Air Quality Report
A.R.S. §49-424.10

Acknowledgments

Numerous agencies, companies, individuals and organizations have collected the ambient air quality monitoring data presented in this report. The Arizona Department of Environmental Quality (ADEQ) publishes data from these various sources to provide as complete of a picture as possible of air quality conditions throughout Arizona and gratefully acknowledges the efforts of all involved. Generally, ambient data presented in this report are collected, processed and reported following U.S. Environmental Protection Agency (EPA) policies and procedures. Air quality data that ADEQ staff and contract operators collect have also received internal and external quality control and assurance checks, including rigorous data verification that ADEQ has, in part, implemented. Data provided by other sources have been checked by the responsible organization but not by ADEQ.

Both private individuals and companies under contract to ADEQ provided invaluable field sampler operation and data processing services in support of monitoring activities during 2001. Their efforts are appreciated as they maneuver on rooftops and metal towers to operate monitoring equipment in uncomfortable weather conditions, or review instrument performance and ambient monitoring data for technical accuracy. Field staff from other public agencies also operate numerous ambient monitoring sites in Arizona, providing spatial resolution and temporal coverage of air quality conditions statewide. ADEQ recognizes the efforts of these other monitoring and reporting agencies, and appreciates the opportunity to publish their data. Several industrial facilities collect and report ambient air quality data to ADEQ, usually to satisfy a permit requirement; their efforts are also acknowledged. Finally, ADEQ staff work daily installing, calibrating, maintaining, conducting quality control checks, collecting, processing, performing quality assurance tests and reporting data from a wide variety of ambient air monitoring instruments. ADEQ management wishes to thank these staff members for their dedication to maintaining and improving the quality of our program.

This report was prepared by ADEQ’s Air Quality Assessment Section, which can be contacted at 1110 W. Washington St., Phoenix, AZ 85007, (602) 771-4383 or, toll free in Arizona at (800) 234-5677, then enter 771-4383. Our Web site is located at www.adeq.state.az.us/environ/air/assess/index.html.

Introduction

This report presents the results of air quality monitoring conducted throughout Arizona in the 2001 calendar year. Data from more than 100 monitoring sites, many of which have multiple instruments measuring a variety of gaseous, particulateand visibility parameters are reported. The majority of the air quality measurements are for conventional pollutants (such as ozone, particulate matter, sulfur dioxide, carbon monoxide, nitrogen dioxide and lead) for which EPA has established national ambient air quality standards (NAAQS). Visibility-related measurements are an increasing part of air monitoring activities in Arizona. In addition to the ADEQ monitoring network, air quality agencies in Maricopa, Pima and Pinal counties also operated networks, as did several industrial facilities. Their data are summarized in this report.

The report on ambient air quality monitoring networks, which begins on Page 3, discusses the purpose, measurement methods and the specific scale of geographic resolution of each network of various air monitoring networks in Arizona.

Beginning on Page 18, the monitoring data report summarizes the monitoring data and shows the compliance status for criteria pollutants and consists of three sections, measurement of traditional criteria pollutants, compliance status of the criteria pollutants and visibility characterization. The text describes how the measurements are made and how they relate to compliance with the NAAQS.

The report on special projects, which begins on Page 67, summarizes activities from special monitoring projects undertaken in 2000 and 2001, which have contined into 2002. Some of the projects presented in this report are the expanding Class I visibility monitoring network for larger national parks and wilderness areas, an ongoing PM_{10} study centered on the Greenwood monitoring site, a new and expanding effort to characterize ozone precursors, the intensive ozone project held in Phoenix in summer 2001 and results from the Governor's Brown Cloud Summit.

Air quality trends are reported beginning on Page 73**.** Air quality trends at most of the long-term monitors reveal improved air quality. Concentrations of carbon monoxide, lead and sulfur dioxide have dramatically improved since measurements began in the 1970s, and all monitors for these pollutants have shown compliance with health standards in recent years. Particulate matter (PM_{10}) concentrations have also improved in rural and industrial areas where controls have been implemented, while less dramatic improvements have occurred in Phoenix and Tucson. Ozone concentrations have been fairly steady in Tucson and Yuma but have decreased since 1997 in Phoenix. Phoenix is the only area where violations of the ozone standard have been recorded, although concentrations have fallen significantly in recent years, and no exceedances have been recorded since 1997. Shorter periods of record for visibility in the urban and national parks and wilderness areas make trend assessments less definitive, but trend assessments are shown for the two urban areas.

Ambient Air Quality Monitoring Networks

[View a photo](#) of the Muleshoe Ranch visibility monitoring site, which is located at 4,400 feet elevation in the Galiuro wilderness area east of Tucson

The federal Clean Air Act of 1970 required EPA to assist states and localities in establishing ambient air quality monitoring networks to characterize human health exposure and public welfare effects of conventional pollutants. The 1977 federal Clean Air Act amendments required each state to implement a visibility monitoring network to cover specified national parks and wilderness areas. The Phoenix and Tucson metropolitan areas also have year-round visibility monitoring networks to assess urban hazes. All of these networks are composed of individual monitoring sites; they are operated to collect ambient air quality data to ensure that Arizona citizens are able to know local air quality conditions and help ADEQ and local air quality control districts identify the causes of polluted air.

Conventional Pollutant Monitoring Networks

The conventional pollutants are presently defined as sulfur dioxide (SO_2), total particulate lead (Pb), suspended particulate matter (PM), ozone (O_3), nitrogen dioxide (NO_2) and carbon monoxide (CO). These pollutants are monitored with federal reference or equivalent methods that EPA has certified. EPA defined particulate matter monitoring in 1987 to measure particles less than or equal to 10 microns in aerodynamic diameter (PM_{10}), and again in 1997 to measure both PM_{10} and, separately, particles less than or equal to 2.5 microns in aerodynamic diameter ($PM_{2.5}$). Networks operated to monitor the nature and causes of visibility impairment use some of the same sampling methods and are described in more detail later in this section. Ambient monitoring networks for air quality are established to sample pollution in a variety of representative settings, to assess the health and welfare effects, and to assist in determining air pollution sources. These networks cover both urban and rural areas of the state. Sampling networks are designed to satisfy monitoring objectives and measurement scales defined in Tables 1 and 2.

For each conventional pollutant, EPA specifies monitoring objectives that define the parameters by which health exposure and public welfare are assessed and measurement scale classifications that describe the influence of atmospheric movement at a given location.

The types and scales of monitoring sites described above are combined into networks, which a number of government agencies and regulated companies operate. These networks are composed of one or more monitoring sites whose data are compared to the NAAQS and statistically analyzed in various ways. The agency or company operating a monitoring network also tracks data recovery, quality control and quality assurance parameters for the instruments operated at their various sites. The agency or company also often measures meteorological variables at the monitoring site.

Table 1: Monitoring Objectives for Air Quality Monitoring Sites	
Number	Definition
1	Determine highest concentrations expected to occur in the area covered by the network
2	Determine representative concentrations in areas of high population density
3	Determine the impact on ambient pollution levels of significant sources or source categories
4	Determine general background concentration levels
5	Determine the extent of regional pollutant transport among populated areas and in support of secondary standards
6	Determine the welfare-related effect in more rural and remote areas (such as visibility impairment and vegetation effects)

Table 2: Measurement Scales for Air Quality Monitoring Sites						
Measurement Scale *represents concentrations in air volumes areas defined below*	Conventional Pollutant					
	Carbon Monoxide (CO)	Sulfur Dioxide (SO_2)	Ozone (O_3)	Nitrogen Dioxide (NO_2)	Lead (Pb)	Particulate Matter (PM_{10}, $PM_{2.5}$)
Micro (0 to 100 m)	X				X	X
Middle (~100 to 500 m)	X	X	X	X	X	X
Neighborhood (~0.5 to 4 km)	X	X	X	X	X	X
Urban (~4 to 50 km)		X	X	X	X	X
Regional (~10 to 100s of km)		X	X		X	X

Some of the agencies do special continuous monitoring for the optical characteristics of the atmosphere and manual sampling of ozone-forming compounds and other hazardous air pollutants. Maricopa, Pima and Pinal counties operate networks primarily to monitor urban air pollution. In contrast, the industrial networks are operated to determine the effects of their emissions on local air quality. The National Park Service's network tracks conditions in and around national parks and monuments. The state network monitors a wide variety of pollutant and atmospheric characteristics, including urban, industrial, rural and background surveillance.

The monitoring networks and their characteristics are shown in Table 3. A list of individual sites and monitoring parameters, based on the best available information at the time of publication, is presented in Appendix 1.

Table 3: Monitoring Networks Operating in Arizona

Network Operator	Geographic Area Monitored	Monitoring Objective*	Measurement Scale(s)**	Pollutant(s) Monitored
Arizona Dept. of Environmental Quality	Statewide	1, 2, 3, 4, 5, 6	Micro, Middle, Neighborhood, Urban, Regional	SO_2, Pb, O_3, NO_2, CO, PM_{10}, $PM_{2.5}$
Arizona Portland Cement Company	Rillito	1, 3	Neighborhood	PM_{10}
ASARCO, Inc.	Hayden	1, 2, 3	Middle , Neighborhood	SO_2
Maricopa County Environmental Svcs Dept.	Phoenix urban area, Maricopa County	1, 2, 3, 4, 5, 6	Micro, Middle, Neighborhood, Urban, Regional	SO_2, Pb, O_3, NO_2, CO, PM_{10}
National Park Service	National parks and monuments	3, 4, 5, 6	Urban, Regional	SO_2, O_3, NO_2, PM_{10}, $PM_{2.5}$
Phelps Dodge Miami Inc. (PDMI)	Miami	1, 2, 3	Neighborhood	SO_2, PM_{10}, $PM_{2.5}$
Phoenix Cement Company	Clarkdale	1, 3	Neighborhood	PM_{10}, $PM_{2.5}$, Pb
Pima County Dept. of Environmental Quality	Tucson urban area, Pima County	1, 2, 3, 4, 5, 6	Micro, Middle, Neighborhood, Urban, Regional	SO_2, Pb, O_3, NO_2, CO, PM_{10}, $PM_{2.5}$

Table 3. Monitoring Networks Operating in Arizona				
Network Operator	Geographic Area Monitored	Monitoring Objective*	Measurement Scale(s)**	Pollutant(s) Monitored
Pinal County Air Quality Control District	Pinal County, Phoenix urban area	1, 2, 3, 4, 5	Middle, Neighborhood, Urban, Regional	O_3, CO, PM_{10}, $PM_{2.5}$
Praxair, Inc.	Kingman	1, 3	Middle	PM_{10}
Salt River Project	Page	1, 3	Urban, Regional	NO_2, O_3, SO_2, PM_{10}, $PM_{2.5}$
Southern California Edison Company	Bullhead City, Ariz. and Laughlin, Nev.	1, 2, 3, 4	Neighborhood, Urban, Regional	SO_2, NO_2, PM_{10}
Tucson Electric Power Company	Tucson and Springerville	1, 2, 3	Middle, Regional	SO_2, NO_2, PM_{10}, $PM_{2.5}$

**See Table 1 for a list of objectives*

***See Table 2 for a definition of the scales*

Eight-hour Ozone Monitoring Network for Phoenix and Surrounding Areas

In early 2001, the Arizona Monitoring Technical Workgroup (composed of representatives from ADEQ, the Fort McDowell Yavapai Nation, the Gila River Indian Community, Maricopa Association of Governments, Maricopa County Environmental Services Department, Pima Association of Governments, Pima Department of Environmental Quality, Pinal County Air Quality Control District and the Salt River Pima-Maricopa Indian Community) met to discuss and recommend changes to the current one-hour ozone monitoring in order to create an eight-hour ozone network to represent Phoenix and surrounding areas.

The U.S. Supreme Court recently upheld EPA's 1997 promulgation of an eight-hour average ozone NAAQS; this standard is operable in all areas attaining the former one-hour average ozone NAAQS in effect since 1980. Areas not currently attaining the one-hour NAAQS must first attain that standard before moving to attain the eight-hour NAAQS.

Review of the eight-hour ozone data indicates that a number of monitoring sites in and around the metropolitan area exceed the eight-hour NAAQS. Because the monitoring data show that the metropolitan area is in violation of the eight-hour NAAQS, EPA must determine an eight-hour ozone nonattainment area boundary for the Phoenix metropolitan area, starting with the consolidated metropolitan statistical area as a default, based on:

- The recommendation of Arizona's governor
- The adequacy of the monitoring network
- The nature and distribution of ozone-causing air pollution emissions

To provide the maximum utility of monitoring data to policymakers in considering the public health and welfare effects of eight-hour average ozone air pollution, and the related nonattainment area boundary, the issue was referred by the Arizona Monitoring Technical Workgroup to ADEQ.

The workgroup held several meetings to evaluate the current one-hour ozone network and design a complementary eight-hour ozone network. The network evaluation process involved review and consideration of a variety of parameters, including current and historical ozone monitoring data, meteorology and pollutant transport, ozone site spatial analysis, EPA network requirements and guidance, projected population growth statistics, and the ozone formation process. Additionally, consideration was made for agency resource availability and basic site availability and security considerations. The meetings concluded with a recommendation for an eight-hour ozone network for the Phoenix and surrounding areas as described in Table 4.

Table 4: Recommended Eight-hour Ozone Network

Site Name	Parameter	Operator
New Ozone Monitoring Sites		
Pleasant Valley	ozone, trace level NOx, HC, MET	ADEQ
Ike's Backbone	ozone, trace level NOx, HC, MET	ADEQ
Far west site/Gila Bend	ozone	ADEQ
Cave Creek	ozone	MCESD
Roosevelt/Tonto	ozone, trace level NOx, HC, MET	ADEQ/MCESD
Perryville	ozone	MCESD
Magma	ozone, trace level NOx, HC, MET	PCAQCD
Stanfield/Maricopa	ozone	PCAQCD
St Johns	ozone, MET	GRIC
Sacaton	ozone, MET	GRIC
Ft. McDowell	ozone	FMIC

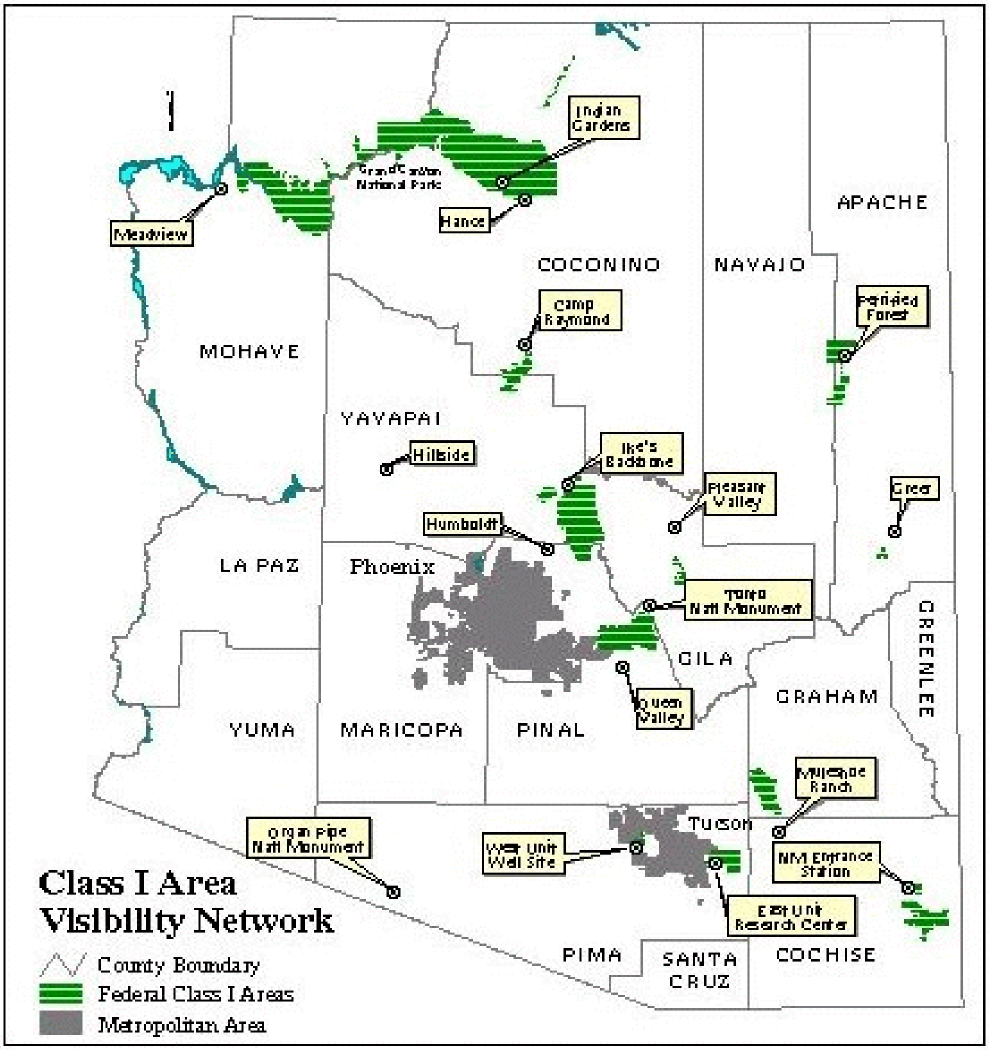
Table 4: Recommended Eight-hour Ozone Network		
Site Name	Parameter	Operator
Salt River #1	ozone	SRPMIC
Salt River #2	ozone	SRPMIC
Ozone Monitoring Sites to be Closed/Relocated		
Mount Ord	ozone	ADEQ/MCESD
Emergency Management	ozone	MCESD
Lake Pleasant	ozone – relocate to Cave Creek	MCESD
Maryvale	ozone – contingent upon site at Perryville	MCESD
Rio Verde or Fountain Hills	ozone – contingent upon location of Ft. McDowell site	MCESD

Visibility Monitoring Networks in National Parks and Wilderness Areas

The intent of the Class I visibility monitoring program is to characterize long-term trends as completely as possible using ambient visibility measurements within constraints of an area's size, terrain or logistics for each of the 12 federally protected Class I areas in Arizona. The long-term strategy of the visibility monitoring network to track short-term and long-term trends in Arizona Class I areas, to assist in identifying any reasonably attributable visibility impairments, and to provide monitoring data if necessary for new or major modifications of categorical major sources.

Arizona continues to participate in the Interagency Monitoring of Protected Visual Environments (IMPROVE) Program as part of the overall national visibility monitoring effort. IMPROVE is a cooperative measurement effort between EPA, federal land management agencies and state air agencies. The objectives of IMPROVE are:

- To establish current visibility and aerosol conditions in mandatory Class I areas
- To identify chemical species and emission sources responsible for existing man-made visibility impairment
- To document long-term trends for assessing progress towards the national visibility goal
- With the enactment of the regional haze rule, to provide regional haze monitoring representing all visibility-protected federal Class I areas



Class I areas were designated based on an evaluation required by Congress in the 1977 federal Clean Air Act amendments. The evaluation, which the U.S. Forest Service and National Park Service performed, reviewed the wilderness areas of parks and national forests which were designated as wilderness before 1977, were more than 6,000 acres in size and have visual air quality as an important resource for visitors. Of the 156 Class I areas designated across the nation, 12 are located in Arizona.

The Arizona Class I visibility network consists of a combination of visibility monitoring sites established by ADEQ and those established by the IMPROVE committee. Monitoring was conducted or is planned at Grand Canyon National Park – Hance, Grand Canyon National Park – Indian Gardens, Petrified Forest National Park, Mt. Baldy Wilderness – Greer Water Treatment Plant, Sycamore Canyon Wilderness – Camp Raymond, Mazatzal Wilderness – Humboldt Mountain, Mazatzal/Pine Mountain Wildernesses – Ike's Backbone, Sierra Ancha Wilderness – Pleasant Valley Ranger Station, Superstition Wilderness – Tonto National

Monument, Superstition Wilderness – Queen Valley, Saguaro National Park – West Unit, Saguaro National Park – East Unit, Chiricahua National Monument – Entrance Station, Galiuro Wilderness – Muleshoe Ranch, Hillside, Organ Pipe National Monument and Meadview.

Each IMPROVE site includes $PM_{2.5}$ sampling with subsequent analysis for the fine particle mass and major aerosol species, as well as PM_{10} sampling and mass analysis. Many of the sites also include optical monitoring with nephelometers or a transmissometer and color photography to document scenic appearance.

More information about the IMPROVE procedures, sites and data can be found on the IMPROVE Web site at http://vista.cira.colostate.edu/improve/ and on the National Park Service Web site at www.aqd.nps.gov/ard/impr/.

Urban Haze Networks

ADEQ monitors urban haze in the Phoenix and Tucson metropolitan areas using a network of instruments to characterize and quantify the extent of urban haze. There are no established federal or state standards for acceptable levels of urban haze. ADEQ began studying the nature and causes of urban hazes by conducting a study in the winter of 1989-90 in Phoenix and the winter of 1992-93 in Tucson. These studies recommended long-term, year-round monitoring of visibility. In 1993, ADEQ began deploying visibility monitoring equipment in Phoenix and Tucson. These visibility monitoring data are needed to provide policymakers and the public with information, track short- and long-term trends, assess source contributions to urban haze and better evaluate the effectiveness of air pollution control strategies.

The current Phoenix and Tucson urban haze networks include transmissometers for measuring light extinction along a fixed path length of about 5 kilometers, nephelometers for measuring light scattering, and particulate filters for quantifying and characterizing particulate matter. Data from urban PM_{10} and $PM_{2.5}$ samplers are characterized for chemical composition and seasonal variation.

Photochemical Assessment Monitoring Station Monitoring

Section 182(c)(1) of the 1990 Clean Air Act Amendments required the administrator to promulgate rules for the enhanced monitoring of ozone, oxides of nitrogen (NOx) and volatile organic compounds (VOCs) to obtain more comprehensive and representative data on ozone air pollution. Immediately following the promulgation of such rules, the affected states were to begin actions necessary to adopt and implement a program to improve ambient monitoring activities and the monitoring of emissions of NOx and VOCs. Each state implementation plan (SIP) for the affected areas must contain commitments to implement the appropriate ambient monitoring network for such air pollutants. The subsequent revisions to 40 CFR 58, 1993, required states to establish photochemical monitoring stations (PAMS) as part of their SIP monitoring networks in ozone nonattainment areas classified as serious, severe or extreme. The principal reasons for requiring the collection of additional ambient air pollutant and meteorological data are the nationwide lack of attainment of the ozone NAAQS and the need for a more comprehensive air quality database for ozone and its precursors.

