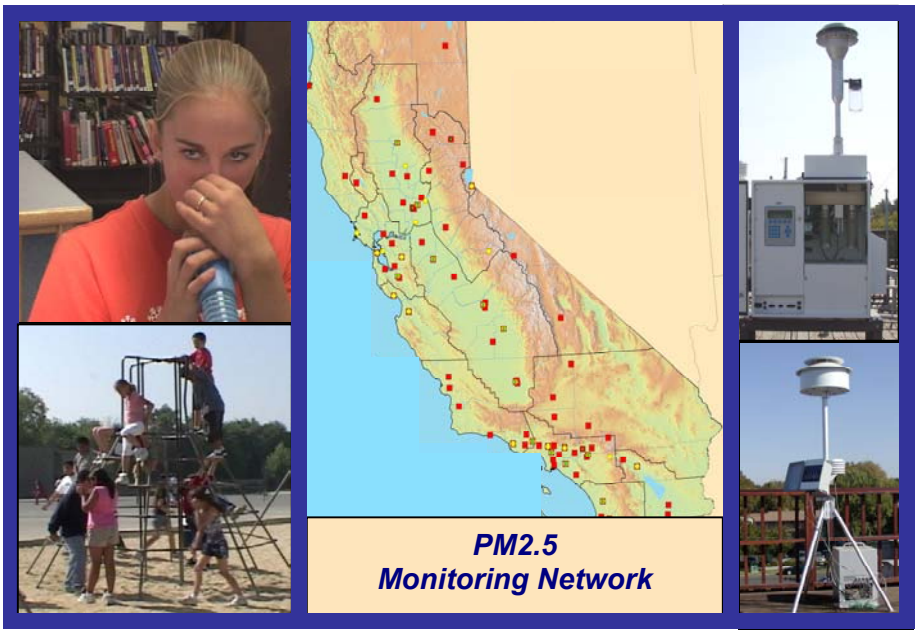
2002 Annual Report on the Air Resources Board's

Fine Particulate Matter Program



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2002 Annual Report on the Air Resources Board's Fine Particulate Matter Program

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"*The energy challenge facing California is real. Every Californian needs to take immediate action to reduce energy consumption. For a list of ways you can reduce demand and cut energy costs, see our Web-site at www.arb.ca.gov.*"

Executive Summary

This report provides the 2002 annual update on the Air Resources Board's (ARB or Board) fine particulate matter (PM2.5) program. It includes the 2002 annual update on ARB's monitoring program.

The major elements of ARB's particulate matter (PM) program are: health and exposure research; air quality monitoring; emission inventory development; air quality modeling; planning; and control strategy development. While our work on these areas during 2002 represents significant progress, it is critical that we continue work in each of these program areas.

Program highlights for 2002 include our Board's approval of a revised PM10 annual average standard and a new PM2.5 annual standard. California's PM10 and PM2.5 standards are the most health-protective standards in the nation. Reaching and maintaining these standards is requisite to protecting public health.

We completed a database structure to house the large amount of data collected during the California Regional PM10/PM2.5 Air Quality Study. We also developed plans for analysis and modeling of these data to support the new PM10 State Implementation Plan for the San Joaquin Valley Air Basin and future clean air plans.

Expansion of the statewide PM2.5 monitoring network continued as scheduled, along with the analysis of data collected from 1999-2001. We conducted a preliminary statewide assessment of ambient PM2.5 characteristics including the sources leading to observed ambient particle concentrations. Most urban areas, as well as some rural areas, exceed one or both of the national PM2.5 standards (24-hour or annual). The South Coast Air Basin and the San Joaquin Valley record the highest 24-hour and annual average concentrations, with values up to twice the standards. In the San Joaquin Valley, where PM2.5 concentrations are highest during the winter months, secondary ammonium nitrate – formed in the atmosphere from reactions of nitrogen oxides emitted from mobile and stationary combustion sources – wood smoke, and direct emissions from motor vehicles are the major contributors. In the South Coast, where PM2.5 concentrations can reach high levels in the spring, fall, and winter, secondary ammonium nitrate, and carbon particles emitted from mobile and stationary combustion sources are the largest contributors.

As part of ARB's Diesel Risk Reduction Plan, we adopted a control measure limiting idling from school buses and other vehicles at schools. We also are developing control measures to reduce PM emissions from diesel-fueled transportation refrigeration units and engines used in stationary equipment like compressors, cranes, and generators. In 2002, we have also verified seven retrofit systems for use with a number of heavy-duty diesel vehicle types and models, bringing the total to nine verified retrofit systems.

Year 2003 efforts will continue in each of the program areas. Analysis of data collected as part of the California Regional PM10/PM2.5 Air Quality Study, as well as the statewide PM2.5 data collected in 2002, will be priorities. Results of these analyses will strengthen the technical underpinnings of our PM2.5 program, enable us to assess progress, and help focus efforts on further strategies needed to reduce unhealthy levels of particulate pollution throughout California.

Why are we concerned about inhalable particulate matter in ambient air?

Exposure to inhalable particulate matter aggravates a number of respiratory illnesses and may even cause early death in people with existing heart and lung disease.

Particulate matter (PM) pollution is one of the most formidable air quality and public health issues facing California. Exposure to particle pollution is linked to increased frequency and severity of asthma attacks, pneumonia and bronchitis, and even premature death in people with existing cardiac or respiratory disease. Those most sensitive to particle pollution include people with existing respiratory and cardiac problems, children, and the elderly. Prolonged and repeated short-term exposure can have adverse impacts. In addition, particulate exhaust from diesel engines has been identified as a toxic air contaminant - suspected to cause cancer and other serious illnesses. All particles with a diameter of 10 microns and smaller (PM10) are harmful. PM10 includes the subsets of "coarse" particles, those between 2.5 microns to 10 microns in diameter (PM10-2.5), and "fine" particles, those 2.5 microns or smaller (PM2.5). Because PM2.5 is a subset of PM10, our programs to address PM10 and PM2.5 are closely linked.

Ambient air quality standards establish the levels above which PM may cause adverse health effects in humans. In 1982, the Air Resources Board (ARB) adopted 24-hour average and annual average PM10 standards. National ambient air quality standards for PM10 have been in place since 1987. However, California's PM10 standards are more health-protective. The U.S. Environmental Protection Agency (U.S. EPA) promulgated new national air quality standards for PM2.5 to complement the existing PM10 standards in 1997.

The national PM2.5 standards were challenged in court by a number of business and industry groups, but the U.S. Supreme Court and the Court of Appeals for the District of Columbia upheld the standards. U.S. EPA is now moving ahead with the implementation of the standards and plans to designate nonattainment areas in the 2004-2005 timeframe. In addition, U.S. EPA is conducting its periodic health review of the PM standards and expects to complete it in 2004.

As required by the Children's Environmental Health Protection Act (Senate Bill 25, Escutia, 1999), ARB and the

California has adopted the most health-protective PM10 and PM2.5 ambient air quality standards in the nation. Reaching and maintaining these standards is requisite to protecting public health.

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Office of Environmental Health Hazard Assessment (OEHHA) have reviewed the State PM10 and sulfate standards for their ability to adequately protect public health, including that of infants and children. This review also included an evaluation of PM2.5. Numerous epidemiological studies have found associations between health effects - mortality, exacerbation of asthma, bronchitis, and reduction in lung function - in infants, children, the elderly, and other potentially sensitive groups and PM10 levels at or below the current State PM10 standards. In June 2002, the Board lowered the level of the PM10 annual standard, established a new annual PM2.5 standard, and retained the current 24-hour standard for sulfates.

The Board also requested that we closely follow work being conducted by the U.S. EPA and their Clean Air Advisory Committee to reanalyze short-term exposure PM studies. The approved recommendations were the outcome of an extensive scientific and public review, including peer review by the University of California appointed Air Quality Advisory Committee. The new annual average State standards will become effective in early 2003. We plan to bring a proposal of nonattainment area designations for the new standards to our Board for consideration by the end of 2003.

Table 1: PM10 and PM2.5 Ambient Air Quality Standards. The levels of the standards are expressed in micrograms per cubic meter ($\mu g/m^3$).

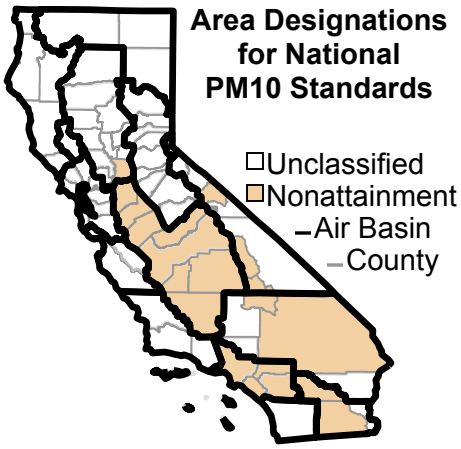
	California		***National***	
PM10	24-hour ($\mu g/m^3$)	Annual ($\mu g/m^3$)	24-hour ($\mu g/m^3$)	Annual ($\mu g/m^3$)
current	50	30	150	50
new		20		
PM2.5				
current			65	15
new		12		

How widespread is the particulate matter problem in the State?

Virtually all of California violates the current State PM10 air quality standards. Several areas, both urban and rural, also violate the national PM10 standards.

Virtually the whole State violates California's current PM10 standards.

Statewide attainment of California's new annual average PM10 and PM2.5 standards would reduce approximately 6,500 premature deaths every year.



