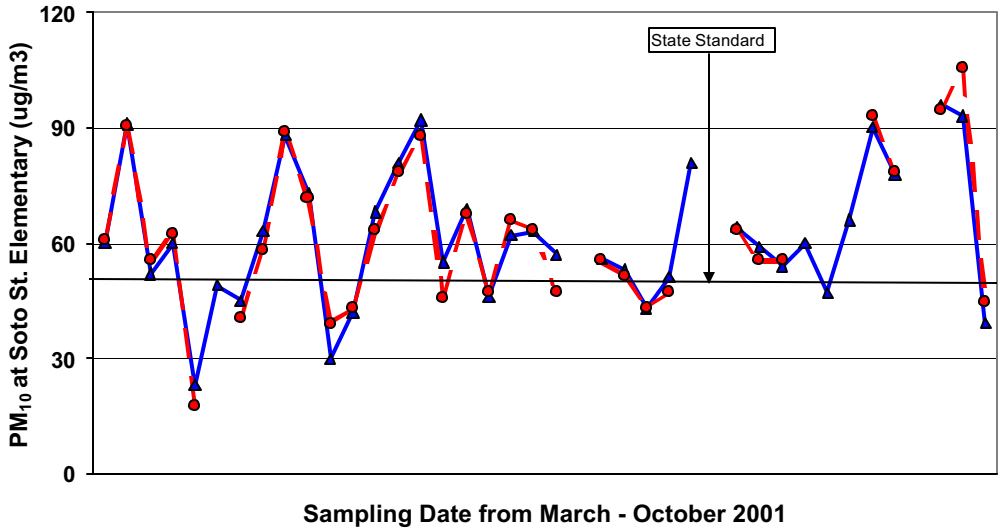


There are, however, situations where air quality right next to a major source of emissions, such as a freeway, cannot be accurately represented by the network. Routine networks rarely represent these higher levels because most networks intentionally represent the typical community level rather than near-source levels. For these situations, we must employ a different method. We illustrate this using method 4 described in Section B above.

We applied method 4, “Special-Purpose and Network Monitors”, to data from the Boyle Heights community collected during the SB 25 special monitoring study. Several freeways surround Boyle Heights and we expected the PM_{10} levels to be higher near these roads. To see whether a monitor representing typical levels of PM_{10} in Boyle Heights could also track the levels near the freeways, we compared PM_{10} data collected next to a freeway to the PM_{10} data collected at the primary monitor representing the community.

During the special study, the primary monitor representing typical pollutant levels was located at Hollenbeck Middle School, about a kilometer from the nearest freeway. Another monitor at Soto Street Elementary School was next to the intersection of several major freeways. At Soto Street, PM_{10} levels averaged 35 percent higher than the levels at Hollenbeck. To see whether this increase was consistent from day to day, we used the daily levels at Hollenbeck to predict the same-day levels at Soto Street. Each daily prediction was determined by increasing the Hollenbeck value by 35 percent. Figure 8 shows the close agreement between the measured levels at Soto Street and the estimates derived from the Hollenbeck data.

Figure8. Measured PM_{10} (solid line) and predicted PM_{10} (dashed line) at Soto Street School in Boyle Heights. Predicted values are 35 percent larger than the measured values at Hollenbeck School, the primary neighborhood site. In the series of predicted levels, breaks represent missing baseline values at Hollenbeck.



The results shown here demonstrate that levels of pollutants near sources may be determined using data from the routine network in combination with information from special monitoring studies.

A recent study[1] by the Office of Environmental Health and Safety of the Los Angeles Unified School District corroborates the relationship we found between PM_{10} levels measured at Hollenbeck and Soto Street. That study included the Boyle Heights area and found that a dispersion model applied to PM_{10} emissions was able to replicate the average impact of freeway emissions on air quality at the Soto Street Elementary School.

Overall, we believe the accuracy with which the routine network can determine PM_{10} and $PM_{2.5}$ for communities without monitors is adequate for characterizing exposures to outdoor levels of these pollutants. In addition, short-term special studies might extend the reach of the routine network to address the elevated exposures to widespread pollutants, like PM_{10} and $PM_{2.5}$ that occur near major sources.

Carbon Monoxide

Carbon monoxide is a widespread pollutant measured hourly at more than 100 monitors around the State. Except for a few isolated areas, California currently meets the air quality standards for CO.

When compared using method 1, "Community-to-Community Comparisons of Monitoring Data", measured levels of CO in the six SB 25 communities were similar to the levels measured at nearby monitors in the routine network (see Section A and Appendix B). We also applied method 2, "Measured Versus Estimated Levels – Criteria Pollutants", to five years of CO data from the routine network to help assess the network's ability to determine CO exposures.

To illustrate the ability of the network to determine daily CO levels, we used the CO data collected by the Wilmington Park Elementary School in Wilmington during the SB 25 special monitoring study. The routine network does not include a monitor in Wilmington, but monitors in North Long Beach, Hawthorne, Lynwood, and other surrounding communities can be used to predict CO levels in Wilmington using method 2. The data from the special study allowed us to compare measured levels in Wilmington with predicted values based on monitors in the routine network. Figure 9 shows how the measured levels (solid line) and the predicted levels (dashed line) track one another. The figure covers a period from November 14, 2001 through February 14, 2002 when CO levels were relatively high. In the figure, the predicted CO levels are almost always greater than the measured levels, but the differences are consistently less than 2 ppm.
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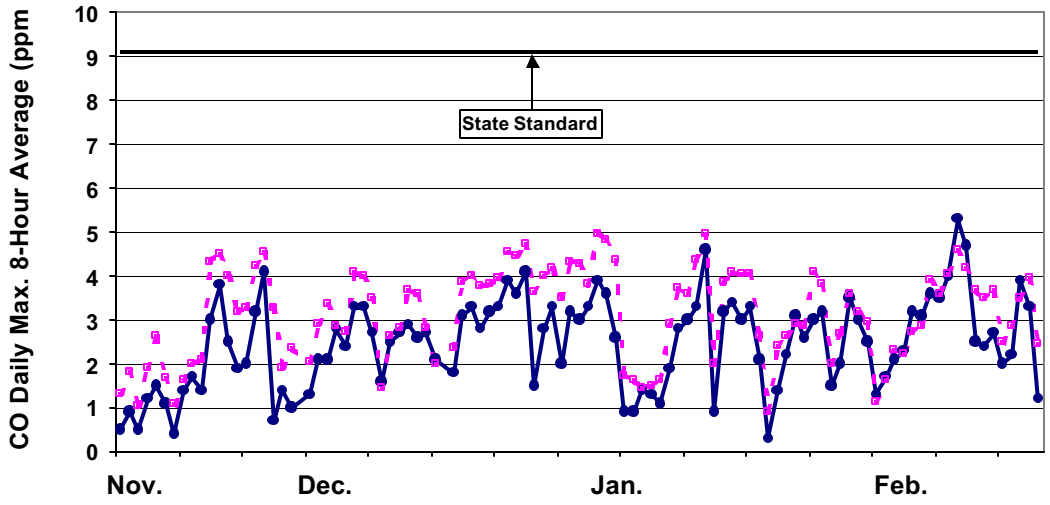
[1] S. Korenstein and B. Piazza, "An Exposure Estimate of PM10 from a Major Highway Interchange: Are Children in Nearby Schools at Risk?" *Journal of Environmental Health*, Volume 65, No.2 (2002).

This type of comparison was repeated for neighborhoods with CO monitors throughout the State. We consistently found that the predicted CO levels were close to the measured levels on a daily basis.

Figure 9. Measured CO (solid line) at Wilmington Park School in Wilmington compared to CO predicted by the routine network (dashed line) from November 14, 2001 through February 14, 2002.



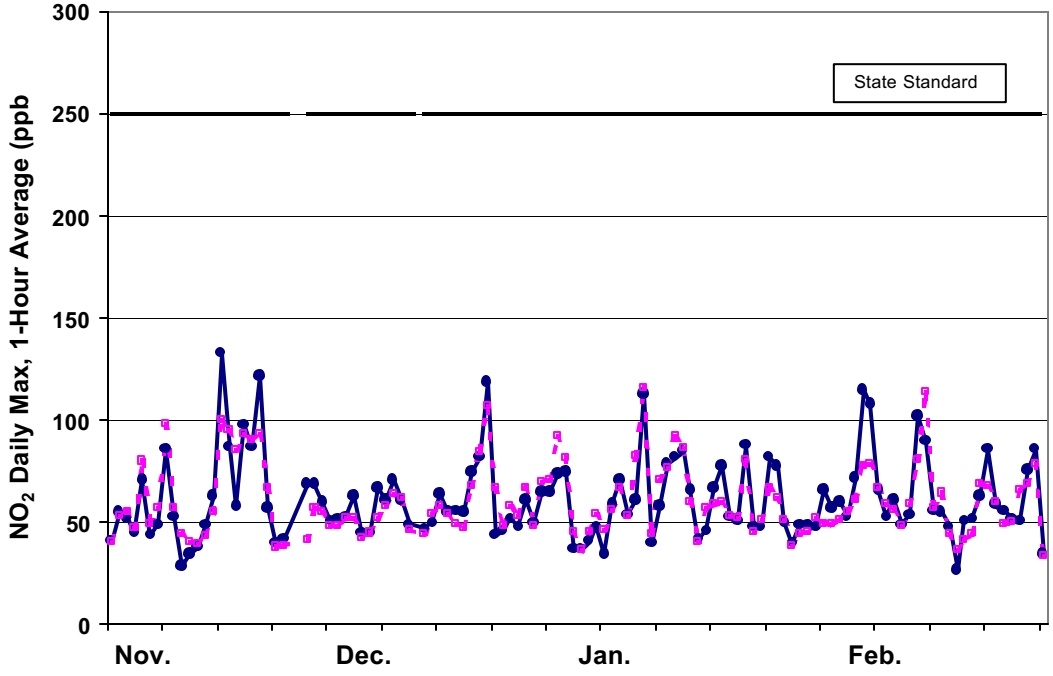
Nitrogen Dioxide

Nitrogen dioxide (NO_2) is a widespread pollutant measured hourly at approximately 120 monitors around the State. Although all areas of California currently meet the air quality standards for NO_2, recent findings on possible health effects of NO_2 call for continued monitoring of this pollutant.

When compared using method 1, "Community-to-Community Comparison of Monitoring Data", measured levels of NO_2 in the six SB 25 communities were similar to the levels measured at nearby monitors in the routine network (see Section A above). To further assess the network's adequacy with respect to NO_2, we applied method 2, “Measured Versus Estimated Levels – Criteria Pollutants”, to five years of NO_2 data from the routine network.

We used the NO_2 data measured at Wilmington Park School to illustrate the relationship between the measured levels and predicted levels based on data from the routine network. Figure 10 depicts the relationship between the measured levels (solid line) and the predicted levels (dashed line). The figure covers a relatively high period for NO_2 levels from November 1, 2001 through February 28, 2002.

Figure 10. Measured NO_2 (solid line) at Wilmington Park School in Wilmington compared to NO_2 predicted by the routine network (dashed line) from November 1, 2001 through February 28, 2002. The horizontal line is the hourly state standard.



In Figure 10, a few days clearly had measured NO_2 levels that were more than 20-25 ppb greater than the predicted levels. However, only 2 percent of the measured values for the whole period of record were more than 20 ppb greater than the predicted levels. Though the differences are large in relative terms, measured and predicted NO_2 levels were still far below the hourly NO_2 standard.

Benzene

Benzene is a widespread toxic pollutant that is measured at about 40 monitors throughout the State. By itself, the relatively small number of benzene monitors might not be adequate to address children's exposures to typical levels of benzene in California neighborhoods. However, we can use another pollutant, CO, to help us determine typical benzene levels every day in many more communities. Benzene is strongly related to CO, and CO is measured continuously at many additional sites. Using the measured CO levels, we can estimate the benzene levels at the additional sites. To show how this works, we apply method 3, “Measured Versus Estimated Levels – Toxics Pollutants”, to the data from five of the sites in the SB 25 special monitoring study. During the study, benzene and CO were measured directly at these five sites. Table 3 compares the measured and predicted benzene levels, expressed as cancer risk.

Table 3. Comparisons of cancer risk levels in five communities based on measured levels and network-based estimates of benzene, where CO levels are used to determine the network-based estimates of benzene.

Site	Level of Risk*			
	Data from SB 25 Community	Network-Based Estimate	Difference**	
			Risk	Percent
Boyle Heights	113	122	- 9	- 8
Crockett	19	17	2	11
Fruitvale	56	46	10	20
Barrio Logan	93	86	7	8
Wilmington	65	83	- 18	- 24

* Level of risk is the average level of the pollutant multiplied by a "unit risk factor."

** Percent differences are determined with respect to the average of the SB 25 and network-based values. All differences are within the normal range of variability for community-to-community comparisons.

Figure 11. Observed and predicted risk due to benzene in SB 25 communities. Risk levels reflect the average benzene (predicted or observed) for the available data, multiplied by a unit-risk factor.