The chief objective of the enhanced ozone monitoring requirements is to provide air quality data that will assist air pollution control agencies in evaluating, tracking the progress of and, if necessary, refining control strategies for attaining the ozone NAAQS. Ambient concentrations of ozone and ozone precursors are used to make attainment and nonattainment decisions, aid in tracking VOC and NOx emission reductions, better characterize the nature and extent of the ozone problem, and examine air quality trends. In addition, data from the PAMS network provide an improved database for evaluating photochemical model performance, especially for future control strategy mid-course corrections as part of the continuing air quality management process. The data are particularly useful to states in ensuring the implementation of the most cost-effective regulatory controls.

The PAMS network array for an area should be fashioned to supply measurements that will assist states in understanding and solving ozone nonattainment problems. EPA has determined that for larger areas, a network that will satisfy a number of important monitoring objectives should consist of the following five sites.

Type 1 Site: Upwind and Background Characterization

These sites are established to characterize upwind background and transported ozone and its precursor concentrations entering the area. They will also identify areas that are subjected to overwhelming incoming transport of ozone. Type 1 sites are located in the predominant morning upwind direction from the local area of maximum precursor emissions and at a distance sufficient to obtain urban scale measurements. Typically, these sites will be located near the upwind edge of the photochemical grid model domain.

Type 2a and 2b Sites: Maximum Ozone Precursor Emissions Impact

These sites are established to monitor the magnitude and type of precursor emissions in the area where maximum precursor emissions representative of the metropolitan statistical area/consolidated metropolitan statistical area (MSA/CMSA) are expected to exist and are suited for the monitoring of urban air toxic pollutants. Type 2 sites are located immediately downwind (using the same morning wind direction as for locating the Type 1 site) of the area of maximum precursor emissions and are typically placed near the downwind boundary of the central business district or primary area of precursor emissions mix to obtain neighborhood scale measurements. A second Type 2 site may be required depending on the size of the areaand should be placed in the second-most predominant morning wind direction.

Type 3 Site: Maximum Ozone Concentration

These sites are intended to monitor maximum ozone concentrations occurring downwind from the area of maximum precursor emissions. Locations for Type 3 sites should be chosen so that urban scale measurements are obtained. Typically, these sites are located 10 to 30 miles from the fringe of the urban area.

Type 4 Site: Extreme Downwind Monitoring

These sites are established to characterize the extreme downwind transported ozone and its precursor concentrations exiting the area and will identify those areas that are potentially contributing to overwhelming ozone transport into other areas. Type 4 sites are located in the predominant afternoon downwind direction from the local area of maximum precursor emissions at a distance sufficient to obtain urban scale measurements. Typically, these sites will be located near the downwind edge of the photochemical grid model domain.

PAMS data include measurements of O_3, NOx, a target list of VOCs including several carbonyls, and surface and upper air meteorology. Most PAMS sites measure 56 target hydrocarbons on either an hourly or three-hour basis during the ozone season. The Type 2 sites also collect data on three carbonyl compounds (formaldehyde, acetaldehyde and acetone) during the ozone monitoring period. Included in the monitored VOC species are 10 compounds classified as hazardous air pollutants. All stations must measure O_3, NOx and surface meteorological parameters on an hourly basis. ADEQ has installed four PAMS monitoring sites to date, the ADEQ Supersite (located near 17th Avenue and Campbell) in Central Phoenix (a Type 2 site); the wind profiler (upper air meteorology) site; the Queen Valley site (Type 3); and the South Phoenix site (Type 2a). A time line describing proposed installation dates of additional sites is provided in Table 5.

Table 5: PAMS Installation Time Line

Type of Ozone		Proposed Installation
PAMS	Season	
Type 1	Pending	Palo Verde – Wintersburg Area
Type 2	1999	Supersite – 17th Avenue and Campbell, Phoenix
Type 2a	2001	South Phoenix – Central and Broadway
Type 3	2001	Queen Valley
Type 4	Pending	Roosevelt Lake

Annual Ambient Air Monitoring Network Review

In 1999, ADEQ expanded the scope of the annual ambient air monitoring network reviews beyond the state and local air monitoring stations (SLAMS) to include all state networks. 40 CFR §58.20(d) requires states to complete and submit to EPA an annual network review.

States are required to commit to and explain the air quality surveillance systems in their state implementation plans. The air quality surveillance systems consist of various sites designated as SLAMS, national air monitoring stations (NAMS) and PAMS. To provide a complete review of the air monitoring network, ADEQ chose to include additional stations classified as special purpose monitoring stations (SPM), which includes urban haze monitoring sites, IMPROVE sites, ADEQ visibility stations located in or near mandatory Class I areas, and source-oriented monitoring sites operated independently by the permittee.

The annual network review determines conformance with the requirements of 40 CFR Part 58, Appendix D (*Network Design Criteria*) and Appendix E (*Probe and Path Siting Criteria*) for sites classified as SLAMS, NAMS, PAMS and SPM. Class I monitoring sites are subject to specific siting and operational guidance developed by the IMPROVE Steering Committee. Results of the annual network review are used to determine how well the network is achieving its required air monitoring objectives, how well it meets data users' needs and how it should be modified (through termination of existing stations, relocation of stations, establishment of new stations, monitoring of additional parameters and/or changes to the sampling schedule) to continue to meet its objectives and data needs. The main purpose of the review is to improve the network so that it provides adequate, representative and useful air quality data.

In the upcoming year, ADEQ anticipates developing or refining existing network plans for the NAAQS and urban haze ambient monitoring programs that will define specific program goals and objectives. The initial monitoring plans will use recommendations made in the annual network review and will go through a review every two to three years considering factors such as data results and completeness, site representativeness, and data representativeness. The monitoring plan review will also tabulate network review results accumulated over the prior three-year period and will recommend changes to the monitoring plans and instrument or operating requirements.

In 2001, ADEQ conducted a Phase II network review for each criteria pollutant in the state-operated network. It was intended to address how well the network achieves the intended objective, how well it meets the data users' needs and if any modification is needed (i.e. termination, relocation, establishing new sites). The review did not include monitoring networks operated by Maricopa, Pima and Pinal counties. The review process considered ambient monitoring data, population, geographic location of sites, criteria pollutant emissions and agency resource allocation.

Data analysis included a review of historical trends, comparison to the applicable NAAQS standard, seasonal variation, inter-site comparison of sites of similar objective, location or air mass, and other information obtained from historical reviews, analysis or studies. Population analysis included an evaluation of the population represented by a monitorand a review of areas where monitoring may be needed (e.g., in an area with a high population growth rate). Geographic analysis employed population density maps, monitor locations and airshed locations to evaluate adequacy of the network.

Also included in the review were practical and resource considerations, such as resources allocated to various networks, inter-network resource analysis to determine if more or less emphasis needs to be placed on a specific pollutant network, how expanding the network for one pollutant in one place may affect the number of samplers in another.

Tables 6 and 7 show the results of the Phase II network review.

Table 6: Summary of Monitoring Sites to Close

Existing Sites to Close	Discussion Summary
Flagstaff – ADOT (PM_{10})	Closed in 2001
Fort Mohave (PM_{10})	Closed in 2001
Prescott (PM_{10})	Close estimated to occur end 2002 after new site located in Prescott Valley area
Nelson (PM_{10})	Closed in 2002
Phoenix – Greenwood (PM_{10})	ADEQ will discontinue dichots in 2002
Clarkdale (PM_{10})	Closed in 2002
Phoenix – Grand Ave (CO)	Site closed 2002
Tempe – Urban Haze Monitors (Maintain FRM)	Close upon installation of new speciation samplers
Estrella Park – Urban Haze Monitors	Close upon installation of new speciation samplers

Table 7: Summary of New Monitoring Locations		
Additional Monitoring Locations	Possible Pollutant(s) to Measure	Estimated Active Date
Lake Havasu	PM_{10}, $PM_{2.5}$, O_3, NO_X, MET	2003
Sierra Vista	PM_{10}, $PM_{2.5}$, O_3, NO_X, MET	2003
Prescott Valley	PM_{10}, $PM_{2.5}$, MET	End 2002
Kingman	PM_{10}, $PM_{2.5}$, O_3, NO_X, MET	2003
Southeast Arizona	O_3, NO_X	Pending equipment availability
Northeast Arizona	O_3, NO_X	Pending Equipment Availability

Monitoring Methods

The gaseous conventional pollutants (SO_2, O_3, NO_2 and CO), as well as PM_{10} (TEOMs) and optical characteristics of the atmosphere (total light extinction, light absorption by gases, light scattering by particles and light absorption by particles) – are monitored with continuous analyzers taking approximately one pollutant sample per second. These values are averaged on an hourly basis and recorded to the correct number of significant digits, based on the form of the air quality standards and the detection limits of the instrument. In most cases, the hourly data are summarized into the appropriate multi-hour averages. The agency or company network operators conduct regular checks of the stability, reproducibility, precision and accuracy of these instruments. Precision and accuracy of ambient data are assessed across an entire network using statistical tests that EPA requires.

Particulate lead (Pb), PM_{10} and $PM_{2.5}$ are usually sampled for 24 hours, from midnight to midnight, most often on every sixth day. Using a timer, ambient air is drawn through an inlet of a specified design at a known flow rate onto a filter that collects all PM less than a diameter specified by the inlet design. The filters are weighed before and after the sample period to determine the difference in mass and then divided by the product of the flow rate with the elapsed time to arrive at a mass per unit volume concentration. In the case of Pb, the filter is then subjected to chemical analysis to determine the amount of Pb particulate and integrated with the flow rate and timer information to calculate the concentration. These data are summarized into the appropriate quarterly or annual averages. These samplers are also certified as federal reference or equivalent methods. The agency or company network operators regular checks of the stability, reproducibility, precision and accuracy of the samplers and laboratory procedures. Again, precision and accuracy of ambient data are assessed across an entire network using statistical tests that EPA requires.

Visibility monitoring methods are generally divided into the three groups of optical, scene and aerosol (PM). Monitoring of visibility requires qualitative and quantitative information about the causes of haze (e.g., what is in the air, the formation, transport and deposition of pollutants) and the nature of haze (what are the optical effects of those pollutants to the observer). Scene conditions of visual air quality associated with hazes are recorded with a camera. In the past, ADEQ has used a super-VHS video format and 35 mm slides. The video camera was programmed to advance at the rate of one frame every four minutes during daylight hours. When scene information is obtained from 35 mm slides, a picture is taken at the same times each day to establish baseline conditions and track variations in haze. ADEQ is currently going to digital and Web cameras for continued documentation of scene conditions.

Quantitative measurement of light extinction (B_{ext}) has four components, :

- Light scattering by gases (B_{sg})
- Light absorption by gases (B_{ag})
- Light scattering by particles (B_{sp})
- Light absorption by particles (B_{ap})

Mathematically, the relationship is expressed as $B_{ext} = B_{sg} + B_{ag} + B_{sp} + B_{ap}$, where the units are inverse megameters (Mm^{-1}), or the amount of light removed per million meters of distance a viewer looks through.

Total optical light extinction (B_{ext}) is measured directly with a device called a transmissometer. The transmissometer generates visible light in the same wavelength (550 nanometers) as the human eye detects and then transmits that light beam over a sight path of several kilometers to a photocell detector. The transmissometer's design and operation allow its data to be directly correlated with human perception of visibility through the atmosphere. Transmissometer data are also used to check the general accuracy of the sum of the components of light extinction as measured by other continuous monitors. Two transmissometers have been operated in Phoenix and Tucson since 1993.

Light scattering by gases (B_{sg}) is a function of air density and is unrelated to air pollution sources. This parameter is derived and does not require measurement. In contrast, the other three components of light extinction are human-caused and require measurement with continuous monitors.

Light absorption by gases (B_{ag}) is determined by continuously measuring nitrogen dioxide (NO_2) since it is the only gas normally present in urban or Class I areas that absorbs significant quantities of visible light. Several EPA reference or equivalent method NO_2 monitors are deployed to verify maintenance of the NAAQS throughout Arizona, including monitoring at Tucson, Phoenix, Queen Valley and Tonto National Monument, while the National Park Service network tracks NO_2 at several national parks in Arizona.

Light scattering by particles (B_{sp}) is determined by continuously, directly measuring particle scattering variation in a calibrated ambient sampling chamber called a nephelometer. The nephelometer samples air at ambient temperature and relative humidity conditions. Routine monitoring with this instrument began in both the Class I area and urban haze networks during 1996. Light absorption by particles (B_{ap}) is determined by continuously measuring the quantity of light transmitted through a filter tape or intermittently through a filter from a PM sampler. Data from these analyses are reported in micrograms per cubic meter ($\mu g/m^3$) of elemental carbon and are converted to the B_{ap} units of Mm^{-1} using a laboratory-derived light absorption coefficient. Routine data collection using a continuous instrument, the aethalometer, began in December 1996 in Phoenix and February 1998 in Tucson. B_{ap} is also measured intermittently using the PM sample filters collected in both the Class I area and urban haze networks.

In monitoring visibility, it is also essential to collect and analyze particulate samples to define and to understand the chemistry of aerosols present before, during and after haze events. The chemical speciation data can be used to determine the contributions of each source category to the observed optical haze data. From these filter data, the chemical components are used to calculate light extinction for the filter sample period and compare with continuous measurements as a check. Finally, the samplers used in the urban haze networks also monitor compliance with PM_{10} and $PM_{2.5}$ national air quality standardsand provide information on the categorical source contributions to observed PM_{10} and $PM_{2.5}$ concentrations. Sampling frequency for PM in the urban networks is generally every sixth day and every third day in the ADEQ and IMPROVE Class I area networks. Every day sampling at all monitoring sites would be cost-prohibitive and personnel-intensive using current particulate sampling technologies.

To more fully understand the causes of hazes often associated with certain atmospheric conditions, it is necessary to monitor certain meteorological parameters. For these reasons, each network includes meteorological data such as temperature, relative humidity, wind speed and direction. Routine measurements of upper air temperature and water vapor are not made in the Phoenix area but information from the twice-daily rawinsonde launches by the National Weather Service at Tucson, Flagstaff, Las Vegas, Nev. and El Paso, Tex. are used to characterize the air masses over Arizona.

Monitoring Data

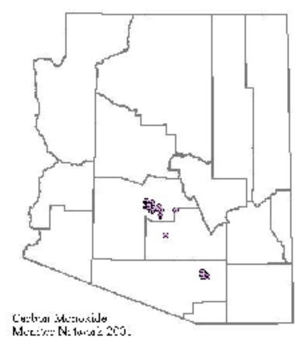
Introduction

[View a photo](#) of ADEQ's Phoenix supersite

Air quality measurements in Arizona can be divided into the three categories of conventional pollutants, visibility and photochemical monitoring. Each category is discussed below. EPA has set NAAQS for the criteria air pollutants, which are carbon monoxide, ozone, nitrogen dioxide, sulfur dioxide, lead and particulate matter 10 microns in size and smaller (PM_{10}). Additional particulate matter monitoring includes the two subsets of PM_{10} of coarse (2.5 to 10 microns in size) and fine (less than 2.5 microns in size) particulate matter. These pollutants are monitored in Arizona by industry, county air pollution districts, Indian tribes and ADEQ. The 2001 data measurements by conventional pollutant begin on Page 18. The data tables in this section are organized by county; site operator information can be found in the site index tables in Appendix 1, which begins on Page 105. Data recovery information (valid samples as a percent of total scheduled samples) is included in the tables. The number of valid samples is important for determining the representativeness of the average data calculations. Information about the compliance requirements and status for the conventional pollutants begins on Page 42. Visibility monitoring information is presented beginning on Page 64.

Conventional Pollutants – 2001 Data

Carbon Monoxide



Carbon monoxide – a colorless, odorless, tasteless gas that is produced in the incomplete combustion of fuels – has a variety of adverse health effects that arise from its ability to chemically bind with blood hemoglobin. Carbon monoxide successfully competes with oxygen for binding with hemoglobin and thereby impairs oxygen transport. This impaired transport leads to several central nervous system effects, such as the impairment of time interval discrimination, changes in relative brightness thresholds, increased reaction time, and headache, fatigue and dizziness. Carbon monoxide exposures also contribute to or exacerbate arteriosclerotic heart disease.

In Arizona's metropolitan areas, about 75 percent of carbon monoxide emissions come from on-road motor vehicles, 20 percent from off-road vehicles or equipment such as construction vehicles and lawn and garden equipment, and 5 percent from fuel combustion from commercial and residential heating. This pollutant has low background levels, with highest concentrations next to busy streets, and has elevated neighborhood concentrations in locations that reflect emissions transported from upwind portions of an area. Its concentrations peak from November to January because its emissions are highest in cold weather – automotive emissions of carbon monoxide vary inversely with temperature – and because the surface layer of the atmosphere is at its most stable in wintertime. Hourly concentrations tend to be at their maximum during morning rush hour and between 6 p.m. and midnight.

Controls have reduced carbon monoxide emissions and the standards have been achieved in the metropolitan Phoenix area in 1996-2001, in stark contrast to the first half of the 1980s, when more than 100 exceedances were recorded each year. Similar improvements have occurred in Tucson, where the last exceedance was recorded in 1984. Equipping vehicles with catalytic converters and electronic ignition systems were the most effective controls, but significant reductions can also be attributed to the vehicle inspection program (beginning in 1976) and oxygenated fuels (beginning in 1989).

Carbon monoxide is monitored continuously with non-dispersive infrared instruments that are deployed in urban neighborhoods and near busy roadways or intersections. In 2001, 15 monitors were operated in greater Phoenix, five in Tucson, and one each in Apache Junction and Casa Grande. Table 8 presents the 2001 carbon monoxide data.

Table 8: 2001 Carbon Monoxide Data (in ppm)

Site or City	One-Hour Average Value		Eight-Hour Average Value		Valid Data Recovery* (%)
	Max Value	2nd High	Max Value	2nd High	
Maricopa County					
Central Phoenix	6.0	5.8	4.8	4.2	98
Glendale[S]	4.7	4.7	3.1	2.8	99
Maryvale[S]	9.0	7.5	7.6	5.2	98
Mesa[S]	4.6	3.8	2.9	2.6	98
North Phoenix[S]	5.2	4.7	2.5	2.5	96
Phoenix – Grand Avenue[S]	10.3	9.6	6.6	6.1	98
Phoenix – Greenwood, MCESD	7.0	6.9	5.2	4.6	98
Phoenix – JLG Supersite	7.0	6.5	5.7	5.2	97

Table 8: 2001 Carbon Monoxide Data (in ppm)					
Site or City	One-Hour Average Value		Eight-Hour Average Value		Valid Data Recovery* (%)
	Max Value	2nd High	Max Value	2nd High	
Phoenix – West Indian School	8.0	7.7	6.8	6.5	98
South Phoenix[S]	6.8	6.3	4.5	3.4	99
South Scottsdale[S]	4.5	4.4	3.2	3.1	97
Surprise[S]	2.6	2.5	1.2	1.1	98
Tempe – MCESD	4.3[#]	4.2[#]	3.2[#]	3.0[#]	65[#]
West Chandler[S]	3.3	3.1	2.2	2.1	97
West Phoenix	8.4	8.2	7.5	6.5	98
Pima County					
Tucson – Alvernon	5.8	5.7	3.0	2.9	99
Tucson – Cherry[S]	3.9	3.6	2.8	2.6	99
Tucson – Children's Park	2.9	2.9	1.7	1.7	97
Tucson – Craycroft	3.7	3.6	1.9	1.7	97
Tucson – Downtown	5.6	5.1	2.7	2.5	99
Pinal County					
Apache Junction – Maintenance Yard	3.8	3.4	1.1	1.0	78
Casa Grande – Airport	1.5	1.1	0.7	0.7	95

**Valid data recovery is the percentage of valid samples collected of the total number of scheduled sampling hours. There were 8,760 sampling hours in 2001. Valid data recovery should be less than 100 percent due to quality assurance testing of the monitors requiring them to be off-line for several hours at a time.*

[S]*Seasonal monitor, operational from Jan. 1 to April 1 and Sept. 1 to Dec. 31; 5,088 sampling hours in non-leap years. Exceptions:*

- *Tucson – Cherry monitor operated Jan. 1-April 15 and Sept. 1-Dec. 31, 5,472 sampling hours.*
- *Surprise monitor operated Jan. 1-April 30 and Sept. 1-Dec. 31; 5,808 sampling hours.*

Lead

Lead, a heavy metal with pronounced toxic effects, is present in the atmosphere as a constituent of fine particles. Chronic lead poisoning attacks the blood, the brain and nervous system, the kidney, and the reproductive system, with such effects as moderate to severe brain and kidney damage, sterility, and abortions, stillbirths and neonatal deaths. Low-level chronic exposure to lead manifests itself first in the inhibition of the biosynthesis of hemoglobin, resulting in the anemia associated with chronic lead poisoning.

Emissions of lead in Arizona come from the smelting of ore, the combustion of fossil fuels and, until the mid-1970s, the use of alkyl lead compounds as anti-knock additives in gasoline. With the phasing out of regular lead gasoline, the automotive emissions of lead to the atmosphere have declined to near zero.

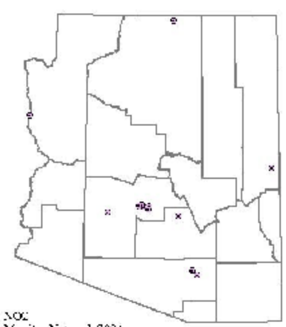
Controls to reduce lead emissions have been extremely effective, with a net 94 percent reduction on a national basis from 1978 to 1987. Automotive emissions were reduced 97 percent through the elimination of lead compounds in gasoline, stationary source fuel combustion emissions were reduced 92 percent, and industrial processes and solid waste disposal emissions were reduced substantially as well.

Lead is monitored by analyzing PM_{10} samples collected for 24 hours on every sixth day. Total suspended particulate (TSP) samplers are the reference method but are no longer used to obtain lead data. Lead is primarily a combustion product, so PM_{10} samples capture ambient lead concentrations adequately.

Lead concentrations have been monitored at 16 locations: four are urban (Phoenix, Douglas, Payson and Nogales), three are located near a smelter (Hayden) or cement plant (Clarkdale), and nine are background sites (Petrified Forest National Park, Chiricahua National Monument, Grand Canyon – Hance, Grand Canyon – Indian Gardens, Tonto National Monument, Palo Verde, Organ Pipe Cactus National Monument and Hillside).

Quarterly lead averages are not included here but are available on request.

