Chapter 1

Introduction

Overview

The California Almanac of Emissions and Air Quality contains information about current and historical air quality and emissions in California. In addition, forecasted emissions are presented. This almanac represents our best current understanding of emissions and best estimate of emission forecasts. This document is a reference for anyone interested in air quality and emissions for criteria pollutants (ozone, particulate matter, ammonia, nitrogen dioxide, and sulfur dioxide) and diesel particulate matter. When using this information, please note that the air quality and emission values are a snapshot of data at a particular point in time. This edition of the almanac is a year 2013 snapshot of the air quality and emission inventory databases. It is important to keep in mind that emission and air quality data can change over time. For example, emission data may be revised to reflect improved estimation methods, and air quality data may be changed because of corrections or additions of data.

The information in this document is based on data maintained in the ARB's emission and air quality databases. The emission estimates are presented at five-year intervals from 2000 to 2035. The vehicle miles traveled (VMT) and human population estimates are provided at five-year intervals from 1990 to 2035. The air quality statistics in this almanac are for the period 1992 to 2011 for ozone, carbon monoxide (CO), nitrogen dioxide (NO_2), and sulfur dioxide (SO_2). In addition, available 2012 statistics for ozone data are included for the five major air basins. Particulate Matter (PM) monitoring did not begin until 1999 for $PM_{2.5}$. Therefore, $PM_{2.5}$ data cover the period 1999 through 2011.

This almanac focuses on air emissions and air quality. The CalEPA has developed a set of indicators to measure California's overall environmental health. The indicators cover all media, not just air, and help us understand the causes of environmental problems, the status of the environment, and the effectiveness of our environmental strategies. The data in this almanac are more detailed indicators of the State's air quality health, and in conjunction with CalEPA's indicators, provide a continuum of information from detailed air quality trends to California's overall environmental health. The most recent set of CalEPA indicators are available at www.oehha.ca.gov/multimedia/epic/.

Organization

This document is divided into four chapters and five appendices that include information, maps, graphs, and tabular data. Chapter 1 contains introductory material. Chapters 2 through 4 and Appendices A and B provide information on the most important criteria pollutants for which health-based ambient air quality standards have been established. Appendix C includes information on population and VMT, and Appendix D contains information on natural emissions. In addition to this information, Appendix E provides lists of the figures and tables included in Chapters 1 through 4 along with a glossary of Air Quality and Emissions terminology.

To help the reader navigate the document, a short summary of each chapter and appendix is provided below:

- **Chapter 1** contains introductory material designed to help the reader better understand the remaining chapters. Included is information about data interpretation, emission estimation, air quality monitoring, the State and national standards, web resources, and area designations for the national standards.
- **Chapter 2** includes current emissions for oxides of nitrogen (NO_x), volatile organic compounds (VOC), particulate matter (PM_{10}, $PM_{2.5}$), diesel particulate matter (DPM), oxides of sulfur (SO_x), and ammonia (NH_3) and air quality data for ozone, $PM_{2.5}$, CO, NO_2, and SO_2. Also included is California's movement towards attaining air quality in regards to ozone and PM standards.
- **Chapter 3** provides historical emission trends from a statewide perspective. Statewide emission trends for NO_x, SO_x, VOC, PM_{10}, $PM_{2.5}$, DPM, and NH_3 and air quality trends for ozone and $PM_{2.5}$.
- **Chapter 4** provides historical emission and air quality trends for the State's five most populated regions. The pollutants covered are ozone, NO_x, SO_x, VOC, PM_{10}, $PM_{2.5}$, DPM, NH_3, and NO_2.
- **Appendix A** provides air quality data for the criteria pollutants: ozone, $PM_{2.5}$, CO, NO_2, and SO_2. Data are provided for all air basins arranged by pollutant.
- **Appendix B** includes more detailed emission data for NO_x, SO_x, VOC, PM_{10}, $PM_{2.5}$, DPM, NH_3, and CO organized alphabetically, by county. Air quality data are provided similar to that provided in Appendix A and include PM_{10} as well. These data are arranged by air basin and county (or county portion) within these air basins.
- **Appendix C** provides tabulated information on surface area, population, and VMT for the entire State and each county.
- **Appendix D** provides emission estimates for natural sources, including wildfires, vegetation (biogenic sources), and oil seeps (geogenic sources) statewide and for each county.
- **Appendix E** provides lists of the figures and tables included in Chapters 1 through 4. A glossary of terms used in the Almanac is provided at the end of this appendix.

California Facts and Figures

California is fortunate to have a wide range of scenic features encompassing mountains, valleys, oceans, and deserts. The Pacific Ocean forms the State's western boundary, stretching more than 1,200 miles from southern California's sunny beaches to northern California's fog-shrouded redwood forests. The inland valleys, with their hot summers and cool winters, boast millions of acres of cropland. The Sierra Nevada Mountain range to the east runs nearly two-thirds the length of the State. Most of the southeastern portion of California is desert, varying from sun-baked Death Valley to the scenic mountain ranges of the Mojave Desert. To a large extent, California's pleasant climate and varied landscape are the major features that draw people to the State.

In terms of size, California is larger than many nations, comprising more than 150,000 square miles of land and almost 8,000 square miles of water.

- California is the nation's most populous state and the third largest in terms of land area.
- There are 58 counties and close to 500 incorporated cities and towns, most of which are located in the large metropolitan areas where the majority of the population lives: South Coast, San Francisco Bay Area, San Diego, San Joaquin Valley, and the greater Sacramento area.
- Thirty five air districts, in conjunction with ARB, manage air quality programs in California.
- California's growing population, along with weather conditions and terrain that favor a build up of pollutants, contribute to the State's air quality challenges.