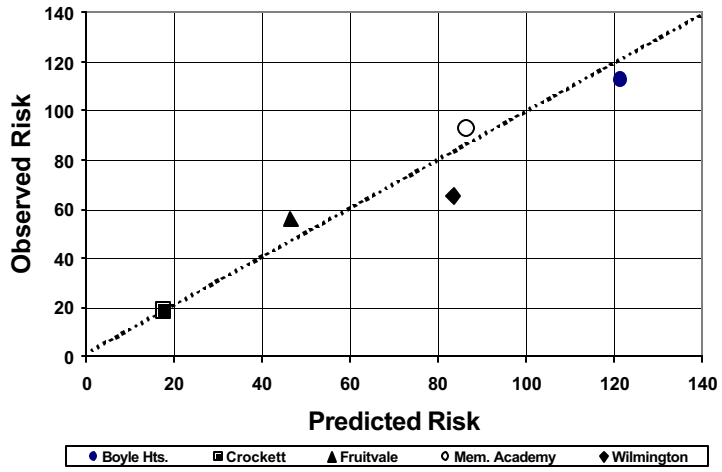


Figure 11 shows a graph of the results in Table 3. The tight cluster of points around the line indicates that this method is an accurate and dependable way to use CO measurements to predict benzene when direct monitoring data is not available.

Although typical benzene levels in a community can often be estimated based on CO data from monitors in surrounding areas, the benzene levels may not be uniform within the community. Gasoline-powered vehicles are the primary source of benzene, and benzene levels in the air can be substantially higher near

heavily traveled roads, such as freeways. Because air monitors usually represent typical or average pollutant levels, the routine network would not be expected to represent the additional benzene present near major roads with dense traffic. To estimate these near-source levels of benzene, we turn to method 5, "Computer Models and Network Monitors", which combines data from the routine air monitoring network with information from a computer model. We illustrate this approach using data from the Barrio Logan study.

Benzene is present throughout Barrio Logan due to emissions from gasoline-powered vehicles. The benzene levels are not uniform throughout Barrio Logan, however, because traffic is concentrated on certain roads, particularly on the I-5 freeway that runs through the community. An air quality model was used to estimate the benzene levels that would result from the freeway traffic alone. Figure 12 shows the results of that model.

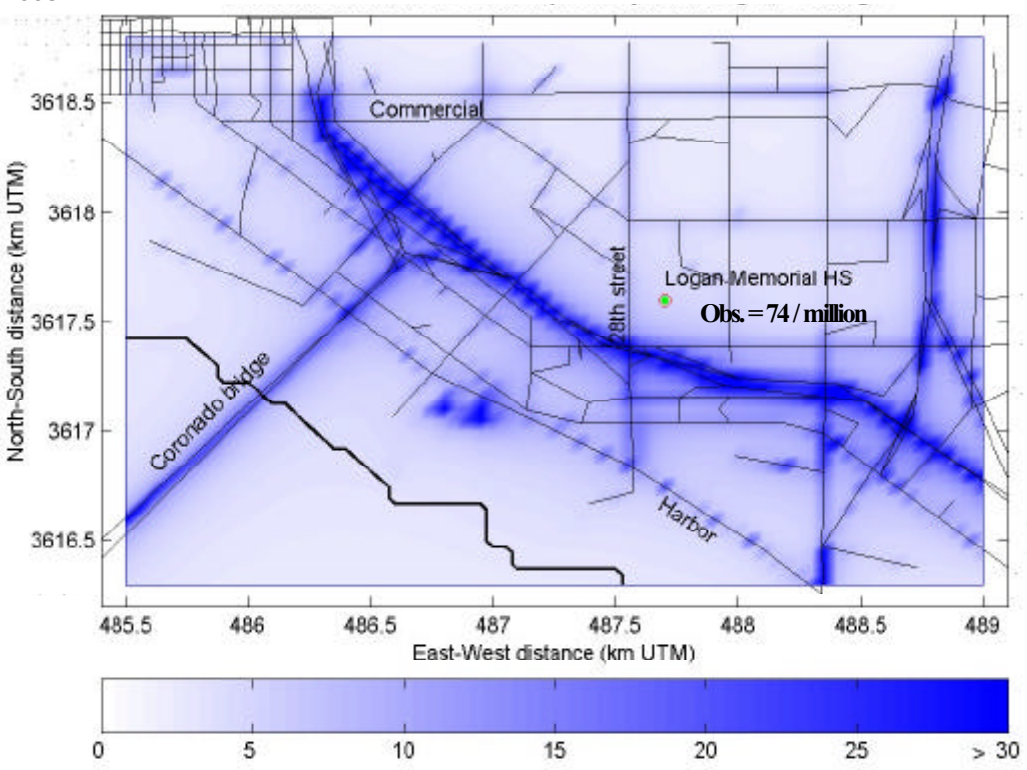
A little to the right in the center of Figure 12 is Logan Memorial, also called Memorial Academy, where the primary air quality monitor was placed during the SB 25 special study. The dark areas in the figure represent areas with high impact from the freeway traffic. The model indicates that cancer risk (excess cancer cases per million people) due to benzene emissions from the freeway is greatest next to the freeway and decreases with distance. Next to the freeway, the modeled cancer risk was about 40. Memorial Academy is about 500 meters from the I-5 freeway, and the modeled risk there was about 5.

However, the model only considered the impact of benzene from freeway traffic; it did not integrate the effects of all benzene emissions in and around the Barrio Logan community. All benzene sources together lead to a general urban background for benzene that contributes substantially to the average benzene levels throughout the Barrio Logan area. The measured benzene levels at Memorial Academy integrated the urban background levels and the impact of benzene from the freeway. Expressed as cancer risk, the measured levels of benzene at Memorial Academy [2] averaged 74, much higher than the modeled risk of 5. The difference, a cancer risk of 69, is an estimate of the impact of the urban background levels of benzene.

To estimate the full benzene levels next to the freeway, we combine the urban background (69) with the modeled level (40), which provides a reasonable estimate of 109 for cancer risk due to benzene next to the freeway. By this calculation, the cancer risk due to benzene next to the freeway was about 50 percent greater than the risk at Memorial Academy.

[2] The risk level noted in the modeling study differs from the risk for benzene at Memorial Academy reported in Table 4 because the time periods covered were not the same.

Figure 12. Benzene risk from local emissions, reflecting proximity to on-road mobile sources.



1,3-Butadiene

Like benzene, 1,3-butadiene is a widespread toxic emitted by gasoline-powered vehicles. 1,3-butadiene is measured by the routine toxics monitors and also at the PAMS sites that support photochemical modeling, for a total of about 40 locations. As we noted above for benzene, this limited network alone might not be adequate to address children's exposures to 1,3-butadiene. However, an analysis using method 3, "Measured Versus Estimated Levels – Toxics Pollutants", shows that 1,3-butadiene levels can be determined effectively for many more communities that do not have a toxics monitor but do have a monitor that measures CO. After the procedures in method 3 are applied, the technique developed for method 2, "Measured Versus Estimated Levels – Criteria Pollutants", can be used to estimate 1,3-butadiene levels in most California communities.

For each SB 25 community, we used method 3 to estimate daily 1,3-butadiene levels. Special monitors in each community measured levels of 1,3-butadiene, so the measured and estimated levels can be compared. Table 4 shows the differences between the risk based on measured levels and the risk based on the

Table 4. Comparisons of cancer risk levels in five communities based on measured levels and network-based estimates of 1,3-butadiene, where local CO data are used to determine the network-based estimates.

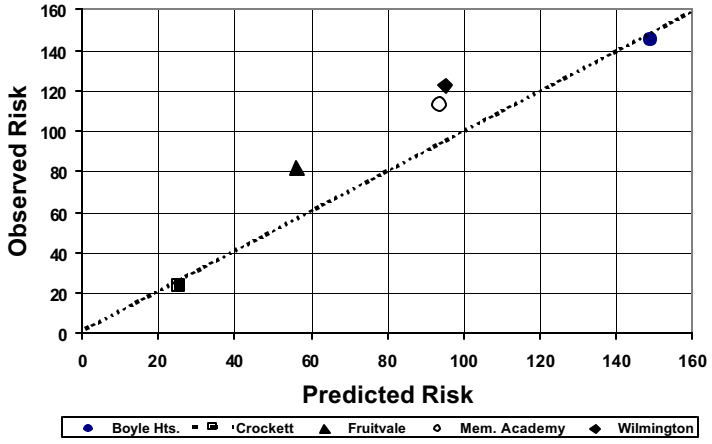
Site	Level of Risk *			
	Data from SB 25 Community	Network-Based Estimate	Difference**	
			Risk	Percent
Boyle Heights	145	149	- 4	- 3
Crockett	23	26	- 3	- 12
Fruitvale	82	56	26	38
Memorial Academy	113	94	19	18t
Wilmington	122	95	27	25

* Level of risk is the average level of the pollutant multiplied by a "unit risk factor."
** Percent differences are determined with respect to the average of the SB 25 and network-based values. All differences are within the normal range of variability for community-to-community comparisons.

estimated levels. Figure 13 shows how well the 1,3-butadiene results agree with a statistical one-to-one fit. The risk level shown in the table may not represent the annual risk level for some communities because an entire year of measurements was not available at all of the SB 25 sites.

The differences between the measured and estimated risk due to 1,3-butadiene at Fruitvale and Wilmington are not especially large. Meteorology and the 1-in-12 day sampling schedule for toxics cause risk levels to vary naturally from year to year at a location or between nearby communities by amounts greater than the differences shown in Table 4.

Figure 13. Observed and predicted risks due to 1,3-butadiene in SB 25 communities. Risk levels reflect the average 1,3-butadiene (predicted or observed) for the available data, multiplied by a unit-risk factor.



Hexavalent Chromium

Hexavalent chromium is a potent toxic air contaminant emitted by a relatively small number of stationary sources. ARB's Barrio Logan Study shows that hexavalent chromium exposures may be high close to specific sources. Because the urban background levels of hexavalent chromium are typically very low, a routine network of outdoor monitors is of limited use in determining near source exposures. A more effective approach might be to use air quality models to estimate the hexavalent chromium levels at locations close to facilities. Method 6, "Air Quality Models with local Emissions Information", is representative of this approach.

Our study of hexavalent chromium in Barrio Logan, an SB 25 community in San Diego shows how this approach might work. As part of the ARB Neighborhood Assessment Program, an air monitoring station was placed at Logan Memorial Academy in Barrio Logan. This monitor measured pollution levels for 17 months, from October 1999 to February 2001, and found very low levels of hexavalent chromium similar to the levels usually found in the rest of urbanized San Diego. Community concerns, however, led to a further study of hexavalent chromium levels in Barrio Logan.

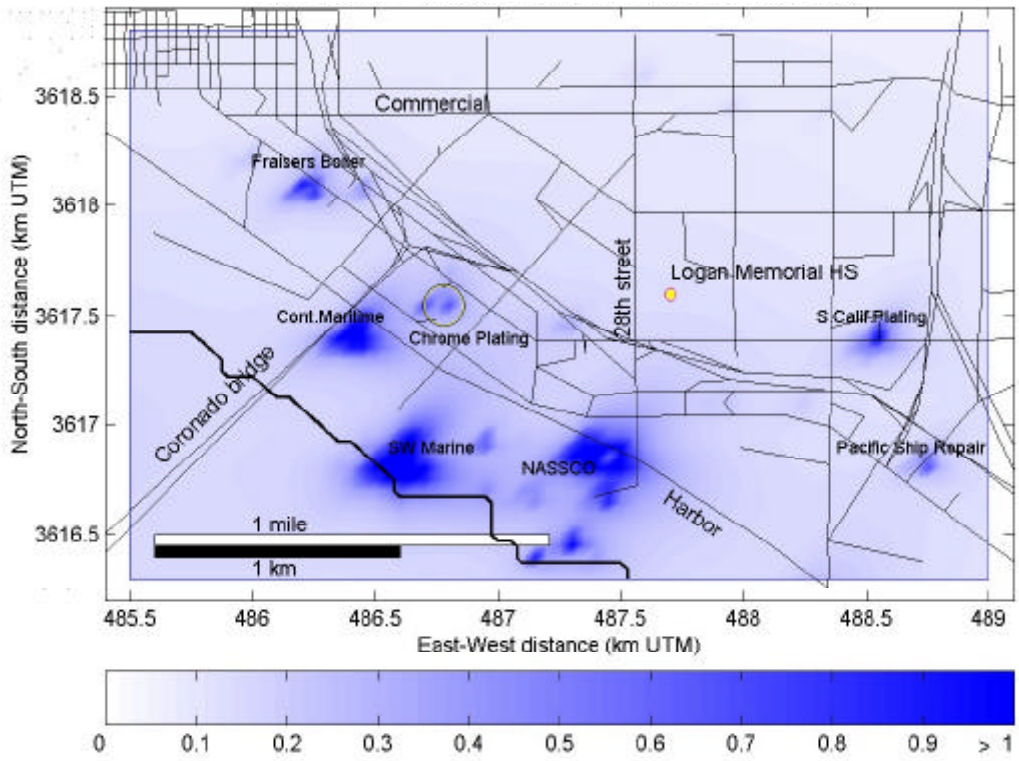
The primary objective of the expanded study of hexavalent chromium in Barrio Logan was to understand localized exposures in this mixed land use community. In the first phase of the study, a computer model was also used to investigate the general patterns of hex chrome levels in the community. An inventory of hexavalent chromium sources was used in conjunction with meteorological data

to simulate these patterns. Figure 14 shows the model predicted the very low levels of hexavalent chromium that were found at Logan Memorial.

The model also showed in Figure 14 where hotspots might cause localized exposures. According to the model, the larger hotspots appeared to pose little risk to residents because they were contained within the fence lines of the facilities (shipyards) that emit hexavalent chromium. Still, the community was concerned about smaller hotspots in residential areas, and this led to further study using monitors placed in the circled area labeled "chrome plating" in Figure 14.