Nitrogen Dioxide



Nitrogen dioxide (NO_2) is a reddish-brown gas that is formed by the oxidation of nitric oxide (NO), which is a byproduct of combustion of all fuels. At the lowest nitrogen dioxide exposure levels at which adverse health effects have been detected, respiratory damage has been observed: destruction of cilia, alveolar tissue disruption and obstruction of the respiratory bronchioles. Animal studies suggest that nitrogen dioxide may be a causal or aggravating agent in respiratory infections. However, community exposure studies to lower ambient levels of nitrogen dioxide have demonstrated no significant links with respiratory symptoms or disease. This pollutant is of greater concern in its reduction of visibility (it causes 5 percent of the visibility reduction in Phoenix) and in its contributory role in the photochemical formation of ozone.

Combustion emissions of nitrogen oxides are 95 percent nitric oxide and 5 percent nitrogen dioxide. Because nitric oxide is rapidly oxidized to nitrogen dioxide, nitric oxide emissions serve as a surrogate for nitrogen dioxide. In a recent Phoenix emissions inventory, the transportation sector dominated nitric oxide emissions: 58 percent of the emissions came from cars and trucks, 27 percent came from off-road vehicles such as trains and diesel-powered construction vehicles, and 15 percent from other sources, including power plants, biogenic emissions from soil and stationary combustion sources. Nitric oxide and nitrogen dioxide concentrations are highest near major roadways. Nitric oxide concentrations decrease rapidly with distance from the roadway, whereas nitrogen dioxide concentrations are more evenly distributed because of their formation through oxidation and their subsequent transport. Concentrations of nitrogen dioxide are highest in the late afternoon and early evening of winter, when rush hour emissions of nitric oxide are converted to nitrogen dioxide under relatively stable atmospheric conditions. Because nitric oxide reacts rapidly with ozone, nocturnal ozone concentrations in cities are often reduced to near-zero levels. This nitric oxide scavenging of ozone does not occur in remote areas. Nocturnal ozone concentrations at background sites are high compared with the urban concentrations.

Nitrogen oxides emissions from motor vehicles have been reduced through retardation of spark timing, lowering the compression ratio, exhaust gas recirculation systems and three-way catalysts. The vehicle inspection program, with its NOx test for light-duty gasoline vehicles 1981 and newer (in Phoenix only) and its opacity test for diesel vehicles, has also helped. Reformulated gasolines also decrease nitrogen oxides emissions: Federal Phase II gasoline, by 1.5 percent for vehicular and 0.5 percent for off-road equipment; California Phase 2 gasoline, by 6.4 percent for vehicular and 7.7 percent for off road equipment.

Nitrogen dioxide (NO_2) is monitored continuously with chemiluminescence instruments, which also determines nitric oxide (NO) concentrations and NOx (the sum of NO_2 and NO) concentrations. These instruments are located in urban neighborhoods where either the emissions are dense or where ozone concentrations tend to be at their maximum. In addition, these monitors are located near major coal-fired electrical power plants. Twelve monitors were operated in Arizona in 2000: eight urban sites and four sites near power plants. Table 9 presents the nitrogen dioxide data collected in Arizona in 2001.

Table 9: 2001 Nitrogen Dioxide (in ppm)				
Site or City	Annual Average	Maximum Value		Valid Data Recovery* (%)
		One-Hour Average	24-Hour Average	
Apache County				
Springerville, Coyote Hills	0.001	0.060	0.006	90
Coconino County				
Page	0.002	0.041	0.018	98
Maricopa County				
Cental Phoenix	0.028	0.094	0.060	96
Palo Verde[S#]	N/A	0.043	0.018	74
Phoenix – Greenwood	0.037	0.118	0.072	96
Phoenix, JLG Supersite[S]	N/A	0.063	0.049	90
South Scottsdale	0.021	0.077	0.046	94
Tempe – MCESD	0.022	0.099	0.062	85
West Phoenix	0.025	0.078	0.056	97
Mohave County				
Bullhead City, SCE[#]	N/A	0.188	0.026	68
Pima County				
Tucson – Children's Park	0.015	0.060	.031	93
Tucson – Craycroft	0.017	0.058	.031	99

**Valid data recovery is the percentage of valid samples collected of the total number of scheduled sampling hours. There were 8,760 sampling hours in 2001. Valid data recovery should be less than 100 percent due to quality assurance testing of the monitors requiring them to be off-line for several hours at a time.*

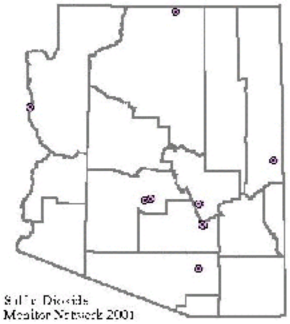
[S]*Seasonal monitors:*

- *Palo Verde operates during summer ozone season, April 1 to Nov. 1, 5; 160 hours*
- *Phoenix JLG Supersite operates during winter CO season, Oct. 1 to May 1; 5,088 hours possible*

[#]*Indicates the data do not satisfy EPA's summary criteria, usually meaning less than 75 percent valid data recovery available.*

Sulfur Dioxide

Exposure to sulfur dioxide, a colorless gas with a pungent, irritating odor at elevated concentrations, alters the mechanical function of the upper airway, including increasing the nasal flow resistance and decreasing the nasal mucus flow rate. Short-term exposures result in an exaggerated air flow resistance in about 10 percent of the subjects tested and produce acute bronchioconstriction in strenuously exercising asthmatics.



In Arizona, the principal source of sulfur dioxide emissions has been the smelting of sulfide copper ore. Most fuels contain trace quantities of sulfur, and their combustion releases both gaseous sulfur dioxide (SO_2) and particulate sulfate (SO_4^{--}). A recent sulfate inventory for Phoenix shows 32 percent of SO_2 emissions come from point sources, 26 percent from area sources, 23 percent from off-road vehicles and equipment, and 19 percent from on-road motor vehicles. Sulfur dioxide is removed from the atmosphere through dry deposition on plants and its conversion to sulfuric acid and eventually to sulfate. Sulfur dioxide has extremely low background levels, with elevated concentrations found downwind of large point sources. Concentrations in urban areas are low and are homogeneously distributed, with annual averages varying from 3 to 11 $\mu g/m^3$.

Major controls were installed in Arizona's copper smelters in the 1980s, which reduced sulfur dioxide emissions substantially. Vehicular emissions of sulfur dioxide and sulfate have been reduced through lowering the sulfur content in diesel fuel and gasoline.

Sulfur dioxide is monitored continuously with pulsed fluorescence instruments, most of which are clustered around copper smelters or coal-fired electric power plants. In 2001, nine reporting monitors were sited near copper smelters, three near power plants and three in urban areas. Table 10 presents the sulfur dioxide data collected in Arizona in 2001.

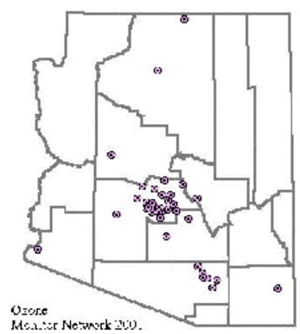
Table 10: 2001 Sulfur Dioxide (in $\mu g/m^3$)						
Site or City	Annual Average	Maximum Value				Valid Data Recovery* (%)
		3-Hour Average		24-Hour Average		
		Max Value	2nd High	Max Value	2nd High	
Apache County						
Springerville – Coyote Hills	0.7	120	39	24	13	90
Coconino County						
Page	3	15	N/A	8	N/A	98
Gila County						
Globe Highway	43	838	N/A	311	N/A	100
Hayden – Garfield Avenue	29	873	N/A	285	N/A	100
Hayden – Montgomery	45	685	N/A	184	N/A	99
Hayden – Old Jail, ADEQ	24	732	575	157	131	96
Hayden – Old Jail, ASARCO	21	877	N/A	152	N/A	100
Miami – Jones Ranch	19	577	N/A	145	N/A	99
Miami, Ridgeline – ADEQ	18	339	235	105	78	100
Miami, Town Site	14	353	N/A	74	N/A	99
Maricopa County						
Central Phoenix	5	44	37	24	24	96
South Scottsdale	5	21	18	16	13	93
Mohave County						
Bullhead City – SCE	2	32	N/A	18	N/A	98

Table 10: 2001 Sulfur Dioxide (in $\mu g/m^3$)						
Site or City	Annual Average	Maximum Value				Valid Data Recovery* (%)
		3-Hour Average		24-Hour Average		
		Max Value	2nd High	Max Value	2nd High	
Pima County						
Tucson – Craycroft, PDEQ	3	16	13	8	8	99
Pinal County						
Hayden – Junction	14	215	N/A	59	N/A	100

**Valid data recovery is the percentage of valid samples collected of the total number of scheduled sampling hours. There were 8,760 sampling hours in 2001. Valid data recovery should be less than 100 percent due to quality assurance testing of the monitors requiring them to be off-line for several hours at a time.*

 # Indicates the data were not available for this report.

Ozone



Ozone – a colorless, slightly odorous gas – is both a natural component of the atmosphere, through its photochemical formation from natural sources of methane, carbon monoxide, hydrocarbons and nitrogen oxides, and an important air contaminant in urban atmospheres. In the stratosphere, ozone blocks harmful ultraviolet radiation. In the urban atmosphere, its formation from anthropogenic emissions of hydrocarbons and nitrogen oxides leads to concentrations harmful to people, animals, plants and materials. Ozone causes significant physiological and pathological changes in both animals and humans at concentrations present in many urban environments. Short-term (one to two hours) exposures to concentrations in the range of 0.1 to 0.4 parts per million induce changes in lung function, including increased respiratory rates, increased pulmonary resistance, decreased tidal volumes and changes in lung mechanics. Symptomatic responses in exercising adults include throat dryness, chest tightness, substernal pain, cough, wheeze, pain on deep inspiration, shortness of breath and headache. These symptoms also have been observed at lower concentrations for longer exposures. Evidence suggests that ozone exposure makes the respiratory airways more susceptible to other bronchioconstrictive challenges. Animal studies suggest that ozone exposure interferes with or inhibits the immune system. Ozone at ambient concentrations injures the stomates, which are the cells that regulate plant respiration, resulting in flecks on the upper leaf surfaces of dichotomous plants and the death of the tips of coniferous needles. Ozone is considered by plant scientists to be the most important of all of the phytotoxic air pollutants, causing over 90 percent of all plant injury from air pollution on a global basis.

Ozone is formed photochemically by the reaction of volatile organic compounds and nitrogen oxides. Volatile organic compound (VOC) emissions in greater Phoenix come from cars and trucks (31 percent), off-road vehicles and equipment such as lawn mowers (27 percent), small stationary sources (20 percent), biogenic emissions from grass, shrubs and trees (17 percent) and point sources (5 percent). Nitrogen oxides (NOx) come from cars and trucks (58 percent), off-road vehicles such as construction equipment and trains (27 percent), electric power plants (7 percent), small stationary sources (4 percent) and biogenic emissions from soil (4 percent). Ozone has relatively high background levels, with the daily maximum in remote areas being about one-half to three-quarters of the daily maximum in the urban areas. In an urban area, the highest ozone concentrations tend to occur on the downwind edge, although high concentrations do occur less frequently in the central city. High ozone concentrations are a summer phenomenon caused when sunlight and evaporative hydrocarbon emissions peak. Ozone concentrations are low to near zero at night, rise rapidly through the morning and peak in the afternoon.

Controls to reduce the precursors of ozone – VOC and NOx – have been successfully implemented for years. NOx and exhaust VOC from vehicles have been reduced through engine modifications and three-way catalytic converters. Evaporative hydrocarbons from vehicles have been reduced through better engineered fuel tanks and auxiliary plumbing combined with carbon absorption canisters. Additional reductions of vehicular VOC have come through ADEQ’s vehicle inspection program, which tests all gasoline vehicles for hydrocarbons (Phoenix and Tucson), through vapor-capturing equipment for gasoline tankers, vapor recovery systems at retail gas stations (Phoenix area only) and reformulated gasoline (Phoenix area only). Stationary source hydrocarbons have been reduced through a variety of better control equipment required by stricter regulations. Despite these efforts, the continued growth in Arizona, combined with the high natural background ozone, will make achieving the eight-hour standard difficult.

Ultraviolet absorption instruments monitor ozone continuously in urban neighborhoods for population exposure, in areas downwind of urban areas for maximum concentration monitoring and in remote areas for background information. In 2001, 37 reporting ozone monitors were in operation; five for background, 22 for urban neighborhoods and 10 for maximum concentrations downwind of urban areas. Tables 11 and 12 present the ozone data collected in Arizona in 2001.

Table 11: 2001 Ozone Data					
Site or City	Max Value	2nd High	3rd High	4th High	Valid Data Recovery* (%)
Cochise County					
Chiricahua National Monument	0.073	0.071	0.071	0.071	88
Coconino County					
Page	0.075	0.068	0.066	0.066	98
Grand Canyon National Park – Hance Camp	0.074	0.074	0.073	0.072	94
Maricopa County					
Blue Point	0.111	0.104	0.093	0.092	98
Cave Creek[S] (began August 2001)	0.112[#]	0.100[#]	0.096[#]	0.092[#]	42[#]
Cental Phoenix	0.091	0.091	0.090	0.090	97
Falcon Field[S]	0.111	0.100	0.097	0.095	98
Fountain Hills	0.110	0.106	0.098	0.097	99
Glendale[S]	0.116	0.099	0.098	0.098	98
Humboldt Mt.[S]	0.098	0.096	0.096	0.096	98
Lake Pleasant[S] (closed 6/01/01)	0.085[#]	0.083[#]	0.082[#]	0.080[#]	50 [#]
Maryvale[S]	0.097	0.091	0.089	0.089	98
Mesa	0.093	0.092	0.088	0.084	93
Mount Ord[S]	0.102[#]	0.089[#]	0.088[#]	0.088[#]	64[#]
North Phoenix	0.110	0.101	0.098	0.097	98
Palo Verde[S]	0.085	0.085	0.083	0.081	85
Phoenix – Emergency Management[S] (closed 6/01/01)	0.073[#]	0.072[#]	0.072[#]	0.072[#]	28[#]

Table 11: 2001 Ozone Data					
Site or City	Max Value	2nd High	3rd High	4th High	Valid Data Recovery* (%)
Phoenix – JLG Supersite	0.101	0.095	0.093	0.092	97
Pinnacle Peak	0.107	0.103	0.102	0.100	98
Rio Verde[S]	0.102	0.100	0.099	0.096	99
South Phoenix	0.098	0.094	0.092	0.086	96
South Scottsdale	0.102	0.101	0.094	0.092	93
Surprise	0.093[#]	0.088[#]	0.087[#]	0.083[#]	70[#]
Tempe – Daley Park	0.099	0.099	0.096	0.093	82
West Chandler[S]	0.105	0.100	0.096	0.092	96
West Phoenix	0.099	0.094	0.094	0.089	93
Pima County					
Saguaro National Park East	0.083	0.075	0.075	0.075	95
Tucson – Children's Park	0.084	0.083	0.082	0.078	99
Tucson – Craycroft	0.089	0.084	0.081	0.079	99
Tucson – Downtown	0.083	0.081	0.080	0.079	99
Tucson – Fairgrounds	0.080	0.077	0.077	0.077	97
Tucson – Tangerine	0.078	0.074	0.073	0.073	99
Pinal County					
Apache Junction – Maintenance Yard	0.102	0.096	0.096	0.092	92
Casa Grande – Airport	0.085	0.084	0.084	0.083	98
Queen Valley[S] (began 5/08/01)	0.103[#]	0.103[#]	0.098[#]	0.093[#]	71[#]

Table 11: 2001 Ozone Data					
Site or City	Max Value	2nd High	3rd High	4th High	Valid Data Recovery* (%)
Yavapai County					
Hillside	0.084	0.080	0.080	0.080	81
Yuma County					
Yuma[S]	0.089	0.087	0.086	0.084	85

**Valid data recovery is the percentage of valid samples collected of the total number of scheduled sampling hours. There were 8,760 sampling hours in 2001. Valid data recovery should be less than 100 percent due to quality assurance testing of the monitors requiring them to be off-line for several hours at a time.*

[S]Seasonal monitor, operational during April 1 to Nov. 1; 5,136 sampling hours in non-leap years.

[#]Indicates the data do not satisfy EPA's summary criteria, usually meaning less than 75 percent valid data recovery available.

Table 12: 2001 Ozone Data (in ppm), Eight-hour Averages						
Site or City	Max Value	2nd High	3rd High	4th High	Daily Exceed.	Sample Days
Cochise County						
Chiricahua National Monument	0.068	0.068	0.067	0.067	0	295
Coconino County						
Page – Navajo Generating Station	0.065	0.063	0.061	0.059	0	359
Grand Canyon National Park – Hance Camp	0.072	0.071	0.071	0.070	0	359
Maricopa County						
Blue Point	0.085	0.081	0.080	0.080	1	361
Cave Creek[S] (began August 2001)	0.099[#]	0.085[#]	0.083[#]	0.083[#]	2[#]	91[#]

Table 12: 2001 Ozone Data (in ppm), Eight-Hour Averages						
Site or City	Max Value	2nd High	3rd High	4th High	Daily Exceed.	Sample Days
Cental Phoenix	0.079	0.077	0.076	0.075	0	356
Falcon Field[S]	0.089	0.085	0.081	0.081	2	212
Fountain Hills	0.087	0.086	0.085	0.084	3	363
Glendale[S]	0.092	0.085	0.080	0.078	2	212
Humboldt Mt.[S]	0.087	0.086	0.085	0.085	4	212
Lake Pleasant[S] (closed 6/01/01)	0.076[#]	0.073[#]	0.073[#]	0.073[#]	0[#]	108[#]
Maryvale[S]	0.083	0.075	0.075	0.073	0	209
Mesa	0.078	0.077	0.077	0.074	0	338
Mount Ord[S]	0.081	0.079	0.077	0.077	0	136
North Phoenix	0.093	0.087	0.086	0.086	4	363
Palo Verde[S]	0.077	0.077	0.075	0.074	0	182
Phoenix – Emergency Management[S] (closed 6/01/01)	0.067[#]	0.065[#]	0.064[#]	0.063[#]	0	60[#]
Phoenix, JLG Supersite	0.086	0.080	0.080	0.079	1	352
Pinnacle Peak	0.095	0.089	0.087	0.086	4	359
Rio Verde[S]	0.083	0.083	0.083	0.083	0	214
South Phoenix	0.086	0.082	0.080	0.076	1	352
South Scottsdale	0.088	0.081	0.079	0.079	1	355
Surprise	0.073	0.073	0.072	0.071	0	256
Tempe – Daley Park	0.088	0.082	0.082	0.079	1	300
West Chandler[S]	0.086	0.084	0.083	0.078	1	209

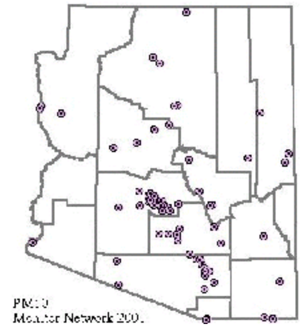
Table 12: 2001 Ozone Data (in ppm), Eight-Hour Averages						
Site or City	Max Value	2nd High	3rd High	4th High	Daily Exceed.	Sample Days
West Phoenix	0.081	0.079	0.076	0.075	0	344
Pima County						
Saguaro National Park East	0.069	0.068	0.068	0.066	0	348
Tucson – Children's Park	0.071	0.070	0.069	0.069	0	362
Tucson – Craycroft	0.075	0.073	0.070	0.069	0	363
Tucson – Downtown	0.071	0.069	0.068	0.065	0	363
Tucson – Fairgrounds	0.071	0.069	0.069	0.066	0	357
Tucson – Tangerine	0.069	0.068	0.067	0.067	0	364
Pinal County						
Apache Junction – Maintenance Yard	0.082	0.081	0.079	0.078	0	336
Casa Grande – Airport	0.078	0.075	0.074	0.079	0	358
Queen Valley[S]	0.084	0.084	0.082	0.079	0	152
Yavapai County						
Hillside	0.078	0.077	0.077	0.077	0	294
Yuma County						
Yuma[S]	0.082	0.076	0.072	0.068	0	181

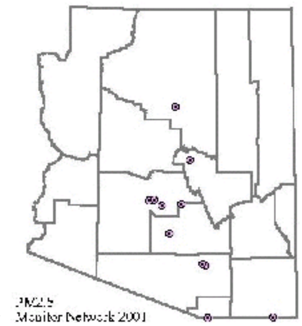
* *Valid data recovery is the percentage of valid samples collected of the total number of scheduled sampling hours. There were 8,760 sampling hours in 2001. Valid data recovery should be less than 100 percent due to quality assurance testing of the monitors requiring them to be off-line for several hours at a time.*

[S] *Seasonal monitor, operational during April 1 to Nov. 1; 5,136 sampling hours in non-leap years.*

[#] *Indicates the data do not satisfy EPA's summary criteria, usually meaning less than 75 percent valid data recovery available.*

Particulate Matter Smaller Than 10 Microns (PM_{10}) and Smaller Than 2.5 Microns ($PM_{2.5}$)





Particulate matter is a collective term describing very small solid or liquid particles that vary considerably in size, geometry, chemical composition and physical properties. Produced by both natural processes (pollen and wind erosion) and human activity (soot, fly ash, and dust from paved and unpaved roads), particulates contribute to visibility reduction, pose a threat to public health and cause economic damage through soil disturbance. Some fine particulates ($PM_{2.5}$) are formed by the condensation of vapors or by their subsequent growth through coagulation or agglomeration. Others are emitted directly from the sources, either by combustion or from mechanical grinding of soils. Coarse particulates (2.5 to 10 microns) are formed through mechanical processes such as the grinding of matter and the atomization of liquids. Fine particulates can also be classified as primary – produced within and emitted from a source with little subsequent change – or secondary – formed in the atmosphere from gaseous emissions. Secondary particulate nitrates and sulfates, for example, form in the atmosphere from the oxidation of sulfur dioxide and nitric oxide, which are two gases. In contrast, most atmospheric carbon is primary, having been emitted directly from combustion sources, although some of the organic carbon in the aerosol is secondary, having been formed by the complex photochemistry of gaseous volatile organic compounds.

The size, shape and chemical composition of particulates determine the health effects that they will have. Particles larger than 10 microns are deposited in the upper respiratory tract. Particles from 2.5 to 10 microns are inhalable and are deposited in the upper parts of the respiratory system. Particles smaller than 2.5 microns are respirable and enter the pulmonary tissues to be deposited there. Particles in the size range of 0.1 to 2.5 microns are most efficiently deposited in the alveoli, where their effective toxicity is greater than larger particles because of the higher relative content of toxic heavy metals, sulfates and nitrates. Epidemiological studies have shown causal relationships between particulates and excess mortality, aggravation of bronchitis, and, in children, small, reversible changes in pulmonary function. Acidic aerosols have been linked to the inability of the upper respiratory tract and pulmonary system to remove harmful particles.