Quick Facts

Overview

The federal Clean Air Act requires U.S. EPA to set national ambient air quality standards for six pollutants: ozone, PM, CO, NO_2, SO_2, and lead. Although the federal standards for these pollutants have been in place for many years, U.S. EPA recently lowered the standards for all pollutants but carbon monoxide, based on the newest scientific evidence of health effects. Over time, California has made dramatic progress in reducing public exposure to these pollutants.

- Over the last 20 years, California's population increased 22 percent and the number of vehicle miles traveled each year increased more than 45 percent.
- At the same time statewide emissions of VOC and NO_x, key contributors to ozone and particulate matter, decreased 50 and 60 percent, respectively, since 1990.
- Today's car is 98 percent cleaner than a similar mid-1970s model, and new diesel engines are 95 percent cleaner than those manufactured during the 1980s.
- As a result, more areas in California continue to come into compliance with the ozone and PM standards.

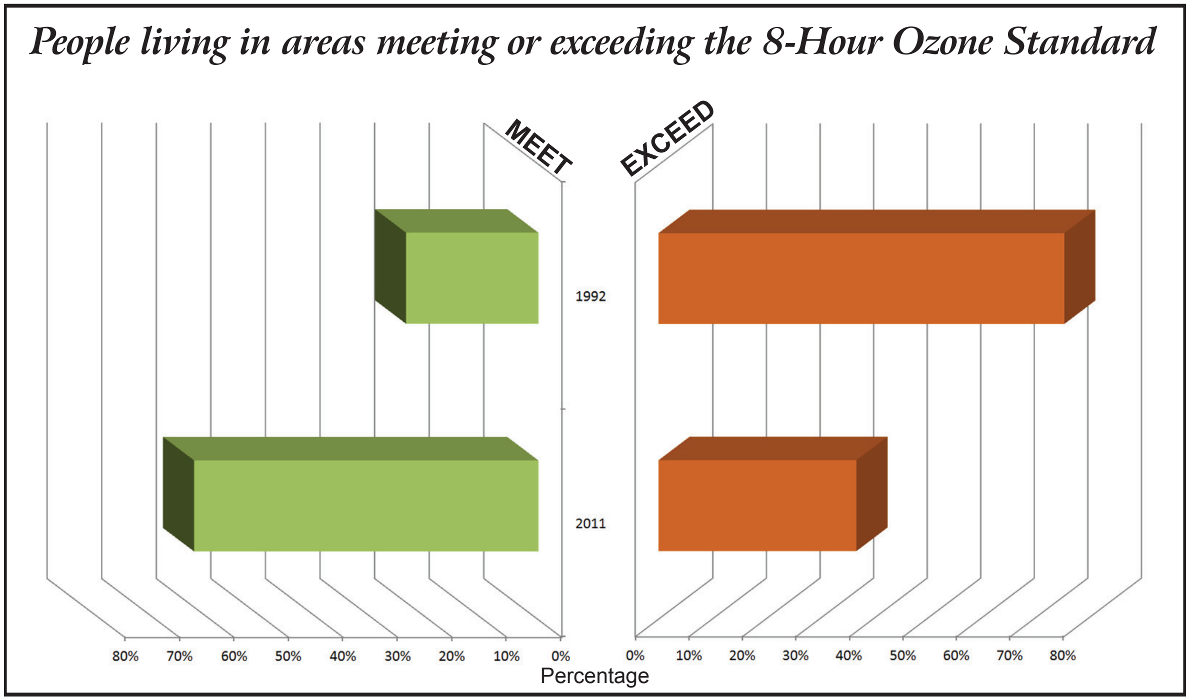

Figure 1-1

Ozone and $PM_{2.5}$ Progress

Although California has made great strides in improving air quality, ozone and $PM_{2.5}$ still present significant challenges. Nonetheless, nearly 63 percent of Californians now live in areas that meet the current federal standard for ozone, compared with only 24 percent in 1990. Progress toward attainment continues to occur throughout the State.

- Compared with 1990, ozone concentrations are about 10 to 50 percent lower throughout California, with some of the largest decreases occurring in areas with the worst ozone air quality.
- As a result, ozone air quality in 23 counties and 10 additional partial county areas now meet the current 8-hour ozone standard of 0.075 ppm.

- Seven areas, originally designated as nonattainment, now attain the previous 8-hour ozone standard of 0.08 parts per million (ppm). In addition, although U.S. EPA revoked the federal 1-hour ozone standard, Sacramento recently attained this milestone.
- Seven areas were originally designated as nonattainment for the 24-hour $PM_{2.5}$ standard. Today, only 3 areas remain nonattainment for this standard.
- The number of days exceeding the 24-hour $PM_{2.5}$ standard statewide has declined dramatically since 2001, from 299 days to 128 days, and the annual average concentrations have declined approximately 35 percent in most California air basins.

The South Coast and San Joaquin Valley pose the most significant remaining challenges for ozone and $PM_{2.5}$ attainment. Additional information on progress in these areas is provided below.

South Coast

California's largest urban area includes most of Los Angeles County, all of Orange County, and the western urbanized portions of Riverside and San Bernardino counties. More than 16 million people, representing 42 percent of the State's population, live in the South Coast and generate 24 percent of the State's NO_x emissions and 16 percent of the State's $PM_{2.5}$ emissions.

Although South Coast ozone and $PM_{2.5}$ levels are still among the highest in the nation, the region's long history of emission control programs has resulted in continued progress over the years. Since 1990, air quality has improved throughout the South Coast, despite significant economic growth and increases in population.