Monitors were set up initially as secondary satellite sites to look at the localized impact of emissions from businesses in the community. We established monitors along a residential street in the vicinity of two commercial chrome-plating operations. The local area included a community center and pool frequented by children along with many homes. The study was scheduled to cover a two-week period in December 2001. However, the initial results showed unexpectedly high values of hexavalent chromium, so monitoring resumed from February through

Figure 14. Results from applying a dispersion model to data for stationary-source emissions of hex-chrome in the Barrio Logan neighborhood of San Diego.



Cr^{6+} (nanograms / cubic meter of air) as simulated by the ISCST3 dispersion model

May 2002. The primary objective of this additional monitoring effort was to identify which source(s) were contributing to the high levels and to determine whether high levels continued to occur.

The supplemental study also included dispersion modeling to help us understand how the high hexavalent chromium levels occurred. The model helped confirm the relationship between one facility and the high levels at one of the monitors. The model was also used to look at the potential impact of the second facility. Using a combination of tools, including monitoring, allowed us to identify one of the two chrome plating operations as the source of the high outdoor concentrations and provided the County of San Diego with sufficient data to address the problem. As a result of this study, the chrome plating operation that caused the high hexavalent chromium levels has shut down.

This example demonstrates that air quality modeling may be used to estimate exposures to highly localized pollutants emitted by sources within communities.

Community-level risks from multiple air toxics

Individually, many toxic compounds present relatively low risk on a community-wide basis (not considering localized "hot-spots"). Their collective risk, however, may be significantly greater in some communities compared to others. To investigate this possibility, pairs of nearby communities can be compared to each other using method 1, "Community-to-Community Comparison of Monitoring Data". We applied this approach to the results of the SB 25 special monitoring study, which show that the routine network may be adequate to characterize the collective community-wide risk due to multiple toxic pollutants that may pose relatively low risks individually.

Table 5 summarizes toxics data from the SB 25 special monitoring study to show the combined risk from seven toxic compounds – acetaldehyde, carbon tetrachloride, formaldehyde, hexavalent chromium, methylene chloride, *para*-dichlorobenzene, and perchloroethylene. The major toxics not included are diesel PM, benzene, 1,3-butadiene, and hexavalent chromium. These pollutants are addressed elsewhere in this report using other methods. The composite risk at the SB 25 monitors was compared directly to the composite risk at a routine toxics monitor in the same general area. The results indicate that, for these pollutants, the composite risk in each of the SB 25 communities is similar to the composite risk in the communities to which they were compared.

Table 5. Comparisons of the composite cancer risk level due to seven toxic air contaminants –acetaldehyde, carbon tetrachloride, formaldehyde, hexavalent chromium, methylene chloride, *para*-dichlorobenzene, and perchloroethylene – in five communities based on data from community monitors and monitors in the routine network.

Community Site	Sum of risk levels for seven toxics from			Location of Network Site
	Community Data	Network Site	Percent Difference	
Barrio Logan	71	76	7	Chula Vista
Boyle Heights	96	99	3	Los Angeles
Crockett	66	67	2	San Pablo
Fruitvale	74	74	0	Fremont
Wilmington	81	90	11	N. Long Beach

All differences are within the normal range of variability for community-to-community comparisons. Percent differences are calculated as the difference divided by the average.

The South Coast Air Quality Management District reported similar results for the MATES II study. The District compared the carcinogenic risk due to toxics emitted from stationary sources and from mobile sources and came to the following conclusions:

- "The carcinogenic risk from one site to another, as ascribed to stationary sources, is rather uniform across the Basin. In this respect, there is not much difference among the four county sites."

- "The differences in carcinogenic risk from one site to another are much more driven by the influence from mobile sources than from stationary sources." [3]

Judging whether risk levels are similar or dissimilar is not always a simple task. We analyzed the natural differences in annual average levels of risk that occur from one community to another or from one time to another. Based on natural differences in composite risk due to perchloroethylene and formaldehyde only, differences of 30 percent or more between nearby communities would not be unusual. When additional pollutants contribute to composite risk, even larger differences would naturally occur. From year to year, the differences could easily reverse directions. Therefore, the differences shown in Table 5 should not raise serious concerns because they may only represent chance rather than real differences between the communities.

The specific risk levels shown in Table 5 should be interpreted with caution because they are based on one year of data or less. For some purposes, the U.S. EPA requires five years of data be used in determining compliance with annual average standards. Results for Crockett and Fruitvale are based on substantially less than a year of data. Sampling has been done for a complete

[3] The South Coast Air Quality Management District's report on the MATES II study can be found at http://www.aqmd.gov/matesiidf/matestoc.htm.

year at each SB 25 site (except Fresno), but the analyses for these two sites are not yet complete. Levels of toxics typically differ by season of the year, so data for Crockett and Fruitvale are not yet annually "balanced." The values in Table 5 can be compared in relative terms to each other, but they should not be compared to risk levels at other sites or from other studies.

D. Indoor and Personal Exposure Study

The children's micro-environmental and personal pollutant exposure study was conducted to provide data on indoor and personal air pollution exposures at three of the special monitoring sites. The data will facilitate further assessment of the ability of the monitoring network to estimate children's exposures.

Special monitoring studies are necessary to assess indoor exposures to air pollutants. The monitoring work for this special study was conducted at Hollenbeck Middle School in Boyle Heights, Wilmington Park Elementary School in Wilmington, and John Swett High School in Crockett. The final results of this study will be published separately when the data analysis is fully complete later this year.

For the children's micro-environmental and personal pollutant exposure study, most samples for PM_{10}, $PM_{2.5}$, elemental and organic carbon (on PM_{10} filters), carbon monoxide, and aldehydes have been analyzed. Laboratory results have not been received for volatile organic compounds and metals (on PM_{10} filters). Although final conclusions cannot be made at this time, the preliminary data available are consistent with other indoor and personal exposure studies, and leads to some general observations regarding pollutant concentrations at the schools, including the following:

- Classroom concentrations of particulate matter and aldehydes at all three schools tended to be equal to or higher than the corresponding outdoor concentrations at the schools, suggesting that there were sources of the pollutants at the schools. This is expected and is consistent with other studies. However, the actual levels of aldehydes in these classrooms were low relative to levels measured in portable classrooms and other indoor settings.

- Carbon monoxide concentrations were uniformly low at all three schools. The outdoor carbon monoxide monitors tended to reflect proximity to roads.

- There were differences in average concentrations of measured pollutants between classrooms within the same school. This was seen for PM_{10}, elemental and organic carbon, and certain aldehydes. This suggests that there were different sources of some of these compounds in the different classrooms.

The data analyzed to date support the conclusion that, for nonreactive compounds, the indoor concentrations are additive combinations of outdoor concentrations and contributions from indoor sources. The preliminary data from the SB 25 micro-environmental and personal exposure study are consistent with other research that shows that routine monitors in outdoor networks are not sufficient to determine the personal exposures unique to each individual. The most important reason for this is that people's personal activities bring them in close proximity to pollutant sources, even outdoors. For example, on the same block, one person may operate a gasoline-powered lawn mower, another may tend an outdoor grill, and a third may paint a shed. Personal exposures to particular pollutants will differ substantially for these individuals, though the same monitors in the routine network represent them all. Only special monitoring studies are able to capture the distinctive differences among personal exposures.

Although numerous studies of personal exposure to particles and gaseous pollutants have been conducted in the U.S., only a few large studies of personal exposures have been completed in California at this time. Nevertheless, measurements of personal exposures to air pollutants are increasingly important in studies of environmental health issues. To determine personal exposures, personal monitors, along with outdoor and indoor monitors, would be needed. Studies of this type provide important data for use in conjunction with network data and exposure models, though costs for such intensive efforts preclude their use on a regular basis.

V. CONCLUSIONS AND RECOMMENDATIONS

California's air quality monitoring network provides the information needed to support a number of program needs. These include determining compliance with the State and national air quality standards and tracking regional air quality trends. The network also provides information that can be used to characterize typical air pollution exposures at the community level – including the exposure of children. In evaluating the ability of the statewide air monitoring network to adequately characterize children's exposure to air pollution, ARB used the results of the SB 25 community monitoring program, network monitoring data, air quality modeling, and statistical analyses.

We found that the statewide air monitoring network can provide reasonable estimates of neighborhood air pollution exposures, except in areas with near-source emissions – that is, in the immediate vicinity of emission sources. At most of the school monitoring sites established for this study, we found that air pollution levels measured were comparable to levels at the nearest routine statewide air monitoring site. We also recognize, however, that pockets with higher pollution levels may exist within communities due to the close proximity of one or more pollution sources. In this report, we identified several technical assessment methods for estimating such localized exposures. ARB has also funded development of lower-cost monitors for use at the community level to supplement the statewide monitoring network.

In terms of indoor exposures, the statewide monitoring network alone cannot address the issue, especially in cases where there are significant indoor sources of pollutants. However, indoor exposures can be reasonably estimated using comprehensive exposure models that combine outdoor air quality data with data from indoor air quality studies and studies of human activity patterns. Several years ago ARB funded development of the California Population Indoor Exposure Model for this purpose.

ARB has three recommendations designed to supplement the exposure information provided by the statewide monitoring network. We are implementing these as part of our community health and environmental justice programs. The recommendations are to:

- Use our mobile monitoring capability for short-term special purpose assessments to supplement the statewide monitoring data.

- Improve emission estimates and air quality modeling methods to assess localized exposures near air pollution sources.

- In the 2003 Innovative Clean Air Technologies (ICAT) Program, fund development of lower-cost monitoring methods to provide for expanded community level monitoring in the future.

Appendix A

Senate Bill 25 (Escutia, Statutes of 1999)

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BILL NUMBER: SB 25 CHAPTERED
BILL TEXT

CHAPTER 731
FILED WITH SECRETARY OF STATE OCTOBER 10, 1999
APPROVED BY GOVERNOR OCTOBER 7, 1999
PASSED THE SENATE SEPTEMBER 8, 1999
PASSED THE ASSEMBLY SEPTEMBER 7, 1999
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AMENDED IN ASSEMBLY JULY 8, 1999
AMENDED IN SENATE JUNE 1, 1999
AMENDED IN SENATE APRIL 28, 1999
AMENDED IN SENATE MARCH 22, 1999

INTRODUCED BY Senator Escutia
(Principal coauthors: Assembly Members Kuehl and Villaraigosa)
(Coauthors: Senators Alarcon, Figueroa, Ortiz, Perata, Polanco, Sher, Solis, and Speier)
(Coauthors: Assembly Members Alquist, Aroner, Firebaugh, Honda, Jackson, Knox, Lempert, Mazzoni, Romero, Shelley, Steinberg, Thomson, Vincent, Washington, and Wildman)

DECEMBER 7, 1998

An act to amend Sections 39606, 39660, and 40451 of, to add Section 39617.5 to, to add Part 3 (commencing with Section 900) to Division 1 of, and to add Article 4.5 (commencing with Section 39669.5) to Chapter 3.5 of Part 2 of Division 26 of, the Health and Safety Code, relating to environmental health protection.

LEGISLATIVE COUNSEL'S DIGEST

SB 25, Escutia. Environmental health protection: children.
(1) Existing law requires the State Air Resources Board to adopt ambient air quality standards in consideration of specified factors, including public health effects, as provided, and to specify threshold levels for health effects in listing substances determined to be toxic air contaminants. Existing law requires the Office of Environmental Health Hazard Assessment, upon request of the state board, to evaluate the health effects of and prepare recommendations regarding specified substances which may be or are emitted into the

ambient air and that may be determined to be toxic air contaminants. Under existing law, the state board's request is required to be in accordance with an agreement that ensures that the office's workload in implementing these provisions will not be increased over that budgeted for the 1991-92 fiscal year, as provided.

This bill would eliminate the requirement for that agreement, and would impose specified requirements on the state board and the office generally relating to the protection of infants and children from environmental health hazards. The bill would require the state board, not later than December 31, 2000, to review all existing health-based ambient air quality standards to determine whether the standards adequately protect the health of the public, including infants and children, and to revise the highest priority air quality standard determined to be inadequate, not later than December 31, 2002. The bill would require the office, by July 1, 2001, to establish a list of up to 5 specified toxic air contaminants that may cause infants and children to be especially susceptible to illness. The bill would require the state board to review and, as appropriate, revise any control measures adopted for those toxic air contaminants, to reduce exposure to those toxic air contaminants, as provided.

(2) Existing law requires the South Coast Air Quality Management District to notify all schools in the South Coast Air Basin whenever any federal primary ambient air quality standard is predicted to be exceeded.

This bill would also require the south coast district to notify day care centers in that basin, to the extent feasible and upon request. The bill would create a state-mandated local program by imposing new duties on the south coast district.

(3) The bill would create the Children's Environmental Health Center within the Environmental Protection Agency to, among other things, serve as chief advisor to the Secretary for Environmental Protection and to the Governor on matters within the jurisdiction of the agency relating to environmental health and environmental protection as it relates to children.

(4) This bill would incorporate additional changes to Section 40451 of the Health and Safety Code, proposed by SB 1195, to be operative only if SB 1195 and this bill are both chaptered on or before January 1, 2000, and this bill is chaptered last.

(5) The California Constitution requires the state to reimburse local agencies and school districts for certain costs mandated by the state. Statutory provisions establish procedures for making that reimbursement, including the creation of a State Mandates Claims Fund to pay the costs of mandates that do not exceed $1,000,000 statewide and other procedures for claims whose statewide costs exceed $1,000,000.