Under the federal Clean Air Act, states must develop plans, known as State Implementation Plans (SIPs), describing how and when they will attain national ambient air quality standards. With ARB's technical support, the San Joaquin Valley Air Basin, the South Coast Air Basin, and the desert air basins prepared the required PM10 SIPs, which were adopted in the mid 1990's. The South Coast and San Joaquin Valley nonattainment areas are currently preparing updated PM10 SIPs. While State law does not require air districts to prepare plans for attaining the State PM10 standards, it does require them to adopt and enforce rules and regulations to expeditiously attain them. However, our statewide program to reduce ozone also reduces PM levels. Attainment plans for PM2.5 will likely be due in the 2007-2008 timeframe - three years after nonattainment areas are designated.

State law does not require air districts to prepare plans showing how and when the State PM10 standards will be met, but does require them to adopt and enforce rules and regulations to expeditiously attain the standards.

What do we know about particulate matter and its sources?

Particulate matter is a complex mixture of many different species generated from a wide array of sources. PM can either be emitted directly into the air in forms such as dust and soot, or it can be formed in the atmosphere (like ozone) from the reaction of gaseous precursors such as

Particulate Matter consists of:

Primary Particles
that are directly emitted into the air and are mostly "coarse" in size, but also include some fine particles

and

Secondary Fine Particles
that are formed in the atmosphere through the chemical reactions of precursor gas emissions, including organic gases, nitrogen oxides, sulfur oxides, and ammonia.

nitrogen oxides (NOx), volatile organic compounds (VOCs), sulfur oxides (SOx), and ammonia. Stagnant conditions and cool temperatures during the winter contribute to the formation of secondary ammonium nitrate and ammonium sulfate particles. NOx and VOCs are also precursors of ozone pollution.

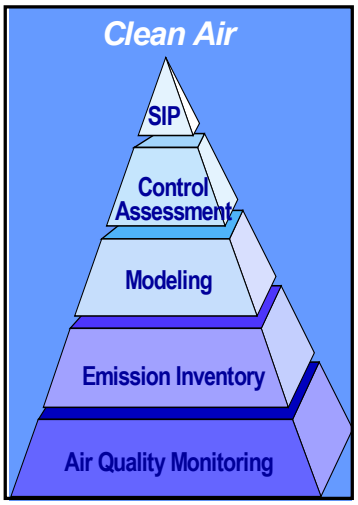
Sources of ambient PM include: combustion sources such as trucks and passenger cars, off-road equipment, industrial processes, residential wood burning, and forest/agricultural burning; fugitive dust from paved and unpaved roads, construction, mining, and agricultural activities; and ammonia sources such as livestock operations, fertilizer application, and motor vehicles. In general, combustion processes form fine particles, whereas particles from dust sources tend to fall in the coarse range. Diesel vehicles are a significant source of particle pollution from the motor vehicle fleet. Because ozone and PM pollution are caused by many of the same sources and precursors, many of the control strategies in California's ozone SIP – particularly NOx controls – provide dual benefits for public health by reducing PM as well.

What are the components of ARB's PM Program to further understand and address the particulate matter problem?

In the last decade, we have enhanced our technical and research program for PM, building the scientific foundation for the PM10 SIPs adopted in the mid 1990's and SIP revisions now underway. Over the past several years, we have also undertaken significant additional work to enhance our understanding of PM2.5, including: health and exposure research; expanded air quality monitoring; emission inventory improvements; development of improved air quality models; and comprehensive field studies. Each of these technical areas plays an important role in developing California's SIP to address the federal PM2.5 standards and strategies to meet the more health-protective State PM10 and PM2.5 standards:

- *Health and exposure research* helps us understand both the impact of exposure to air pollutants (including who is susceptible to injury and the mechanisms of injury) as well as who is exposed, for how long, when, and where.

ARB continues enhancing its technical and research programs, building the foundation for federal PM10 State Implementation Plan (SIP) revisions now underway, SIPs to address the federal PM2.5 standards, and strategies to meet the more health-protective State PM10 and PM2.5 standards.



The SIP Building Blocks

This helps us determine the appropriate levels for setting health-protective standards.

- *Air quality monitoring* provides information on which areas violate the standards and the nature and extent of the problem.

- *Emission inventories* provide an accounting of the sources of PM emissions and the quantities of emissions produced from these sources.

- *Air quality models and data analyses* link air quality monitoring and emission inventory data with information on meteorology and atmospheric chemistry to tell us the relationship between emissions and air quality. This allows us to determine how much we need to reduce emissions to meet the air quality standards. We also use modeling to understand how air pollution is transported between regions. In support of our modeling efforts, we undertake extensive field studies to obtain the intensive meteorological, emissions, and air quality data needed to run the models.

- *State Implementation Plans* describe how and when we will attain air quality standards. Plans include the technical foundation of monitoring data, emission inventories, and air quality models, as well as identified and assessed control strategies for reducing emissions.

- *Control strategy development and implementation* is the critical step. In developing control strategies, we consider technical feasibility and cost-effectiveness as well as the socioeconomic and environmental impacts of regulations. Many ARB regulations provide multiple benefits. Because they reduce emissions of both ozone and PM2.5 precursors, these controls provide dual benefits for public health.

This report covers our recent accomplishments and planned activities in each of these program areas.

Our program to characterize and control PM2.5 is closely related to two other ARB programs: the diesel particulate matter risk management efforts and the regional haze program. In 1998, the Board identified particulate emissions from diesel-fueled engines as a toxic air

The **Children's Health Study** is the nation's first large-scale effort to explore the effects on school-aged children of long-term exposure to outdoor air pollution, including PM.

Over 5,000 students in 12 southern California communities are participating.

Each child's lung growth and changes in respiratory health are measured annually.

Study findings show that children living in areas with high levels of PM2.5, acid vapor, elemental carbon, and nitrogen dioxide have lower lung function growth than children living in areas with lower air pollution levels.

contaminant (TAC). We estimate the statewide average potential lifetime cancer risk from breathing outdoor PM from diesel-fueled engines to be 540 chances in a million, which represents a significant threat to public health. We are now evaluating ways to reduce the risk associated with exposure to particulate emissions from diesel engines. These risk management efforts dovetail with existing efforts to control emissions to attain the PM and ozone air quality standards.

In 1999, U.S. EPA finalized its new program to reduce the regional haze that impairs visibility in many national parks and wilderness areas. Because fine particles are a main contributor to visibility impairment, our PM control program will improve visibility as well. In California, the regional haze program will be aligned with the PM2.5 planning efforts, so that the necessary technical work can be coordinated.

Health and Exposure Research

ARB has taken a lead in research to more clearly define how particle pollution impacts the health of Californians. Extensive research projects are underway both nationally and within California to clarify some of the uncertainties regarding who is at risk, how to best define a safe level of PM, the mechanism of injury, and the role of specific components of PM in producing harmful health impacts. ARB is also a leader in research on people's exposure to particles and the toxic components of particles in indoor and in-vehicle environments.

- ***Children's Health Study***

The Children's Health Study (CHS) is a large long-term study which follows the lung development and respiratory health of about 5,000 school children in grades 4 through 12, in 12 southern California communities. A recent analysis of CHS participants examined the effect of changes in air pollution levels on lung function growth in children who moved away from CHS communities to other communities. This study found that children had increased lung function growth if the new communities to which they moved had lower particulate pollution and had decreased lung function growth if the new communities had higher particulate pollution. This analysis, published in July 2002, confirms previous results from the CHS that linked

reductions in lung function growth with exposure to higher levels of nitrogen dioxide, PM2.5, and acid vapors. The results also indicate that during the teen years of development, the rate of lung function growth can be altered by a large change in exposure to air pollution. Results of this study highlight the importance of reducing exposure to PM and that immediate benefits to children's health can be obtained.

Recently completed **health and exposure research** studies sponsored by the ARB demonstrate that:

- ***Fresno Asthmatic Children's Environment Study (FACES)***

The objective of FACES, the first project sponsored under ARB's Vulnerable Populations Research Program, is to investigate how air pollutant concentrations at the neighborhood level impact the nature and progression of asthma in school-aged children. The study began in November 2000, with 210 children participating by October 2002. Their respiratory health is being evaluated periodically over four years, in conjunction with measurements of air pollution in the field. Investigators are performing intensive community, home, and school-based air monitoring to produce a refined estimate of air pollution exposure for each participant. Fresno was selected as the study location because the community has a high level of childhood asthma, as well as persistent poor air quality. It is also the site of two extensive air-monitoring efforts, the California Regional PM10/PM2.5 Air Quality Study and a federal particulate matter monitoring supersite.

- Ambient PM2.5 and PM10 levels measured in California's Central Valley are strongly associated with emergency room visits and hospital admissions due to acute and chronic respiratory conditions.

- ***Particulate Air Pollution and Morbidity in the California Central Valley: A High Particulate Pollution Region***

This study, completed in June 2002, investigated the relationship between the daily ambient measures of PM2.5, PM10, the coarse fraction of PM, selected chemical components of PM, and other air pollutants, with daily hospital admissions and emergency room visits for acute respiratory, chronic respiratory, and cardiovascular diseases. The study population was the Kaiser Permanente membership living in the Central Valley. Study results show that PM2.5 and PM10 are strongly and consistently associated with emergency room visits and hospitalizations due to acute respiratory conditions, such as croup, acute bronchitis, and pneumonia. PM2.5 and PM10 levels also correlated with hospital visits and hospitalizations due to the exacerbation of chronic

respiratory diseases, such as asthma, chronic obstructive pulmonary disease, emphysema, and chronic bronchitis. However, no consistent associations between fine PM and cardiovascular events were seen.