- VMT increased 42 percent from 1990 to 2010, and population increased 20 percent, yet on-road NO_x emissions decreased 62 percent and $PM_{2.5}$ emissions decreased 53 percent.
- Today, approximately 55 percent of the South Coast population lives in areas that meet the current federal 8-hour ozone standard. Contrast this with 1990, when air quality throughout the South Coast region violated the standard.
- In 1990, ozone concentrations exceeded the 8-hour standard on 181 days with concentrations as high as 0.186 ppm. The 2011 design value was 0.107 ppm, with 106 days exceeding the standard.
- The South Coast has experienced dramatic improvements in $PM_{2.5}$. Both annual and 24-hour concentrations decreased almost 50 percent since 2001, and concentrations are nearing the levels of the federal standards with compliance of both standards expected by 2014.

San Joaquin Valley

The San Joaquin Valley (Valley) also faces significant challenges in terms of ozone and $PM_{2.5}$ air quality. The Valley encompasses a large area that includes eight counties, bordered by the San Francisco Bay and Sacramento Valley areas of northern California and the South Coast region of southern California. Although the Valley is the State's largest agricultural area, urban and industrial development has increased substantially over the last several decades. About 10 percent of the State's population now lives in the Valley, generating about 15 percent of the State's NO_x emissions and 20 percent of the State's $PM_{2.5}$ emissions.

Over the next decade, population and VMT are expected to grow more rapidly in the Valley than in other parts of the State. The wide distribution of emission sources, along with weather and terrain that provide optimum conditions for the formation of high ozone and $PM_{2.5}$ concentrations, further complicates the challenge of improving air quality. However, despite these challenges and as a result of ongoing emission control programs, ozone and $PM_{2.5}$ air quality in the San Joaquin Valley has improved since the 1990s.

- Between 1990 and 2010, VMT increased 87 percent and population increased 45 percent, yet on-road NO_x emissions decreased 33 percent and $PM_{2.5}$ emissions decreased 56 percent.
- Today, about 17 percent of San Joaquin Valley residents live in areas that meet the current federal 8-hour ozone standard. In 1992, ozone concentrations exceeded the standard throughout the Valley.
- While progress toward attainment has been more gradual in the Valley than in other parts of the State, the federal 8-hour ozone design value has decreased 12 percent since 1990, and the number of days exceeding the standard has decreased 29 percent (from 153 to 109).
- Annual and 24-hour $PM_{2.5}$ design values decreased 26 and 40 percent, respectively, during the last decade. Compliance with the annual standard of 15 $\mu g/m^3$ is expected in 2014, and with the 24-hour standard in 2019.

Interpreting the Emission and Air Quality Statistics

Understanding Emission Data. Emission inventory trends make use of historical emission inventory data and projections based on expectations of future economic and population growth and emission controls. As mentioned earlier, our best understanding of emissions and best estimate of emission forecasts are reflected here. The historical emission inventory data in this almanac were updated to reflect improvements in emission inventory methodologies. Included are the latest point source estimates provided by districts as well as inventory improvements from recent State Implementation Plans (SIPs). The future year projections for stationary and area-wide sources were developed using the California Emissions Projection Analysis Model (CEPAM) assuming a 2012 base year and California-specific economic projections. These economic projections were prepared by TranSystems (formerly E.H. Pechan and Associates) and reflect information provided by local air districts. The stationary source emission forecasts reflect control measure information received from local air districts as of June 2013. Future year emission projections for on- and off-road vehicles were developed using the ARB EMFAC2011 and various off-road models, respectively. For more information on these forecasts, please see the ARB State Implementation Plan (SIP) web page at *www.arb.ca.gov/planning/sip/sip.htm*.

Understanding Air Quality Statistics. California has a network of more than 200 air quality monitoring sites located throughout the State. Each year, more than 10 million measurements are collected at these sites and stored in a comprehensive air quality database. It would be difficult, if not impossible, to analyze each individual measurement. So, we use air quality indicators to summarize the data.

An air quality indicator is a summary statistic that reflects a certain aspect of air quality in a particular region. No single indicator provides a complete picture of air quality, because each one tells a different story. Therefore, it is important to evaluate multiple indicators to better understand the degree of progress made and the nature of the air quality challenge an area faces.

A number of factors can influence the value of an air quality indicator. Two of the most important factors are changes in emissions and year-to-year variations in weather. Long term changes (over the course of five to ten years or more) generally reflect emissions reductions achieved by emissions control programs. In contrast, changes over a shorter timeframe (one or two years) often reflect year-to-year variations in weather. For example, ozone concentrations are generally lower than normal during summers with relatively cool temperatures and good dispersion and higher than normal during summers with hot temperatures and poor dispersion. Weather can also have a noticeable impact on $PM_{2.5}$, with higher concentrations during winters with cold, stable conditions and lower concentrations during winters with frequent storms and unstable concentrations. Weather related fluctuations in air quality are independent of changes in emissions.

Additionally, measurements may be affected by exceptional events. Exceptional events are unusual or naturally occurring events that can affect air quality but are not reasonably preventable or controllable. Example of exceptional events include high winds and wildfires. All of these factors should be kept in mind when using and interpreting the trends.

This document presents long term trends to assess the improvements in air quality resulting from emissions reductions. Several indicators are used to provide a more complete picture of the overall changes. These include indicators that are directly comparable with the federal standards, as well as indicators that characterize the high concentrations, the frequency with which high concentrations occur, and the difference in concentrations from one location to another. The following paragraphs provide brief descriptions of the indicators, how they are calculated, their limitations, and their value to understanding overall air quality.

High Concentration: The high concentration indicator is easy to determine and provides information about the level, or severity of an air quality problem. The high concentration indicator for ozone is the fourth high 8-hour average concentration. Very simply, all 8-hour average concentrations for each site during a particular year are ranked from high to low. The fourth highest concentration is the ozone high concentration indicator. This value is then averaged with the fourth high from the two previous years to get the Design Value.