This bill would provide that, if the Commission on State Mandates determines that the bill contains costs mandated by the state, reimbursement for those costs shall be made pursuant to these statutory provisions.

THE PEOPLE OF THE STATE OF CALIFORNIA DO ENACT AS FOLLOWS:

SECTION 1. The Legislature finds and declares all of the following:
(a) Infants and children have a higher ventilation rate than adults relative to their body weight and lung surface area, resulting in a greater dose of pollution delivered to their lungs.
(b) Children have narrower airways than adults. Thus, irritation or inflammation caused by air pollution that would produce only a slight response in an adult can result in a potentially significant obstruction of the airway in a young child.
(c) Children spend significantly more time outdoors, especially in the summer, when ozone air pollution levels are typically highest. National statistics show that children spend an average of 50 percent more time outdoors than adults.
(d) Air pollution is known to exacerbate asthma and be a trigger for asthma attacks in infants and children, 500,000 of whom are afflicted with this chronic lung disease in California.
(e) Infant's and children's developing organs and tissues are more susceptible to damage from some environmental contaminants than are adult organs and tissues.
(f) It is the intent of the Legislature in enacting this act, to require that the state's air quality standards and airborne toxic control measures be reviewed to determine if they adequately protect the health of infants and children, and that these standards and measures be revised if they are determined to be inadequate.
(g) It is also the intent of the Legislature in enacting this act to require the State Air Resources Board and the Office of Environmental Health Hazard Assessment to consider the health impacts to all populations of children, including special subpopulations of infants and children that comprise a meaningful portion of the general population, such as children with asthma, cystic fibrosis, or other respiratory conditions or diseases, in setting or revising standards pursuant to this act.
SEC. 2. Part 3 (commencing with Section 900) is added to Division 1 of the Health and Safety Code, to read:
PART 3. CHILDREN'S ENVIRONMENTAL HEALTH CENTER

900. There is hereby created the Children's Environmental Health

Center within the Environmental Protection Agency. The primary purposes of the center shall include all of the following:
(a) To serve as the chief advisor to the Secretary for Environmental Protection and to the Governor on matters within the jurisdiction of the Environmental Protection Agency relating to environmental health and environmental protection as each of those matters relates to children.
(b) To assist the boards, departments, and offices within the Environmental Protection Agency to assess the effectiveness of statutes, regulations, and programs designed to protect children from environmental hazards.
(c) To coordinate within the Environmental Protection Agency and with other state agencies, regulatory efforts, research and data collection, and other programs and services that impact the environmental health of children, and coordinate with appropriate federal agencies conducting related regulatory efforts and research and data collection.
(d) In consultation with the State Air Resources Board and the Office of Environmental Health Hazard Assessment, and notwithstanding Section 7550.5 of the Government Code, to report to the Legislature and the Governor no later than December 31, 2001, on the progress of the state board and the office toward implementing the act that added this part during the 1999-2000 Regular Session and to make recommendations for any statutory or regulatory changes that may be necessary to carry out the intent of that act to protect the public health, including infants and children, from air pollutants and toxic air contaminants.
SEC. 3. Section 39606 of the Health and Safety Code is amended to read:
39606. (a) The state board shall do both of the following:
(1) Based upon similar meteorological and geographic conditions and consideration for political boundary lines whenever practicable, divide the state into air basins to fulfill the purposes of this division.
(2) Adopt standards of ambient air quality for each air basin in consideration of the public health, safety, and welfare, including, but not limited to, health, illness, irritation to the senses, aesthetic value, interference with visibility, and effects on the economy. These standards may vary from one air basin to another. Standards relating to health effects shall be based upon the recommendations of the Office of Environmental Health Hazard Assessment.
(b) In its recommendations for submission to the state board pursuant to paragraph (2) of subdivision (a), the Office of Environmental Health Hazard Assessment, to the extent that information is available, shall assess the following:

(1) Exposure patterns, including, but not limited to, patterns determined by relevant data supplied by the state board, among infants and children that are likely to result in disproportionately high exposure to ambient air pollutants in comparison to the general population.
(2) Special susceptibility of infants and children to ambient air pollutants in comparison to the general population.
(3) The effects on infants and children of exposure to ambient air pollutants and other substances that have a common mechanism of toxicity.
(4) The interaction of multiple air pollutants on infants and children, including the interaction between criteria air pollutants and toxic air contaminants.
(c) In assessing the factors specified in subdivision (b), the office shall use current principles, practices, and methods used by public health professionals who are experienced practitioners in the field of human health effects assessment. The scientific basis or scientific portion of the method used by the office to assess the factors set forth in subdivision (b) shall be subject to peer review as described in Section 57004 or in a manner consistent with the peer review requirements of Section 57004. Any person may submit any information for consideration by the entity conducting the peer review, which may receive oral testimony.
(d) (1) No later than December 31, 2000, the state board in consultation with the office, shall review all existing health-based ambient air quality standards to determine whether, based on public health, scientific literature, and exposure pattern data, the standards adequately protect the health of the public, including infants and children, with an adequate margin of safety. The state board shall publish a report summarizing these findings.
(2) The state board shall revise the highest priority ambient air quality standard determined to be inadequate to protect infants and children with an adequate margin of safety, based on its report, no later than December 31, 2002. Following the revision of the highest priority standard, the state board shall revise any additional standards determined to be inadequate to protect infants and children with an adequate margin of safety, at the rate of at least one per year. The standards shall be established at levels that adequately protect the health of the public, including infants and children, with an adequate margin of safety.
(e) Nothing in this section shall restrict the authority of the state board to consider additional information in establishing ambient air quality standards or to adopt an ambient air quality standard designed to protect vulnerable populations other than infants and children.
SEC. 4. Section 39617.5 is added to the Health and Safety Code, to

read:
39617.5. (a) Not later than January 1, 2003, the state board shall do all of the following:
(1) Evaluate the adequacy of the current monitoring network for its ability to gather the data necessary to determine the exposure of infants and children to air pollutants including criteria air pollutants and toxic air contaminants.
(2) Identify areas where the exposure of infants and children to air pollutants is not adequately measured by the current monitoring network.
(3) Recommend changes to improve air pollution monitoring networks and data collection to more accurately reflect the exposure of infants and children to air pollutants.
(b) In carrying out this section, the state board, in cooperation with the districts, shall expand its existing monitoring program in six communities around the state in nonattainment areas, as selected by the state board, to include special monitoring of children's exposure to air pollutants and toxic contaminants. The expanded program shall include placing air pollution monitors near schools, day care centers, and outdoor recreational facilities that are in close proximity to, or downwind from, major industrial sources of air pollutants and toxic air contaminants, including, freeways and major traffic areas. The purpose of the air pollution monitors shall be to conduct sampling of air pollution levels affecting children. Monitoring may include the use of fixed, mobile, and other monitoring devices, as appropriate.
(c) The expanded monitoring program shall include the following:
(1) Monitoring during multiple seasons and at multiple locations within each community at schools, day care centers, recreational facilities, and other locations where children spend most of their time.
(2) A combination of upgrading existing fixed monitoring sites, establishing new fixed monitoring sites, and conducting indoor and outdoor sampling and personal exposure measurements in each community to provide the most comprehensive data possible on the levels of children's exposure to air pollutants and toxic air contaminants.
(d) Data collected from expanded air quality monitoring activities conducted pursuant to this section may be used for any purpose authorized by law, including, but not limited to, determinations as to whether an area has attained or has not attained the state and national ambient air quality standards, if the monitoring devices from which the data was collected meet the monitoring requirements specified in Section 58.14 of Title 40 of the Code of Federal Regulations for special purpose monitors, all other monitoring requirements of Part 58 of Title 40 of the Code of Federal Regulations, and all applicable requirements specified in regulations

adopted by the state board.
SEC. 5. Section 39660 of the Health and Safety Code is amended to read:
39660. (a) Upon the request of the state board, the office, in consultation with and with the participation of the state board, shall evaluate the health effects of and prepare recommendations regarding substances, other than pesticides in their pesticidal use, which may be or are emitted into the ambient air of California and that may be determined to be toxic air contaminants.
(b) In conducting this evaluation, the office shall consider all available scientific data, including, but not limited to, relevant data provided by the state board, the State Department of Health Services, the Occupational Safety and Health Division of the Department of Industrial Relations, the Department of Pesticide Regulation, international and federal health agencies, private industry, academic researchers, and public health and environmental organizations. The evaluation shall be performed using current principles, practices, and methods used by public health professionals who are experienced practitioners in the fields of epidemiology, human health effects assessment, risk assessment, and toxicity.
(c) (1) The evaluation shall assess the availability and quality of data on health effects, including potency, mode of action, and other relevant biological factors, of the substance, and shall, to the extent that information is available, assess all of the following:
(A) Exposure patterns among infants and children that are likely to result in disproportionately high exposure to ambient air pollutants in comparison to the general population.
(B) Special susceptibility of infants and children to ambient air pollutants in comparison to the general population.
(C) The effects on infants and children of exposure to toxic air contaminants and other substances that have a common mechanism of toxicity.
(D) The interaction of multiple air pollutants on infants and children, including the interaction between criteria air pollutants and toxic air contaminants.
(2) The evaluation shall also contain an estimate of the levels of exposure that may cause or contribute to adverse health effects. If it can be established that a threshold of adverse health effects exists, the estimate shall include both of the following factors:
(A) The exposure level below which no adverse health effects are anticipated.
(B) An ample margin of safety that accounts for the variable effects that heterogeneous human populations exposed to the substance under evaluation may experience, the uncertainties associated with

the applicability of the data to human beings, and the completeness and quality of the information available on potential human exposure to the substance. In cases in which there is no threshold of significant adverse health effects, the office shall determine the range of risk to humans resulting from current or anticipated exposure to the substance.

(3) The scientific basis or scientific portion of the method used by the office to assess the factors set forth in this subdivision shall be reviewed in a manner consistent with this chapter by the Scientific Review Panel on Toxic Air Contaminants established pursuant to Article 5 (commencing with Section 39670). Any person may submit any information for consideration by the panel, which may receive oral testimony.

(d) The office shall submit its written evaluation and recommendations to the state board within 90 days after receiving the request of the state board pursuant to subdivision (a). The office may, however, petition the state board for an extension of the deadline, not to exceed 30 days, setting forth its statement of the reasons that prevent the office from completing its evaluation and recommendations within 90 days. Upon receipt of a request for extension of, or noncompliance with, the deadline contained in this section, the state board shall immediately transmit to the Assembly Committee on Rules and the Senate Committee on Rules, for transmittal to the appropriate standing, select, or joint committee of the Legislature, a statement of reasons for extension of the deadline, along with copies of the office's statement of reasons that prevent it from completing its evaluation and recommendations in a timely manner.

(e) (1) The state board or a district may request, and any person shall provide, information on any substance that is or may be under evaluation and that is manufactured, distributed, emitted, or used by the person of whom the request is made, in order to carry out its responsibilities pursuant to this chapter. To the extent practical, the state board or a district may collect the information in aggregate form or in any other manner designed to protect trade secrets.

(2) Any person providing information pursuant to this subdivision may, at the time of submission, identify a portion of the information submitted to the state board or a district as a trade secret and shall support the claim of a trade secret, upon the written request of the state board or district board. Subject to Section 1060 of the Evidence Code, information supplied that is a trade secret, as specified in Section 6254.7 of the Government Code, and that is so marked at the time of submission, shall not be released to any member of the public. This section does not prohibit the exchange of properly designated trade secrets between public agencies when those

trade secrets are relevant and necessary to the exercise of their jurisdiction if the public agencies exchanging those trade secrets preserve the protections afforded that information by this paragraph.

(3) Any information not identified as a trade secret shall be available to the public unless exempted from disclosure by other provisions of law. The fact that information is claimed to be a trade secret is public information. Upon receipt of a request for the release of information that has been claimed to be a trade secret, the state board or district shall immediately notify the person who submitted the information, and shall determine whether or not the information claimed to be a trade secret is to be released to the public. The state board or district board, as the case may be, shall make its determination within 60 days after receiving the request for disclosure, but not before 30 days following the notification of the person who submitted the information. If the state board or district decides to make the information public, it shall provide the person who submitted the information 10 days' notice prior to public disclosure of the information.

(f) The office and the state board shall give priority to the evaluation and regulation of substances based on factors related to the risk of harm to public health, amount or potential amount of emissions, manner of, and exposure to, usage of the substance in California, persistence in the atmosphere, and ambient concentrations in the community. In determining the importance of these factors, the office and the state board shall consider all of the following information, to the extent that it is available:

(1) Research and monitoring data collected by the state board and the districts pursuant to Sections 39607, 39617.5, 39701, and 40715, and by the United States Environmental Protection Agency pursuant to paragraph (2) of subsection (k) of Section 112 of the federal act (42 U.S.C. Sec. 7412(k)(2)).

(2) Emissions inventory data reported for substances subject to Part 6 (commencing with Section 44300) and the risk assessments prepared for those substances.

(3) Toxic chemical release data reported to the state emergency response commission pursuant to Section 313 of the Emergency Planning and Community Right-To-Know Act of 1986 (42 U.S.C. Sec. 11023) and Section 6607 of the Pollution Prevention Act of 1990 (42 U.S.C. Sec. 13106).

(4) Information on estimated actual exposures to substances based on geographic and demographic data and on data derived from analytical methods that measure the dispersion and concentrations of substances in ambient air.