- Indoor home cooking activities using either gas or electric stoves result in PM levels that exceed California's ambient air quality standards and indoor air quality guidelines.

- ***Residential Indoor Cooking Exposures Study***

In this recently completed study, investigators found that cooking with either gas or electric stoves leads to high levels of indoor PM2.5, PM10, ultrafine particles - particles that are less than 100 nanometers in diameter - and some gaseous co-pollutants. The resulting levels of PM and nitrogen dioxide exceeded California ambient air quality standards and indoor air quality guidelines. We will use the study data to provide guidance to the public on how to reduce pollutant exposure from cooking activities.

- ***Analysis of Personal and Indoor PM Exposures***

The main objective of this study is to use real-time measurements to precisely quantify the source contributions of outdoor air to indoor and personal PM2.5 exposure levels among healthy persons in Southern California. Field work was completed in the first quarter of 2002. Data analysis is underway, and a final report is expected in early 2003.

- Children are exposed to higher concentrations of diesel PM during their school bus commutes when the buses are idling, located near other diesel vehicles, and traveling on or near freeways.

- ***School Bus Exposure Study***

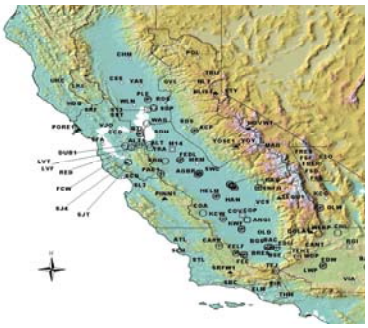
This study seeks to characterize the range of exposure to pollutants, such as diesel exhaust PM, experienced by children during their school bus commutes. Measurements were obtained inside and near buses. The field work was completed in the summer of 2002. Preliminary results show higher in-bus concentrations during idling, when the test bus was near other diesel vehicles, and when traveling on or near freeways. Lower concentrations were generally observed when windows were open and the bus was moving. We expect the study final report in spring 2003.

- ***Monitoring of In-School Exposures***

The objective of this project is to measure a variety of pollutants, including PM10 and PM2.5, inside schools in Boyle Heights, Wilmington, and Crockett, three of the Children's Environmental Health Protection Act communities. The monitoring phase was completed in the summer of 2002. The investigators obtained indoor and personal monitoring data. Sample analyses are now in progress, and a final report is expected in 2003.

CRPAQS

The most extensive and sophisticated PM10/PM2.5 field study in the nation.



CRPAQS air quality and meteorology monitoring network

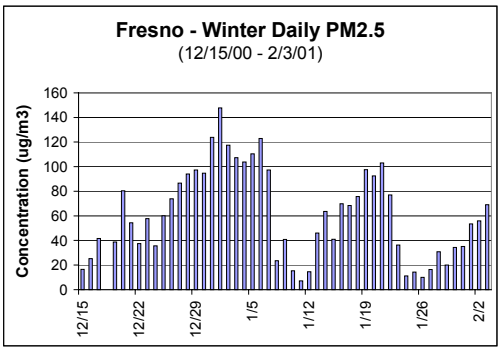
Field work consisted of 14 months of monitoring throughout the San Joaquin Valley and surrounding areas and intensive monitoring during fall and winter, when PM10 and PM2.5 concentrations are highest.

Monitoring Station in Bakersfield

The study is providing key technical information needed to develop PM SIPs and additional particulate reduction strategies in the study area.

California Regional PM10/PM2.5 Air Quality Study

The $27 million California Regional PM10/PM2.5 Air Quality Study (CRPAQS) is providing the key technical information needed to develop PM10 and PM2.5 SIPs for the San Joaquin Valley and surrounding areas. The now completed field program was divided into: a long-term program from December 1999 through January 2001; a summer field program in July and August of 2000; a fall episodic program in October and November of 2000; and, a winter episodic program in December and January 2000/2001. The field program was conducted over a domain extending from the Pacific Ocean in the west into the Mojave Desert in the east, and from the upper Sacramento Valley in the north to the Tehachapi Mountains in the south.



The field program was successful in capturing a very extensive episode of high PM10 and PM2.5 concentrations in the winter of 2000/2001. We recently characterized ambient PM levels, PM size distribution, chemical composition, and meteorology during this episode in support of the San Joaquin Valley Air Basin PM10 SIP revision currently under development. The episode included four different periods in which the national 24-hour PM2.5 standard of 65 $\mu g/m^3$ was exceeded. High PM2.5 concentrations occurred over a broad spatial extent including both urban and rural areas. The main PM chemical components included ammonium nitrate and carbon. Stagnant weather conditions, lack of rainfall, and cold temperatures were conducive to the formation of high PM2.5 levels.

We have built a final database structure to house the large amount of data collected during the field programs. The data have being submitted; we processed the majority of the data into the database by the end of 2002. We have also developed plans for analysis and air quality modeling of the data to support development of clean air plans. The field study data analysis and modeling will assess the

relationships between air quality, meteorology, and emissions in order to identify the mechanisms contributing to PM formation, identify contributing sources, and assess the effects of potential control measures. In March 2002, the CRPAQS Policy Committee approved a number of proposals for the initial data analysis of field program measurements. In-house analysis activities are already underway and contracted activities began in October 2002. We expect to present findings in the fall of 2003. Modeling work began in mid-2002 and will continue through the development of PM and regional haze SIPs.

California's PM2.5 monitoring network now includes:

- Federally-approved monitors that measure PM2.5 mass over a 24-hour period at 81 sites;
- Samplers that quantify PM2.5 mass continuously at 34 sites;
- Monitors that collect PM2.5 samples for analysis of chemical components at 17 sites.

Air Quality Monitoring

California's air quality monitoring program provides information used for determining which areas violate standards, characterizing the sources that contribute to pollution, assessing pollution transport, and supporting health studies and other research. Monitoring data also provide the ultimate check on the effectiveness of our air quality programs. California has a PM10 air monitoring network with over 150 monitors statewide. To address the extent and nature of the PM2.5 problem in California, ARB and air districts are enhancing and expanding the PM2.5 monitoring program. The *2002 Annual Update on the PM2.5 Monitoring Program* is included in Appendix A.

The installation of federally approved PM2.5 mass monitors throughout the State began in 1998 and is now complete, with monitors at 81 sites. ARB and air districts are continuing to expand the PM2.5 monitoring network including speciation monitors, continuous samplers, and background monitors.

Speciation monitors provide information about the composition and ultimately the sources of PM2.5 pollution. As of September 2002, we have installed filter-based speciation monitors at 17 sites.

To provide "real time" PM2.5 air quality information, we are adding continuous PM2.5 monitors to our network. So far we have positioned continuous PM2.5 monitors at 34 sites throughout the State. Continuous monitors will support many facets of the PM2.5 program, including background monitoring, public notification, smoke management, U.S./Mexico border monitoring, and complete temporal

To improve **emission estimates** of PM2.5 and its precursors ARB is:

- Incorporating estimates of directly emitted PM2.5 and the PM2.5 precursor ammonia.

- Updating the existing PM10 emission inventory for the on-going SIP development in the San Joaquin Valley and South Coast air districts, which directly improves PM2.5 estimates.

- Incorporating data obtained from ARB funded research projects into the inventory. Projects completed this year include:

- Improved emission estimates of ammonia from fertilizer application and soils;

- Emission estimates of PM2.5 from commercial charbroiling and deep-fat frying operations; and

- Improved methods to estimate PM2.5 emissions from wildland fires, wood stoves and fireplaces, and agricultural burning.

coverage for locations with the highest concentrations. Continuous monitors will also provide data that ultimately can be used to assess possible short-term health effects due to exposure to peak concentrations of limited duration.

Background sites are intended to quantify PM2.5 concentrations in the absence of anthropogenic emissions. Continuous PM2.5 monitors have been installed at two background sites – Point Reyes and Saint Nicolas Island.

Emission Inventory Development

Work is ongoing to improve our emission estimates for PM2.5 and its precursors. This work is leading to the development of a statewide inventory of the emissions and sources of PM2.5. The inventory will include estimates of future emissions, which consider growth (e.g., in population, miles traveled, housing) and the benefits of adopted air quality programs.

Our existing emission inventory includes estimates for directly emitted PM10, as well as estimates for gaseous precursors, such as NOx, SOx, and VOCs. We are now incorporating emission estimates for PM2.5 and additional particulate precursors such as ammonia. We are also involved in a significant update of the PM10 emission inventory for pending SIPs. In support of this effort, we have: worked with the San Joaquin Valley transportation planning agencies to improve PM10 emission estimates from vehicle transit on paved roads; worked closely with the agricultural community to update PM10 emission estimates for land preparation and harvesting activities; and improved PM10 estimates from construction activities and from transit on unpaved roads. The PM10 inventory update for the San Joaquin Valley will be completed in the fall of 2002. This work directly improves the quality of our PM2.5 estimates.

To quantify and better understand PM2.5 emissions, we fund a number of PM2.5 emission inventory research projects. Projects completed this year include: improved emission estimates of ammonia from fertilizer applications and soils; estimates of PM2.5 emissions from commercial charbroiling and deep-fat frying operations; and improved methods to estimate PM2.5 emissions from wildland fires, woodstoves and fireplaces, and agricultural burning.

Air Quality Models

Link information on:

Air quality monitoring
Emission inventory
Meteorology
Atmospheric chemistry

to tell us:

the relationship between emissions and air quality

so we can determine:

emission reductions needed to attain air quality standards and evaluate effectiveness of control strategies

Combined with our external research, we are also incorporating internal improvements to the emission inventory using geographic information system (GIS) technology. This is improving the quality, consistency, and accessibility of emission inventory data.