In contrast to ozone, there are two high concentration indicators for $PM_{2.5}$: the 98th percentile concentration and the annual average concentration. Similar to ozone, 24-hour $PM_{2.5}$ concentrations measured at a site during a particular year are ranked from high to low; the 98th percentile concentration is the value below which 98 percent of all the daily values fall. Generally, the 98th percentile concentration is the second high for sites that sample every six days, the third high for sites that sample every three days, and the eighth high for sites that sample every day. The annual average $PM_{2.5}$ concentration is much easier to calculate — it is simply an average of the quarterly averages during a given year.

The high concentration indicators for both ozone and $PM_{2.5}$ are based on data for a single year and are generally calculated for each individual site.

Design Value: The design value is based on the high concentration indicator and is the only indicator that can be directly compared with a national ambient air quality standard (federal standard, standard, or NAAQS). The design value is used for determining attainment or nonattainment, thus providing an indication of how far an area has to go before it meets the standard. The design value calculations for ozone and $PM_{2.5}$ are different, but both are based on data collected during a three year period, with the design value assigned to the end year. For example, a 2011 design value is based on data from 2009, 2010, and 2011. Using three years of data helps make the indicator more stable and less likely to be influenced by year-to-year changes in weather.

A design value is calculated for each individual federal standard. Currently, there is one federal standard for ozone: an 8-hour standard of 0.075 ppm. The ozone design value is calculated as a three year average of the fourth highest 8-hour concentration.

There are two federal standards for $PM_{2.5}$: a 24-hour standard of 35 $\mu g/m^3$ and an annual standard of 15.0 $\mu g/m^3$. The 24-hour $PM_{2.5}$ design value is calculated as a three year average of the 98th percentile concentration. Similarly, the annual $PM_{2.5}$ design value is a three year average of the annual average concentrations.

Design values for both ozone and $PM_{2.5}$ are calculated for each individual monitoring site in an area. The site with the highest design value becomes the design site for the entire area. As a result, large portions of a nonattainment area may actually attain the standard before the area is deemed attainment.

Ozone Exceedance Days: The exceedance days indicator provides a measure of the frequency of an air quality problem. Ozone concentrations are measured daily, and the number of ozone exceedance days is a simple count of the number of days during a year that at least one site in the area had a measured concentration that was higher than the federal standard (note that because $PM_{2.5}$ is not measured daily, no $PM_{2.5}$ exceedance day statistics are provided).

Although the ozone exceedance days indicator gives a good indication of the frequency of exposure to concentrations above the federal standard, it has several limitations. First, the indicator gives no information about how widespread the exceedances are, because it counts only one exceedance day, even though exceedances may be measured at multiple sites. Second, the indicator gives no information about the level of exposure – was the concentration that exceeded just above the federal standard or far above the standard. Finally, the exceedance days indicator can be highly influenced by weather because it is based on data for only one year.

Ozone Contour Maps: Contour maps present a simplified picture of how ozone air quality differs across an area. The maps are based on measured data that is mapped across a grid. An indicator value is estimated for each grid point, giving greater weight to measurements that are located close by and lesser weight to those located further away. As a result, the denser the monitoring network, the more representative the resulting contours. Contour maps work well for urban areas, where the population is distributed fairly uniformly and there is a relatively dense network of monitoring sites. Conversely, they do not work well in rural areas which are sparsely populated and have very few monitoring sites.

Almost any indicator value can be mapped, but the most commonly mapped are the design value indicator and the exceedance days indicator. Ozone contour maps are useful for comparing relative changes in the indicator over time or relative differences within an area or between areas. However, because of the nature of the estimation procedure, contour maps are not well suited for evaluating absolute changes or differences.

SUMMARY: In summary, air quality indicators provide a means for summarizing data to simplify the evaluation of air quality trends. Some indicators are simple to calculate and easy to understand, while others are more complex. Because each indicator relates to a specific aspect of air quality, no single indicator provides a complete picture of air quality. Each indicator has strengths and weaknesses. Therefore, it is important to evaluate multiple indicators to facilitate the best understanding of historical progress and future challenges.

Meteorology's Role in Air Quality

This almanac presents air quality trends for a 20-year period. These trends reflect the progress achieved through a long history of emission control programs. Besides emissions, the trends are affected by meteorology (weather) and terrain. Meteorology causes year-to-year changes in air quality trends that can mask the benefits of emission reductions. Therefore, this almanac focuses on long-term rather than short-term trends.

Meteorology does not affect all pollutants in all places the same way. Ozone is formed in the atmosphere as sunlight initiates a complex set of chemical reactions. On hot sunny days, the abundant sunlight starts the ozone-forming processes and high temperatures promote fast chemical reactions. If the air is stagnant, the ozone formed is not dispersed or diluted by cleaner air. So, the highest ozone concentrations usually occur on hot and sunny days with light breezes or calm air. In some areas, high ozone levels may represent transport from upwind regions; local weather conditions associated with transport may differ from place to place. Since hot and sunny summer days typically lead to high ozone, it is not surprising that cold and cloudy winter days have much lower concentrations.

California's terrain also plays a role in promoting high levels of pollutants. The mountains that surround the San Joaquin Valley and those that form a barrier to the east of the Los Angeles area tend to retain air within these basins, which limits the dispersion of all pollutants, including ozone.