SEC. 6. Article 4.5 (commencing with Section 39669.5) is added to Chapter 3.5 of Part 2 of Division 26 of the Health and Safety Code,

to read:

Article 4.5. Special Provisions For Infants And Children

39669.5. The Legislature finds and declares that certain toxic air contaminants may pose risks that cause infants and children to be especially susceptible to illness and that certain actions are necessary to ensure their safety from toxic air contaminants.
(a) By July 1, 2001, the following shall occur:
(1) The office, in consultation with the state board, shall establish a list of up to five toxic air contaminants identified or designated by the state board pursuant to Section 39657 that may cause infants and children to be especially susceptible to illness. In developing the list, the office shall take into account public exposures to toxic air contaminants, whether by themselves or interacting with other toxic air contaminants or criteria pollutants, and the factors listed in subdivision (c) of Section 39660. The office shall submit a report containing the list and its reasons for including the toxic air contaminants on the list to the Scientific Review Panel on Toxic Air Contaminants established pursuant to Article 5 (commencing with Section 39670).
(2) The scientific review panel, in a manner consistent with this chapter, shall review the list of toxic air contaminants submitted by the office pursuant to paragraph (1). As part of the review, any person may submit any information for consideration by the panel, which may receive oral testimony.
(b) (1) Within two years of the establishment of the list required pursuant to subdivision (a), the state board shall review and, as appropriate, revise any control measures adopted for the toxic air contaminants identified on the list, to reduce exposure to those toxic air contaminants pursuant to Article 4 (commencing with Section 39665), to protect public health, and particularly infants and children.
(2) Within three years of the establishment of the list required pursuant to subdivision (a), for up to five of those toxic air contaminants for which no control measures have been previously adopted, the state board shall prepare a report on the need for regulations, following the procedure specified in Section 39665. The state board shall adopt within that same three-year timeframe, as appropriate, any new control measures to reduce exposure to those toxic air contaminants pursuant to Article 4 (commencing with Section 39665), to protect public health, particularly infants and children.

(c) Beginning July 1, 2004, the office shall annually evaluate at least 15 toxic air contaminants identified or designated by the state board pursuant to Section 39657, and provide threshold exposure

levels and nonthreshold health values, as appropriate, for those toxic air contaminants. The activities required pursuant to this subdivision shall continue until all toxic air contaminants are evaluated. The levels shall be established pursuant to the procedures adopted for health and risk assessments pursuant to paragraph (2) of subdivision (b) of Section 44360, and taking into account the factors listed in subdivision (c) of Section 39660. Based on this evaluation, and after review by the scientific review panel as prescribed in paragraph (2) of subdivision (a), the office shall update the list established pursuant to subdivision (a), by July 1, 2005, and each year thereafter. Within three years of the initial or subsequent listing update, for up to five of the toxic air contaminants contained on that list for which no control measures have been previously adopted, or for at least five of the toxic air contaminants if more than five toxic air contaminants have been identified, the state board shall prepare a report on the need for regulation, following the procedure specified in Section 39665. The state board shall adopt within that three-year timeframe, as appropriate, new control measures, pursuant to Article 4 (commencing with Section 39665), to reduce exposure to those toxic air contaminants, to protect public health, and particularly infants and children.

(d) Toxic air contaminants evaluated and listed pursuant to this section shall not include substances in those uses that are not subject to regulation by the state board pursuant to this chapter.

SEC. 7. Section 40451 of the Health and Safety Code is amended to read:

40451. (a) The south coast district shall use the Pollutant Standards Index developed by the Environmental Protection Agency and shall report and forecast pollutant levels daily for dissemination in the print and electronic media.

(b) Using existing communication facilities available to it, the south coast district shall notify all schools and, to the extent feasible and upon request, daycare centers in the South Coast Air Basin whenever any federal primary ambient air quality standard is predicted to be exceeded.

(c) Whenever it becomes available, the south coast district shall disseminate to schools, amateur adult and youth athletic organizations, and all public agencies operating parks and recreational facilities in the south coast district the latest scientific information and evidence regarding the need to restrict exercise and other outdoor activities during periods when federal primary air quality standards are exceeded.

(d) Once every two months and annually, the south coast district shall report on the number of days and locations that federal and state ambient air quality standards were exceeded and the number of

days and locations of these occurrences.
SEC. 7.5. Section 40451 of the Health and Safety Code is amended to read:
40451. (a) The south coast district shall use the Pollutant Standards Index developed by the United States Environmental Protection Agency and shall report and forecast pollutant levels daily for dissemination in the print and electronic media. Commencing July 1, 2001, the south coast district shall also include in its report and forecast levels of PM2.5 in excess of the 24-hour federal ambient air standard, as adopted in July 1997, or any standard adopted by the United States Environmental Protection Agency that succeeds that standard.
(b) Using existing communication facilities available to it, the south coast district shall notify all schools and, to the extent feasible and upon request, daycare centers in the South Coast Air Basin whenever any federal primary ambient air quality standard is predicted to be exceeded. Commencing July 1, 2001, using communication facilities available to it, the south coast district shall also notify all schools in the South Coast Air Basin when the ambient level of PM2.5 is predicted to exceed the 24-hour federal ambient air standard, as adopted in July 1997, or any standard adopted by the United States Environmental Protection Agency that succeeds that standard.
(c) Whenever it becomes available, the south coast district shall disseminate to schools, amateur adult and youth athletic organizations, and all public agencies operating parks and recreational facilities in the south coast district the latest scientific information and evidence regarding the need to restrict exercise and other outdoor activities during periods when federal primary air quality standards and the 24-hour federal ambient air standard for PM2.5, as adopted in July 1997, or any standards adopted by the United States Environmental Protection Agency that succeed those standards, are exceeded.
(d) Once every two months and annually, the south coast district shall report on the number of days and locations that federal and state ambient air quality standards were exceeded. Commencing July 1, 2001, the south coast district shall also include in that report the number of days and locations on and at which the 24-hour federal ambient air standard for PM2.5, as adopted in July 1997, or any standard adopted by the United States Environmental Protection Agency that succeeds that standard, is exceeded.
SEC. 8. Section 7.5 of this bill incorporates amendments to Section 40451 of the Health and Safety Code proposed by both this bill and SB 1195. It shall only become operative if (1) both bills are enacted and become effective on or before January 1, 2000, (2) each bill amends Section

40451 of the Health and Safety Code, and (3) this bill is enacted after SB 1195, in which case Section 7 of this bill shall not become operative.

SEC. 9. Notwithstanding Section 17610 of the Government Code, if the Commission on State Mandates determines that this act contains costs mandated by the state, reimbursement to local agencies and school districts for those costs shall be made pursuant to Part 7 (commencing with Section 17500) of Division 4 of Title 2 of the Government Code. If the statewide cost of the claim for reimbursement does not exceed one million dollars ($1,000,000), reimbursement shall be made from the State Mandates Claims Fund.

Appendix B

Summary Data for the Six SB 25 Community Monitoring Sites

Summary Data for the Six SB 25 Community Monitoring Sites

The purpose of this appendix is to provide summary information on the six SB 25 sites. The six SB 25 sites include Barrio Logan, Boyle Heights, Wilmington, Crockett, Fruitvale, and Fresno. The data for six sites described in this appendix represent the diversity of weather, geography, and air pollution sources present in California from diesel exhaust, automobiles, neighborhood sources, refineries, and marine sources. We used the data from six sites as well as other information to evaluate the adequacy of the network and those findings are discussed in Chapter IV of the report. Descriptions of the sites are presented in Chapter III. The tables which follow summarize the ambient air data received to date. In some cases, additional data are still being collected. More detailed information, such as month by month summaries and risk information, is available from ARB's website at *http://www.arb.ca.gov/ch/programs/sb25/sb25.htm*.

In the tables, the data collected at the SB 25 sites are presented and compared to data from neighboring long-term monitoring sites and satellite sites where available. The long-term monitoring sites are part of the routine air monitoring network that collects measurements throughout the state. In addition to the primary sites at each of the SB 25 sites, four satellite sites were established (in Barrio Logan, Boyle Heights, and Wilmington) for this study to provide additional information on local sources and to better understand source-receptor relationships in those communities. The satellite site and SB 25 site in Barrio Logan did not operate concurrently; therefore, that satellite site is not included in the following discussion but is discussed briefly in Chapter IV of this report. Detailed information and findings from the Barrio Logan satellite site are provided in "Ambient Air Monitoring for Hexavalent Chromium and Metals in Barrio Logan: May 2001 through May 2002", soon to be published.

For criteria pollutants, we compared the collected SB 25 data to historical data available at the neighboring long-term sites because concurrent data at the long-term sites were not available at the time of this analysis. The data from the long-term sites were available for a longer duration than for the SB 25 sites, therefore the data (for example, 1998 through 2001) were statistically normalized to provide a more relevant comparison. One example is the number of days exceeding the air quality standard ("exceedance days") for criteria pollutants. For the SB 25 sites, the number of exceedance days is simply the number of sampling days during the monitoring period on which the standard was exceeded. The number of exceedance days at the neighboring site, however, was mathematically scaled to represent the same number of sampling days as the SB 25 site. This scaled value is referred to as the "expected number of days of exceedances" in the tables provided in this report.

The neighboring sites chosen for comparison to the SB 25 sites were those which provided the best information on the air quality levels at the SB 25 sites.

Proximity to the SB 25 sites and completeness of data for comparison were the criteria we used to determine which neighboring sites to use for the comparisons. In some instances a single neighboring site met our criteria for use, however, in other instances more than one neighboring site was used. For example, this was necessary if the closest site did not measure all of the pollutants for which data were available at the SB 25 site. Regardless of the number of neighboring sites used, our goal was to provide the best comparison possible for each SB 25 site.

Separate reports are in preparation for each community and will include a summary of the data collected, relevant emission sources, and any other information learned about the community. The detailed analyses in these reports will compare the SB 25 data with the data concurrently monitored at the nearby long-term sites. Consequently, some of the summary information for the nearby long-term monitoring sites may differ between this report and the detailed individual SB 25 reports.

Barrio Logan

The SB 25 site in Barrio Logan was located at Memorial Academy. Criteria pollutant data were collected from October 1999 to February 2001, and air toxics data were collected for the same time period. The data summarized here covered the one-year period from October 1999 to September 2000.

Table 1 compares criteria pollutant data collected at Memorial Academy to data collected at the long-term monitoring site on 12th Avenue in downtown San Diego. As shown in the table, average levels for all criteria pollutants were comparable at both sites. There were no exceedances of the State standards for CO and NO_2, and only a single ozone exceedance at each site; based on this we conclude that the air quality for those pollutants is relatively clean at these sites. However, there were a few exceedances of the PM_{10} standard, with the Barrio Logan site experiencing two more exceedances than the downtown San Diego site.

Table 1. Summary of Criteria Pollutant Data at Memorial Academy (October 1999 – September 2000) compared to San Diego 12th Avenue

		Memorial Academy (Barrio Logan)				San Diego 12th Avenue***	
Pollutant	*Units*	*Days Sampled*	*Maximum*	*Average***	*Days Exceeding Standard**	*Expected # Days Exceeding Standard ******	*Average***
Ozone	ppb	326	103.0	42.9	1	1	44.5
CO	ppm	341	7.5	2.4	0	0	2.1
NO_2	ppb	300	118.0	45.2	0	0	40.6
PM_{10}	ug/m^3	46	61	34	6	4	31
$PM_{2.5}$ ‡	ug/m^3	292	50	18	N/A	N/A	17

* Based on the State standard for each pollutant. For $PM_{2.5}$, a 24-hour State standard has not yet been established.
** Based on the average daily maximum value for ozone, CO, and NO_2.
*** Based on 1998-2001 annual levels.
**** Scaled to represent the same number of sampling days as for the Memorial Academy site.
‡ The average for $PM_{2.5}$ at the long-term San Diego 12th avenue site was based upon the 1999-2001 filter-based $PM_{2.5}$ federal reference method data. The Memorial Academy site was monitored with the continuous hourly $BAM_{2.5}$, but the 24-hour average was used in this summary.

Table 2 compares the air toxics measurements from Memorial Academy to measurements taken at the Chula Vista site six miles away. Annual average levels of benzene and 1,3-butadiene were somewhat higher at Memorial Academy than at Chula Vista, while levels for the other air toxics were similar. Most measurements of hexavalent chromium, methylene chloride, and para-dichlorobenzene were below the detection limits. Although diesel PM is a major contributor to overall risk levels in many areas, a direct measurement method for it is still in development; therefore, data for that toxic air contaminant are not included.

Table 3 summarizes the potential cancer risk for each of the compounds in Table 2 for the same sites. Consistent with the data presented in Table 2, risk levels for benzene and 1,3-butadiene were somewhat higher at Memorial Academy than at Chula Vista, while risk levels for the other compounds were similar. Benzene and 1,3-butadiene contributed more than half of the overall risk from the top nine air toxics (excluding diesel PM) at Chula Vista, and almost two-thirds at Memorial Academy. Overall, the potential cancer risk from the top nine air toxics was higher at the Memorial Academy site than at the Chula Vista site. However, a more detailed analysis of these data provided in the Technical Support Document for the report entitled "Air Quality at Memorial Academy Charter School in Barrio Logan, a Neighborhood Community in San Diego" revealed that the difference was not statistically discernible.