Air Quality Modeling

We develop air quality models and run these models to predict how emissions, weather, and terrain influence ambient levels of pollutants, based on monitoring data, emission inventories, and atmospheric chemistry. Air quality models are also used to determine the emission reductions needed to achieve air quality standards and to evaluate the effectiveness of control strategies. Regional models are used to assess pollution transport from one area to another. These types of transport assessments are needed to ensure that necessary actions are taken in both upwind and downwind air districts to meet air quality standards.

California has developed some of the most advanced photochemical models in the nation for ozone. However, the state of modeling is not as advanced for PM, in part because of a lack of the extensive air quality and meteorological data needed to run modeling simulations. We are working to advance the state of PM modeling for use in developing PM2.5 attainment plans and PM control strategies. Activities to improve PM modeling capabilities are currently in progress in collaboration with researchers at the University of California at Davis (UCD). Data collected during the CRPAQS field program will be used to evaluate and improve the performance of our meteorological and air quality models.

For attainment planning, the PM2.5 modeling analyses must show the “carrying capacity,” or how many tons of emissions each affected area can hold before it exceeds the daily or annual PM2.5 standards. The carrying capacity for PM2.5 and precursors determines the type and amount of emission reductions needed from new control measures. PM2.5 models will also form the basis for regional haze models to assess the impact of our control strategies on visibility in California and in downwind states.

California has developed the most sophisticated models in the nation for ozone. We are now working to advance the state of PM modeling for use in developing PM2.5 attainment plans and PM control strategies.

Data collected during the CRPAQS field program will be used to evaluate and improve the performance of our meteorological and air quality models.

As an integral part of the San Joaquin Valley PM10 SIP development, ARB and the San Joaquin Valley Air Pollution Control District have prepared a modeling protocol to provide a road map for conducting attainment planning for the national PM10 standards. We have concluded from extensive field measurements in the San Joaquin Valley that secondary PM2.5 contributes significantly to violations of the national PM10 standards. Thus, in collaboration with UCD researchers, we are currently running the PM2.5 models developed so far as part of the attainment modeling effort.

The Western Regional Air Partnership (WRAP), which is one of the five regional planning bodies created by U.S. EPA and managed by the Western Governors Association, is currently conducting PM modeling to support regional haze attainment plans to be submitted in 2003 by some Western States. While California will not submit its regional haze attainment plan until 2008 under a different provision of the regulation, we are participating in the WRAP modeling forum.

What have we learned about the PM2.5 problem in California?

The California PM2.5 monitoring network began operating in 1998, but the majority of the sites started sampling in 1999. Three years of complete data are required to make comparisons to the national PM2.5 standards. Although three years of complete data are also required to determine if an area attains the new State PM2.5 standard, data showing exceedances of the standard are sufficient to determine that an area does not attain the standard. A preliminary assessment of the PM2.5 ambient concentration data collected during the last three years indicate that four air basins exceed the national annual PM2.5 standard of 15 ug/m^3 - Sacramento Valley, San Diego, San Joaquin Valley, and South Coast. Two of these air basins - San Joaquin Valley and South Coast - also exceed the national 24-hour PM2.5 standard of 65 ug/m^3. However, many areas do not have enough data yet to make comparisons with the standards. Boundaries delineating nonattainment areas for the national standards will be determined through the area designations process, which U.S. EPA expects to complete in the 2004-2005 timeframe.

A preliminary **analysis of PM2.5 monitoring data** collected during the last three years indicate that:

- Four air basins, representing both urban and rural areas, exceed the national annual PM2.5 standard. Two of these air basins also exceed the national 24-hour standard.

- Eight air basins, representing many urban areas, as well as some rural areas, may exceed the new State annual PM2.5 standard.

- The South Coast and San Joaquin Valley Air Basins recorded the highest 24-hour and annual average PM2.5 concentrations in the State.

Table 2: Air Basins Exceeding the National PM2.5 Standards *(preliminary, based on 1999-2001 data)*

Air Basin	Design Value ($\mu g/m^3$)	
	Annual	24-hour
Sacramento Valley	15.4	
San Diego	17.1	
San Joaquin Valley	24.7	104
South Coast	30.1	77

Our preliminary assessment also shows that eight air basins may exceed the new State annual PM2.5 standard of 12 $\mu g/m^3$: Mountain Counties, Sacramento Valley, San Diego, San Francisco Bay Area, San Joaquin Valley, Salton Sea, South Central Coast, and South Coast. ARB expects to designate nonattainment areas for the State PM2.5 standard by the end of 2003, following a public consultation process.

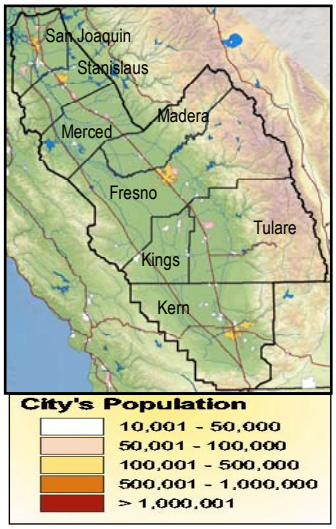
The South Coast and the San Joaquin Valley Air Basins recorded the highest annual averages and 24-hour concentrations in the State. The annual averages were about twice the level of the State standard. For these air basins, we have conducted a preliminary assessment of the characteristics of ambient PM2.5. We analyzed ambient PM2.5 (1999 throughout the first part of 2002) data from California's air quality monitoring network, and chemical composition and source attribution information from a variety of special studies.

The San Joaquin Valley Air Basin

High PM10 and PM2.5 concentrations in the San Joaquin Valley have been recorded during the fall and winter seasons. From mid-November through February, PM2.5 makes up a large portion – up to 90 percent - of PM10. In October and early November, the coarse component drives the PM10 levels, with the PM2.5 fraction accounting for approximately 35 percent of the PM10 concentrations. PM2.5 concentrations are generally low the remainder of the year.

During the winter, PM2.5 concentrations remain elevated for extended periods, as shown on the figure below. In the

San Joaquin Valley Air Basin



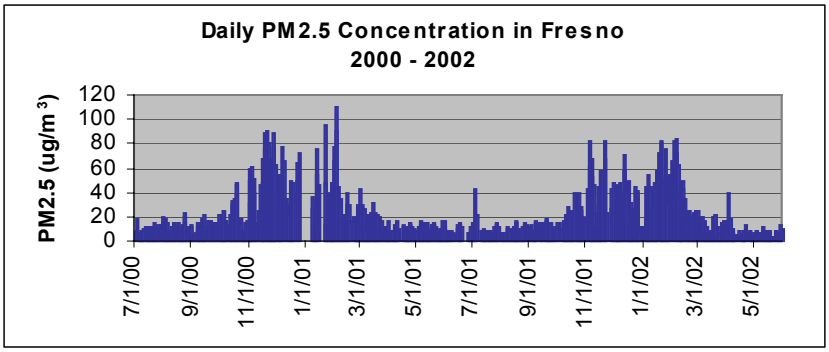
- High PM10 and PM2.5 concentrations occur during fall (October to early November) and winter (mid-November to February).
- In the fall, PM2.5 contributes about one third to ambient PM10 levels.
- In the winter, PM2.5 is the major contributor to PM10.
- Sources contributing significantly to high PM2.5 concentrations in winter include:

- Mobile and stationary combustion processes that emit NOx, the precursor to secondary nitrate particles;

- Diesel and gasoline fueled vehicles emitting particles; and

- Residential wood burning in fireplaces and wood stoves.

air basin, in the winter of 2000/2001, thirty-eight days

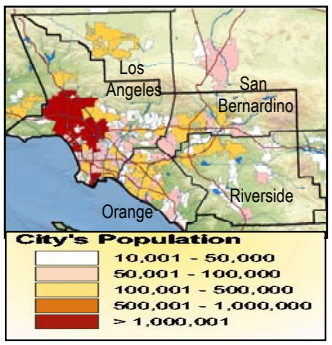


exceeded the level of the national 24-hour PM2.5 standard of 65 $\mu g/m^3$ with a peak concentration of 155 $\mu g/m^3$. In the winter of 2001/2002, twenty-six days exceeded the level of the standard, with concentrations reaching up to 96 $\mu g/m^3$. Ten sites in seven counties exceeded the level of the standard during these two winters. This indicates the broad magnitude of the PM2.5 problem in the San Joaquin Valley Air Basin.

Based on 1999-2001 data, six sites located in Fresno, Kern, Stanislaus, and Tulare counties exceeded the 24-hour PM2.5 standard, with design values ranging from 68 $\mu g/m^3$ to 104 $\mu g/m^3$. Nine sites located in Fresno, Kern, San Joaquin, Stanislaus, and Tulare counties exceeded the national annual PM2.5 standard of 15 $\mu g/m^3$, with design values ranging from 16.4 ug/m^3 to 24.7 $\mu g/m^3$.

In urban areas (e.g., Fresno), emission sources contributing to elevated PM2.5 levels include: vehicle exhaust particles from diesel- and gasoline-fueled cars, trucks, and off-road equipment; and smoke particles from residential wood combustion in fireplaces and wood stoves. Motor vehicles and stationary combustion sources also emit NOx, which reacts in the atmosphere to form secondary nitrate particles. Winter conditions, including low temperatures, low wind speeds, low inversion layers, and high humidity, favor the formation of secondary nitrate particles. Mobile sources such as diesel vehicles and locomotives contribute to the SOx that forms secondary sulfate particles. Animal feedlots, fertilizers, and motor vehicles emit ammonia, which combines with sulfate and nitrate to form secondary ammonium nitrate and ammonium sulfate particles. In rural areas of the San Joaquin Valley, while ammonium nitrate is a large

South Coast Air Basin



- High PM2.5 ambient concentrations occur in the spring, fall, and winter.