The Arizona Comparative Environmental Risk Project – a multi-disciplinary investigation into human exposure to all environmental risks completed in 1995 – ranked outdoor air quality in general and particulate matter in particular as the highest environmental risk in the state. In this study, annual premature deaths from exposure to PM_{10} concentrations in Arizona were estimated at 963, which included 667 in

Maricopa County and 88 in Tucson. Increased percentages of hospital admissions for respiratory disease (1 to 4 percent, depending on the city), of asthma episodes (5 to 14 percent), of lower respiratory symptoms (5 to 15 percent) and of coughs (2 to 6 percent) were attributed to the prevailing annual PM_{10} concentrations in 1991. Chronically high particulate concentrations in the ambient air continue to pose a serious health threat to many Arizonans.

Coarse particulate emissions are mostly geological and are dominated by dusts from three activities: re-entraining dust from paved roads, driving on unpaved roads and earthmoving associated with construction. Soil dust from these sources and others contribute more than 70 percent of the coarse particulates in Phoenix. On days with winds in excess of 15 miles per hour, wind erosion of soil contributes to this loading. With a more diverse chemical composition, fine particulate ($PM_{2.5}$) emissions are more evenly distributed among a larger number of sources. At the Phoenix JLG Supersite, receptor modeling indicates gasoline and diesel engine exhaust account for more than two-thirds of the $PM_{2.5}$ emissions. Soil dust contributes another 10.5 percent. In other urban and rural areas, this mixture of sources will vary. Agricultural and mining areas, for example, will be more heavily influenced by emissions from these activities.

$PM_{2.5}$ concentrations tend to be at their highest in the central portions of urban areas, diminishing to background levels at the urban fringe. In contrast, PM_{10} concentrations are not smoothly spatially distributed because each monitoring site is strongly influenced by the degree of localized emissions of coarse particulates. Background concentrations of PM_{10} are about 40 percent of the urban maxima (20 $\mu g/m^3$ for an annual average background versus about 50 $\mu g/m^3$ for the urban maximum). Background concentrations of $PM_{2.5}$ are about 5 $\mu g/m^3$, in contrast to the urban maxima of 12 to 15 $\mu g/m^3$. Concentrations of both size ranges of particulates tend to be higher in the late fall and winter, when atmospheric dispersion is at a seasonal low. PM_{10} maximum concentrations can occur in any season, provided nearby sources of coarse particulates are present or when strong and gusty winds suspend soil disturbed by human activities. Hourly concentrations of particulates tend to peak during those hours of the worst dispersion, which is from sunset to mid-morning.

Controls to reduce particulates have been in place for decades, beginning with an ordinance that required watering to reduce dust from construction in Pima County in the 1960s. Maricopa County's umbrella dust abatement rule, Rule 310, has been revised many times through the years and now regulates construction dust, track-out dust from construction sites, and dust from unpaved parking and vacant lots. Efforts to reduce dust resuspended from paved roads have concentrated on eliminating track-out from construction sites, curbing and stabilizing road shoulders, and investigating more efficient street sweepers. Secondary fine particulates have been reduced by vehicular emission controls, which have reduced their precursor gases to fine particulates. Reducing gaseous hydrocarbon emissions has led to a significant reduction in the primary carbon emitted in motor vehicle exhaust. In Maricopa County, the Governor's Agricultural Best Management Practices Committee developed a rule containing best management practices for agricultural activities intended to reduce particulate emissions from tilling and harvesting activities of cropland and non-cropland. In a recent PM_{10} SIP, the Maricopa Association of Governments committed to implement 77 new measures, including enhanced enforcement of the county dust rules, implementation of agricultural best management practices, diesel engine replacement and retirement programs and requirements for cleaner burning fireplaces.

Particulates are monitored by pulling ambient air through a filter, generally for 24 hours every sixth day, weighing the filter before and after, and measuring the volume of air sampled. Prior to 1998, the concentrations were calculated using the information gathered and a standard temperature (25 °Celsius) and pressure (1 atmosphere). For 1998 and 1999, EPA required concentrations to be calculated using local (at the monitor) temperature and pressures. Beginning in 2000, the concentrations reverted to the standard temperature and pressure calculation.

The monitoring instruments are fitted with different aerodynamic devices to segregate particle size fractions. Particulates can also be monitored continuously with a tapered element oscillating microbalance (TEOM) instrument.

The 2001 PM_{10} data reported in Table 13 represent 74 monitors throughout Arizona and two in Mexico, which are located in Agua Prieta and Nogales, Sonora. TEOM data are not included in this table. Particulate data from the IMPROVE network were also not included because the complete data set for 2001 had not been processed. Both sets are available from ADEQ's Air Quality Assessment Section upon request.

EPA began a nationwide program to measure $PM_{2.5}$ using federal reference method monitors made to EPA specifications in anticipation of a new federal standard for fine particulates. In 1999, 2000and 2001, 11 federal reference method samplers were located in Arizona. The fine particulate portion of the PM_{10} measurement made by dichot monitors has been measured for many years in Arizona and has served as an approximation for the $PM_{2.5}$ measurement; however is it not exactly equivalent to that measurement. Table 14 lists only the federal reference method measurements for 2001.

Table 13: 2001 PM_{10} Data (in $\mu g/m^3$)					
Site or City	Method	Annual Average	24-Hour Average		Data Recovery* (in percent)
			Max Value	2nd High	
Apache County					
Springerville – Coalyard	Dichot	11.6	35	28	95
Springerville – Coyote Hills	Dichot	7.8	27	22	97
Cochise County					
Douglas – Red Cross	Dichot	29.3#	137#	110#	52#
Paul Spur	Partisol	19.9	55	45	97
Coconino County					
Flagstaff – ADOT (closed 08/05/01)	Partisol	14.7#	35#	30#	52##
Flagstaff – Middle School	Dichot	17.8#	47#	40#	80#
Page – Navajo Generating Station	Dichot	9.8	27	22	100
Sedona – Post Office	Dichot/ Partisol	12.3#	23#	21#	90#
Gila County					
Hayden – Old Jail	Dichot	30.6	141	58	87
Miami – Golf Course	Dichot	23.1	108	65	98
Miami – Ridgeline	Dichot	14.4	104	40	97
Payson	Partisol	21.7	62	48	89
Graham County					
Safford	Dichot	22.5	68	38	97
Maricopa County					
Central Phoenix	Hi-Vol	38.0	124	65	98

Table 13: 2001 PM_{10} Data (in $\mu g/m^3$)					
Site or City	Method	Annual Average	24-Hour Average		Data Recovery* (in percent)
			Max Value	2nd High	
Chandler	Hi-Vol	48.0	146	99	100
Estrella	Dichot	26.0#	122#	51#	90#
Gilbert (closed 12/31/01)	Hi-Vol	39.0	121	119	100
Glendale	Hi-Vol	33.0	110	63	95
Higley	Hi-Vol	50.0	**176**	93	97
Maryvale	Hi-Vol	38.0	123	94	97
Mesa	Hi-Vol	30.0	98	55	100
North Phoenix	Hi-Vol	30.0	99	55	100
Palo Verde	Dichot	22.9#	71#	54#	85#
Phoenix – ASU West (closed 8/06/01)	Dichot	22.0#	42#	39#	59##
Phoenix – Durango Complex	Hi-Vol	**58.0**	**189**	142	100
Phoenix – Greenwood, ADEQ	Dichot	45.8#	135#	116#	61#
Phoenix – Greenwood, MCESD	Hi-Vol	49.0	145	99	97
Phoenix – JLG Supersite	Dichot	30.3	109	58	97
Phoenix – Salt River	Hi-Vol	**94.0**	**281**	**275**	98
South Phoenix	Hi-Vol	50.0	143	92	98
South Scottsdale	Hi-Vol	33.0	110	53	100
Surprise	Hi-Vol	27.0	107	52	97
Tempe – Community Center	Dichot	31.4	109	55	95
West Chandler	Hi-Vol	34.0	134	58	100
West Phoenix	Hi-Vol	43.0	142	91	100

Table 13: 2001 PM_{10} Data (in $\mu g/m^3$)					
Site or City	Method	Annual Average	24-Hour Average		Data Recovery* (in percent)
			Max Value	2nd High	
Mohave County					
Bullhead City – ADEQ	Dichot	16.9#	39#	35#	74#
Bullhead City – SCE**	Hi-Vol	23.0#	51#	49#	76#
Fort Mohave (closed 10/01/01)	Partisol	10.2#	30#	28#	41##
Kingman – Praxair NE	Hi-Vol	12.6	37	36	95
Kingman – Praxair SW	Hi-Vol	12.5	36	24	97
Navajo County					
Show Low	Partisol	15.6#	58#	41#	62#
Pima County					
Ajo – ADOT	Partisol	13.6	34	31	89
Green Valley	Hi-Vol	23.0	78	73	84
Organ Pipe Cactus National Monument	Dichot	10.3	23	21	90
Rillito – ADEQ	Partisol/ Dichot	33.6	89	75	100
Rillito – APCC	Hi-Vol	26.0	77	64	84
South Tucson – ADEQ	Dichot	24.7	113	92	98
South Tucson – PDEQ	Hi-Vol	31.0	134	115	96
Tucson – Broadway and Swan	Hi-Vol	26.0	120	70	100
Tucson – Corona de Tucson (ADEQ)	Dichot	15.7	136	83	82
Tucson – Corona de Tucson (PDEQ)	Hi-Vol	16.0	133	85	97
Tucson – Craycroft	Dichot	22.8	115	48	95

Table 13: 2001 PM_{10} Data (in $\mu g/m^3$)					
Site or City	Method	Annual Average	24-Hour Average		Data Recovery* (in percent)
			Max Value	2nd High	
Tucson – Orange Grove	Hi-Vol	29.0	111	100	96
Tucson – Prince Road	Hi-Vol	33.0	125	83	98
Tucson – Santa Clara	Hi-Vol	26.0	131	111	95
Tucson – Tangerine	Hi-Vol	17.0	81	62	98
Tucson – U of A Central	Dichot	25.1	122	49	98
Pinal County					
Apache Junction – Maintenance Yard (North)	Hi-Vol	22.7	49	45	90
Apache Junction – Maintenance Yard (South)	Hi-Vol	23.4	94	55	90
Casa Grande – Downtown	Hi-Vol	29.2	104	55	90
Casa Grande – Eleven Mile Corner	Hi-Vol	47.2	146	138	90
Coolidge – Maintenance Yard	Hi-Vol	32.0	73	70	89
Eloy – City Complex	Hi-Vol	35.1	142	71	97
Mammoth – County Complex	Hi-Vol	22.6	99	63	95
Pinal Air Park	Hi-Vol	26.7	103	73	84
Stanfield	Hi-Vol	41.9	134	112	97
Santa Cruz County					
Nogales – Post Office	Dichot	47.5	213	112	93
Yavapai County					
Clarkdale –School	Dichot	15.5	31	27	87
Clarkdale – NW (#2)	Dichot	36.0	141	123	98

Table 13: 2001 PM_{10} Data (in $\mu g/m^3$)					
Site or City	Method	Annual Average	24-Hour Average		Data Recovery* (in percent)
			Max Value	2nd High	
Clarkdale – SE (#1)	Dichot	44.0	122	119	98
Hillside (monitor replaced with IMPROVE monitor 5/07/01)	Dichot	11.6#	24#	15#	20##
Nelson – West (closed 8/11/01)	Dichot	14.2#	49#	30#	52##
Prescott	Partisol	15.9#	32#	26#	67#
Yuma County					
Yuma – Juvenile Center	Dichot	40.6#	150#	77#	33#
Mexico					
Agua Prieta – Fire Station	Dichot	**62.5**	146	129	97
Nogales – Fire Station	Dichot	**66.5**	**214**	**165**	93

Bold denotes an exceedance, defined as any daily value greater then 150 $\mu g/m^3$ when rounded to the nearest 10 $\mu g/m^3$ and any average value greater than 50 $\mu g/m^3$ when rounded to the nearest 1 $\mu g/m^3$.

**Valid data recovery is the percentage of valid samples collected of the total number of scheduled samples. There were 61 monitoring days scheduled in 2001 for monitors on the every 6th day schedule.*

N/A – Not available

***Bullhead City – SCE: No samples 8/29 through 10/21 while new monitoring equipment installed. Monitoring schedule changed to every third day beginning 10/22/02.*

#Indicates the data do not satisfy EPA's summary criteria, usually meaning less than 75 percent valid data recovery available in one or more calendar quarters.

##Indicates the site was closed during the year; incomplete valid data for recovery statistics.

Table 14: 2001 PM2.5 Data (in $\mu g/m^3$)					
City or Site	Method	Annual Avg	24-Hour Avg		Data Recovery* (in percent)
			Max	2nd High	
Cochise County					
Douglas – Red Cross[1]	FRM	7.1#	24.4#	11.8#	34#
Coconino County					
Flagstaff – Middle School[1]	FRM	7.1#	21.9#	16.4#	87#
Gila County					
Payson[2]	FRM	8.8#	27.2#	24.0#	79#
Maricopa County					
Phoenix – Desert West[3]	FRM	10.9	63.4	45.1	92
Phoenix – JLG Supersite[3]	FRM	9.2	28.9	28.5	86
Phoenix – JLG Supersite ($PM_{2.5}$ speciation monitor)[2]	FRM	12.4	41.7	32.7	91
Tempe – Community Center[2]	FRM	9.4	27.0	25.0	95
West Phoenix[3]	FRM	10.9	51.7	49.0	85
Pima County					
Tucson – Children's Park[2]	FRM	6.8#	17.5#	15.1#	71#
Tucson – Orange Grove[2]	FRM	7.6	20.9	20.4	80
Pinal County					
Apache Junction – Fire Station[2]	FRM	6.2	14.0	13.5	96
Casa Grande – Downtown[1]	FRM	7.7	18.1	16.7	98
Santa Cruz County					
Nogales – Post Office[1]	FRM	10.7	35.2	25.7	95

**Valid data recovery is percentage of valid samples collected of the total number of scheduled samples*

[1]Samples collected every sixth day – 61 sample days in 2001

[2]Samples collected every thirrd day – 122 sample days in 2001

[3]Samples collected every day – 365 sample days in 2001

[#]Indicates the data do not satisfy EPA's summary criteria, usually meaning less than 75 percent valid data recovery available in one or more calendar quarters.

Conventional Pollutants – Compliance

Carbon Monoxide

There are two NAAQS for carbon monoxide: an eight-hour standard (most critical for compliance) and a one-hour standard. The eight-hour standard is 9 ppm and the one-hour standard is 35 ppm. According to the Code of Federal Regulations, compliance for both standards is determined by having no more than one exceedance per calendar year. EPA determines attainment of the standard at all sites in the non-attainment (or monitoring) area by evaluating two calendar years of data from each site. The highest of the second-highest values for the two-year period must not exceed the standard of 9 ppm (greater than or equal to 9.5 ppm to adjust for rounding) for the eight-hour standard or 35 ppm (greater than or equal to 35.5 ppm) for the one-hour standard.

No exceedances of the one-hour standard were recorded in 2000 or 2001. No exceedances of the eight-hour standard were recorded in 2000 or 2001. The data are presented in Table 15 and Table 16.

Table 15. 2000-2001 One-Hour Carbon Monoxide Compliance (in ppm)

NAAQS for one-hour carbon monoxide: The second-highest value for the two-year period must not exceed 35 ppm

2000-2001 One-Hour Carbon Monoxide NAAQS Compliance Values by County

	Exceedances	Violations
Maricopa	0	0
Pima	0	0
Pinal	0	0

Summary: 21 of 21 monitors in compliance

Table 15: 2000-2001 One-Hour Carbon Monoxide Compliance (in ppm)

City or Site	2000		2001		Compliance Value
	Max Value	2nd High	Max Value	2nd High	
Maricopa County					
Central Phoenix	8.1	8.0	6.0	5.8	8.0
Glendale[S]	4.6	4.6	4.7	4.7	4.7

Table 15: 2000-2001 One-Hour Carbon Monoxide Compliance (in ppm)					
City or Site	2000		2001		Compliance Value
	Max Value	2nd High	Max Value	2nd High	
Maryvale[S]	9.3	9.1	9.0	7.5	9.1
Mesa[S]	6.0	5.1	4.6	3.8	5.1
North Phoenix[S]	6.0	5.9	5.2	4.7	5.9
Phoenix – Grand Avenue[S]	10.5	10.5	10.3	9.6	10.5
Phoenix – Greenwood	8.1	8.1	7.0	6.9	8.1
Phoenix – JLG Supersite	9.1	7.9	7.0	6.5	7.9
Phoenix – West Indian School	11.9	8.9	8.0	7.7	8.9
South Phoenix[S]	10.0	8.4	6.8	6.3	8.4
South Scottsdale[S]	5.0	4.9	4.5	4.4	4.9
Tempe – Daley Park	5.0	4.6	4.3	4.2	4.6
West Chandler[S] (site moved 1/2 mile in 2000)	5.7	3.8	3.3	3.1	3.8
West Phoenix	10.6	10.4	8.4	8.2	10.4
Pima County					
Tucson – Alvernon	8.9	7.5	5.8	5.7	7.5
Tucson – Cherry	5.3	5.0	3.9	3.6	5.0
Tucson – Children's Park	3.8	3.5	2.9	2.9	3.5
Tucson – Craycroft	5.4	5.4	3.7	3.6	5.4
Tucson – Downtown	6.7	6.0	5.6	5.1	6.0
Pinal County					
Apache Junction – Maintenance Yard	1.4	1.3	3.8	3.4	3.4
Casa Grande – Airport	2.4	2.2	1.5	1.1	2.2

[S]*Seasonal monitor, operational Jan. 1 to April 1 and Sept. 1 to Dec. 31*

Table 16. 2000-2001 Eight-Hour Carbon Monoxide Compliance (in ppm)

NAAQS for eight-hour carbon monoxide: The second-highest value for the two-year period must not exceed 9 ppm

2000-2001 Eight-Hour Carbon Monoxide NAAQS Compliance Values by County

	Exceedancese	Violations
Maricopa	0	0
Pima	0	0
Pinal	0	0

Summary: 21 of 21 monitors in compliance

Table 16: 2000-2001 Eight-Hour Carbon Monoxide Compliance (in ppm)

City or Site	2000		2001		Compliance Value
	Max Value	2nd High	Max Value	2nd High	
Maricopa County					
Central Phoenix	5.3	5.0	4.3	4.1	5.0
Glendale[S]	3.5	3.2	3.1	2.8	3.2
Maryvale[S]	7.0	7.0	7.5	5.3	7.0
Mesa[S]	4.3	3.4	2.9	2.7	3.4
North Phoenix[S]	3.1	3.1	2.5	2.5	3.1
Phoenix – Grand Avenue[S]	6.0	6.0	6.6	6.1	6.1
Phoenix – Greenwood	5.6	5.6	4.7	4.6	5.6
Phoenix – JLG Supersite	6.9	6.4	5.7	5.2	6.4
Phoenix West Indian School	6.8	6.7	6.6	6.4	6.7
South Phoenix[S]	5.9	4.7	3.4	3.4	4.7
South Scottsdale[S]	3.3	3.1	3.2	3.1	3.1
Tempe – Daley Park	3.7	3.5	3.2	3.0	3.5
West Chandler[S] (site moved 1/2 mile in 2000)	2.5	2.3	2.3	2.2	2.3
West Phoenix	7.4	7.2	6.7	6.5	7.2
Pima County					
Tucson – Alvernon	5.0	4.7	3.0	2.9	4.7

Table 16: 2000-2001 Eight-Hour Carbon Monoxide Compliance (in ppm)					
City or Site	2000		2001		Compliance Value
	Max Value	2nd High	Max Value	2nd High	
Tucson – Cherry	3.7	3.3	2.8	2.6	3.3
Tucson – Children's Park	1.9	1.9	1.7	1.7	1.9
Tucson – Craycroft	2.7	2.4	1.9	1.7	2.4
Tucson – Downtown	3.8	3.5	2.7	2.5	3.5
Pinal County					
Apache Junction – Maintenance Yard	0.6	0.6	1.1	1.0	1.0
Casa Grande – Airport	0.9	0.8	0.7	0.7	0.8

[S] Seasonal monitor, operational from Jan. 1 to April 1 and Sept. 1 to Dec. 31

Lead

In 2001, the NAAQS for lead, 1.5 micrograms per cubic meter ($\mu g/m^3$) averaged for a calendar quarter, was not exceeded at any Arizona monitor.

Table 17: 2001 Lead Quarterly Average NAAQS Compliance Values, By County		
	Exceedances	Violations
Apache	0	0
Cochise	0	0
Coconino	0	0
Gila	0	0
Maricopa	0	0
Pima	0	0
Pinal	0	0
Santa Cruz	0	0
Yavapai	0	0
Summary: 16 of 16 monitors in compliance		

Nitrogen Dioxide

Table 18: 2001 Nitrogen Dioxide Average		
	Exceedances	Violations
Apache	0	0
Maricopa	0	0
Mohave	0	0
Pima	0	0
Summary: 16 of 16 monitors in compliance		

The NAAQS for nitrogen dioxide is 0.053 parts per million (ppm) for an annual average. The standard is attained when the annual arithmetic mean concentration in a calendar year is less than or equal to 0.053 ppm. To demonstrate attainment, the annual mean must be based upon hourly data that are at least 75 percent complete. The 2001 nitrogen dioxide annual averages near Arizona power plants ranged from 2 percent to 17 percent of the standard; in the urban areas, 30 percent to 70 percent. All Arizona sites were in compliance with the NAAQS. Refer to Table 9 for the 2001 averages.

Sulfur Dioxide

There are three NAAQS for sulfur dioxide, two primary (annual average and 24-hour block average) and one secondary (three-hour block average). The annual average standard is 80 $\mu g/m^3$ (approximately 0.03 ppm) and the maximum 24-hour block average standard is 365 $\mu g/m^3$ (approximately 0.14 ppm). To demonstrate attainment, neither standard can be exceeded in a calendar year. In addition, the averages must be based upon hourly data that are 75 percent complete. A 24-hour block average is considered valid if at least 75 percent of the hourly averages for the 24-hour period are available. The 24-hour averages are determined from successive non-overlapping 24-hour blocks which begin at midnight each day.