Table 2. Summary of Top Nine Air Toxics (Excluding Diesel PM*) at Memorial Academy (October 1999 – September 2000) Compared to Chula Vista

		Memorial Academy (Barrio Logan)			Neighboring Site (Chula Vista)**
Pollutant	***Units***	***Minimum***	***Maximum***	***Annual Average***	***Annual Average***
1,3-Butadiene	ppb	0.02	0.79	0.23	0.15
Acetaldehyde	ppb	0.15	2.10	0.80	0.79
Benzene	ppb	0.10	3.10	0.80	0.58
Carbon Tetrachloride	ppb	0.05	0.13	0.09	0.10
Formaldehyde	ppb	0.53	5.50	2.22	2.30
Hexavalent Chromium***	ng/m^3	0.10	0.20	0.10	0.11
Methylene Chloride***	ppb	0.50	0.50	0.50	0.47
Para-dichlorobenzene***	ppb	0.10	0.20	0.10	0.12
Perchloroethylene	ppb	0.01	0.31	0.08	0.07

* Diesel-PM not included because a direct measurement method is in development.
** Based on 1998-2001 annual levels.
*** Most of the observed values were below the limit of detection. In those instances, a value equal to one-half of the limit of detection was assumed.

Table 3. Potential Cancer Risk of Top Nine Air Toxics (Excluding Diesel PM*) at Memorial Academy (October 1999 – September 2000) Compared to Chula Vista

	Memorial Academy (Barrio Logan)	Neighboring Site (Chula Vista)**
Pollutant	***Annual Average***	***Annual Average***
1,3-Butadiene	86	56
Acetaldehyde	4	4
Benzene	74	53
Carbon Tetrachloride	24	26
Formaldehyde	16	17
Hexavalent Chromium***	15	16
Methylene Chloride***	2	2
Para-dichlorobenzene***	7	8
Perchloroethylene	3	3
Totals	231	185

* Diesel-PM not included because a direct measurement method is in development.
** Based on 1998-2001 annual levels.
*** Most of the observed values were below the limit of detection. In those instances, a value equal to one-half of the limit of detection was assumed.

Boyle Heights

The SB 25 site in Boyle Heights was located at Hollenbeck Middle School. Criteria pollutant data were collected from March 2001 to May 2002, and air toxics data were measured from February 2001 to January 2002. The data summarized here covered the one-year period from March 2001 to February 2002 for criteria pollutant data, and February 2001 to January 2002 for air toxics data.

Table 4 summarizes the criteria pollutant data collected at Hollenbeck Middle School, and compares them to measurements taken at the long-term monitoring site on North Main Street in downtown Los Angeles. As shown in the table, average levels for most criteria pollutants were comparable at both sites, although $PM_{2.5}$ levels at Hollenbeck Middle School were about a third higher than those measured at the downtown site. The school site is located in the residential area of Boyle Heights and is approximately one-half mile downwind of the convergence of four major Los Angeles area freeways. There were no exceedances of the State standards for CO and NO_2 at either site. Although average ozone and PM_{10} levels were similar at both sites, there were differences in the numbers of days exceeding the State standards. The downtown site had over twice the number of days exceeding the State ozone standard. The Hollenbeck site had a few more exceedances of the State PM_{10} standard. A possible reason might be its proximity of the Hollenbeck site to Interstate 5 and three other local freeways, resulting in higher PM impacts from heavy duty traffic on the freeways under the right weather conditions.

Table 4. Summary of Criteria Pollutant Data at Hollenbeck (March 2001 – February 2002) Compared to Downtown Los Angeles (Los Angeles North Main Street)

		Hollenbeck (Boyle Heights)				North Main Street*** (Downtown Los Angeles)	
Pollutant	*Units*	*Days Sampled*	*Maximum*	*Average***	*Days Exceeding Standard**	*Expected # Days Exceeding Standard ****	*Annual Average***
Ozone	ppb	360	111.0	43.5	5	12	45.1
CO	ppm	357	8.2	2.9	0	0	2.6
NO_2	ppb	355	160.0	60.9	0	0	61.4
PM_{10}	ug/m^3	56	81	47	20	16	42
$PM_{2.5}$ ‡	ug/m^3	279	104	30	N/A	N/A	22

* Based on the State standard for each pollutant. For $PM_{2.5}$, a 24-hour State standard has not yet been established.
** Based on the average daily maximum value for ozone, CO, and NO_2.
*** Based on 1998-2001 annual levels.
**** Scaled to represent the same number of sampling days as for the Hollenbeck site.
‡ The average for $PM_{2.5}$ at the long-term Downtown Los Angeles site was based upon the 1999-2001 filter-based $PM_{2.5}$ federal reference method data. The Hollenbeck site was monitored with the continuous hourly $BAM_{2.5}$, but the 24-hour average was used in this summary.

To better investigate the impact of vehicular emissions on children in the area, particulate monitoring was also conducted at two satellite sites near Hollenbeck Middle School: the East Los Angeles Mathematics, Science, and Technology Center (or "Science Center"), and Soto Street Elementary School (or "Soto Street"). These satellite sites provided information about how air pollutant concentrations change as distances from the freeways increased. Particulate matter air samples were collected at the two satellite sites on the same sampling schedule as at Hollenbeck Middle School.

Tables 5 and 6 compare the particulate data collected at the Hollenbeck Middle School site to the two satellite sites. The 24-hr state PM_{10} standard (50 ug/m^3) was exceeded at all three Boyle Heights monitoring sites, but much more frequently at Soto Street. The particulate matter levels at Soto Street were consistently higher than at the other two study sites. Particulate matter levels and frequency of state standard exceedance were comparable at the Hollenbeck and Science Center sites. The monitoring suggests that there is a noticeable freeway impact on PM_{10} levels at Soto Street School, but the lower levels at the two nearby sites indicate that the freeway impacts decrease rapidly with distance from the freeway. This observation agrees with computer simulations of the impact of freeway emissions performed by ARB staff.

Table 5. Summary of Particulate Air Pollutant Data at Hollenbeck Compared to the Science Center Satellite Site (March 2001 – October 2001 for both sites)

		Hollenbeck (Boyle Heights)				Science Center (Boyle Heights)			
Pollutant	*Units*	*Days Sampled*	*Maximum*	*Average*	*Days Exceeding Standard**	*Days Sampled*	*Maximum*	*Average*	*Days Exceeding Standard**
PM_{10}	ug/m^3	34	78	46	9	32	79	47	10

* Based on the 24-hour State Standard for PM_{10}.

Table 6. Summary of Particulate Air Pollutant Data at Hollenbeck Compared to the Soto Street Satellite Site (March 2001 – October 2001 for both sites)

		Hollenbeck (Boyle Heights)				Soto Street (Boyle Heights)			
Pollutant	*Units*	*Days Sampled*	*Maximum*	*Average*	*Days Exceeding Standard**	*Days Sampled*	*Maximum*	*Average*	*Days Exceeding Standard**
PM_{10}	ug/m^3	34	78	46	9	37	96	62	28

* Based on the 24-hour State Standard for PM_{10}.

Table 7 summarizes the air toxics measurements from Hollenbeck Middle School, and compares them to measurements taken at the neighboring North Main Street site in downtown Los Angeles. Annual average levels for most air toxics were similar; however, levels of 1,3-butadiene and acetaldehyde were slightly higher at Hollenbeck than at the downtown site, while levels of methylene chloride were higher at the downtown Los Angeles site. Most measurements of hexavalent chromium and *para*-dichlorobenzene were below the detection limits. Although diesel PM is a major contributor to overall risk levels in many areas, a direct measurement method for it is still in development; therefore, data for that toxic air contaminant are not included.

Table 8 summarizes the potential cancer risk for each of the compounds in Table 7 for the same sites. Risk levels for 1,3-butadiene were somewhat higher at Hollenbeck than at the downtown Los Angeles site, while risk levels for the other compounds were similar. Benzene and 1,3-butadiene contributed almost three-fourths of the overall risk from the top nine air toxics (excluding diesel PM) at both sites. The overall potential cancer risk from the top nine air toxics was slightly higher at the Hollenbeck site than at the downtown Los Angeles site.

Table 7. Summary of Top Nine Air Toxics (Excluding Diesel PM*) at Hollenbeck (February 2001 – January 2002) Compared to Downtown Los Angeles (Los Angeles North Main Street)

		Hollenbeck (Boyle Heights)			Neighboring Site North Main Street** (Downtown Los Angeles)
Pollutant	***Units***	***Minimum***	***Maximum***	***Annual Average***	***Annual Average***
1,3-Butadiene	ppb	0.07	1.80	0.42	0.37
Acetaldehyde	ppb	0.05	3.70	1.42	1.25
Benzene	ppb	0.33	6.80	1.24	1.23
Carbon Tetrachloride	ppb	0.07	0.10	0.09	0.10
Formaldehyde	ppb	0.05	9.50	3.56	3.53
Hexavalent Chromium***	ng/m^3	0.10	0.35	0.12	0.13
Methylene Chloride	ppb	0.11	5.70	0.64	0.85
Para-dichlorobenzene***	ppb	0.15	0.45	0.18	0.15
Perchloroethylene	ppb	0.03	0.44	0.17	0.21

* Diesel PM not listed because a direct measurement method is in development.
** Based on 1998-2001 annual levels.
*** Most of the observed values were below the limit of detection. In those instances, a value equal to one-half of the limit of detection was assumed.

Table 8. Potential Cancer Risk of Top Nine Air Toxics (Excluding Diesel PM*) at Hollenbeck (February 2001 – January 2002) Compared to Downtown Los Angeles (Los Angeles North Main Street)

	Hollenbeck (Boyle Heights)	Neighboring Site North Main Street** (Downtown Los Angeles)
Pollutant	***Annual Average***	***Annual Average***
1,3-Butadiene	158	137
Acetaldehyde	7	6
Benzene	115	114
Carbon Tetrachloride	24	26
Formaldehyde	26	26
Hexavalent Chromium***	18	19
Methylene Chloride	2	3
Para-dichlorobenzene***	12	10
Perchloroethylene	7	9
Totals	369	350

* Diesel-PM not listed because a direct measurement method is in development.
** Based on 1998-2001 annual levels.
*** Most of the observed values were below the limit of detection. In those instances, a value equal to one-half of the limit of detection was assumed.

Wilmington

The SB 25 site in Wilmington was located at Wilmington Park School. Criteria pollutant data were collected from June 2001 to June 2002, and air toxics data were measured from May 2001 to July 2002. A summary of the data for that site for the annual period of July 2001 to June 2002 is presented below.

Table 9 summarizes the criteria pollutant data collected at Wilmington Park School, and compares them to measurements taken at the long-term monitoring site in North Long Beach. As shown in the table, average levels for most criteria pollutants were comparable at both sites, although NO_2 levels at Wilmington Park School were slightly lower than those measured at the North Long Beach site, and PM levels were slightly higher. There were no exceedances of the State standards for ozone, CO, and NO_2 at the Wilmington site, indicating that the air quality for those pollutants is relatively clean at that site. The North Long Beach site also had no CO and NO_2 exceedances, and averaged only two ozone exceedances per year. The Wilmington site had a few more exceedances of the State PM_{10} standard than did the North Long Beach site.

Table 9. Summary of Criteria Pollutant Data at Wilmington Park School (July 2001 – June 2002) compared to North Long Beach

		Wilmington Park School (Wilmington)				North Long Beach***	
Pollutant	*Units*	*Days Sampled*	*Maximum*	*Average***	*Days Exceeding Standard**	*Expected # Days Exceeding Standard*****	*Annual Average***
Ozone	ppb	363	92.0	42.5	0	2	40.4
CO	ppm	356	8.4	1.6	0	0	2.0
NO_2	ppb	359	133.0	45.2	0	0	52.9
PM_{10}	ug/m^3	57	81	39	14	10	36
$PM_{2.5}$ ‡	ug/m^3	314	88	28	N/A	N/A	21

* Based on the State standard for each pollutant. For $PM_{2.5}$, a 24-hour State standard has not yet been established.
** Based on the average daily maximum value for ozone, CO, and NO_2.
*** Based on 1998-2001 annual levels.
**** Scaled to represent the same number of sampling days as for the Wilmington site.
‡ The average for $PM_{2.5}$ at the long-term North Long Beach site was based upon the 1999-2001 filter-based $PM_{2.5}$ federal reference method data. The Wilmington Park School site was monitored with the continuous hourly $BAM_{2.5}$, but the 24-hour average was used in this summary.

Criteria pollutant monitoring was also conducted at a satellite site in Wilmington: Hawaiian Elementary School (540 Hawaiian Avenue). The primary focus of the monitoring at this site was to obtain additional information regarding the concentration of diesel particulate from the freeways located to the west of the site and from the port activities located to the south. Table 10 compares the criteria pollutant data collected at Hawaiian Elementary School to that collected at Wilmington Park School. Only PM_{10} measurements are currently available at both sites; CO and NO_2 were monitored by the South Coast Air Quality

Management District, and those results will be published by the district at a later date. As shown in the table, the number of days exceeding state standard for PM_{10} and average levels of PM_{10} were slightly higher at the Hawaiian Elementary School site.

Table 10. Summary of Particulate Air Pollutant Data at Wilmington Park School Compared to the Hawaiian Elementary School Satellite Site (November 2001 – May 2002))

		Wilmington Park School (Wilmington)				Hawaiian Elementary School (Wilmington)			
Pollutant	***Units***	***Days Sampled***	***Maximum***	***Average***	***Days Exceeding Standard****	***Days Sampled***	***Maximum***	***Average***	***Days Exceeding Standard****
PM_{10}	ug/m^3	31	78	39	9	28	80	46	12
* Based on the 24-hour State Standard for PM_{10}.									