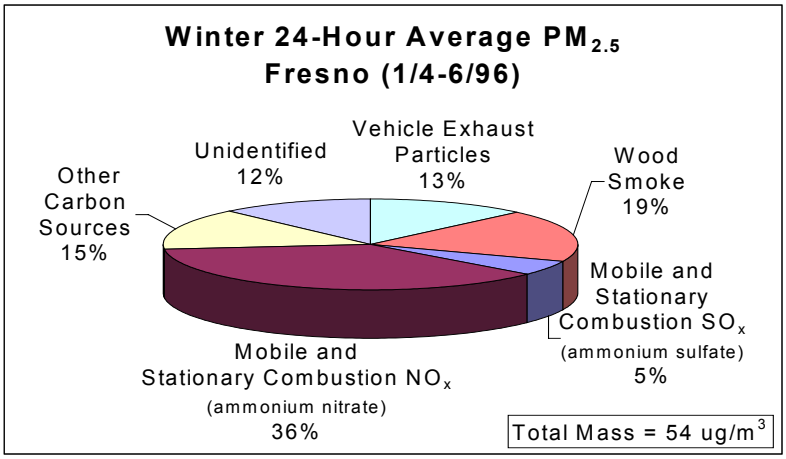
- On an annual average-basis, PM2.5 contributes approximately half of the PM10 concentrations in the region.

- PM2.5 chemical composition data and emission inventory information indicate that major sources contributing to ambient PM2.5 levels include:

- Diesel- and gasoline-fueled combustion sources, such as cars, trucks, industrial equipment and other stationary combustion processes that emit NOx, the precursor of secondary nitrate particles; and

- Mobile and stationary sources that emit carbon particles.

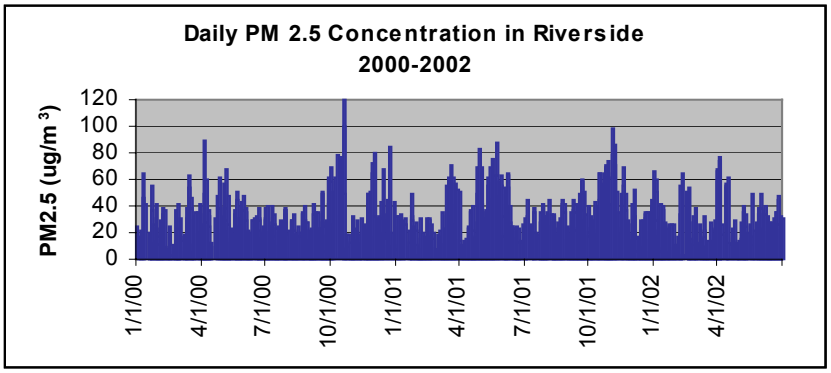
contributor to winter PM2.5, wood smoke and vehicle exhaust particles are not as prominent as in urban areas.



Source apportionment data are from the 1995 Integrated Monitoring Study, a precursor to CRPAQS. Chemical composition data from ambient PM2.5 samples and from emission sources were used in a Chemical Mass Balance Model to establish which sources and how much of their emissions contribute to ambient PM2.5 levels

The South Coast Air Basin

As illustrated in the figure below, PM2.5 concentrations can reach high levels in the spring, fall, and winter. However, high PM2.5 concentrations have been recorded most frequently during the fall (seventeen days in 2000 and twelve days in 2001) and winter (nine days in 1999). The highest daily PM2.5 concentrations have been measured in the fall. – 120 $\mu g/m^3$ in 2000 and 98 $\mu g/m^3$ in 2001, with at least fourteen sites in the four counties exceeding the level of the standard. This indicates the broad magnitude of the PM2.5 problem in the South Coast Air Basin.



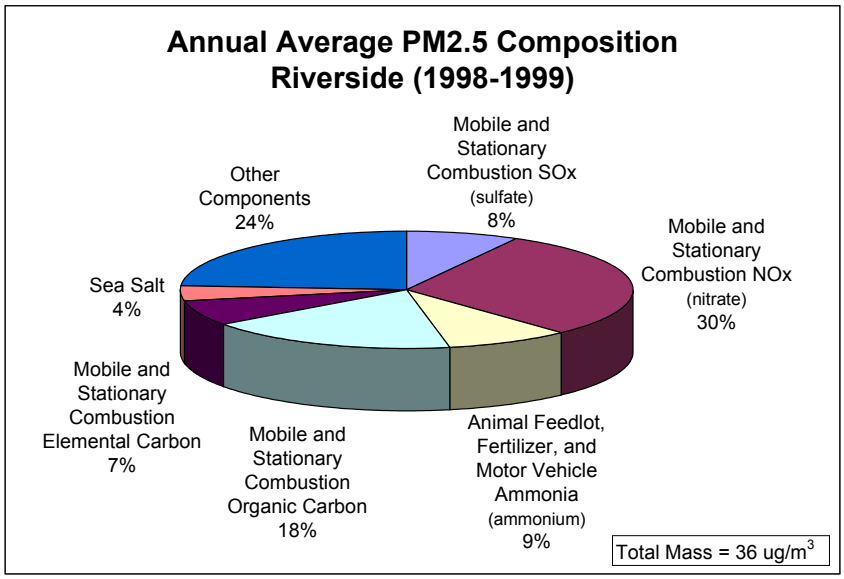
On an annual average basis, PM2.5 constitutes approximately 50 percent of the PM10 levels measured in

To fine-tune our current knowledge of PM2.5, in the future we will:

- Extend the analyses performed to include full data from 2002 to determine compliance with the PM2.5 standards;
- Analyze data from the PM2.5 speciation monitors when it becomes available;
- Conduct further analysis of selected episodes, including assessing the influence of meteorological factors, evaluating the role of transport, and examining variations in emission sources; and
- Integrate analyses from the PM network with data from special studies such as CRPAQS.

the South Coast Air Basin. Based on 1999-2001 data, nine sites located in Los Angeles, Riverside, and San Bernardino counties exceeded the national annual PM2.5 standard of 15 $\mu g/m^3$ with design values ranging from 22.6 $\mu g/m^3$ to 30.1 $\mu g/m^3$. Four sites located in Riverside and San Bernardino counties exceed the national 24-hour PM2.5 standard of 65 $\mu g/m^3$ with design values ranging from 67 $\mu g/m^3$ to 77 $\mu g/m^3$.

PM2.5 chemical composition data indicate that on an annual average basis, NOx from vehicle exhaust and industrial and other stationary combustion processes contribute most significantly to PM2.5 in the region. Diesel- and gasoline-fueled combustion sources, such as cars, trucks, industrial equipment, and other stationary combustion processes contribute to the sizable organic and elemental carbon portions of PM2.5. Mobile sources such as diesel vehicles and locomotives contribute to the SOx that form secondary sulfate particles. Animal feedlots, fertilizer application, and motor vehicles emit ammonia that forms secondary ammonium nitrate and ammonium sulfate particles.



Chemical composition data are from a one-year study conducted August 1998-July 1999 by the South Coast Air Quality management District as part of the Technical Enhancement Program (TEP2000). ARB's emission inventory data indicate possible sources of the PM2.5 components in the region.

To fine-tune our current knowledge of PM2.5, in the future we will: extend the analyses performed to include full data from 2002 to determine compliance with the PM2.5 standards; analyze data from the PM2.5 speciation monitors when it becomes available; conduct further

PM Attainment Plans

- For the national PM2.5 standards, nonattainment areas will likely be designated in the 2004-2005 timeframe and PM2.5 SIPs will be due in 2007-2008.

- The San Joaquin Valley Air Basin failed to attain the PM10 standard by its due date and is presently developing a new PM10 SIP. ARB is providing technical support to the San Joaquin Valley Air Pollution Control District in this effort. The plan will include both directly emitted and secondary PM10 control strategies.

analysis of selected episodes, including assessing the influence of meteorological factors, evaluating the role of transport, and examining variations in emission sources; and integrate analyses from the PM network with data from special studies such as CRPAQS.

What are we doing to address the particulate matter problem?

Planning

The timeline for developing PM2.5 attainment plans (SIPs) is dictated by when nonattainment areas are designated, which in turn is determined by when sufficient PM2.5 air quality monitoring data are available. In 1998, we began collecting PM2.5 monitoring data using the federal reference method for comparison to the standards. Three years of complete monitoring data are needed to designate areas as attainment or nonattainment. Now that the legal challenge to the standards has been resolved, U.S. EPA is developing guidance detailing nonattainment area designation criteria and the specific planning requirements and timelines for the PM2.5 standards. We expect nonattainment areas will be designated in the 2004-2005 timeline. SIPs would then be due three years later, in the 2007-2008 timeframe.

In the meantime, PM10 nonattainment areas continue implementing their PM10 SIPs. The San Joaquin and the South Coast PM10 nonattainment areas are currently revising their PM10 attainment plans.

The San Joaquin Valley Air Pollution Control District (SJVAPCD) failed to attain the national PM10 standards by its attainment deadline of December 2001. Due to the failure to attain, the Clean Air Act requires the SJVAPCD to develop a PM10 SIP showing 5% annual reduction of PM emissions, as well as demonstrating attainment at the earliest possible date. The District plans to submit the SIP to the ARB for its consideration in the summer of 2003. The plan will then be submitted to U.S. EPA. ARB is also providing technical support to the SJVAPCD in the areas of air quality monitoring, emission inventory development, air quality modeling, and control measure development.