Meteorology affects PM, though some of its effects differ from its effects on ozone. Ambient PM is comprised of primary PM that is directly emitted and secondary PM that forms in the atmosphere through chemical and physical processes. Primary PM includes dust and soot, while secondary PM includes particulate nitrates and sulfates. Some areas are subject to strong winds that lift dust into the air resulting in high concentrations of primary PM. In other situations, cold, calm, and humid air can promote the buildup of secondary PM. Relatively high PM levels in the South Coast and San Joaquin Valley often occur in the winter under these meteorological conditions. The lowest PM concentrations often occur on rainy winter days when winds disperse PM and rain washes PM out of the air.

Year-to-year variations in meteorology can affect year-to-year changes in ambient air quality trends. As a result, meteorological variations add to the difficulty of interpreting long term air quality trends. However, data for meteorological parameters such as temperature, wind speed, and wind direction can help characterize a year with respect to the weather conditions influencing air pollution. Similar to ozone, annual average PM concentrations are also affected by meteorology – in particular, rainfall. These year-to-year variations in the average meteorological conditions are reflected in the long term pollutant trends.

The Web Resources Section provides information on how to access sources of meteorological data. Sources such as ARB's real-time Air Quality and Meteorological Information System (AQMIS2) allow access to various parameters including wind speed/direction, temperature, humidity, and visibility.

Sources of Emissions in California

California is a large state with many diverse sources of air pollution. To estimate the sources and quantities of pollution, the ARB, in cooperation with local air districts and industry, maintains an inventory of California emission sources. Sources are divided into four major emission categories: stationary sources, area-wide sources, mobile sources, and natural sources.

Stationary source emissions are based on estimates made by facility operators and local air districts. Emissions from specific facilities can be identified by name and location. Area-wide emissions are estimated by ARB and local air district staffs. Emissions from area-wide sources may be either from small individual sources, such as residential fireplaces, or from widely distributed sources that cannot be tied to a single location, such as consumer products and dust from unpaved roads. Mobile source emissions are estimated by ARB staff with assistance from districts and other government agencies. Mobile sources include on-road cars, trucks, and buses and other sources such as boats, off-road recreational vehicles, aircraft, and trains. Natural sources are also estimated by the ARB staff and the air districts. These sources include biogenic hydrocarbons, geogenic hydrocarbons, natural wind-blown dust, and wildfires.

For the inventoried emission sources, the ARB compiles emission estimates for criteria pollutants. Chapters 2 through 4 and Appendices A and B focus on four criteria pollutants: ozone, PM, NO_2, and SO_2. Emissions related to these criteria pollutants include volatile organic compounds (VOC), oxides of nitrogen (NO_x), oxides of sulfur (SO_x), ammonia (NH_3), directly emitted PM_{10} and $PM_{2.5}$, and diesel PM (DPM).

While some pollutants are directly emitted, others are formed in the atmosphere by chemical reactions of *precursor emissions*. Such is the case with ozone, which is formed in the atmosphere when NO_x and VOC react in the presence of sunlight. PM which includes PM_{10} and $PM_{2.5}$, is a complex pollutant that can either be directly emitted or formed in the atmosphere from precursor emissions. PM precursors include NO_x, VOC, SO_x, and NH_3. Examples of directly emitted PM include dust and soot.

Hydrocarbons are classified as to how photochemically reactive they are: relatively reactive or relatively non-reactive. Emissions of *Total Organic Gases* (TOG) and *Volatile Organic Compounds* (VOC) are two classes of hydrocarbons measured for California's emissions inventory. TOG includes all hydrocarbons, both reactive and non-reactive. In contrast, VOC includes only the reactive hydrocarbons.

Air Quality Monitoring

The ARB, local air districts, National Park Service, and other public agencies operate a comprehensive statewide network of monitors. Air districts generate comprehensive network plans containing detailed information on their networks and work to ensure the adequacy of the monitoring network in characterizing the air quality in the area.

As shown in Figure 1-2, there are more than 200 monitoring sites in California. In addition to the California sites, a few monitoring sites are located in Mexico. These sites were established in cooperation with the U.S. EPA and the Mexican government to monitor the cross-border transport of pollutants and pollutant precursors.

Each year, more than 10 million air quality measurements from all of these sites are collected and stored in a comprehensive air quality database maintained by the ARB. To ensure the integrity of the data, the ARB routinely conducts audits and reviews of the monitoring instruments and the resulting data.

Figure 1-2

California Air Basins

California contains a wide variety of climates, physical features, and emission sources. This variety makes the task of improving air quality complex, because what works in one area may not be effective in another area. To better manage common air quality problems, California is divided into 15 air basins, as shown in Figure 1-3 and Table 1-1. The ARB established the initial air basin boundaries during 1968.

An air basin generally has similar meteorological and geographical conditions throughout the region. To the extent possible, the air basin boundaries follow political boundary lines and are defined to include both the source area and the receptor area. However, air masses can move freely from basin to basin. As a result, pollutants such as ozone and PM, as well as their precursors, can be transported across air basin boundaries, and interbasin transport is dealt with in air quality programs. Although established in 1968, the air basin boundaries have been changed several times over the years, to provide for better air quality management.