Table 11 summarizes the air toxics measurements from Wilmington Park School, and compares them to measurements taken at the neighboring site in North Long Beach. Average levels for four of the air toxics (1,3-butadiene, carbon tetrachloride, hexavalent chromium, and *para*-dichlorobenzene) were similar at both sites. Average levels for the other air toxics (acetaldehyde, benzene, formaldehyde, methylene chloride, and perchloroethylene) were higher at the North Long Beach site. Most measurements of hexavalent chromium and *para*-dichlorobenzene were below the detection limits. Although diesel PM is a major contributor to overall risk levels in many areas, a direct measurement method for it is still in development; therefore, data for that toxic air contaminant are not included.

Table 12 summarizes the potential cancer risk for each of the compounds in Table 11 for the same sites. Risk levels for most air toxics were similar, however the benzene risk at the North Long Beach site was higher than for the Wilmington site. Benzene and 1,3-butadiene contributed over two-thirds of the overall risk from the top nine air toxics (excluding diesel PM) at both sites. The overall potential cancer risk from the top nine air toxics was about 10 percent lower at the Wilmington site than at the North Long Beach site.

Table 11. Summary of Top Nine Air Toxics (Excluding Diesel PM*) at Wilmington Park School (July 2001 – June 2002) Compared to North Long Beach

		Wilmington Park School (Wilmington)			Neighboring Site (North Long Beach)**
Pollutant	***Units***	***Minimum***	***Maximum***	***Average***	***Annual Average***
1,3-Butadiene	ppb	0.02	1.50	0.30	0.30
Acetaldehyde	ppb	0.18	3.40	1.05	1.16
Benzene	ppb	0.11	2.90	0.70	1.01
Carbon Tetrachloride	ppb	0.07	0.11	0.09	0.10
Formaldehyde	ppb	0.52	6.80	2.59	2.86
Hexavalent Chromium***	ng/m^3	0.10	0.32	0.11	0.12
Methylene Chloride	ppb	0.05	1.30	0.34	0.58
Para-dichlorobenzene***	ppb	0.15	0.46	0.16	0.13
Perchloroethylene	ppb	0.01	0.50	0.10	0.17

* Diesel-PM not listed because a direct measurement method is in development.
** Based on 1998-2001 levels.
*** Most of the observed values were below the limit of detection. In those instances, a value equal to one-half of the limit of detection was assumed.

Table 12. Potential Cancer Risk of Top Nine Air Toxics (Excluding Diesel PM*) at Wilmington Park School (July 2001 – June 2002) Compared to North Long Beach

	Wilmington	Neighboring Site (North Long Beach)**
Pollutant	***Average***	***Annual Average***
1,3-Butadiene	115	113
Acetaldehyde	5	6
Benzene	65	94
Carbon Tetrachloride	24	27
Formaldehyde	19	21
Hexavalent Chromium***	17	18
Methylene Chloride	1	2
Para-dichlorobenzene***	11	9
Perchloroethylene	4	7
Totals	261	297

* Diesel-PM not listed because a direct measurement method is in development.
** Based on 1998-2001 levels.
*** Most of the observed values were below the limit of detection. In those instances, a value equal to one-half of the limit of detection was assumed.

Crockett

The SB 25 site in Crockett was located at John Swett High School. Data for criteria pollutants and air toxics have been collected since October 2001; measurements are expected to end in Spring 2003. A summary of the data collected for the periods December 2001 to November 2002 (criteria pollutant data) and October 2001 to September 2002 (air toxics data) is presented below.

For the three SB 25 sites previously discussed (Barrio Logan, Boyle Heights, and Wilmington), a single neighboring site met our criteria for comparison; these criteria were proximity to the SB 25 site and completeness of data available for comparison. However, for the John Swett High School site in Crockett, no single neighboring site met both of our criteria. The nearest neighboring site (Crockett – Kendall) only measured a subset of those compounds measured at the SB 25 site. The nearest neighboring site with complete data availability was the ARB-operated El Portal site in San Pablo. Therefore, both sites were used for the comparison to provide the best and most complete comparison possible.

Table 13 summarizes the criteria pollutant data collected at John Swett High School, and compares them to measurements taken at the long-term monitoring site in Vallejo (304 Tuolumne Street). As shown in the table, average levels of NO_2 and PM_{10} were comparable at both sites. Levels of ozone were somewhat higher at the Crockett site, while CO levels at the Crockett site were less than half of those measured at the Vallejo site. There were no exceedances of the State standards at the Crockett site, indicating good air quality at that site. The Vallejo site also had no CO and NO_2 exceedances, and averaged only two ozone and PM_{10} exceedances per year. The vast majority of the $PM_{2.5}$ BAM data at the Crockett site have been invalidated and so it would not be meaningful to use limited data to summarize the information. However, the validated data are available on the web at this link: *http://www.arb.ca.gov/ch/communities/studies/crockett/crockett.htm*.

Table 13. Summary of Criteria Air Pollutant Data at John Swett High School (December 2001 – November 2002) Compared to Vallejo-Tuolumne Street

		John Swett High School (Crockett)				Vallejo*** (ARB)	
Pollutant	*Units*	*Days Sampled*	*Maximum*	*Average***	*Days Exceeding Standard**	*Expected # Days Exceeding Standard****	*Annual Average***
Ozone	ppb	365	89.0	40.9	0	2	34.4
CO	ppm	363	3.2	0.6	0	0	1.5
NO_2	ppb	338	69.0	24.7	0	0	24.6
PM_{10}	ug/m^3	53 †	40	19	0	2	18
$PM_{2.5}$ ‡	ug/m^3	N/A	N/A	N/A	N/A	N/A	13

* Based on the State standard for each pollutant. For $PM_{2.5}$, a 24-hour State standard has not yet been established.
** Based on the average of daily maximum values for ozone, CO, and NO_2, and 24-hour values for PM_{10} and $PM_{2.5}$
*** Based on 1998-2001 levels.
**** Scaled to represent the same number of sampling days as for the Crockett site.
† Based on PM10 data from November 2001 to October 2002.
‡ The average for $PM_{2.5}$ at the long-term Vallejo site was based upon the 1999-2001 filter-based $PM_{2.5}$ federal reference method data.

Air toxics data from John Swett High School in Crockett are presented in Tables 14 through 15. The neighboring sites used for comparison were the ARB-operated El Portal site in San Pablo and the Kendall Street site in Crockett.

The El Portal site in San Pablo is approximately nine miles from the SB 25 Crockett site. The Crockett Kendall site is operated by the BAAQMD and is approximately half a mile away from the SB 25 Crockett site. Only a subset of the air toxics data was available from the Crockett Kendall site.

Table 14 summarizes the air toxics measurements from John Swett High School, and compares them to measurements taken at the San Pablo and Crockett Kendall sites. Except for methylene chloride, the levels of the air toxics measured in common at the two Crockett sites (benzene, carbon tetrachloride, methylene chloride, and perchloroethylene) were similar; methylene chloride was about four times higher at the Crockett Kendall site.

Average levels of 1,3-butadiene and benzene were about a factor of two higher at the San Pablo site than the Crockett sites, while methylene chloride was substantially higher. Acetaldehyde was slightly higher at the San Pablo site than the Crockett SB 25 site. Levels of formaldehyde and *para*-dichlorobenzene were higher at the Crockett SB 25 site than at the San Pablo site. Most measurements of hexavalent chromium and *para*-dichlorobenzene were below the detection limits. Although diesel PM is a major contributor to overall risk levels in many areas, a direct measurement method for it is still in development; therefore, data for that toxic air contaminant are not included.

Table 15 summarizes the potential cancer risk for each of the compounds in Table 14 for the same sites. The individual and total risk values for the four air

toxics measured in common at the two Crockett sites were similar. Consistent with the data in Table 14, risk levels for 1,3-butadiene were more than twice as high for the San Pablo site, while risk levels for benzene were about twice as high. Risk levels for the other compounds were the same or similar. Benzene, 1,3-butadiene, and carbon tetrachloride contributed almost two-thirds of the overall risk from the top nine air toxics (excluding diesel PM) at the Crockett SB 25 site and approximately 75 percent of the risk at the San Pablo site. The overall potential cancer risk for the top nine air toxics was about a third lower at the Crockett SB 25 site than at the San Pablo site. Much of this difference can be attributed to differences in benzene and 1,3-butadiene. Similar to the overall cancer risk for the top nine air toxics, the total cancer risk for the four air toxics measured in common was about a third lower at the both Crockett sites than at the San Pablo site.

A more detailed statistical analysis of data collected at Crockett and San Pablo has not been conducted because monitoring has not been completed at the Crockett SB 25 site. Upon completion of monitoring at Crockett, a more detailed statistical analysis, similar to the ones for Barrio Logan, Boyle Heights, and Wilmington, will be conducted to compare cancer risk at Crockett to San Pablo.

Table 14. Summary of Top Nine Air Toxics (Excluding Diesel PM*) at John Swett High School (October 2001 to September 2002) Compared to San Pablo-El Portal and Crockett Kendall – Bay Area (BA) sites.

		John Swett High School (Crockett)			Neighboring Site	
					San Pablo (El Portal) (ARB)**	Crockett Kendall (BA)***
Pollutant	***Units***	***Minimum***	***Maximum***	***Average***	***Annual Average***	***Annual Average***
1,3-Butadiene	ppb	0.02	0.25	0.06	0.13	Not Monitored
Acetaldehyde	ppb	0.10	1.50	0.44	0.52	Not Monitored
Benzene	ppb	0.08	0.58	0.24	0.49	0.26
Carbon Tetrachloride	ppb	0.07	0.12	0.09	0.11	0.10
Formaldehyde	ppb	0.42	4.90	1.83	1.19	Not Monitored
Hexavalent Chromium****	ng/m^3	0.1	0.2	0.1	0.10	Not Monitored
Methylene Chloride	ppb	0.05	0.18	0.07	0.50	0.27
Para-dichlorobenzene****	ppb	0.15	0.15	0.15	0.10	Not Monitored
Perchloroethylene	ppb	0.01	0.07	0.02	0.03	0.02

* Diesel-PM not listed because a direct measurement method is in development.
** Based on 1998-1999 levels
*** Based on 2000-2001 levels.
**** Most of the observed values were below the limit of detection. In those instances, a value equal to one-half of the limit of detection was assumed.

Table 15. Potential Cancer Risk of Top Nine Air Toxics (Excluding Diesel PM*) at John Swett High School (October 2001 to September 2002) Compared to San Pablo-El Portal and Crockett Kendall-Bay Area (BA) sites.

	John Swett High School (Crockett)	Neighboring Site	
		San Pablo (ARB)**	Crockett Kendall (BA)***
Pollutant	***Average***	***Annual Average***	***Annual Average***
1,3-Butadiene	22	50	Not Monitored
Acetaldehyde	2	3	Not Monitored
Benzene	22	45	24
Carbon Tetrachloride	25	30	27
Formaldehyde	13	9	Not Monitored
Hexavalent Chromium****	15	15	Not Monitored
Methylene Chloride	0	2	1
Para-dichlorobenzene****	10	7	Not Monitored
Perchloroethylene	1	1	1
Totals for all 9 Air Toxics	110	162	N/A
Totals for the four common air toxics	48	78	53

* Diesel-PM not listed because a direct measurement method is in development.
** Based on 1998-1999 levels
*** Based on 2000-2001 levels.
**** Most of the observed values were below the limit of detection. In those instances, a value equal to one-half of the limit of detection was assumed.

Fruitvale

The SB 25 site in Fruitvale was located at Lockwood Elementary School. Criteria pollutant and air toxics data have been collected since November 2001; measurements are expected to end in Spring 2003. A summary of the data collected for the periods December 2001 to November 2002 (criteria pollutant data) and November 2001 to October 2002 (air toxics data) for that site is presented below.

For three of the SB 25 sites previously discussed (Barrio Logan, Boyle Heights, and Wilmington), a single neighboring site met our criteria for comparison; these criteria were proximity to the SB 25 site and completeness of data available for comparison. However, for the Fruitvale site no single neighboring site met both of our criteria. The nearest neighboring sites (Oakland-Alice and Oakland – Davie Stadium) only measured a subset of those compounds measured at the SB 25 site. The nearest neighboring site with complete data availability was the Chapel Way site in Fremont. Therefore, three sites were used for the comparison to provide the best and most complete comparison possible.

Table 16 summarizes the criteria pollutant data collected at Lockwood Elementary School, and compares them to measurements taken at the long-term monitoring sites in Oakland (Alice Street) and Fremont (Chapel Way). Ozone levels were very similar at Lockwood and Fremont, while the ozone levels were lower at Oakland (Alice Street) compared to Lockwood. In general, ozone levels were fairly low at all three sites. CO levels were similar at all three sites. There were no exceedances of the State standards at either of the Lockwood and Oakland (Alice Street) sites for the criteria pollutants measured. The Fremont site had an average of four days of ozone levels above the state standard and two days of PM_{10} above the state standard on an annual basis compared to Lockwood which had no days above the state standard, indicating good air quality at Lockwood. Average PM_{10} levels were the same at Fruitvale and Fremont, whereas average $PM_{2.5}$ levels were slightly higher at the Lockwood site, but still relatively clean.