- The South Coast Air Quality Management District is currently preparing a comprehensive update to its Air Quality Management Plan, which will provide for attainment of the national PM10 standard by 2006 and the national ozone standard by 2010. Strategies in the plan reduce PM2.5 as well.

- We plan to address visibility concerns for national parks and wilderness areas in California in coordination with our PM2.5 SIPs in 2007-2008. However, we are currently coordinating with other western states to address our contribution to visibility impairment in the Grand Canyon region in 2003.

The South Coast Air Quality Management District (SCAQMD) is currently conducting a periodic comprehensive update of its Air Quality Management Plan (AQMP), which will provide for attainment of the national PM10 standards by 2006 and the national ozone standard by 2010. The new AQMP will include updated emissions data, a new attainment demonstration, and an updated assessment of local, State, and federal emission reduction measures. The District plans to submit the AQMP to ARB as a revision to the SIP in the summer of 2003. The plan will then be submitted to the U.S. EPA.

In regards to control measures, ARB and the Districts will be looking at both directly emitted and secondary PM10 control strategies. Many of the strategies in the SJVAPCD and the SCAQMD attainment plans will therefore reduce PM2.5 as well.

For regional haze, U.S. EPA intends to require visibility SIPs at the same time as PM2.5 SIPs. The regional haze regulation also provides an alternative approach for the nine states that participated in the Grand Canyon Visibility Transport Commission (including California). These states may choose to pursue an accelerated plan submittal in 2003, based on the Commission's recommendations for improving visibility at the Grand Canyon. We are coordinating with other western states to address our contribution to visibility impairment in the Grand Canyon region in 2003, and plan to address visibility concerns for national parks and wilderness areas in California in coordination with our PM2.5 SIPs in the 2007 to 2008 timeframe.

Control Strategy Development and Implementation

ARB develops control strategies for stationary, area, and mobile sources to reduce emissions and achieve air quality goals. The development of control strategies is based on the need for additional reductions to meet State and federal requirements, determined from emission inventories and modeling data, available controls, and technical feasibility. Control strategies are also evaluated for cost-effectiveness and socioeconomic and environmental impacts. Our assessment of the controls needed to attain State and national standards will include estimating the PM2.5 benefits from current and planned

To develop **control strategies,** ARB considers emission reduction targets based on **:**

- Emission inventory and modeling data;
- Available controls;
- Cost-effectiveness; and
- Socio-economic impacts.

Our goal is for the full implementation of ARB's comprehensive **Diesel Risk Reduction Plan** to result in 75 percent reduction of diesel PM emissions and associated risk by 2010.

Diesel PM emissions are responsible for the majority of airborne cancer risk in the State.

control programs for PM10 and ozone. In addition to regulations, we are pursuing emission reductions from voluntary programs, such as the Carl Moyer Program and the lower-emission school bus program. Those programs provide grants for the incremental cost of cleaner trucks, buses, boats, agricultural equipment, and other diesel engines. We have also developed guidelines for agricultural and prescribed burning to minimize smoke impacts.

Efforts to meet PM air quality standards relate closely to our efforts to characterize and manage the risk associated with toxic particulate emissions from diesel engines. An advisory committee of representatives from industry, environmental groups, government agencies, and the public is assisting with our risk management activities.

- **Diesel Risk Reduction Plan**

In September 2000, our Board approved the Diesel Risk Reduction Plan (Plan) that outlines a comprehensive program to further reduce PM emissions and resultant health risk from diesel-fueled engines and vehicles. Overall, emissions from diesel engines are responsible for the majority of the potential airborne cancer risk in California. The Plan includes the development of numerous new control measures over the next several years aimed at substantially reducing emissions from new and existing diesel-fueled stationary engines, on-road, and off-road engines and vehicles. The Plan also includes new requirements to reduce the sulfur content of diesel fuel. Low-sulfur fuel, with a sulfur content level of a maximum of 15 parts per million by weight (ppm), will enable the use of advanced diesel PM control technology to meet future emission standards. Our goal is for the full implementation of the plan to result in a 75 percent reduction of diesel PM emissions and associated health risk by 2010. We continue working on the plan implementation.

- ***Solid Waste Collection Vehicles Rule***

We held public workshops on the development of new in-use performance standards for on-road heavy-duty diesel-fueled residential and commercial solid waste collection vehicles in February and December 2002. We have also met with the affected industry, municipalities, and environmental groups. In December 2002, we completed the data collection phase of a study to support

As part of the **Diesel Risk Reduction Plan,** we are developing the following control measures:

- For on-road heavy-duty diesel-fueled **solid waste collection vehicles**

- For **transport refrigeration units.**

- For **diesel-fueled stationary engines**, including engines used in compressors, cranes, generators, pumps, grinders, and emergency backup generators.

the current understanding on the applicability of current retrofit technology. In April 2002, we launched a survey of waste collection vehicle fleets to assess the status of smoke emissions and retrofit installations. We plan to bring the proposed regulation to our Board for consideration in the spring of 2003.

- Control Measure for Transport Refrigeration Units

In January, April, and November 2002, we held public workshops to discuss the diesel particulate matter control measure being developed for transport refrigeration units. These units are auxiliary engines mounted on trucks to keep food and other perishables cool during transit. We also held the first workgroup meeting. We plan to present the proposed regulation to our Board for consideration in the fall of 2003.

- Control Measure for Diesel-Fueled Stationary Engines

In January, April, and November 2002, we held public workshops to discuss regulatory approaches to reduce emissions from stationary diesel-fueled engines – engines used in compressors, cranes, generators, pumps, grinders, and emergency backup generators. Representatives from air districts, engine manufacturers, and public stakeholders provided helpful input at the meetings. The proposal has since been modified to reduce overall cost to industry while retaining health benefits. We plan to bring the proposed regulation to our Board for consideration in mid 2003.

- Control Measure to Limit School Bus Idling and Idling at Schools

In December 2002, our Board adopted an Airborne Toxics Control Measure (ATCM) to limit school bus idling and idling of public transit and charter type buses and heavy-duty vehicles while operating on or near school grounds at schools. The ATCM is intended to reduce diesel PM and other pollutants in these vehicles' exhaust. The control measure is a high priority because children riding in, and playing near, buses and heavy-duty vehicles are regularly exposed to the highest levels of air pollutants from these sources.

- ARB has **verified** nine **retrofit systems** for use with a number of heavy-duty diesel vehicle types and model years:

  - Five retrofit systems use diesel particulate filters and are capable of reducing PM emissions by 85 percent. Two of these systems also reduce NOx by 25 percent.

  - Four systems use a diesel oxidation catalyst and are capable of achieving 25 percent PM reductions. One of these systems also reduces NOx by 25 percent.

- In 2002 ARB approved the **Diesel Emission Control Strategy Verification Procedure** for evaluating PM reductions from a variety of control mechanisms.

- Retrofit Verification

The most effective retrofit technology available to date is the diesel particulate filter (DPF), found to reduce PM emissions by at least 85 percent. In August 2001, we verified two particulate filters for use with a number of heavy-duty diesel engines in several on-road applications and model years. In October 2001, we extended these verifications to include most 1994-2001 model years, and in July 2002, we extended them to include 2002 model years.

In 2002, we verified seven retrofit systems. Three of these systems use diesel particulate filters and are capable of achieving greater than 85 percent PM, with two of these systems also achieving 25 percent NOx reductions. Four systems use a diesel oxidation catalyst and are capable of achieving greater than 25 percent PM reductions. One of these systems can also reduce NOx by 25 percent. Thus far, only specific model year engines are compatible with these verified technologies.

In May 2002, our Board adopted the proposed Diesel Emission Control Strategy Verification Procedure with some modifications. The procedure will evaluate PM reductions provided by a variety of control strategies, including diesel particulate filters, diesel oxidation catalysts, fuel additives, and alternative diesel fuels. We are currently preparing a notice of modified text detailing the changes.

In October 2001 and February 2002, we held the 4th and 5th International Diesel Retrofit Advisory Committee meetings to discuss diesel retrofit technology. The committee includes technical experts and stakeholders representing agricultural, industry, and environmental interests.

- **Carl Moyer Program (Reduction of Diesel Emissions)**

In March 2002, we updated our Board on the status of the Carl Moyer Program. In the 2001-2002 Budget, the Governor made a one-time budget appropriation of $16 million to continue the program for a fourth year. A portion of these funds is targeted in areas to directly benefit low-income communities and communities of color. The funds were distributed to air districts beginning November 2001. Including this year's budget appropriation, the program has received a total of $114 million. Air districts have provided an additional $41 million in matching funds.

The **Carl Moyer** grant program offsets the cost of cleaner trucks, buses, boats, and agricultural equipment. During its first three years, the program has provided approximately 11 tons per day of NOx and approximately 1,100 pounds per day of PM emission reductions. Most of these emission benefits will occur for a minimum of five years, with some large engine projects providing emission reduction benefits for 20 or more years.

In the first quarter of 2002, ARB awarded grants to three air districts to offset costs associated with the use of **alternative diesel fuels** in existing diesel-powered heavy-duty vehicles. These fuels can reduce NOx emissions over 10 percent and PM emissions over 60 percent.