The secondary three-hour standard is 1300 $\mu g/m^3$ (approximately 0.50 ppm) and is not to be exceeded more than once per calendar year. The three-hour averages are determined from successive non-overlapping three-hour blocks starting at midnight each calendar day.

In Arizona, the maximum concentration sites – all near copper smelters – comply with these standards; the concentrations being no higher than 66 percent of the three-hour, 78 percent of the 24-hour and 51 percent of the annual average standards. Sites near power plants are close to background levels, with annual averages from less than 1 to 8 $\mu g/m^3$. See Table 10 on Page 25 for the 2001 averages.

Table 19: 2001 Sulfur Dioxide Average NAAQS Compliance Values, By County						
County	Annual		Three Hour		24-Hour	
	Exceedances	Violations	Exceedances	Violations	Exceedances	Violations
Apache	0	0	0	0	0	0
Coconino	0	0	0	0	0	0
Gila	0	0	0	0	0	0
Maricopa	0	0	0	0	0	0
Mohave	0	0	0	0	0	0
Pima	0	0	0	0	0	0
Pinal	0	0	0	0	0	0
Summary: 15 out of 15 monitors in compliance						

Ozone

The NAAQS include a standard for one-hour ozone and a proposed standard for eight-hour ozone. The one-hour standard is 0.12 ppm. Compliance with this standard is attained when the expected number of days per calendar year with maximum hourly average concentrations above 0.12 ppm (0.124 ppm for rounding) is equal to or less than one. A daily exceedance is defined as any day having one or more hourly averages equal to or greater than 0.125 ppm. Hourly averages for at least 75 percent of the hours sampled (18-24 hours per day) must be present. The most recent three calendar years of daily averages are used to determine if the annual standard is met.

No exceedances of the one hour standard occurred in Arizona in 2001. The last exceedance of the one-hour standard occurred in 1996 in Phoenix.

EPA developed the proposed eight-hour ozone standards in response to human exposure studies that showed adverse health effects occur at lower ozone concentrations extending over several hours. The new ozone standard was proposed in 1997, but was subsequently the subject of a lawsuit. The U.S. Supreme Court has upheld EPA’s decision that an eight-hour standard is viable, but remanded the case to EPA to further determine what the final standard should be. Monitoring agencies continue to record monitoring data to gather information on occurrence and ability for future compliance with an eight-hour standard.

The proposed eight-hour ozone standard is 0.08 ppm (0.84 for rounding) for a daily maximum eight-hour average. This standard is met when the average of the annual fourth-highest daily maximum eight-hour average ozone concentration is less than or equal to 0.08 ppm. The most recent three calendar years are used to assess compliance with the standard.

Table 20. 1999 to 2001 Eight-Hour Ozone Compliance (in ppm)

Proposed NAAQS: The three-year average of the annual fourth-highest daily maximum eight-hour average ozone concentration is less than or equal to 0.08 ppm

1999 to 2001 Eight-Hour Ozone NAAQS Compliance Values, By County

	Eight-Hour Exceedances 1999	2000	2001	Sites in Violation
Cochise	0	0	0	0
Coconino	0	0	0	0
Maricopa	62	57	27	6
Pima	3	6	0	0
Pinal	2	6	0	0
Yavapai	3	1	0	0
Yuma	1	0	0	0

Summary: 27 of 33 monitors in compliance for 1999 to 2001

Table 20: 1999 to 2001 Eight-Hour Ozone Compliance (in ppm)

City or Site	Fourth-Highest Value			Three-Year Average
	1999	2000	2001	
Cochise County				
Chiricahua National Monument	0.072	0.071	0.067	0.070
Coconino County				
Page	0.065	0.063	0.059	0.062
Grand Canyon National Park – Hance Camp	0.077	0.071	0.070	0.073
Maricopa County				
Blue Point	0.088	0.088	0.080	**0.085**
Central Phoenix	0.078	0.077	0.075	0.077
Falcon Field[S]	0.082	0.075	0.081	0.079
Fountain Hills	0.086	0.085	0.084	**0.085**
Glendale[S]	0.083	0.081	0.078	0.080

Table 20: 1999 to 2001 Eight-Hour Ozone Compliance (in ppm)				
City or Site	Fourth-Highest Value			Three-Year Average
	1999	2000	2001	
Humboldt Mt.[S]	0.088	0.083	0.085	0.085
Lake Pleasant[S] (closed 6/01/01)	0.081	0.083	0.073[#]	0.079
Maryvale[S]	0.080	0.081	0.074	0.078
Mesa	0.084	0.076	0.074	0.078
Mt. Ord[S]	0.088	0.090	0.077	**0.085**
North Phoenix	0.084	0.087	0.086	**0.085**
Palo Verde	0.080	0.080	0.074	0.078
Phoenix – Emergency Management[S] (closed 6/01/01)	0.087	0.070	0.063[#]	0.073
Phoenix – JLG Supersite	0.061	0.077[#]	0.079	0.072
Pinnacle Peak	0.085	0.086	0.086	**0.085**
Rio Verde[S]	0.085	0.086	0.083	0.084
South Phoenix	0.075	0.084	0.077	0.078
South Scottsdale	0.072	0.080	0.079	0.077
West Chandler (site moved 1/2 mile in 2000)[S]	0.069	0.078	0.078	0.075
West Phoenix	0.091	0.081	0.075	0.082
Pima County				
Saguaro National Park East	0.071	0.074	0.066	0.073
Tucson – Children's Park	0.072	0.077	0.069	0.072
Tucson – Craycroft	0.071	0.075	0.069	0.071
Tucson – Downtown	0.064	0.067	0.065	0.065
Tucson – Fairgrounds	0.068	0.074	0.066	0.069
Tucson – Tangerine	0.073	0.073	0.067	0.071

Table 20: 1999 to 2001 Eight-Hour Ozone Compliance (in ppm)				
City or Site	Fourth-Highest Value			Three-Year Average
	1999	2000	2001	
Pinal County				
Apache Junction – Maintenance Yard	0.080	0.082	0.078	0.080
Casa Grande – Airport	0.078	0.085	0.079	0.080
Yavapai County				
Hillside	0.084	0.083	0.077	0.081
Yuma County				
Yuma[S]	0.079	0.061	0.068	0.069

Bold values indicate monitors in violation of the standard.

[S]Seasonal monitor, operational during April 1 to Nov. 1.

[#]Indicates the data do not satisfy EPA's summary criteria, usually meaning less than 75 percent valid data recovery available.

Particulate Matter – PM_{10}

With the delay in adopting the proposed PM_{10} and $PM_{2.5}$ standards, 2001 compliance will be assessed using the rules in place prior to the 1997 proposal. Therefore, the NAAQS for particulate matter 10 microns and less in diameter (PM_{10}) are 50 $\mu g/m^3$ for the annual arithmetic mean concentration and 150 $\mu g/m^3$ for the 24-hour average concentration.

The annual standard is met when the three-year average of the annual means is less than or equal to 50$\mu g/m^3$. The annual average is determined by calculating quarterly (three month) averages of the samples collected during that quarter; a minimum of 75 percent of the samples must be present to produce a valid annual average. The four quarterly averages are used to produce the annual average. This value is rounded to the nearest 1 $\mu g/m^3$ for comparison to the standard.

Compliance with the 24-hour PM_{10} standard is attained when the expected exceedance rate of occurrence of samples greater than or equal to 150 $\mu g/m^3$ is one or less per year measured over three years. A sample value is rounded to the nearest 10 $\mu g/m^3$ for comparison with the standard to determine if it is an exceedance (i.e., a sample value of 154 $\mu g/m^3$ is not an exceedance; a sample value of 155 $\mu g/m^3$ is an exceedance). Since the majority of monitoring sites collect samples on a less than every day schedule, the expected exceedance rate must be calculated by quarter following EPA guidelines. The same requirements of 75 percent completeness and three consecutive years of data apply. Tables 21 and 22 present the 1999 to 2001 data.

Table 21. 1999 to 2001 Annual Average PM_{10} Compliance (in µg/m^3)

NAAQS: The three-year average of annual averages is less than or equal to 50 µg/m^3.

Annual averages are rounded to nearest 1 µg/m^3 for comparison to the standard.

1999 to 2001 PM_{10} Annual Average NAAQS Compliance Values, By County

	Sites above Standard 1999	2000	2001	Sites in Violation
Apache	0	0	0	0
Cochise	0	0	0	0
Coconino	0	0	0	0
Gila	0	0	0	0
Maricopa	3	7	2	3
Mohave	0	0	0	0
Navajo	0	0	0	0
Pima	0	0	0	0
Pinal	1	1	0	1
Santa Cruz	1	0	0	0
Yavapai	0	0	0	0
Yuma	0	0	0	0

Summary: 71 of 75 monitors in compliance for 1999 to 2001

Table 21: 1999 to 2001 Annual Average PM_{10} Compliance (in µg/m^3)

City or Site	1999	2000	2001	Three-Year Average
Apache County				
Springerville – Coalyard	11.3	11.6	11.6	12
Springerville – Coyote Hills	8.1	9.6#	7.8	9
Cochise County				
Douglas – Red Cross	35.2#	37.9	29.3#	34
Paul Spur	29.3	22.9	19.9	24
Coconino County				
Flagstaff – ADOT	18.0#	15.3	14.7#	16
Flagstaff – Middle School	14.0	15.5	17.8#	16

Table 21: 1999 to 2001 Annual Average PM_{10} Compliance (in $\mu g/m^3$)				
City or Site	1999	2000	2001	Three-Year Average
Page – Navajo Generating Station	7.4	10.8	9.8	9
Sedona	N/A	10.8	12.3#	N/A
Gila County				
Hayden – Old Jail	35.3	33.6#	30.6	33
Miami – Golf Course	22.0	27.0	23.1	24
Miami – Ridgeline	13.0	16.1	14.4	15
Payson	20.7	24.6	21.7	22
Graham County				
Safford	N/A	26.9#	22.5	N/A
Maricopa County				
Central Phoenix	43.6#	46.3	38.0	43
Chandler	**59.6**	**56.8**	48.0	**55**
Estrella	34.4	32.2#	26.0#	31
Gilbert	45.4	49.1	39.0	45
Glendale	36.3	40.8	33.0	36
Higley	**61.2**	**57.9#**	50.0	**56**
Maryvale	44.7	47.7	38.0	44
Mesa	35.3	37.0	30.0	34
North Phoenix	34.5	37.1	30.0	34
Palo Verde	21.7	20.6	22.9#	22
Phoenix – ASU West (closed 8/06/01)	30.7	32.1	22.0#	28
Phoenix – Durango Complex	**68.0#**	**70.0**	**58.0**	**65**

Table 21: 1999 to 2001 Annual Average PM_{10} Compliance (in $\mu g/m^3$)				
City or Site	1999	2000	2001	Three-Year Average
Phoenix – Greenwood (ADEQ)	**53.1**	**52.8#**	45.8#	**51**
Phoenix – Greenwood (MCESD)	**55.8**	**61.1**	49.0	**55**
Phoenix – JLG Supersite	35.1	36.3	30.3	34
Phoenix – Salt River	**101.0**	**101.0**	**94.0**	**99**
South Phoenix	N/A	61.3	50.0	N/A
South Scottsdale	40.1	40.2	33.0	38
Tempe – Community Center	36.0	38.3	31.4	35
West Chandler (Site moved ½ mile in 2000)	48.2	44.0	34.0	42
West Phoenix	51.3	52.5	43.0	49
Mohave County				
Bullhead City – ADEQ	12.9	15.3	16.9#	15
Bullhead City – SCE	29.5	29.0	23.0#	27
Fort Mohave (closed 10/01/01)	12.3#	14.3	10.2#	12
Kingman – Praxair NE	15.4	15.0#	12.6	14
Kingman – Praxair SW	15.6	13.4	12.5	14
Navajo County				
Show Low	16.2#	14.9	15.6#	16
Pima County				
Ajo	21.7	18.5	13.6	18
Green Valley	17.9	16.7	23.0	19
Organ Pipe Cactus National Monument	10.0#	12.2	10.3	11

Table 21: 1999 to 2001 Annual Average PM_{10} Compliance (in $\mu g/m^3$)				
City or Site	1999	2000	2001	Three-Year Average
Rillito – ADEQ	35.8#	42.1#	33.6	37
Rillito – APCC	30.7	30.8	26.0	29
South Tucson – ADEQ	N/A	28.0	24.7	N/A
South Tucson – PDEQ	48.4	38.4	31.0	39
Tucson – Broadway and Swan	31.6	30.0	26.0	29
Tucson – Corona de Tucson (ADEQ)	N/A	15.2	15.7	N/A
Tucson – Corona de Tucson (PDEQ)	18.4	17.9	16.0	17
Tucson – Craycroft	26.0	24.1	22.8	24
Tucson – Orange Grove	45.8	38.8	29.0	38
Tucson – Prince Road	43.7	37.7	33.0	38
Tucson – Santa Clara	34.0	31.0	26.0	30
Tucson – Tangerine	18.4	18.4	17.0	18
Tucson – U of A Central	26.0	26.2	25.1	26
Pinal County				
Apache Junction – Maintenance Yard (North)	25.8	27.4	22.7	25
Apache Junction – Maintenance Yard (South)	27.5	28.4	23.4	26
Casa Grande – Downtown	35.3	34.7	29.2	33
Casa Grande – Eleven Mile Corner	**71.0**	**67.5**	47.2	**62**
Coolidge – Maintenance Yard	39.6	37.4	32.0	36
Eloy	45.9	41.7	35.1	41
Mammoth	22.5	22.0	22.6	22

Table 21: 1999 to 2001 Annual Average PM_{10} Compliance (in $\mu g/m^3$)				
City or Site	1999	2000	2001	Three-Year Average
Pinal Air Park	30.3	30.9	26.7	29
Stanfield	**56.6**	45.7	41.9	48
Santa Cruz County				
Nogales – Post Office	**52.5**#	47.6	47.5	49
Yavapai County				
Clarkdale – School	15.3	15.8	15.5	16
Clarkdale – NW (#2)	22.6	22.9	36.0	27
Clarkdale – SE (#1)	28.1	29.6	44.0	34
Hillside	7.5#	9.9#	11.6#	10
Nelson – West (closed 8/11/01)	12.4	13.6#	14.2#	13
Prescott	N/A	11.8	15.9#	N/A
Yuma County				
Yuma – Juvenile Center	35.2#	42.2#	40.6#	39
Mexico				
Agua Prieta – Fire Station	**63.0**	**81.3**	**62.5**	**69**
Nogales – Fire Station	**59.8**	**76.9**	**66.5**	**68**

Bold denotes value above the standard.

N/A – Not available

#Indicates the data do not satisfy EPA's summary criteria, usually meaning less than 75 percent valid data recovery available in one or more calendar quarters.

Table 22. 1999 to 2001 Maximum 24-Hour Average PM_{10} Compliance (in $\mu g/m^3$)

NAAQS: Expected occurrence of exceedances (samples equal to or greater than 150 ug/m3) is one or less over three consecutive years.

Sample values are rounded to the nearest 10 $\mu g/m^3$ to determine exceedance; values less than or equal to 154 $\mu g/m^3$ are not exceedances; values greater than or equal to 155 $\mu g/m^3$ are exceedances.

1999 to 2001 PM_{10} Maximum 24-Hour Compliance Values, By County

	Sites with Exceedances 1999	2000	2001	Sites in Violation
Apache	0	0	0	0
Cochise	0	0	0	0
Coconino	0	0	0	0
Gila	0	0	0	0
Maricopa	1	7	3	6
Mohave	0	0	0	0
Navajo	0	0	0	0
Pima	0	0	0	0
Pinal	1	1	0	1
Santa Cruz	1	0	1	1
Yavapai	0	0	0	0
Yuma	0	0	0	0

Summary: 60 of 69 monitors in compliance for 1999 to 2001

Table 22: 1999 to 2001 Maximum 24-Hour Average PM_{10} Compliance (in $\mu g/m^3$)

City or Site	1999		2000		2001		3-Year Avg Expected Rate of Exceedance
	Max 24-Hr Avg	Exp. Exc.	Max 24-Hr Avg	Exp. Exc.	Max 24-Hr Avg	Exp. Exc.	
Apache County							
Springerville – Coalyard	49	0	31	0	35	0	< 1.0
Springerville – Coyote Hills	25	0	20#	0	27	0	< 1.0
Cochise County							
Douglas – Red Cross	83#	0	104	0	137#	0	< 1.0
Paul Spur	78	0	58	0	55	0	< 1.0
Coconino County							
Flagstaff – ADOT (closed 08/05/01)	62#	0	38	0	35#	0	< 1.0
Flagstaff – Middle School	35	0	39	0	47#	0	< 1.0
Page – Navajo Generating Station	20	0	26	0	27	0	< 1.0

Table 22: 1999 to 2001 Maximum 24-Hour Average PM_{10} Compliance (in $\mu g/m^3$)							
City or Site	1999		2000		2001		3-Year Avg Expected Rate of Exceedance
	Max 24-Hr Avg	Exp. Exc.	Max 24-Hr Avg	Exp. Exc.	Max 24-Hr Avg	Exp. Exc.	
Sedona	17	0	24	0	23#	0	< 1.0
Gila County							
Hayden – Old Jail	84	0	86#	0	141	0	< 1.0
Miami – Golf Course	43	0	59	0	108	0	< 1.0
Miami – Ridgeline	34	0	62	0	104	0	< 1.0
Payson	47#	0	88	0	62	0	< 1.0
Graham County							
Safford	125#	0	94#	0	68	0	< 1.0
Maricopa County							
Central Phoenix	85#	0	135	0	124	0	< 1.0
Chandler	110	0	**202**	**6.6**	146	0	**2.2**
Estrella	80	0	82#	0	122#	0	< 1.0
Gilbert	90	0	128	0	121	0	< 1.0
Glendale	77	0	122	0	110	0	< 1.0
Higley (MCESD)	N/A	N/A	327#	8.3#	176	6.0	N/A
Maryvale	104	0	**173**	**6.1**	123	0	**2.0**
Mesa	80	0	126	0	98	0	< 1.0
North Phoenix	70	0	114	0	99	0	< 1.0
Palo Verde	83	0	75	0	71#	0	< 1.0
Phoenix – ASU West	55	0	101	0	**N/A**	N/A	N/A
Phoenix – Durango Complex	148	0	**300**	**11.8**	**189**	**6.0**	**5.9**
Phoenix – Greenwood (MCESD)	117	0	**164**	**11.8**	145	0	**3.9**
Phoenix – JLG Supersite	78	0	84	0	109	0	< 1.0

Table 22: 1999 to 2001 Maximum 24-Hour Average PM_{10} Compliance (in $\mu g/m^3$)							
City or Site	1999		2000		2001		3-Year Avg Expected Rate of Exceedance
	Max 24-Hr Avg	Exp. Exc.	Max 24-Hr Avg	Exp. Exc.	Max 24-Hr Avg	Exp. Exc.	
Phoenix – Salt River	**256**	**51.0**	**244**	**42.7**	**281**	**49.0**	**47.5**
South Phoenix	126#	0	**175**	**6.1**	143	0	**2.0**
South Scottsdale	87	0	100	0	110	0	< 1.0
Tempe – Community Center	82	0	95	0	109	0	< 1.0
West Chandler	151	0	135	0	134	0	< 1.0
West Phoenix	111	0	151	0	142	0	< 1.0
Mohave County							
Bullhead City – SCE	122	0	79	0	51#	0	< 1.0
Bullhead City – ADEQ	26	0	42	0	39#	0	< 1.0
Fort Mohave (closed 10/01/01)	30#	0	119	0	30#	0	< 1.0
Kingman – Praxair NE	44	0	55#	0	37	0	< 1.0
Kingman – Praxair SW	46	0	53#	0	36	0	< 1.0
Navajo County							
Show Low	38#	0	35#	0	58#	0	< 1.0
Pima County							
Ajo – ADOT	41	0	47	0	34	0	< 1.0
Green Valley	38	0	63	0	78	0	< 1.0
Organ Pipe Cactus National Monument	18#	0	29	0	23	0	< 1.0
Rillito – ADEQ	98#	0	129#	0	89	0	< 1.0
Rillito – APCC	123	0	77	0	77	0	< 1.0
South Tucson – PDEQ	214	2##	142	0	134	0	< 1.0
Tucson – Broadway/Swan	89	0	119	0	120	0	< 1.0

Table 22: 1999 to 2001 Maximum 24-Hour Average PM_{10} Compliance (in $\mu g/m^3$)							
City or Site	1999		2000		2001		3-Year Avg Expected Rate of Exceedance
	Max 24-Hr Avg	Exp. Exc.	Max 24-Hr Avg	Exp. Exc.	Max 24-Hr Avg	Exp. Exc.	
Tucson – Corona de Tucson (PDEQ)	51	0	88	0	133	0	< 1.0
Tucson – Craycroft	55	0	117	0	115	0	< 1.0
Tucson – Orange Grove (PDEQ)	235	4[##]	141	0	111	0	< 1.0
Tucson – Prince Road	118	0	89	0	125	0	< 1.0
Tucson – Santa Clara	97	0	97	0	131	0	< 1.0
Tucson – Tangerine	41	0	71	0	81	0	< 1.0
Tucson – U of A Central	54	0	75	0	122	0	< 1.0
Pinal County							
Apache Junction – Maintenance Yard (North)	64	0	111	0	49	0	< 1.0
Apache Junction – Maintenance Yard (South)	64	0	107	0	94	0	< 1.0
Casa Grande – Downtown	64	0	83	0	104	0	< 1.0
Casa Grande – Eleven Mile Corner	**368**	**18.3**	**321**	**11.8**	**146**	**12**	**10.0**
Coolidge – Maintenance Yard	83	0	77	0	73	0	< 1.0
Eloy – City Complex	142	0	102	0	142	0	< 1.0
Mammoth – County Complex	50	0	64	0	99	0	< 1.0
Pinal Air Park	60	0	74	0	103	0	< 1.0
Stanfield	106	0	149	0	134	0	< 1.0
Santa Cruz County							
Nogales – Post Office	**169**[#]	**12.2**	130	0	**213**	**6.0**	**6.1**

Table 22: 1999 to 2001 Maximum 24-Hour Average PM_{10} Compliance (in $\mu g/m^3$)							
City or Site	1999		2000		2001		3-Year Avg Expected Rate of Exceedance
	Max 24-Hr Avg	Exp. Exc.	Max 24-Hr Avg	Exp. Exc.	Max 24-Hr Avg	Exp. Exc.	
Yavapai County							
Clarkdale – School	30	0	37	0	31	0	< 1.0
Clarkdale – NW (#2)	48	0	55	0	141	0	< 1.0
Clarkdale – SE (#1)	53	0	74	0	122	0	< 1.0
Hillside	22#	0	30#	0	24#	0	< 1.0
Nelson – West (closed 8/11/01)	32	0	32#	0	49#	0	< 1.0
Prescott	N/A	N/A	25	0	32#	0	N/A
Yuma County							
Yuma – Juvenile Center	102	0	132#	0	150#	0	< 1.0

N/A – Not available

#Indicates the data do not satisfy EPA's summary criteria, usually meaning less than 75 percent valid data recovery available in one or more calendar quarters.