Table 16. Summary of Criteria Pollutant Data at Lockwood Elementary School (December 2001 – November 2002) Compared to Oakland - Alice Street and Fremont Chapel Way

		Lockwood Elementary School (Fruitvale)				Oakland*** (Alice Street) (ARB)		Fremont (Chapel Way) (ARB)	
Pollutant	*Units*	*Days Sampled*	*Maximum*	*Average***	*Days Exceeding Standard**	*Expected # Days Exceeding Standard****	*Annual Average***	*Expected # Days Exceeding Standard* ****	*Annual Average* **
Ozone	ppb	354	84.0	34.5	0	0	24.9	4	36.8
CO	ppm	348	7.7	1.6	0	0	1.5	0	1.3
NO_2	ppb	360	80.0	31.7	0	Not Monitored	Not Monitored	0	33.4
PM_{10}	ug/m^3	52 †	46	22	0	Not Monitored	Not Monitored	2	23
$PM_{2.5}$ ‡	ug/m^3	299	79	16	N/A	Not Monitored	Not Monitored	N/A	12

* Based on the State standard for each pollutant. For $PM_{2.5}$, a 24-hour State standard has not yet been established.
** Based on the average daily maximum value for ozone, CO, and NO_2, and 24-hour values for PM_{10} and $PM_{2.5}$.
*** Based on 1998-2001 annual levels.
**** Scaled to represent the same number of sampling days as for the Lockwood Elementary site.
† Based on PM_{10} data from November 2001 to October 2002.
‡ The average for $PM_{2.5}$ at the long-term Fremont site was based upon the 1999-2001 filter-based $PM_{2.5}$ federal reference method data. The Lockwood Elementary School site was monitored with the continuous hourly $BAM_{2.5}$, but the 24-hour average was used in this summary.

Air toxics data from Lockwood Elementary School are presented in Tables 17-18. These data are compared against data from the Chapel Way site in Fremont and the Davie Stadium site in Oakland.

The Fremont site is operated by the ARB, and is approximately 20 miles from the Fruitvale site. However, it is the closest site to Lockwood Elementary that has a complete set of air toxics data for comparison to Fruitvale. The Oakland site is operated by the Bay Area Air Quality Management District and is the closest neighboring site; it is about four miles from the Fruitvale site. Only a subset of the compounds was measured at the Oakland site.

Table 17 summarizes the air toxics measurements from Lockwood Elementary School, and compares them to measurements taken at neighboring sites in Fremont (Chapel Way) and Oakland (Alice Street). Of the four air toxics measured in common at the Fruitvale and Oakland sites, the average levels for three (carbon tetrachloride, methylene chloride, and perchloroethylene) were similar, while benzene levels at the Fruitvale site were higher than at the Oakland site. Average levels of methylene chloride at the Fremont site were more than twice the levels at the Fruitvale and Oakland sites. Formaldehyde was slightly higher at the Fremont site than at the Fruitvale site. Most measurements of hexavalent chromium and *para*-dichlorobenzene were below the detection limits. Although diesel PM is a major contributor to overall risk levels in many areas, a

direct measurement method for it is still in development; therefore, data for that toxic air contaminant are not included.

Table 18 summarizes the potential cancer risk for each of the compounds in Table 17 for the same sites. Risk levels for the four air toxics measured in common at the Fruitvale and Oakland sites (benzene, carbon tetrachloride, methylene chloride, and perchloroethylene) were similar except for benzene, which was about a third less at the Oakland site than at the other two sites. Overall risk from the four common air toxics was about 20 percent lower at the Oakland site than at the Fruitvale and Fremont sites.

Risk levels for 1,3-butadiene were slightly higher at the Lockwood Elementary site than at the Fremont site, while the risk levels for the other compounds were the same or similar. Similar to the other SB 25 sites, benzene and 1,3-butadiene contributed almost two-thirds of the overall risk from the top nine air toxics (excluding diesel PM) at both sites. The overall potential cancer risk for the top nine air toxics was similar for both sites.

Table 17. Summary of Top Nine Air Toxics (Excluding Diesel PM*) at Lockwood Elementary School (November 2001 – October 2002) Compared to Fremont-Chapel Way and Oakland-Davie Stadium-Bay Area (BA) sites.

		Lockwood Elementary School (Fruitvale)			Neighboring Site**	
					Fremont (ARB)	Oakland (Davie) (BA)
Pollutant	***Units***	***Minimum***	***Maximum***	***Average***	***Annual Average***	***Annual Average***
1,3-Butadiene	ppb	0.02	1.00	0.19	0.17	Not Monitored
Acetaldehyde	ppb	0.05	1.70	0.69	0.79	Not Monitored
Benzene	ppb	0.08	2.30	0.56	0.59	0.38
Carbon Tetrachloride	ppb	0.07	0.14	0.09	0.10	0.11
Formaldehyde	ppb	0.50	7.80	1.96	2.28	Not Monitored
Hexavalent Chromium***	ng/m^3	0.10	0.54	0.13	0.10	Not Monitored
Methylene Chloride	ppb	0.05	6.90	0.26	0.65	0.28
Para-dichlorobenzene***	ppb	0.15	0.33	0.15	0.11	Not Monitored
Perchloroethylene	ppb	0.01	0.61	0.08	0.07	0.05

* Diesel-PM not listed because a direct measurement method is in development.
** Based on 1998-2001 levels.
*** Most of the observed values were below the limit of detection. In those instances, a value equal to one-half of the limit of detection was assumed.

Table 18. Potential Cancer Risk of Top Nine Air Toxics (Excluding Diesel PM*) at Lockwood Elementary School (November 2001 – October 2002) Compared to Fremont-Chapel Way and Oakland-Davie Stadium-Bay Area (BA) sites.

	Lockwood Elementary School (Fruitvale)	Neighboring Site**	
		Fremont (ARB)	Oakland Davie (BA)
Pollutant	***Average***	***Annual Average***	***Annual Average***
1,3-Butadiene	70	64	Not Monitored
Acetaldehyde	3	4	Not Monitored
Benzene	52	54	35
Carbon Tetrachloride	24	26	28
Formaldehyde	14	17	Not Monitored
Hexavalent Chromium***	19	15	Not Monitored
Methylene Chloride	1	2	1
Para-dichlorobenzene***	10	7	Not Monitored
Perchloroethylene	3	3	2
Totals for all 9 Air Toxics	196	192	N/A
Totals for the four common air toxics	80	85	66

* Diesel-PM not listed because a direct measurement method is in development.
** Based on 1998-2001 levels.
*** Most of the observed values were below the limit of detection. In those instances, a value equal to one-half of the limit of detection was assumed..

Fresno

Air quality data from the First Street monitoring site and one mobile trailer at the Fremont Elementary School – is being considered as part of an ongoing monitoring program associated with the Fresno Asthmatic Children's Environment Study. This large health study in combination with the ambient monitoring will provide critical insights into the role of specific air pollutants and other environmental factors in acute responses and the natural history of childhood asthma.

The SB 25 site in Fresno is located at Fremont Elementary School. Data have been collected at that site since June 2002 (criteria pollutants) and July 2002 (air toxics); measurements are expected to end in Summer 2003. A summary of a portion of the data collected for that site is presented below. At this time only a few months of criteria pollutant and air toxics data are available for the Fresno SB 25 site. Because of the limited amount of data, it is impossible to characterize the seasonal variations which occur at most sites. For example, ozone is typically highest in summer when there is abundant sunlight and temperatures are highest; air toxics are typically highest in winter when the air is most stagnant, allowing pollutants to accumulate. Therefore, we believe it is prudent to hold off making any conclusions about measurements at the Fresno SB 25 site until at least a full year of data are available.

Table 19 summarizes the criteria pollutant data collected at Fremont Elementary School, and compares them to measurements taken at the nearby long-term monitoring site at Fresno First Street. Since only five months of data were available at the time of this analysis, average levels for Fresno First Street were calculated in two different ways: the annual average for the period of 1998-2001 and a matched month average (June through October) for the period of 1998-2001 as the sampling conducted for Fremont Elementary School.

The average levels and number of days exceeding the standards for all pollutants were generally similar for both sites, although PM_{10} and $PM_{2.5}$ levels at the Fremont Elementary School site were slightly higher than at the First Street site. Except for PM_{10}, the numbers of exceedances of the State standards were also similar. The numbers of PM_{10} exceedance days were higher at the Fremont Elementary site, probably reflecting the fact that the average levels at that site were close to the standard.

Table 19. Summary of Criteria Pollutant Data at Fremont Elementary School (June 2002 – October 2002) Compared to Fresno First Street

		Fremont Elementary School (Fresno)				Fresno First Street***	
Pollutant	*Units*	*Days Sampled*	*Maximum*	*Average***	*Days Exceeding Standard**	*Expected # Days Exceeding Standard****	*Average***
Ozone	ppb	143	145.8	85.7	39	43	81.6
CO	ppm	144	4.2	1.3	0	0	1.1
NO_2	ppb	143	77.5	44.3	0	0	39.7
PM_{10} †	ug/m^3	144	119	47	55	31	40
$PM_{2.5}$ ‡	ug/m^3	142	58	23	N/A	N/A	15

* Based on the State standard for each pollutant. For $PM_{2.5}$, a 24-hour State standard has not yet been established.
** Based on the average daily maximum value for ozone, CO, and NO_2.
*** Based on 1998-2001 data with months that correspond to the data collected at Fremont Elementary.
**** Scaled to represent the same number of sampling days as for the Fremont Elementary site.
† PM10 sampling frequency at Fresno First Street was once every six days, using a high volume size selective inlet sampler; the sampling frequency at the Fremont Elementary site using a BAM10 monitor was hourly, but the 24-hour average was used in this summary.
‡ The average for $PM_{2.5}$ at the long-term Fresno First Street site was based upon the 1999-2001 filter-based $PM_{2.5}$ federal reference method data. The Fremont Elementary site was monitored with the continuous hourly $BAM_{2.5}$, but the 24-hour average was used in this summary.

Table 20 summarizes the air toxics measurements from Fremont Elementary School, and compares them to measurements taken at the neighboring site at Fresno First Street. With the exception of methylene chloride, the matched month average levels at the First Street site were similar to the average levels observed at Fremont Elementary; methylene chloride was significantly higher at the First Street site. The annual average benzene and 1,3-butadiene levels at the First Street site were significantly higher than the matched month average levels, however for all other compounds the two averages were reasonably similar. All measurements of *para*-dichlorobenzene were below the detection limits. Although diesel PM is a major contributor to overall risk levels in many areas, a direct measurement method for it is still in development; therefore data for that toxic air contaminant are not included.

Table 21 summarizes the potential cancer risk for each of the compounds in Table 20 for the same sites. Consistent with the data in Table 21, annual average risk levels for benzene and 1,3-butadiene were significantly higher than both the matched month average risk levels for the First Street site and the average levels observed at the Fremont Elementary site. The risk levels for the other air toxics were similar. On an annual average basis, benzene and 1,3-butadiene contributed almost two-thirds of the overall risk from the top nine air toxics (excluding diesel PM) at the First Street site, yet only about 45 percent of the risk during the matched months. Those same two compounds contributed approximately 40 percent of the overall potential cancer risk at the Fremont Elementary site. The overall potential cancer risk from the top nine air toxics was similar for the same months at both sites, but significantly higher at the First

Street site when considering annual average levels. Of the two, the matched-month average comparison is the more reliable.

Table 20. Summary of Top Nine Air Toxics (Excluding Diesel PM*) at Fremont Elementary School (July 2002 – October 2002) Compared to Fresno First Street

		Fremont Elementary School (Fresno)			Fresno First Street**	
Pollutant	***Units***	***Minimum***	***Maximum***	***Average***	***Matched-Month Average***	***Annual Average***
1,3-Butadiene	ppb	0.02	0.37	0.08	0.10	0.21
Acetaldehyde	ppb	1.40	5.80	2.38	2.09	1.58
Benzene	ppb	0.14	2.30	0.43	0.44	0.74
Carbon Tetrachloride	ppb	0.07	0.10	0.09	0.09	0.09
Formaldehyde	ppb	2.60	9.80	4.81	5.13	3.88
Hexavalent Chromium †	ng/m^3	0.10	0.29	0.14	0.13	0.11
Methylene Chloride	ppb	0.05	0.33	0.10	0.39	0.42
Para-dichlorobenzene***	ppb	0.15	0.15	0.15	0.13	0.12
Perchloroethylene	ppb	0.01	0.05	0.02	0.04	0.05

* Diesel-PM not listed because a direct measurement method is in development.
** Based on 1998-2001 levels.
*** Most of the observed values were below the limit of detection. In those instances, a value equal to one-half of the limit of detection was assumed.
† Based on hexavalent chromium data for Fremont Elementary School (August 2002 to October 2002) and First Street (1998-2001 from August to October each year).

Table 21. Potential Cancer Risk of Top Nine Air Toxics (Excluding Diesel PM*) at Fremont Elementary School (July 2002 – October 2002) Compared to Fresno First Street

	Fremont Elementary School (Fresno)	Fresno First Street**	
Pollutant	***Average***	***Matched-Month Average***	***Annual Average***
1,3-Butadiene	29	39	81
Acetaldehyde	12	10	8
Benzene	40	41	69
Carbon Tetrachloride	23	23	24
Formaldehyde	35	38	29
Hexavalent Chromium †	20	19	17
Methylene Chloride	0	1	1
Para-dichlorobenzene***	10	8	8
Perchloroethylene	1	2	2
Totals	**170**	**181**	**239**

* Diesel-PM not listed because a direct measurement method is in development.
** Based on 1998-2001 levels.
*** Most of the observed values were below the limit of detection. In those instances, a value equal to one-half of the limit of detection was assumed.
† Based on hexavalent chromium data for Fremont Elementary School (August 2002 to October 2002) and First Street (1998-2001 from August to October each year).