During its first three years, the program has provided approximately 11 tons per day of NOx and approximately 1,100 pounds per day of PM emission reductions. Most of these emission benefits will occur for a minimum of five years, with some large engine projects providing emission reduction benefits for 20 or more years. The successful implementation of this program has resulted in the repower or purchase of over 4,300 cleaner burning heavy-duty engines, including refuse vehicles, urban transit buses, school buses, agricultural irrigation pumps, marine vessels, and forklifts.

- **The Alternative Diesel Fuel Program**

Under this program, $500,000 was available for ARB to distribute to air districts to offset the incremental operating costs of alternative diesel fuel used in on- and off-road heavy-duty vehicles and equipment. During the first quarter of 2002, we awarded grants to the three air districts (South Coast, Sacramento, and Bay Area) that submitted applications for funding of Alternative Diesel Fuel Program projects. Alternative diesel fuels, or emulsified fuels, are currently being introduced into the market. These fuels have been formulated for use in existing diesel-powered vehicles and equipment, new and old, without hardware add-ons, engine modifications or replacements. Emulsified diesel can reduce NOx emissions over 10 percent and PM emissions over 60 percent. The program requires NOx reductions of at least 10 percent and particulate reductions of at least 15 percent to qualify for participation in the program. In the fourth quarter of 2002, ARB received program status reports from the three districts. The districts have funded projects that focus on using PuriNOx in on-road and off-road equipment, such as loaders, scrapers, and utility tractors. Project participants have committed to using PuriNOx for two years, leading to two years of NOx and PM emission reductions.

- **The Lower-Emission School Bus Program**

The program, co-administered by the ARB and the California Energy Commission, provides grants to upgrade California's aging and high-polluting school bus fleet. Approved by the Board in December 2000, the program implements Governor Davis' directive to reduce school children's exposure to both smog-forming and cancer-causing pollution from school buses. The program's two components - a new bus purchase component and an

The **Lower Emission School Bus Program** provides grants for public school districts to purchase new cleaner buses or emission reducing retrofit devices. By the end of 2002, about 450 new buses were purchased. We expect to see about 3,000 in-use school buses equipped with retrofit devices to reduce toxic PM2.5 emissions by late 2003.

In October 2002, ARB amended the **Transit Bus Fleet Rule** that will significantly reduce NOx and toxic PM2.5 emissions by requiring cleaner engines, cleaner diesel fuel, retrofits to reduce PM emissions from in-use buses, and phase-in of zero-emissions buses. The goal is for every bus to be 85 percent cleaner.

in-use diesel bus retrofit component - are funded to a total amount of $66 million for the 2000-2001 and 2001-2002 fiscal years.

Through the new bus purchase component, public school districts are provided grants to replace their high-polluting pre-1987 school buses with new lower-emitting alternative-fuel school buses or with new lower-emitting diesel school buses that are equipped with catalytic particulate filters requiring the use of low-sulfur diesel fuel. In most cases, the grants pay up to 75 percent of the new bus purchase price. A portion of program funds are targeted in areas to directly benefit low-income communities and communities of color. By the end of 2002 about 450 new school were purchased.

The in-use diesel bus retrofit component of the program pays the full purchase and installation cost of ARB-verified retrofit devices to reduce harmful PM emissions. The ARB has already verified retrofit systems fitted with diesel particulate filters for use with most 1994 and later model year diesel engines used in on-road heavy-duty vehicles. Some retrofit funds may also be used to pay for other retrofit devices, such as diesel oxidation catalysts, once verified by the ARB. By late 2003, we expect to see about 3,000 in-use school buses equipped with retrofit devices to reduce toxic PM emissions.

- **Transit Bus Fleet Rule**

In October 2002, our Board approved amendments to the transit bus fleet rule geared to regain reductions in PM emissions that have been foregone because of the lack of technology for pre-1994 engines. The rule, adopted by our Board in February 2000, will significantly reduce emissions of NOx and toxic diesel particulate exhaust over the next ten years by requiring cleaner engines, cleaner diesel fuel, retrofits to reduce particulate matter emissions from older diesel transit buses, and a phase-in of zero emission buses. The regulation allows transit agencies to choose between a diesel and alternative fuel path to lower emissions. The goal is for every bus on the road to be at least 85% cleaner.

- **Smoke Management Program**

In March 2000, our Board adopted amendments to the State's Smoke Management Guidelines (Guidelines) to

To date, ARB has reviewed and approved **Smoke Management Programs** from 24 air districts. The program's objective is to minimize the impacts of agricultural and prescribed burning on ambient air, including PM levels.

ARB's control measure to reduce toxic airborne contaminant emissions from **outdoor residential waste burning** will also result in PM10 emission reductions.

minimize the impacts from agricultural and prescribed burning on ambient air, including PM levels. The Guidelines emphasize effective planning, coordination among burners and air quality managers, and use of the most technically advanced air quality and meteorology burn management tools. An important element of the Guidelines is the consideration of alternatives to open burning. The Guidelines require air districts to develop their smoke management programs for ARB review and approval. By the end of December 2002, we reviewed and approved smoke management programs from 24 air districts. We have also launched an alternatives to burning web-site providing an interactive map with locations of biomass users.

- **Control Measure for Outdoor Residential Waste Burning**

In February 2002, our Board approved an ATCM to reduce emissions of toxic air contaminants from outdoor residential waste burning. The control measure will also result in PM10 emission reductions. We estimate that one household burning waste outdoors produces 25 pounds of PM10 per year. The ATCM prohibits the outdoor burning of residential waste materials other than natural vegetation, as well as the use of burn barrels. The ATCM also requires any residential burning to take place only on permissive burn days and requires the use of an ignition device approved by the local air pollution control officer. The ATCM provides exemptions for the burning of paper and cardboard and the use of burn barrels in very low population density areas. The exemptions expire in ten years unless they are renewed. The prohibitions will take effect on January 1, 2004, after we conduct a year-long public education and outreach program on the adverse health effects of residential waste burning, the regulation elements, and the alternatives for waste disposal.

- **Periodic Smoke Inspection Program**

The Periodic Smoke Inspection Program (PSI Program) requires all California fleets with two or more heavy-duty diesel powered trucks or buses to perform annual smoke inspections and to repair failing vehicles. Enacted in 1998, the PSI Program required all private and public fleets to complete their first annual inspections by October 1, 1999. Through the end of December 2002, we have called upon more than 12,500 fleets and have found 69.5 percent of

California's **Periodic Smoke Inspection Program** requires all fleets with two or more heavy-duty diesel powered trucks or buses to perform annual smoke inspections and to repair failing vehicles. Through the end of December 2002, we have called upon more than 12,500 fleets and have found 69.5 percent of these fleets to be either full or partially compliant.

ARB conducts random **roadside inspections of heavy-duty vehicles** to ensure smoke emissions are within acceptable limits. Through the end of December 2002, we inspected more than 83,000 vehicles. More than 4,300 trucks and buses have been repaired.

these fleets to be either full or partially compliant. The remaining 30.5 percent of fleets are non-complying and receive follow-up inspections and are eventually brought into compliance. Recalcitrant fleets make up a small percentage of the non-complying fleets but are a major concern of the program. Recalcitrant fleets are being brought into compliance through the issuance of citations and other follow-up actions.

- **Heavy-Duty Vehicle Roadside Inspection Program**

Under the Heavy-Duty Vehicle Roadside Inspection Program, inspectors conduct random roadside tests of diesel trucks to ensure that smoke emissions are within acceptable levels and that emission control devices have not been tampered with. Owners of failing vehicles are issued citations and required to make repairs. Through the end of December 2002, we inspected over 83,000 vehicles since the program was restarted in June 1998 (with over 16,000 inspections in 2002). The inspections have resulted in more than 4,300 citations and over 1,500 non-penalty "fix-it" tickets. The failure rate has decreased from 11 percent when the program was restarted to less than 7 percent. More than 4,300 trucks and buses have been repaired to date. We have instituted a formal program to pursue those owners who are delinquent in clearing their citations in order to ensure that repairs are made. Industry acceptance of the program is good, as indicated by the low rate of citation appeals – approximately 2 percent. The penalties that we collect through the inspection program are recycled back to the industry in the form of incentive programs that promote cleaner heavy-duty engines.

California's PM2.5 monitoring network now includes:

- Federally-approved monitors that measure PM2.5 mass over a 24-hour period at 81 sites;

Appendix A

2002 Annual Update on the PM2.5 Air Quality Monitoring Program

California's air quality monitoring program provides information used for determining which areas violate standards, characterizing the sources that contribute to pollution, determining background concentrations, assessing pollution transport, and supporting health studies and other research. Monitoring data also provide information on how effective our programs are in improving the air quality. California already has a PM10 air monitoring network with over 150 monitors statewide. To assess the nature and extent of the PM2.5 problem in California, ARB and air districts are enhancing and expanding the PM2.5 monitoring program. This effort began in 1998 and will continue until our network is fully in place.

Federal Reference Monitors

The first step in deploying this new network was the siting of PM2.5 mass monitoring equipment. The installation of federally-approved PM2.5 mass monitors at 81 sites throughout California began in 1998 and was completed in 2000. Due to performance limitations in California's environment, we replaced samplers with a different brand of federally-approved monitor in 2002. These monitors collect particulate samples on filters, which are later weighed and analyzed in a laboratory. Because of this two-step process, PM2.5 air quality data collected with these monitors are not immediately available. To provide "real-time" PM2.5 air quality information, we are adding continuous PM2.5 mass monitors to our network.