##Exceedances at the Orange Grove and South Tucson sites in Pima County in 1999 are flagged as due to natural events and are excluded from the compliance calculation.

Particulate Matter – $PM_{2.5}$

The proposed NAAQS for particulate matter 2.5 microns and smaller in diameter ($PM_{2.5}$) are under review due to litigation at the federal level. These standards will still be used to assess the compliance of the monitors operating in Arizona during 2001. The proposed standards are 15.0 micrograms per cubic meter ($\mu g/m^3$) for the annual arithmetic mean concentration and 65 $\mu g/m^3$ for the 24-hour average concentrations.

The annual $PM_{2.5}$ standard is met when the three-year average of annual means is less than or equal to 15.0 $\mu g/m^3$. This three-year average is determined by calculating the quarterly averages for each year (with 75 percent data recovery in each quarter) to determine the calendar year average and then averaging the three years together.

The 24-hour standard is met when the three-year average of the 98th percentile values is less than or equal to 65 $\mu g/m^3$. There must also be 75 percent data completeness for each year.

Please note that the data in the Table 17 are from federal reference monitors since there are now three years of available data for these monitors. In prior years, the Dichot fine measurement was used as an approximate equivalent for $PM_{2.5}$, but the federal reference monitors provide a more accurate measurement of this pollutant.

Table 23. 1999 to 2001 Annual Average $PM_{2.5}$ Compliance (in $\mu g/m^3$)

Proposed NAAQS: The three-year average of annual means is less than or equal to15 $\mu g/m^3$

1999 to 2001 $PM_{2.5}$ Annual Average NAAQS Compliance Values, By County

	Sites with Exceedances 1999	2000	2001	Sites in Violation
Cochise	0	0	0	0
Coconino	0	0	0	0
Gila	0	0	0	0
Maricopa	0	0	0	0
Pima	0	0	0	0
Santa Cruz	0	0	0	0

Summary: 11 of 11 federal reference monitors

Table 23: 1999 to 2001 Annual Average $PM_{2.5}$ Compliance (in $\mu g/m^3$)

City or Site Federal Reference Monitors	1999	2000	2001	Three-Year Avg
Cochise County				
Douglas – Red Cross	9.0#	8.9	7.2#	8.4#
Coconino County				
Flagstaff – Middle School	8.4#	6.9	7.1#	7.5#
Gila County				
Payson	9.8	10.1#	8.9#	9.6#
Maricopa County				
Phoenix – Desert West	11.4	12.1	10.9	11.5
Phoenix – JLG Supersite	12.2	11.5#	9.2	11.0#
Tempe – Community Center	10.8	10.3	9.4	10.2

Table 23: 1999 to 2001 Annual Average $PM_{2.5}$ Compliance (in $\mu g/m^3$)				
City or Site Federal Reference Monitors	1999	2000	2001	Three-Year Avg
Table 23: 1999 to 2001 Annual Average $PM_{2.5}$ Compliance (in $\mu g/m^3$)				
City or Site Federal Reference Monitors	1999	2000	2001	Three-Year Avg
Pima County				
Tucson – Children's Park	8.8	6.8#	6.8#	7.5#
Tucson – Orange Grove	9.7#	7.8#	7.6#	8.4#
Pinal County				
Apache Junction – Fire Station	7.4	7.3	6.3	7.0
Casa Grande – Downtown	9.5	8.5	7.7	8.6
Santa Cruz County				
Nogales – Post Office	12.5	12.8#	10.7	12.0#

N/A – Not available

#Indicates the data do not satisfy EPA's summary criteria, usually meaning less than 75 percent valid data recovery available in one or more calendar quarters.

Table 24. 1999 to 2001 24-Hour Average $PM_{2.5}$ Compliance (in $\mu g/m^3$)

Proposed NAAQS: The three-year average of the 98th percentile values is less than or equal to 65 μg/m3.

Note: The three-year average is rounded to the nearest 1 $\mu g/m^3$ for comparison to the standard.

1999 to 2001 $PM_{2.5}$ 24-Hour Average NAAQS Compliance Values, By County

	Sites with Exceedances 1999	2000	2001	Sites in Violation
Cochise	0	0	0	0
Coconino	0	0	0	0
Gila	0	0	0	0
Maricopa	0	0	0	0
Pima	0	0	0	0
Santa Cruz	0	0	0	0

Summary: 11 of 11 federal reference monitors in compliance for 1999 to 2001

Table 24. 1999 to 2001 24-Hour Average $PM_{2.5}$ Compliance (in $\mu g/m^3$)				
City or Site Federal Reference Monitors	98th Percentile Observations			Three-Year Average
	1999	2000	2001	
Cochise County				
Douglas – Red Cross	23.0#	38.5	24.4#	29#
Coconino County				
Flagstaff – Middle School	24.9#	24.5	16.4#	22#
Gila County				
Payson	25.5	27.3#	24.0#	26#
Maricopa County				
Phoenix – Desert West	34.1	34.1	35.3	35
Phoenix – JLG Supers ite	30.1	32.1#	25.0	29#
Tempe – Community Center	24.0	20.2	22.7	22
Pima County				
Tucson – Children's Park	19.8	11.1#	15.1#	15#
Tucson – Orange Grove	23.7#	12.8#	20.4#	19#
Pinal County				
Apache Junction – Fire Station	15.5	18.0	13.1	16
Casa Grande – Downtown	18.1	18.9	16.7	18
Santa Cruz County				
Nogales – Post Office	39.1	34.4#	25.7	33#

N/A – Not available

 # Indicates the data do not satisfy EPA's summary criteria, usually meaning less than 75 percent valid data recovery available in one or more calendar quarters.

Visibility Data

Visibility monitoring is of three types: aerosol, optical and scene. Aerosol measurements include the physical properties of the ambient atmospheric particles (chemical composition, size, shape, concentration, temporal and spatial distribution and other physical properties) through which a scene is viewed. The chemical species that comprise a particulate sample have different extinction efficiencies. Extinction efficiency is the extent to which an individual or a specific particle will either scatter or absorb light, thus blocking the light's path to one's eye. The overall impact of particles can be estimated by summing the effect of all the component species. This method is the primary approach used in the draft national regional haze rule for estimating present visibility and charting trends for future plan reviews.

ADEQ operates several types of monitors designed to characterize different optical phenomena. Visibility data from these monitors can be expressed by several different measurement units: deciview, inverse megametersand visual range. Inverse megameters is a representation of the ratio between how much light is not received by a sensor compared to the amount of light that leaves a source. Higher numbers mean worse visibility.

Class I Areas

In anticipation of the federal regional haze rule, ADEQ, in 1997, undertook development of a visibility monitoring program directed at Class I areas in partnership with Arizona's federal land managers. The aim is to collect data at all of Arizona's Class I areas. Based on the regional haze rule, five years of data will be needed to determine baseline and projected visibility conditions. Since the IMPROVE program consists only of aerosol sampling, ADEQ will jointly operate sites by installing nephelometers that measure light scattering. Since IMPROVE aerosol samplers will only operate every three days and represent 24 hour averages, taking continuous measurements provides insight into variation in visibility impairment with time, along with advancing the understanding of the relationship between particles and light scattering.

Table 25 summarizes the nephelometer data from locations in or near Arizona Class I areas from 1998 to 2001. The data are summarized into three categories for all hours (24 hours a day): the average visibility of the dirtiest 20 percent of the sampled hours, the mean visibility of all hoursand the average visibility of the cleanest 20 percent of the sampled hours.

Table 25: Visibility in Class I Areas (Nephelometer Data in Mm^{-1})				
Site	Year	Mm^{-1} (24 hour Averages)		
		Mean of the 20% Dirtiest Sampled Hours	Mean of all Sampled Hours	Mean of the Cleanest 20% Sampled Hours
Humboldt Mountain *Mazatzal Wilderness and Pine Mountain Wilderness*	1998	24	9	0
	1999	25	12	3
	2000	28	13	3
	2001	21	9	1
Mount Ord *Mazatzal Wilderness (site closed in 2000)*	1998	28	12	2
	1999	22	11	3
McFadden Peak *Sierra Ancha Wilderness (site closed in 2000)*	1998	24	10	1
	1999	18	7	0
Muleshoe Ranch *Chiracahua National Monument Wilderness, Galiuro Wilderness, Chiricahua Forest Service Wilderness*	1998	24	11	4
	1999	20	11	3
	2000	22	11	3
	2001	24	12	4
Rucker Canyon *Chiricahua Wilderness (site closed in 2001)*	1998	30	12	3
	1999	20	10	4
	2000	18	8	1
Pleasant Valley Ranger Station *Sierra Ancha Wilderness*	2001	28	14	5
Camp Raymond *Sycamore Canyon Wilderness*	1998	N/A	N/A	N/A
	1999	28	13	4
	2000	28	13	3
	2001	28	13	3

Table 25: Visibility in Class I Areas (Nephelometer Data in Mm^{-1})				
Site	Year	Mm^{-1} (24 hour Averages)		
		Mean of the 20% Dirtiest Sampled Hours	Mean of all Sampled Hours	Mean of the Cleanest 20% Sampled Hours
Tucson Mountain *Saguaro National Park (Includes both the West facilities support building and the National Park Service well site)*	1998	30	12	2
	1999	24	13	6
	2000	23	12	5
	2001	22	11	3

N/A – Not available

Urban Haze

In addition to the 24-hour PM_{10} samples collected for regulatory purposes that can also be used in the assessment of urban haze (shown earlier), ADEQ has collected six-hour samples of PM_{10} and $PM_{2.5}$. The six-hour samples were for the morning hours (5 a.m. to 11 a.m.) And were collected in the Phoenix and Tucson metropolitan areas. This program ended in July 2001 for all six-hour sampling sites.

Along with the particulate matter sampling, ADEQ also operated transmissometers and nephelometers in Phoenix and Tucson. Data from these instruments from 1998 to 2001 are presented in Tables 26. The data are separated into categories for all hours and for 6-hours. Each category is further summarized into the average visibility for the dirtiest 20 percent of the sampled hours, the mean visibility of all hoursand the cleanest 20 percent of the sampled hours.

Table 26. Phoenix and Tucson Urban Haze Data 1998 to 2001 (in Mm^{-1})							
Site	Year	Mm^{-1} 24 Hour Samples			Mm^{-1} 5 a.m. to 11 a.m.		
		Dirtiest 20%	Mean	Cleanest 20%	Dirtiest 20%	Mean	Cleanest 20%
Phoenix Transmissometer	1998	133	78	45	136	84	50
	1999	127	72	38	128	77	42
	2000	131	74	38	134	80	42
	2001	118	69	36	118	73	42
Phoenix Nephelometer	1998	91	35	10	77	34	13
	1999	87	36	11	74	36	14

Table 26. Phoenix and Tucson Urban Haze Data 1998 to 2001 (in Mm^{-1})

Site	Year	Mm^{-1} 24 Hour Samples			Mm^{-1} 5 a.m. to 11 a.m.		
		Dirtiest 20%	Mean	Cleanest 20%	Dirtiest 20%	Mean	Cleanest 20%
	2000	93	39	12	80	39	15
	2001	73	32	12	66	33	15
Tucson Transmissometer	1998	102	57	28	119	69	34
	1999	90	57	35	107	65	38
	2000	98	56	27	114	66	31
	2001	96	55	26	109	66	33
Tucson Nephelometer (U of A Central)	1998	45	21	4	47	23	7
	1999	43	23	10	41	24	11
	2000	40	20	8	40	22	9
	2001	42	23	10	44	25	13

N/A – Not available

Special Projects

Introduction

View a photo of the Doppler Radar Wind Profiler used in the Phoenix Ozone Study

In addition to ADEQ's statewide regulatory ambient air monitoring program, the Air Quality Division undertook several special projects during 2001 and the early part of 2002. Two of these projects (Douglas/Agua Prieta and the Air Toxics Monitoring Program) addressed the need for more in-depth knowledge of the emissions from specific areas. One of the studies, the Phoenix Ozone Study, was a collaborative effort with national researchers to advance the understanding of how nocturnal accumulations of ozone precursors in an urban core contribute to ozone formation later in the day. Also included is a progress report on the recommendation from the Governor's Brown Cloud Summit to develop a visibility index and cap and trade programs for the Phoenix metropolitan area. The final two summaries discuss short-term air monitoring performed for recent emergency events. All of these studies go beyond just collecting monitoring data to determine population exposure and visibility degradation. Instead, these studies seek to better understand air pollutant science, provide data for numerical models for dispersions and ultimately better understand the relationship between emissions and air pollutant concentrations. The knowledge gained from these studies can then be used by decision-makers to choose the most effective control strategies that will continue to improve the state's air quality.

Douglas/Agua Prieta

A comprehensive emissions inventory for the Douglas, Ariz., and Agua Prieta, Sonora, Mexico area was completed in June 2002. Pollutant information contained in the emissions inventory includes volatile organic compounds, oxides of nitrogen, carbon monoxide, oxides of sulfur, hazardous air pollutants and particulate matter (PM_{10} and $PM_{2.5}$). ADEQ staff used a new approach that couples geographic information system software with satellite imaging software for analysis of high-resolution digital satellite images to identify and quantify land uses contributing to air pollution.

Arizona State University staff are using this emissions inventory as one of the inputs into the dispersion model for the air quality of the Douglas/Agua Prieta area. Two previous ADEQ studies provided the meteorological and air quality monitoring data inputs. This modeling will simulate pollutant concentrations in the Douglas/Agua Prieta area. The goal is to understand the risks posed to human health from air pollutants and to evaluate the benefits of proposed control measures that reduce the emissions of air pollutants.

The Douglas/Agua Prieta study was the second extensive border study that ADEQ conducted; the first was a study of Nogales, Ariz. and Nogales, Sonora, conducted from 1994 to 1999. A third border study, which will focus on Yuma, Ariz. and San Luis, Sonora, Mexico is planned to begin in 2003.

Phoenix Ozone Study

An interdisciplinary team of atmospheric scientists from a variety of government and academic institutions conducted an intensive field experiment in Phoenix in June 2001 to determine features of the urban ozone formation phenomenon. The team was assisted by ADEQ's Air Assessment Section personnel, who provided logistical support, laborand instruments. This team performed extensive meteorological and air pollutant measurements including use of an instrumented aircraft, instrumentation sites at the top of and halfway up the Bank One building in downtown Phoenixand at a site in the far west valley near Cotton Lane and Greenway Road. In contrast to the U.S. Department of Energy's ozone study of 1998, which examined the transport, chemical reactivity and age of the Phoenix urban plume, the objective of the 2001 experiment was to understand the vertical distribution of ozone precursors during nighttime hours and during the evolution of the convective boundary layer in the morning. To this end, an Arizona State University team determined vertical meteorological and ozone profiles with a tethered balloon in central Phoenix and has submitted their theoretical interpretations of these data to a peer-reviewed journal. With a more complete understanding of the vertical scale of ozone formation, the investigators will be able to formulate more accurate photochemical models to explicitly identify the nocturnal and morning photochemistry of urban ozone formation.

Air Toxics Monitoring Program Implementation

In conjunction with the PAMS program, ADEQ began monitoring for air toxics at three sites in the Phoenix area in 2001. Air Toxics monitoring includes volatile organic compound (VOC) canister sampling and carbonyl cartridge sampling over 24-hour time frames (midnight to midnight); PAMS monitoring consists of the same type of samples, but over 3-hour time frames. The 24-hour VOC canisters are analyzed at the EPA contract laboratory for both air toxics compounds and PAMS compounds during the PAMS season (May through October), and for air toxics compounds the remainder of the year.

Currently there are three PAMS and air toxics monitoring sites: JLG Supersite in Phoenix; Queen Valley near the edge of Tonto National Forest and north of the junction of highways 60 and 79; and South Phoenix which is a Maricopa County Environmental Services Department site near Central Avenue and Broadway Road.

The Governor's Brown Cloud Summit

On March 15, 2000, Governor Jane Dee Hull signed Executive Order 2000-3, establishing the Brown Cloud Summit with the following objectives:

- To identify ways to reduce the brown cloud, recognizing that they may also help the Valley's other air quality problems
- Keep in mind ongoing work by other groups to improve visibility at national parks and wilderness areas throughout the west
- Seek comments from citizens throughout its work
- Develop proposals on how to put the pollution reduction measures into place and track their effect on visibility

Measurements taken in 1994 through 1998 show that the brown cloud is getting worse. The dirtiest days, which occur in fall and winter, have become 10 percent worse. The cleanest days, typically during spring and summer, have become 64 percent worse.

Causes of the Brown Cloud

Air quality monitoring indicates that the brown cloud is the result of pollution created in the metropolitan area. The brown cloud in Phoenix is five times worse than in places in Arizona with clean air, like Organ Pipe National Monument or Grand Canyon National Park. Its primary causes are not dust blowing in from the desert pollution traveling here from Los Angeles, but daily activities, such as driving cars and trucks, using lawnmowers and leaf blowers, and burning fireplaces.

Extremely small particles are the principal cause of the brown cloud. Each particle, about the size of a single grain of flour, can float in the atmosphere for days, behaving much like a gas. More than half the $PM_{2.5}$ is caused by the burning of gasoline and diesel fuel in vehicles and in off-road mobile sources, such as construction equipment like loaders and bulldozers, locomotives, lawn mowers, leaf blowers, and other devices that emit air pollution as they move. $PM_{2.5}$ particles containing carbon, like soot from tail pipes, are particularly effective in reducing visibility because they scatter *and* absorb light.

Weather conditions, such as temperature, wind speed and humidity make the brown cloud look different on different days. Nightly temperature inversions, which are stronger in the valley during winter, play the biggest role. Every evening after sunset, the surface of the land cools off more rapidly than does the air above. As a result, fine particles and gases from combustion produced that day are trapped under the inversion. At the same time, a mass of cooler air slides down from the mountains, pushing the pollution across the valley from east to west. That's why if you look to the west from the top of Squaw Peak right after sunrise on a relatively calm, dirty day you will see a dense, relatively thin layer of brown haze. If you stay there for several hours, you will see the thickness of the haze layer as the inversion lifts and temperatures rise. Around midmorning, the direction of the air flow in the Valley reverses, as the relatively warmer air makes its way from west to east, moving up toward the mountains. If you stayed on Squaw Peak into the afternoon, you would see that the brown cloud had diminished in the west compared with the east.

The Summit's Three-pronged Approach

The Summit's recommendations to Governor Hull revolve around three themes:

- Citizen-set goals to improve the brown cloud, improve the understanding of the nature of the haze throughout the valley, and improve monitoring to assess progress
- Long-term, market-driven strategies to help reach the visibility goal and provide health benefits
- Short-term, voluntary and mandatory measures to reduce emissions and improve public health

Executive Order 2000-3 also directed the summit "to establish options for a visibility standard or other method to track progress in improving visibility in the Phoenix area." The summit looked at an experience in Denver, Colo., which adopted a visibility standard in 1990. The summit chose a visibility target called "blue sky days" to track progress until a public survey can establish a daily index value. A blue sky day would be achieved for any day with at least six daylight hours when visibility is greater than 25 miles. The goals of 250, 260 and 275 blue sky days were recommended for 2001, 2002 and 2003, respectively. A survey was conducted in 2002 to ask citizens and visitors what level of haze is acceptable to them. By December 2003 The survey results will be used to establish a visibility index. The actual level of haze would be reported daily and measured against the index. The summit recommended continuing and expanding the existing visibility monitoring network to track trends. The summit also recommended appropriation of adequate funding to support these activities.

The summit's final report was submitted to Governor Hull on Jan. 16, 2001. Additional information is available at www.adeq.state.az.us/environ/air/browncloud/index.html.

Implementation of the Summit's Recommendations

Many of the summit's recommendations were included in House Bill 2538 and later adopted in A.R.S. 49-558. In order to implement the recommendations of the summit, ADEQ formed two committees, the Visibility Index Oversight Committee and the Cap and Trade Oversight Committee.

The Visibility Index Oversight Committee was asked to provide advise to ADEQ in the following ways; review the consultant's proposal for conducting the visibility survey, meet with the selected contractor after the actual survey is complete to discuss likely success and whether additional surveying may be required, review the draft analysis report from the contractor, release it for public comment, and hopefully provide consensus support for the final version, present the index to the public jointly with ADEQ at a media event, provide the visibility index to the Cap and Trade Oversight Committee for their consideration as one method to track progress in improving visibility.

The statute requires that on or before Dec. 31, 2003, ADEQ establish a daily visibility index to be used in evaluating and reporting current visibility conditions and progress toward visibility improvement goals in Area A. The visibility index must be based on the results of the public survey of a representative cross-section of residents in Area A and must address what visual air qualities and acceptable visual range should be expected to occur. Until the visibility index is established, ADEQ will use the number of blue sky days that occur during the year as an interim method for evaluating and reporting current visibility conditions and progress toward visibility improvement goals in Area A. The target number of blue sky days is 250 in 2001, 260 in 2002 and 275 in 2003.

In order to implement the program ADEQ must expand the Phoenix area urban haze monitoring network. When the expansion is complete the network will include two transmissometers, five nephelometers and five digital cameras, all with near real-time posting to a newly designed Web site. The network will be deployed to represent the West Valley, Central Phoenix and East Valley as well as views of familiar landmarks such as the White Tank Mountains, Estrella Mountains, Camelback Mountain, Superstition Mountains and the downtown

Phoenix area.

The Cap and Trade Oversight Committee will be asked to provide advice to ADEQ in the following ways: 1) review the consultants' proposals and work products, receive the recommendation of the Visibility Index Oversight Committee and consider whether the Program should be based on the visibility index or emissions reductions, 2) based on the information produced by the consultants, determine the appropriate program elements. These may include air pollutants affected, source categories appropriate for inclusion in trading, allocation methods, the relationship between emissions reductions and improvements in visibility, reporting and record-keeping with relation to regulatory requirements, compliance and enforcement methods, the role of banking, and numerous other issues, 3) determine the feasibility of a Cap and Trade program, 4) present any recommended Program to the public jointly with ADEQ, 5) considering input from the public, present final Program recommendations, including any necessary legislation or ADEQ rule-making.