Figure 1-3

List of Counties in Each Air Basin

Great Basin Valleys Air Basin
- Alpine
- Inyo
- Mono

Lake County Air Basin
- Lake

Lake Tahoe Air Basin
- El Dorado (portion)
- Placer (portion)

Mojave Desert Air Basin
- Kern (portion)
- Los Angeles (portion)
- Riverside (portion)
- San Bernardino (portion)

Mountain Counties Air Basin
- Amador
- Calaveras
- El Dorado (portion)
- Mariposa
- Nevada
- Placer (portion)
- Plumas
- Sierra
- Tuolumne

Table 1-1

North Central Coast Air Basin
- Monterey
- San Benito
- Santa Cruz

North Coast Air Basin
- Del Norte
- Humboldt
- Mendocino
- Sonoma (portion)
- Trinity

Northeast Plateau Air Basin
- Lassen
- Modoc
- Siskiyou

Sacramento Valley Air Basin
- Butte
- Colusa
- Glenn
- Placer (portion)
- Sacramento
- Shasta
- Solano (portion)
- Sutter
- Tehama
- Yolo
- Yuba

List of Counties in Each Air Basin

Salton Sea Air Basin
- Imperial
- Riverside (portion)

San Diego Air Basin
- San Diego

San Francisco Bay Area Air Basin
- Alameda
- Contra Costa
- Marin
- Napa
- San Francisco
- San Mateo
- Santa Clara
- Solano (portion)
- Sonoma (portion)

San Joaquin Valley Air Basin
- Fresno
- Kern (portion)
- Kings
- Madera
- Merced
- San Joaquin
- Stanislaus
- Tulare

Table 1-1 (continued)

South Central Coast Air Basin
- San Luis Obispo
- Santa Barbara
- Ventura

South Coast Air Basin
- Los Angeles (portion)
- Orange
- Riverside (portion)
- San Bernardino (portion)

Criteria Air Pollutants

National Ambient Air Quality Standards and Designations

Very simply, an ambient air quality standard is the definition of "clean air." More specifically, a standard establishes the concentration above which the pollutant is known to cause adverse health effects to sensitive groups within the population, such as children and the elderly. Both California and the federal government have adopted health-based standards for the *criteria pollutants*, which include but are not limited to ozone, PM_{10}, $PM_{2.5}$, CO, and lead. U.S. EPA recently revised the national PM, ozone, lead, NO_2, and SO_2 standards. Information on all of the new standards can be found on the U.S. EPA's website at *www.epa.gov/airquality/urbanair/*, click on the pollutant of interest and select "Regulatory Actions".

An abbreviated list of the national ambient air quality standards can be found on page 1-23, while a complete list can be found on the ARB website at *www.arb.ca.gov/research/aaqs/aaqs.htm*. In general, the air quality standards are expressed as a measure of the amount of pollutant per unit of air. For example, the PM standards are expressed as micrograms of particulate matter per cubic meter of air ($\mu g/m^3$) and the ozone standards are expressed in parts per million (ppm).

Designations

Both the California and federal governments use monitoring data to designate areas according to their attainment status for most of the pollutants with ambient air quality standards. The purpose of the designations is to identify those areas exceeding air quality standards and thereby initiate planning efforts to achieve air quality levels protective of public health. There are three basic designation categories: nonattainment, attainment, and unclassified. Historically, California standards have been more stringent than federal standards. However, U.S. EPA has recently tightened federal standards for a number of pollutants. This has resulted in both state and federal standards being similar in their ability to protect human health.

A *nonattainment designation* indicates that the air quality violates an ambient air quality standard. Although a number of areas may be designated as nonattainment for a particular pollutant, the severity of the problem can vary greatly. To identify the severity of the problem and the extent of planning required, ozone and PM nonattainment areas are assigned a classification that is commensurate with the severity of their air quality problem (e.g., moderate, serious, severe).

In contrast to nonattainment, an *attainment designation* indicates that the air quality does not violate the established standard. Under the federal Clean Air Act, nonattainment areas that are redesignated as attainment must develop and implement maintenance plans designed to assure continued compliance with the standard.

Finally, an *unclassified designation* indicates that there are insufficient data for determining attainment or nonattainment. The U.S. EPA combines unclassified and attainment into one designation for ozone, PM_{10}, $PM_{2.5}$ and CO. More detailed information on the area designation categories can be found on the ARB's website at *www.arb.ca.gov/desig/desig.htm*.

Ozone

Ozone, a colorless gas which is odorless at ambient levels, is the chief component of urban smog. Ozone is not directly emitted as a pollutant, but is formed in the atmosphere when hydrocarbon and NO_x precursor emissions react in the presence of sunlight. Meteorology plays a major role in ozone formation. Generally, low wind speeds or stagnant air, coupled with warm temperatures and cloudless skies provide the optimum conditions for ozone formation. As a result, summer is generally the peak ozone season. Because of the reaction time involved, peak ozone concentrations often occur far downwind of the precursor emissions. Therefore, ozone is a regional pollutant that often impacts a large area.

The ARB and U.S. EPA are required to periodically review its air quality standards and the most recent health studies to ensure that the standards are adequately protective of human health. Air quality standards have become more stringent over time as new studies have shown adverse impacts at lower concentration levels.

In 1997, U.S. EPA made a fundamental change to the ozone standard, moving from a 1-hour averaging time to an 8-hour averaging time. The 8-hour standard is designed to protect against the chronic health effects of day-long exposures to unhealthy concentrations.

On March 12, 2008, U.S. EPA completed their review of the most current health studies and concluded that the level of the national ozone standard at 0.08 ppm was not sufficiently protective of human health. They subsequently adopted a new standard of 0.075 ppm. It has triggered a new set of planning requirements which build upon previous SIP efforts. For more information on the new national ozone standard, please refer to the U.S. EPA's webpage at *www.epa.gov/air/ozonepollution/actions.html*.

National Ozone Standard:
0.075 ppm for 8 hours,
not to be exceeded,
based on the fourth highest
concentration averaged
over three years.

Establishing a more stringent (health-protective) standard means that more areas are identified as having unhealthy air, there are a greater number of days when concentrations exceed the standard, and concentrations have to be reduced by a greater percentage in order to meet the more stringent standard. Although air quality standards change over time, changing the level of a standard does not negate the progress already made. It does, however, change the target used to judge compliance.