Continuous Mass Monitors

Continuous PM2.5 mass monitors provide valuable information for public reporting, temporal representation, health studies, transport studies, and background monitoring. PM2.5 mass can be measured continuously with several different commercially available technologies. We have chosen the Beta Attenuation Monitor (BAM) for use in California and have used a combination of State and

- Samplers that quantify PM2.5 mass continuously at 34 sites;

and

- Monitors that collect PM2.5 samples for analysis of chemical components at 17 sites.

federal funds to purchase 37 units. By December 2002, monitors have been placed at 34 field sites.

- **Background sites.** These sites are intended to quantify regionally representative PM2.5 concentrations for sites located away from populated areas and other significant emission sources. Background concentrations for the PM2.5 program are defined as concentrations that would be observed in the absence of anthropogenic emissions of PM and the aerosol particles formed from anthropogenic precursor emissions of VOC, NOx, and SOx. Sources of background PM include particles of soil and crustal material, emissions of organic particles resulting from natural combustion processes such as wildfires, and organic aerosols formed from VOC emissions from vegetation. In addition, natural emissions of gaseous sulfur compounds contribute to a background sulfate component. Our PM2.5 monitoring network now includes two background sites. BAM continuous monitors have been installed at Point Reyes and San Nicolas Island.

- **U.S./Mexico Border Monitoring.** Since 1992, we have participated in cooperative monitoring efforts in the California-Mexico border region with the U.S. EPA, San Diego County and Imperial County Air Pollution Control Districts, and Mexico's environmental regulatory agencies. The objective is to characterize the causes and severity of air pollution in the region, assess the extent of pollutant transport across the California-Mexico border, and develop strategies to improve air quality. As part of this effort, we sited one continuous PM2.5 mass sampler in each of the Mexican cities of Mexicali and Rosarito and two samplers in Tijuana.

Speciation Monitors

Another major stage of network implementation is the deployment of PM2.5 speciation monitors. Speciation monitoring provides valuable information about the composition (and ultimately sources) of PM2.5 pollution. However, monitoring of the individual species that make up PM is still an emerging field, with continuous speciation measurements the greatest challenge. To develop the best speciation network, California will need to take full advantage of emerging technologies – including instrumentation that is not yet commercially available. We

ARB is evaluating various **continuous sampling technologies.**

Nitrate and Sulfate Monitors

Organic Carbon and Elemental Carbon Monitors

are participating in the development of new sampling technology and critical research in this field, including special studies to evaluate newly emerging methods not currently used in routine monitoring.

- **Federally-Required Speciation Monitors.** There are two components to the PM2.5 speciation network in California. The first component, mandated by the U.S. EPA, requires filter-based PM2.5 speciation monitoring at seven California sites that will be part of a national trends network for PM2.5 speciation. These monitors are the National Air Monitoring Stations monitors for the speciation network. Siting of the seven PM2.5 speciation monitors in Bakersfield, El Cajon, Fresno, Sacramento, San Jose, Riverside, and Simi Valley was completed in January 2002.

- **Additional Speciation Monitors**. The second component of California's PM2.5 speciation network is the selection and deployment of samplers at selected State and Local Monitoring Stations (SLAMS). Data from these sites will provide additional information needed for developing effective air quality attainment plans. The focus of the SLAMS PM2.5 speciation network is potential nonattainment areas that do not have data available from special studies.

ARB and the air districts have deployed filter-based speciation monitors at ten sites - Anaheim, Calexico, Chico, Fontana, Escondido, Los Angeles, Modesto, Portola, Sacramento, and Visalia as of September 2002. To complete the SLAMS speciation network, we are also evaluating various continuous sampling technologies. As part of this evaluation, we have purchased speciation samplers that employ advanced technologies. These include four types of continuous PM2.5 speciation monitors to measure nitrate, black carbon, sulfate, and organic carbon/elemental carbon (OC/EC).

Ultrafine Particle Counter Network

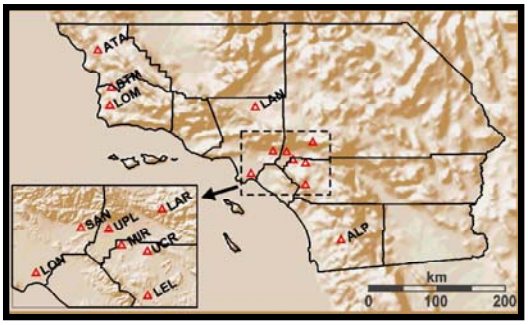
In support of the Children's Health Study, we recently deployed a network of ultrafine particle counters in Southern California including: Los Angeles (Lancaster, Glendora, and Long Beach), Riverside (Lake Elsinore, Mira Loma, and Riverside), San Bernardino (Lake Arrowhead

Ultrafine particle monitoring network

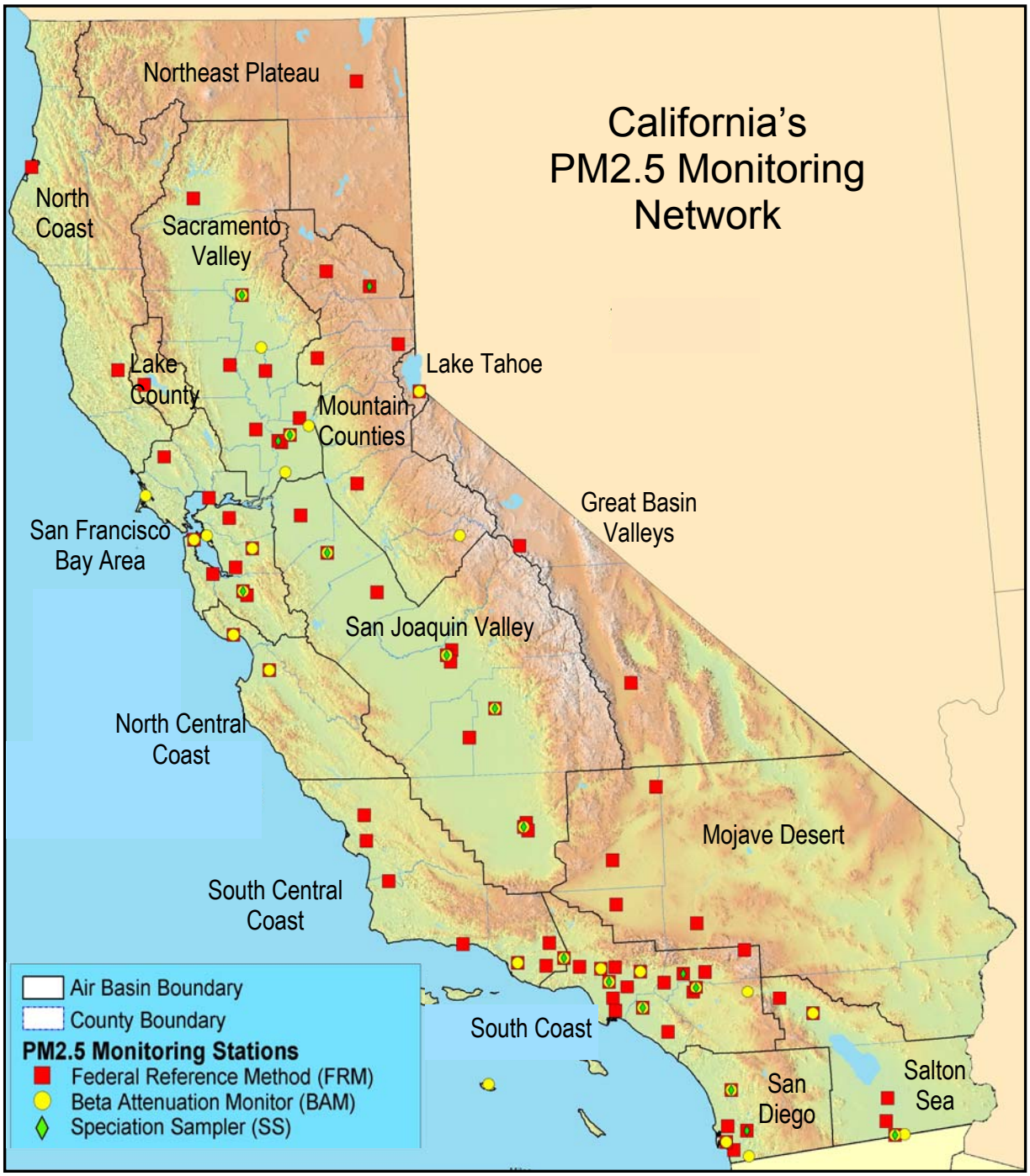
In support of the Children's Health Study, we deployed ultrafine particle counters in 12 Southern California communities.

Ultrafine Particle Sampler

and Upland), Santa Barbara (Santa Maria and Lompoc), San Luis Obispo (Atascadero), and San Diego (Alpine) counties. Ultrafine particles - particles that are 100 nanometers or less in diameter - are usually present in high numbers and due to their small size can be especially harmful to human health. They are emitted by common combustion sources such as cars, trucks, buses and power plants. Data from this monitoring effort will provide new insights into the impact of PM on children's health and into approaches to effectively reduce the levels of all particles in community air.



Ultrafine Particle Counter Network


California's
PM2.5 Monitoring
Network
Northeast Plateau
North
Coast
Sacramento
Valley
Lake
County
Lake Tahoe
Mountain
Counties
Great Basin
Valleys
San Francisco
Bay Area
San Joaquin Valley
North Central
Coast
Mojave Desert
South Central
Coast
South Coast
San
Diego
Salton
Sea
Air Basin Boundary
County Boundary
PM2.5 Monitoring Stations
Federal Reference Method (FRM)
Beta Attenuation Monitor (BAM)
Speciation Sampler (SS)