Hazardous Air Response Team

The ADEQ Hazardous Air Response Team (HART) responds to air quality emergencies such as heavy smoke from fires or toxic releases that threaten air quality. HART's objectives include air quality monitoring for public exposure of air pollutants and to provide meteorological support regarding dispersion. Since it started in 1992, the Team has responded to more than 80 incidents. During the calender year of 2001, HART responded to four incidents; a gasoline tanker rollover in the Phoenix area, a mulch fire in north Phoenix, a wood chip fire in Queen Creek and large refuse fire across the border from Naco, Ariz. During the first six months of 2002, the team responded to two industrial fires in the Phoenix metropolitan area and four forest fires; the Indian Fire in Prescott, the Bullock Fire in San Manuel, the Walker Fire in Nogales and the Rodeo-Chediski fire near Show Low.

Rodeo-Chediski Fire

The Rodeo-Chediski fires in east-central Arizona began on June 18 and June 20, 2002, respectively, merged on June 23. These two fires eventually burnt nearly 500,000 acres of prime forest land, destroyed nearly 500 homesand caused the evacuation of about 15,000 residents of the Mogollon Rim. By July 2 the fire was essentially contained and the residents allowed back into Show Low, Heber, Overgaard, Forest Lakes and other communities. Below-average rainfall for the last three years, coupled with brisk westerly and southwesterly winds for several of the fire days, produced an extremely hot and fast-moving fire. The smoke produced by the fire formed an immense plume, towering to 30,000 feet, which after transport to the north and east, fumigated down to ground level in Winslow, Holbrook, Snowflake. The HART took measurements of this smoke in these communities from June 20-27. Staff from the U. S. Forest Service and ADEQ then set up semi-permanent monitors in several communities and took measurements until July 10, 2002.

In summary, smoke from the Rodeo-Chediski fire in east-central Arizona constituted a public health emergency from June 20 through June 30, 2002 in several different communities including Show Low, Snowflake, Heber and Holbrook. Air monitoring for particulates was done at many different towns and at one fire camp during the smokiest days of the fire. Readings were compared to the EPA's air quality index for $PM_{2.5}$, used for general assessment of health risks, and the ADEQ Quality Rule R-18-2-220 used to define "air pollution emergency episodes." Both one-hour and four-hour averages of airborne particles either10 microns and smaller (PM_{10}) or 2.5 microns and smaller ($PM_{2.5}$) exceeded the "hazardous" (EPA) and "emergency" (ADEQ) guidelines on nine different occasions in Heber, Holbrookand Snowflake. On many other occasions the PM_{10} concentrations exceeded the "very unhealthy" (EPA) and "alert" (ADEQ) guidelines. Populations exposed to these elevated concentrations of smoke, both residents and evacuees, numbered about 30,000, all of which were breathing particulate-laden air for at least several hours to a few days from June 20 through about June 30.

Trends

Introduction

View a photo of the 1999 average best and average worst visibility impairment in the Phoenix area

Whether air quality meets the standards is an important question, but one posed more often is whether the air quality is improving or deteriorating. In Arizona, because of the phasing out of leaded gasoline in the mid-1970s and the installation of effective controls on copper smelters in the 1980s, the concentrations of both lead and sulfur dioxide decreased rapidly. Although improvements have also been made in the concentrations of carbon monoxide, ozone and particulates, the last two still exceed air quality standards at some sites: the eight-hour ozone standard at two sites in greater Phoenix, and the 24-hour and annual PM_{10} standards at a few urban and rural sites. Visibility – the aspect of the urban atmosphere that is most obvious to the population – is measured continuously in Tucson and Phoenix. This discussion examines the trends in these three common air pollutants and urban visibility trends in Arizona.

Carbon Monoxide

Since the mid to late 1970s, carbon monoxide concentrations have declined by as much as two-thirds. In Tucson, the maximum annual eight-hour concentration of carbon monoxide at 22nd Street and Alvernon declined from 12 to 4 parts per million (ppm). In Phoenix at 18th Street and Roosevelt (Central Phoenix), the decline was from 23.0 to 7.1 ppm (Figures 2and 3). The number of exceedances of the eight-hour standard – 9 ppm – in Phoenix decreased from 75 to 0 at Central Phoenix. The entire Phoenix network of carbon monoxide monitors recorded over 100 exceedances each year from 1981 through 1986, with an average of 134 per year. No exceedances were recorded by this network in 1997 and 1998, a single exceedance was recorded. in 1999, and none in 2000 to 2001. Most of this improvement can be attributed to Federal new-vehicle emission standards, augmented by emission reductions from the vehicle inspection and maintenance program, which began in 1976, and the use of oxygenated fuels in the winter, beginning in 1989.

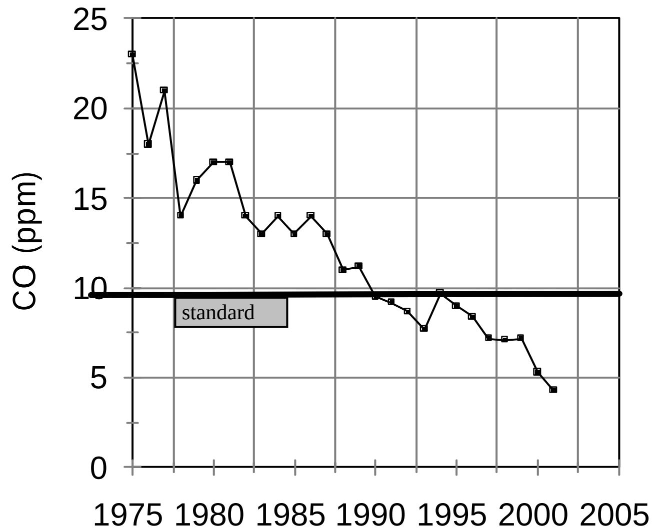


Figure 2: Maximum eight-hour carbon monoxide concentrations at Central Phoenix: 1975-2001

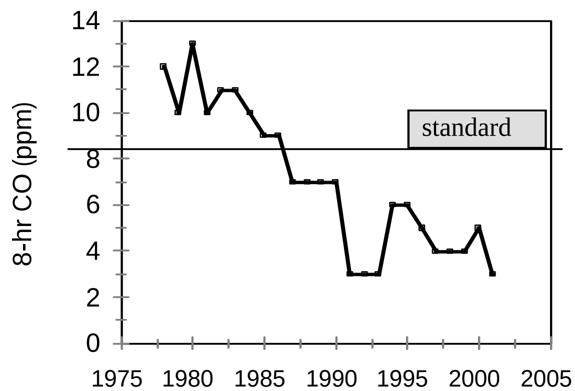


Figure 3: Eight-hour carbon monoxide maxima at 22nd Street and Alvernon Way in Tucson

Ozone

One-Hour Ozone Concentrations

Maximum one-hour average ozone concentrations have remained steady in Tucson and Yuma, but have declined in Phoenix since 1980 (Figure 4). Yuma and Tucson have met the one -hour standard of 0.124 ppm consistently since monitoring began. In the Phoenix airshed, the standard was exceeded regularly through the mid 1990s, with sharp decreases since. The Phoenix decrease in ozone concentrations has been nowhere near as pronounced as its declining carbon monoxide trend, but the net result has been similar: no exceedances of the ozone standard have been recorded since 1996. Because of its relatively high background level and its photochemical formation from hydrocarbons and nitrogen oxides, changes in emissions would not be expected to translate into proportional changes in concentrations.

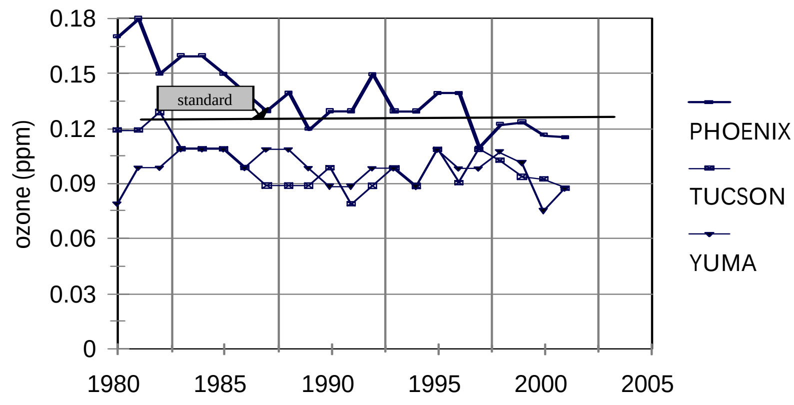


Figure 4: Maximum one-hour ozone concentrations in three cities

Eight-hour Ozone Concentrations

A new eight-hour ozone standard, proposed by EPA in 1997, is expressed as the three-year average of the annual fourth-highest concentration, not to exceed 0.08 parts per million. This proposed standard was the subject of a lawsuit. The U.S. Supreme Court upheld EPA's decision that an eight-hour standard is viable but remanded the case to EPA to implement the final standard, although not questioning what its numerical value should be. Analysis of ambient ozone concentrations nationwide showed that the proposed eight-hour standard is likely to be exceeded in many areas across the United States where the one-hour standard is met. Phoenix falls into this category; Tucson and Yuma do not. Long-term trends of the fourth-highest ozone concentrations in Tucson fluctuate between 0.06 and 0.08 ppm, but, overall, are steady, with the exception of Saguaro National Monument East, which shows a slight increase (Figure 5).

In contrast to the within-standard concentrations in Tucson, 24 of the 28 sites in greater Phoenix have recorded annual fourth-highest ozone values in excess of 0.084 ppm in 1995 to 2001. The standard of 0.084 ppm is the *de facto*, or operational standard, in contrast to the statutory standard of 0.08 ppm. This operational standard takes into account the precision of the instrumental method and the rounding off to the nearest 0.01 ppm. In metropolitan Phoenix, these elevated eight-hour ozone concentrations have occurred at fewer monitoring sites and at lower values in 2001 than in 1995. For instance, of the 20 sites operational both in 1995 or 1996 and 2000 or 2001, 14 recorded fourth-highest values greater than 0.084 ppm in 1995, but only five in 2000 and three in 2001. The values have decreased as well, with typical fourth-highest concentrations decreasing from 1995-96 to 2000-01: Blue Point Bridge, 0.098 to 0.088; Mesa, 0.092 to 0.076; Phoenix Supersite, 0.102 to 0.079; and North Phoenix, 0.095 to 0.087 ppm. Elevated concentrations of ozone averaged for eight hours, then, when looking at the annual fourth-highest values, have exceeded the 0.084 ppm guideline in metropolitan Phoenix, although the extent and severity of these high concentrations were much greater six years ago than in 2001.

Looking at the specific statistical form of the standard – the three-year average of the annual fourth-highest eight-hour ozone concentration – metropolitan Phoenix has exceeded the standard, but, as with the annual fourth-highest values, the extent and severity are decreasing with time. Consider the three-year periods ending with 1997 through 2001: the first being 1995 to 1997 and the last 1999 to 2001. In the first two three-year periods (Table 27), 11 and 12 monitoring sites, respectively, had average fourth-highest values exceeding 0.084 ppm (or 84 ppb). In the last two periods, the numbers of such sites had decreased to five and two, respectively. The magnitude of these three-year averages has decreased substantially, as well. The highest average for the period ending in 1997 was 96.3 ppb; the highest average in 2001 was 11 percent lower, just above the standard at 85.3 ppb. These trends, consistent with the decreasing one-hour maximum ozone trends and with the annual fourth-highest eight-hour ozone trends, would suggest that the eight-hour standard will be attained in two to three years.

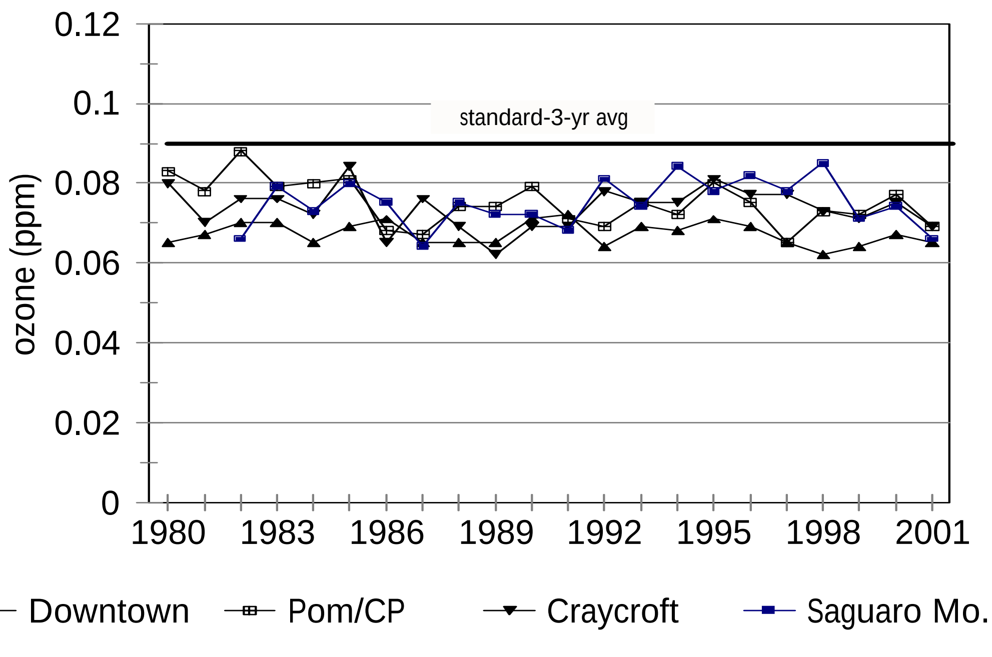


Figure 5: Annual four highest eight-hour ozone concentrations in Tucson

Table 27: Three-Year Averages of the Annual Four Highest Eight-Hour Ozone Concentrations in Phoenix and Environs
(Units are in parts per billion (ppb); bold values exceed the operational standard of 84 ppb)

	1995-1997	1996-1998	1997-1999	1998-2000	1999-2001
Emergency Management	**96.3***	**87.3**	84.7	82.3	76.3
North Phoenix	**93.7***	**92.3**	**88.0**	**86.3**	**85.3**
Salt River Pima	**93.0***	**90.7**	84.3	Closed	Closed
Phoenix Supersite	**92.7***	**85.3**	73.7	72.7	72.3
Blue Point	**90.3***	**89.3**	**86.0**	**88.7**	**85.3**
Apache Junction	**90.0***	**86.0**	81.7	81.3	79.7
Mesa	**89.7**	**85.3**	81.0	79.3	77.3
Pinnacle Peak	**89.0**	**86.7**	81.0	81.7	82.0
Fountain Hills	**89.0**	**85.0**	82.3	81.7	81.0
Falcon Field	**89.0**	**85.0**	82.3	81.7	81.0
Mount Ord	**88.0**	**90.7**	**87.3**	**88.7**	84.7
South Scottsdale	84.3	80.7	75.3	76.0	76.0
West Phoenix	84.3	84.7	**85.3**	**86.0**	82.3
Maryvale	84.0	83.7	81.3	83.0	78.3
Humboldt Mountain	83.7	**88.0**	**86.0**	**86.3**	84.7
Maximum	**96.3**	**92.3**	**88.0**	**88.7**	**85.3**
n > 84 ppb	11	12	5	5	2

Particulates

PM_{10}

The concentrations of PM_{10} have decreased considerably throughout the state in both urban and rural settings. Nonetheless, this pollutant, more than any other, continues to exceed the annual standard of 50 µg/m^3. For example, annual PM_{10} concentrations in South Phoenix averaged 63 µg/m^3 from 1985 through 1989, but only 49 µg/m^3 in 1995-97, a decrease of 22 percent. Similar percentage decreases occurred from the 1980s at Central Phoenix and West Phoenix (Figures 6 and 7).

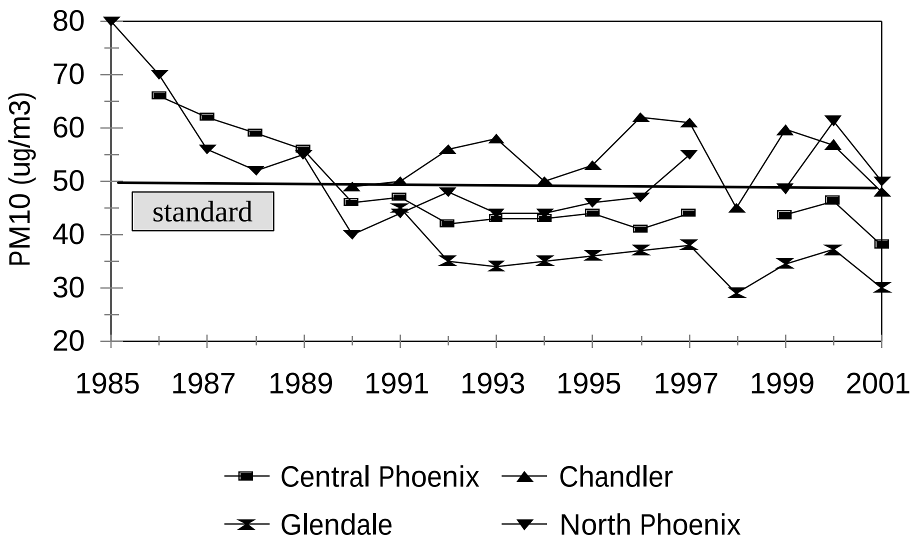


Figure 6: PM_{10} trends at four metropolitan Phoenix sites

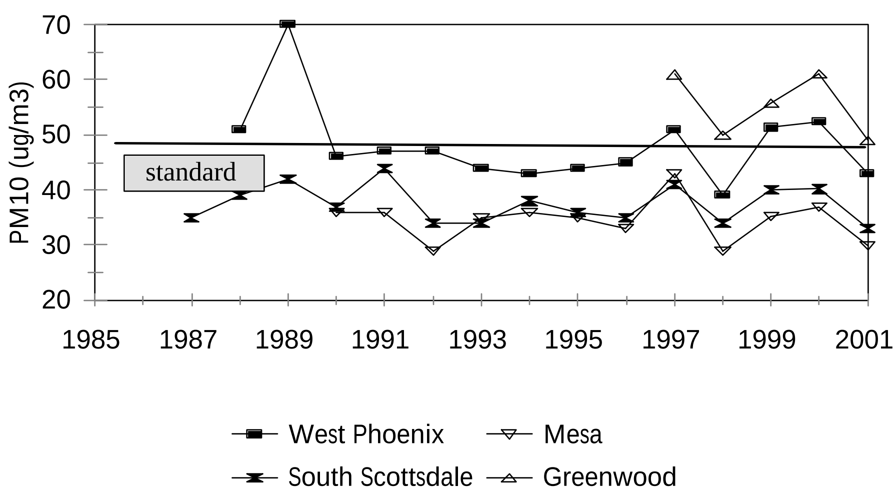


Figure 7: PM_{10} trends at four additional metropolitan Phoenix sites

Despite these improvements in the PM_{10} particulates concentrations, unlike the case for carbon monoxide and ozone, the annual standard for PM_{10} continues to be violated. Annual concentrations for the last 10 years, presented in Table 28, demonstrate that some sites in metropolitan Phoenix have been above the standard for one or more years: Chandler, South Phoenix, West Phoenix and Greenwood. Each of these sites presents a different mix of localized emission sources. Chandler's emissions have gone from agricultural to earthmoving for residential and road construction. South Phoenix, near the industrial Salt River area, may be subject to emissions from the industrial and area sources there. Without any nearby industrial or earthmoving activity, West Phoenix PM_{10} concentrations would appear to be the result of the transport of metropolitan wide emissions into this part of town through prevailing winds. Two miles southwest of West Phoenix, Greenwood combines the high regional concentrations with its close proximity to a major arterial street and major freeway.

Table 28: Annual PM_{10} Concentrations for 10 Years in Metropolitan Phoenix (in $\mu g/m^3$)

	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Central Phoenix	42	43	43	44	41	44	38*	44	46	38
Chandler	**56**	**58**	50	**53**	**62**	**61**	45	**60**	**57**	48
Glendale	34	35	33	33	34	38	29	36	41	33
North Phoenix	35	34	35	36	37	38	29	35	37	30
South Phoenix	48	44	44	46	47	**55**	31*	49	**61**	50
West Phoenix	47	44	43	44	45	**51**	39	**51**	**53**	43
Mesa	29	35	36	35	33	43	29	35	37	30
South Scottsdale	34	34	38	36	35	41	34	40	40	33
Greenwood	N/A	N/A	N/A	N/A	N/A	**61**	50	**56**	**61**	49

Bold values exceed the annual standard of 50 ug/m3

**Does not satisfy EPA summary criteria*

N/A – Data not available

In Tucson, the background site of Corona de Tucson and the rural site of Green Valley have had steady, even trends of PM_{10}, but the four long-term urban sites all show substantial decreases. Orange Grove averaged 45.5 µg/m^3 in 1985-86, but steadily decreased in the next 15 years to an average concentration in 1997-98 of 27.5 µg/m^3 – a decrease of 40 percent. South Tucson, Prince Road and Broadway/Swan showed smaller, but substantial, decreases (Figure 8). Similar to the Phoenix monitoring sites, the 1999 concentrations in Tucson increased substantially over their 1998 levels, again due to the drier weather.

These PM_{10} reductions in the urban settings can probably be attributed to a reduction of coarse particulate emissions caused by paving roads, alleys and road shoulders, and better controls of construction dust emissions.