Change in Federal Ozone Standards over time

Pollutant	Year	Averaging Time	Standard
Ozone	1979	1-Hour	0.12 ppm
	1997	8-Hour	0.08 ppm
	2008	8-Hour	0.075 ppm

Table 1-2

Ozone - National 8-Hour Area Designations

There are two designation categories for ozone — attainment/unclassified and nonattainment. Figure 1-4 shows the designations for the national 8-hour standard, which were effective as of April 30, 2012. An area violates the national 8-hour ozone standard if the fourth highest 8-hour concentration averaged over a three-year period exceeds the level of the standard at any monitoring site in the region. There are 15 nonattainment areas in California, including the State's five largest urban areas. In addition, a number of smaller counties and rural areas exceed the standard.

The following areas were designated as nonattainment for the revised national 8-hour ozone standard by the U.S. EPA.

- Calaveras County
- Chico (Butte County)
- Imperial County
- Kern County (Eastern Kern)
- Los Angeles-San Bernardino Counties (West Mojave Desert)
- Los Angeles-South Coast Air Basin
- Mariposa County
- Nevada County (Western part)
- Riverside County (Coachella Valley)
- Sacramento Metropolitan (includes portions of El Dorado, Placer, and Yolo-Solano Counties)
- San Diego County
- San Francisco Bay Area
- San Joaquin Valley
- San Luis Obispo County (Eastern San Luis Obispo)
- Tuscan Buttes
- Ventura County

Figure 1-4

Particulate Matter ($PM_{2.5}$)

Exposure to PM aggravates a number of respiratory illnesses and may even cause early death in people with existing heart and lung disease. Both long-term and short-term exposure can have adverse health impacts. All particles with a diameter of 10 microns or smaller (PM_{10}) are harmful. PM_{10} includes the subgroup of finer particles with a diameter of 2.5 microns or smaller ($PM_{2.5}$). These finer particles pose an increased health risk because they can deposit deep in the lungs and contain substances that are particularly harmful to human health.

PM is a mixture of substances that includes elements such as carbon and metals; compounds such as nitrates, sulfates, and organic compounds; and complex mixtures such as diesel exhaust and soil. These substances may occur as solid particles or liquid droplets. Some particles are emitted directly into the atmosphere. Others, referred to as secondary particles, result from gases that are transformed into particles through physical and chemical processes in the atmosphere.

Sources of fine particles include all types of combustion activities (motor vehicles, power plants, wood burning, cooking, etc.) and certain industrial processes. Particles with diameters between 2.5 and 10 micrometers are referred to as "coarse." Sources of coarse particles include crushing or grinding operations, and dust from paved or unpaved roads. Other particles may be formed in the air from the chemical reactions of gases. They are indirectly formed when gases from burning fuels react with sunlight and water vapor. These can result from fuel combustion in motor vehicles, at power plants, and in other industrial processes.

EPA issued the fine particle standards in 1997 after evaluating hundreds of health studies and conducting an extensive peer review process. The 1997 annual standard was established at a level of 15 $\mu g/m^3$, based on the 3-year average of annual mean $PM_{2.5}$ concentrations.

National $PM_{2.5}$ Standards:
35 $\mu g/m^3$ for 24 hours based on the 98th percentile concentration averaged over three years, not to be exceeded *and*
12 $\mu g/m^3$ annual arithmetic mean averaged over 3 years, not to be exceeded.

The 1997 24-hour standard was established at a level of 65 $\mu g/m^3$, determined by the 3-year average of the annual 98th percentile concentrations.

The agency modified the standards in 2006, when they reaffirmed the 15 $\mu g/m^3$ annual standard and lowered the 24-hour standard from 65 $\mu g/m^3$ to 35 $\mu g/m^3$. On December 14, 2012, EPA strengthened the annual standard for fine particles to 12.0 $\mu g/m^3$ and retained the 24-hour fine particle standard of 35 $\mu g/m^3$.

Change in Federal $PM_{2.5}$ Standards over time

Pollutant	Year	Averaging Time	Standard
$PM_{2.5}$	1997	Annual	15.0 $\mu g/m^3$
		24-Hour	65 $\mu g/m^3$
	2006	24-Hour	35 $\mu g/m^3$
	2012	Annual	12 $\mu g/m^3$

Table 1-3

$PM_{2.5}$ - National Area Designations

The U.S. EPA promulgated first time area designations for the 1997 annual $PM_{2.5}$ standard in early 2005. The San Joaquin Valley and South Coast air basins were the only two areas designated as non-attainment. An area violates the annual $PM_{2.5}$ standard when the 3-year annual average exceeds 15.0 $\mu g/m^3$ at any one site.

U.S. EPA promulgated area designations for the recently tightened 24-hour $PM_{2.5}$ standard which was effective in Spring 2009. An area violates the 24-hour standard when the 3-year average of the 98th percentile concentrations exceeds 35 $\mu g/m^3$ at any one site. Figure 1-5 shows the areas that are designated nonattinment for the 24-hour and annual $PM_{2.5}$ standard. However, all areas except South Coast, San Joaquin Valley, and Imperial now record design values meeting the standard.

The following areas were designated as nonattainment for the revised National 24-hour $PM_{2.5}$ standard by the U.S. EPA.

- Butte County AQMD (partial)
- Imperial County APCD (partial)
- South Coast AQMD
- Sacramento Metropolitan nonattainment area (includes portions of El Dorado, Placer, and Yolo-Solano Counties)
- Bay Area AQMD
- San Joaquin Valley APCD
- Feather River AQMD (partial)

The designation process for the revised annual $PM_{2.5}$ standard will be finalized in early 2015.

Figure 1-5

Carbon Monoxide

CO is a colorless and odorless gas that is directly emitted as a by-product of combustion. The highest concentrations are generally associated with cold stagnant weather conditions that occur during winter. In contrast to ozone, which tends to be a regional pollutant, CO problems tend to be localized. All of California complies with State and federal CO standards.

National CO Standards:
35 ppm for 1 hour *and*
9 ppm for 8 hours,
neither to be exceeded
more than once per year.

National NO_2 Standards:
100 ppb for 1 hour *and*
53 ppb annually,
not to be exceeded
more than once per year.

National SO_2 Standards:
75 ppb for 1 hour *and*
50 ppb for 3 hours,
not to be exceeded
more than once per year.

Nitrogen Dioxide

NO_2 is one of a group of highly reactive gases known as "oxides of nitrogen (NO_x)." NO_2 is the component of greatest interest and the indicator for the larger group of nitrogen oxides. It forms quickly from emissions from cars, trucks and buses, powerplants, and off-road equipment. It is also linked to the formation of ground-level ozone, fine particle pollution, and a number of adverse affects on the respiratory system. On January 22, 2010 the U.S. EPA finalized revisions to the 1-hour NO_2 standard, lowering the level to 100 ppb. This level defines the maximum allowable concentration anywhere in an area. It will protect against adverse health effects associated with short-term exposure to NO_2, including respiratory effects that can result in hospitalization. All of California complies with federal NO_2 standards.

Sulfur Dioxide

SO_2 is one of a group of highly reactive gases known as "oxides of sulfur (SO_x)." The largest sources are from fossil fuel combustion at power plants and other industrial facilities. SO_2 is linked with a number of adverse affects on the respiratory system. On June 2, 2010 the U.S. EPA finalized revisions to the 1-hour SO_2 standard, lowering the level to 75 ppb. U.S. EPA's evaluation of the scientific information and the risks posed by breathing SO_2 indicate that this new 1-hour standard will protect public health by reducing people's exposure to high short-term (5-minutes to 24-hours) concentrations of SO_2. All of California complies with federal SO_2 standards.

National Ambient Air Quality Standards

Pollutant	Averaging Time	National Standards[1]	
		Primary[2]	Secondary[3]
Ozone (O_3)	1 Hour	—	—
	8 Hour	0.075 ppm	Same as Primary Standard
Particulate Matter (PM_{10})	24 Hour	150 $\mu g/m^3$	Same as Primary Standard
Fine Particulate Matter ($PM_{2.5}$)	24 Hour	35 $\mu g/m^3$	Same as Primary Standard
	Annual Arithmetic Mean	12 $\mu g/m^3$	15 $\mu g/m^3$
Carbon Monoxide (CO)	8 Hour	9 ppm	—
	1 Hour	35 ppm	
Nitrogen Dioxide (NO_2)	Annual Arithmetic Mean	53 ppb	Same as Primary Standard
	1 Hour	100 ppb	—
Sulfur Dioxide (SO_2)	3 Hour	—	0.5 ppm
	1 Hour	75 ppb	—
Lead	Rolling 3 Month Average	.15 $\mu g/m^3$	Same as Primary Standard

1. National standards (other than ozone, particulate matter, and those based on annual averages or annual arithmetic mean) are not to be exceeded more than once a year. The ozone standard is attained when the fourth highest eight hour concentration in a year, averaged over three years, is equal to or less than the standard. For PM_{10}, the 24 hour standard is attained when the expected number of days per calendar year with a 24-hour average concentration above 150 $\mu g/m^3$ is equal to or less than one. For $PM_{2.5}$, the 24 hour standard is attained when 98 percent of the daily concentrations, averaged over three years, are equal to or less than the standard. Contact U.S. EPA for further clarification and current federal policies.
2. National Primary Standards: The levels of air quality necessary, with an adequate margin of safety to protect the public health.
3. National Secondary Standards: The levels of air quality necessary to protect the public welfare from any known or anticipated adverse effects of a pollutant.

Table 1-4

Web Resources (www.arb.ca.gov/californiaalmanac)

Much of the information used to develop the Almanac is accessible through a variety of databases and tools available on the ARB website at *www.arb.ca.gov/californiaalmanac*.

Data

Real-time Air Quality Data - Air Quality and Meteorological Information System (AQMIS2) - Allows access to near real-time air quality and meteorological data. These data are available in tabular summary reports.

Historical Air Quality Data - Aerometric Data Analysis and Management System (iADAM) - Allows access to historical data (data for record) in tabular summary reports or displayed as graphs.

Emission Inventory Data - Allows access to historical and projected emissions, vehicle activity, and human population. Data are available for 2012, as well as for the years 2000-2035 at five year intervals.

Facility Search Engine - Allows users to locate criteria or toxics emissions data for a specific facility.

Top 25 Source Categories - Provides users with emissions for the top 25 highest emitting source categories by geographic area.

EMFAC - EMFAC2011 is ARB's official model for estimating emissions from on-road cars, trucks, and buses in California. The web-based EMFAC emission database provides annual and seasonal estimates for VMT, vehicle population, trips and emissions by vehicle type for years 1990-2035.

Information

Area Designations - Provides information regarding the designation of areas in California with respect to the State ambient air quality standards.

Air Quality Standards - Provides information on State and national air quality standards.

Central California Air Quality Studies (CCAQS) - Comprises two studies with the goal of providing an improved understanding of PM and visibility in central California.

Climate Change - Information regarding ARB's Climate Change Program.

Goods Movement Plan (GMP) - Presentation materials and policy information on California's Goods Movement Plan.

Community Health - Provides information on Community Health progams in place.

Air Quality Data Monitoring Sites - Air monitoring web site with access to the most recent quality assurance information on any particular air monitoring site. This information consists of pollutants monitored, location, operation information, and photos of the site, if available.