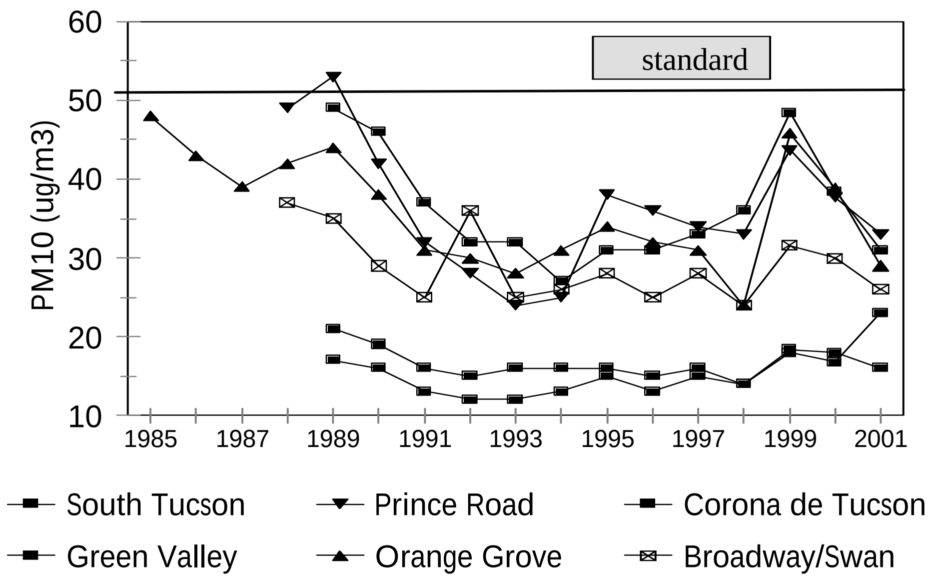


Figure 8: PM_{10} trends at six metropolitan Tucson sites

Throughout the state, PM_{10} concentrations have declined since 1985 at many sites. Consider a group of high concentration sites: Douglas, Hayden and Nogales concentrations have been cut in half, Payson and Paul Spur have been reduced threefold, and Rillito and Yuma have decreased 40 percent. In each of these localities, road paving and better industrial dust controls can be given credit for most of the improvement (Figure 9).

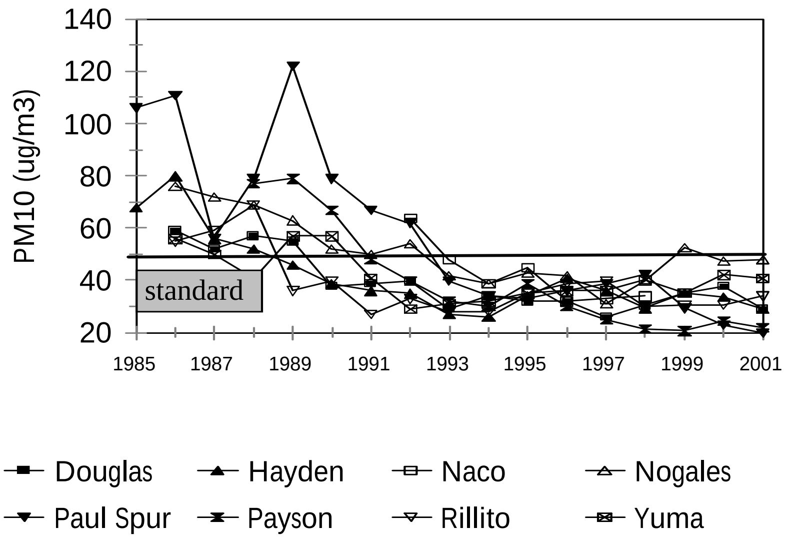


Figure 9: Annual PM_{10} concentrations at the higher concentration sites in Arizona

PM_{10} concentrations at the sites with lower concentrations have decreased, as well, with Ajo concentrations reduced by 50 percent, Bullhead City by 66 percent and Safford by 15 percent. Other lower concentration sites in the lower elevations were steady or slightly decreasing (Figure 10).

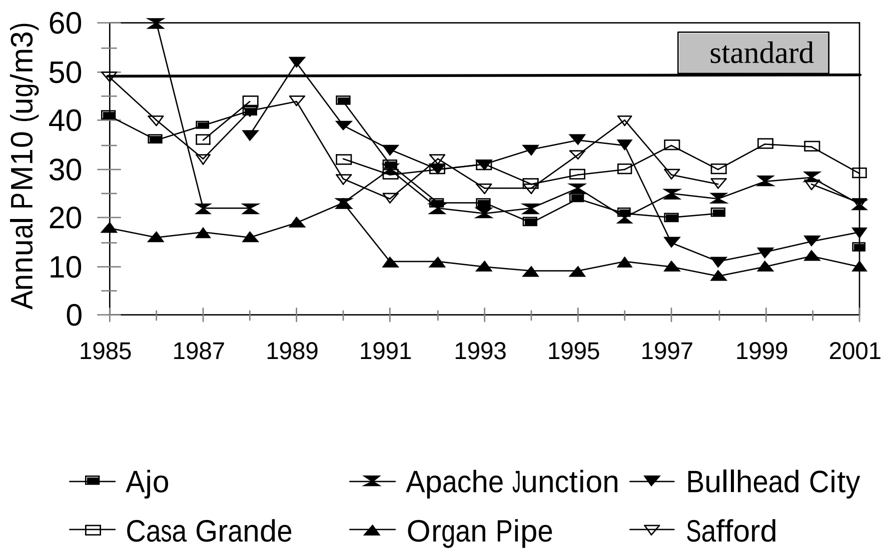


Figure 10: Annual PM_{10} concentrations at lower concentration sites at lower elevations

With the exception of Montezuma's Castle, a background site that has had an even trend, all of the higher-elevation, low-concentration sites showed decreasing trends for

PM_{10}. Clarkdale decreased 38 percent; Flagstaff, 69 percent; Joseph City, 45 percent; Nelson, 45 percent; and Show Low, 56 percent. Part of these decreases may be attributed to cleaner-burning wood stoves and fireplaces (Figure 11). What is encouraging in these various sites is that not a single one shows an upward trend, whether urban, industrial, agricultural or rural.

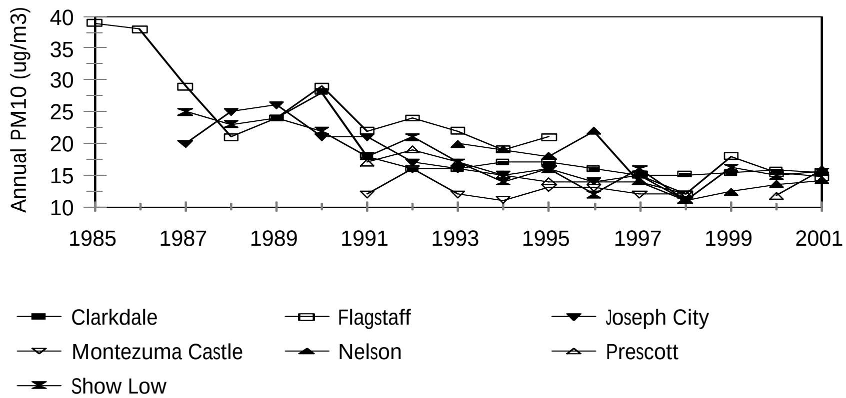


Figure 11: Annual PM_{10} concentrations at low concentration sites at higher elevations

$PM_{2.5}$

$PM_{2.5}$ has not been monitored as long as PM_{10}. Measurements of this fine particle fraction were taken with dichotomous samplers at all sites until 2000. These samplers give an approximate cutpoint between fine and coarse particles somewhere in the range of 2.5 to 3.0 microns. Consequently, measurements taken with these samplers should be termed “fine particulates” and not “$PM_{2.5}$.” In Arizona, the earliest measurements began in 1991 in the smaller cities and towns, in 1994 in Tucson, and in 1995 in Phoenix. In any case, slight downward trends at the urban sites are apparent. Nogales, Yumaand Flagstaff have shown consistent trends, while Payson’s is significantly down by 39 percent. Exceedances of the annual $PM_{2.5}$ standard occurred for four years in Payson and for one year in Higley. Payson, Nogalesand the central area of Phoenix have the highest concentrations of fine particulates. Flagstaff and the urban fringe of Tucson (the Tangerine and Fairgrounds sites) have the lowest concentrations. These data are presented in Table 29 and Figures 12, 13 and 14.

Table 29: Annual $PM_{2.5}$ Concentrations Throughout Arizona (in $\mu g/m^3$)

Statewide				
	Yuma	Flagstaff	Payson	Nogales
1991	7.6	N/A	**17.9**	12.3
1992	5.7	N/A	**17.2**	12.6
1993	6.1	5.4	13.0	9.7
1994	8.3	4.9	**15.8**	10.4
1995	7.2	5.8	**15.7**	14.3
1996	8.7	11.2	14.4	13.3
1997	6.0	5.0	12.2	11.3
1998	8.3	4.7	10.9	12.5
1999	7.9	4.9	9.8	16.0[a]
2000	8.7	4.8	10.0	12.8
2001	N/A	7.1*	8.9*	10.7*

Phoenix					
	Higley	Tempe	Supersite	ASU West	Estrella
1995	**15.4**	10.0	12.6	11.1	11.7
1996	11.1	10.0	13.4	10.5	11.1
1997	10.4	9.8	12.1	9.1	7.9
1998	9.4	9.4	10.9	8.3	7.1
1999	11.1	10.1	10.8	9.1	8.9
2000	10.0	10.0	10.4	8.5	7.7
2001	N/A	9.4*	9.2*	N/A	N/A

Tucson					
	Orange	22 Cray	Tangerine	Fairgrounds	Central
1994	9.4	7.9	5.3	5.8	8.9
1995	8.9	8.6	5.3	5.1	8.9
1996	8.2	6.4	4.9	4.7	7.7
1997	8.7	7.3	5.1	5.5	8.4
1998	7.3	6.3	5.0	5.0	7.5
1999	9.6	7.5	N/A	N/A	7.2
2000	7.6	N/A	N/A	N/A	7.8
2001	7.6*	N/A	N/A	N/A	N/A

Bold values exceed the standard of 15 µg/m³

N/A – Not available

** Data are from federal reference monitors, not dichot monitors.*

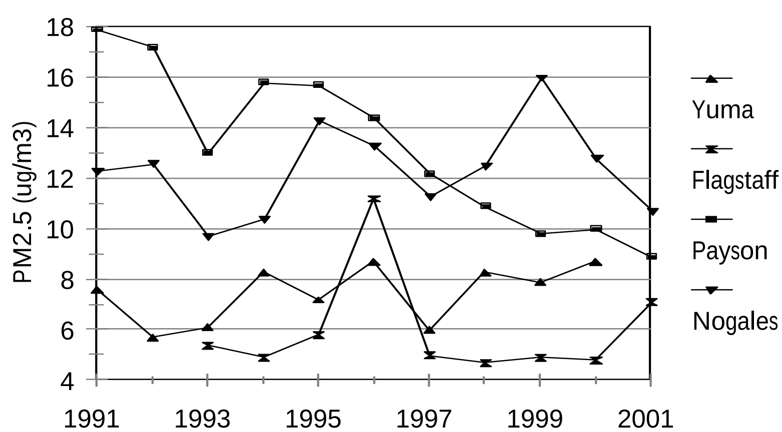


Figure 12: Statewide $PM_{2.5}$ trends

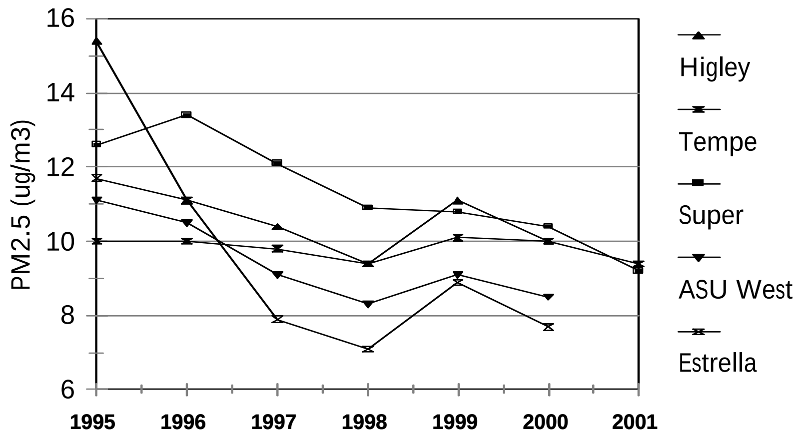


Figure 13: Metropolitan Phoenix $PM_{2.5}$ trends

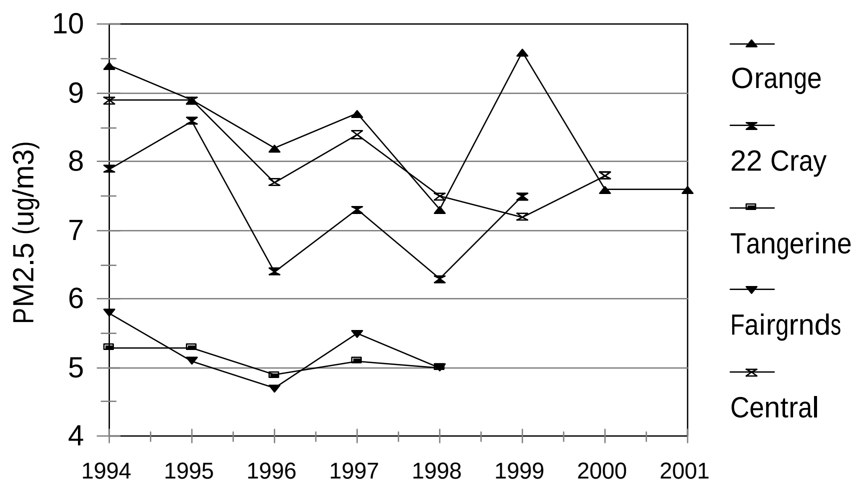


Figure 14: Metropolitan Tucson $PM_{2.5}$ trends

Visibility

Optical measurements of visibility have been made continuously since 1993 in Tucson and since 1994 in Phoenix. Light extinction – the degree to which sunlight is reduced by its interaction with fine particles and gases in the atmosphere – is measured continuously with transmissometers. These measurements have been divided into six categories: the mean of the dirtiest 20 percent of all hours, the mean of all hours and the mean of the cleanest 20 percent of all hours – for both the entire day and the 5 to 11 a.m. period. Table 30 and Figures 15 and 16 present these data.

Table 30: Light Extinction in Phoenix and Tucson (in Mm-1)

Phoenix						
Year	All Hours			5-11 a.m.		
	Dirtiest 20%	Mean	Cleanest 20%	Dirtiest 20%	Mean	Cleanest 20%
1994	123	63	28	129	70	33
1995	138	75	38	134	78	42
1996	133	78	44	129	80	45
1997	137	83	50	136	87	54
1998	135	79	46	138	85	51
1999	125	71	38	124	75	42
2000	131	73	38	135	80	42
2001	118	69	36	118	73	41
% Dif '94-'01	-4.07	+9.52	+28.57	-8.53	+4.29	+24.24
Annual %	-0.51	+1.19	+3.57	-1.07	+0.54	+3.03

Tucson						
Year	All Hours			5-11 a.m.		
	Dirtiest 20%	Mean	Cleanest 20%	Dirtiest 20%	Mean	Cleanest 20%
1993	108	64	35	129	74	39
1994	92	58	35	110	68	40
1995	102	61	35	116	68	38
1996	104	65	39	116	73	43
1997	91	59	36	105	66	38
1998	N/A	N/A	N/A	N/A	N/A	N/A
1999	97	60	36	111	67	39
2000	101	57	27	115	66	31

2001	96	55	26	109	66	33
% Dif '93-'01	-11.1	-14.06	-25.71	-15.50	-10.81	-15.38
Annual %	-1.23	-1.56	-2.86	-1.72	-1.20	-1.71

The percentage difference between either 1993 or 1994 and 2001 is divided by the number of years to give the average annual percentage change.

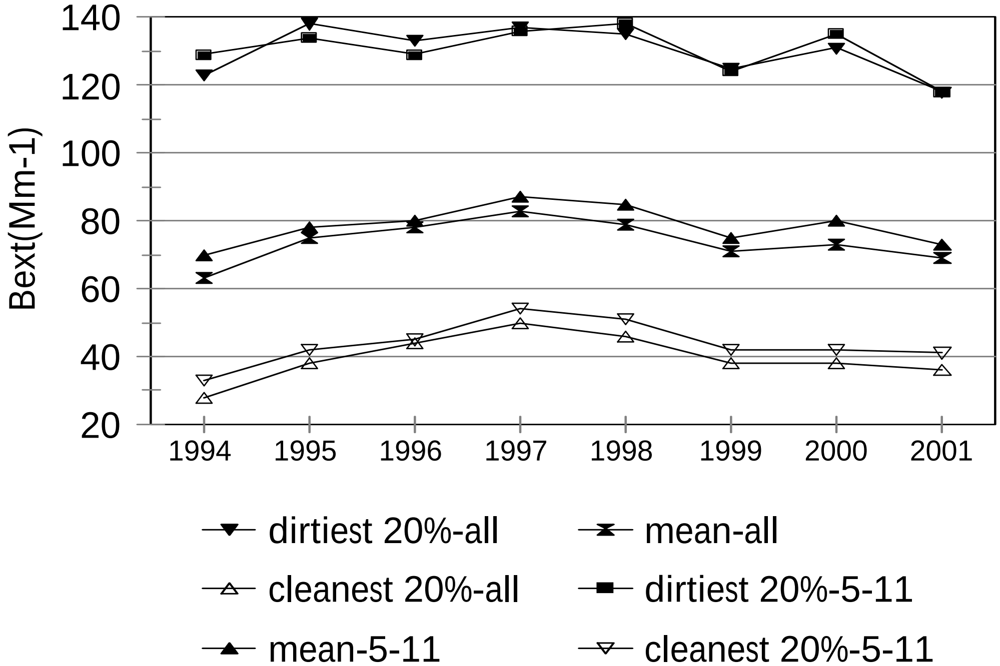


Figure 15: Light extinction trends in Phoenix

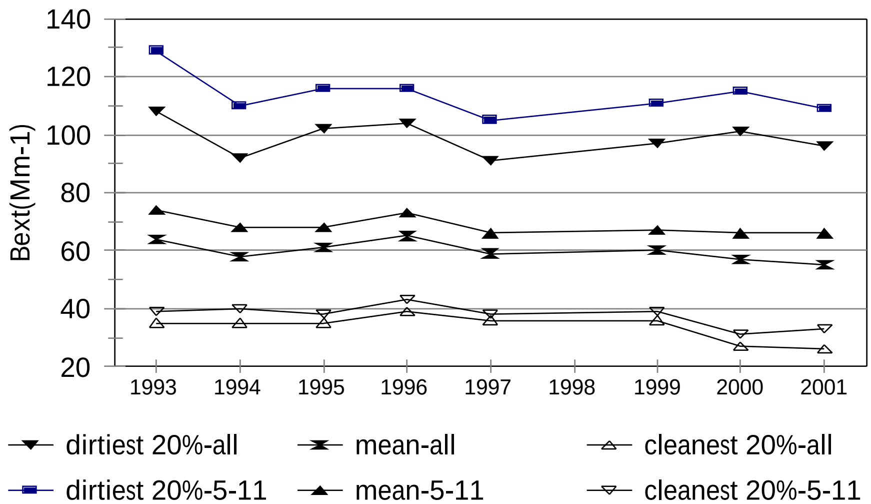


Figure 16: Light extinction trends in Tucson

Tucson visibility shows improving trends in all six categories, although these trends are not strong, have not been constant through the yearsand are somewhat obscured by considerable year-to-year variability. For example, the net decrease from 1993 to 2001 in the light extinction of the 20 percent cleanest days is 26 percent, but it has all come about in the last three years. Phoenix has stronger trends, but in the opposite direction: four of six categories of light extinction have increased from 1994 to 2001 with an apparent peak in 1997. Because the light extinction of the cleanest 20 percent of the hours has increased about five times faster than the dirtiest 20 percent, the increasing mean values have resulted because of a migration from the cleanest 20 percent to the mean. This increase can be attributed to increases in nitrogen oxides and carbonaceous fine particulate emissions from motor vehicles; metropolitan Phoenix vehicle miles traveled increases about 3 percent a year and has now reached 68 million miles on an average weekday.

Seasonal patterns also vary between the two cites, with the mean and dirtiest 20 percent of all hourly light extinction values in Phoenix showing more pronounced winter and fall maxima than the Tucson counterparts (Figure 17). Both cities show almost no seasonal variation in the cleanest 20 percent of all hours. The seasonal light extinction values in Phoenix are considerably higher than Tucson’s: for the dirtiest 20 percent of all hours, 52 percent higher in winter, 19 percent higher in spring, 13 percent higher in summerand 49 percent higher in fall. These measurements of the

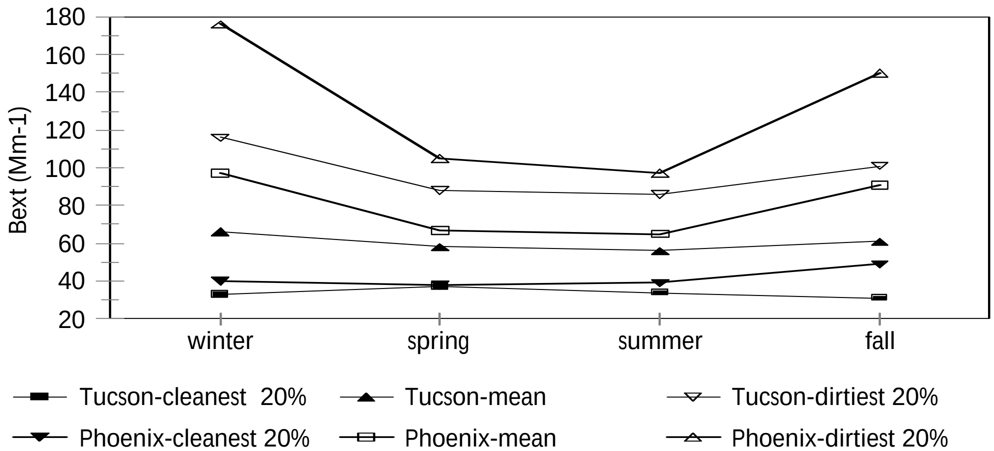


Figure 17: Seasonal patterns of hourly light extinction in Tucson and Phoenix: 1993 to 1998

poorer visibility in Phoenix will come as no surprise to those Arizonans familiar with both airsheds.

Conclusions

Since monitoring of air pollutants began in the late 1960s in Arizona, considerable progress has been made in reducing concentrations of lead, sulfur dioxide, and carbon monoxide. Lead has been reduced to near background levels; sulfur dioxide concentrations near copper smelters, which chronically exceeded the standards until the mid-1980s, are now well within these standards; and carbon monoxide concentrations, which regularly exceeded standards in neighborhoods and near busy intersections in Phoenix (and to a far lesser extent in Tucson), now meet the standards. One-hour ozone concentrations in Phoenix met the standard in 1997-2001, the first years since monitoring began. Phoenix ozone concentrations in the 1980s and early 1990s ranged as high as 0.15 to 0.18 parts per million (the standard is 0.12 ppm), in contrast to the highest, most recent reading of 0.14 ppm in 1996. In 1995-1997, 11 monitoring sites in greater Phoenix exceeded the new eight-hour ozone standard; in 1999-2001 only two sites exceeded the standard.

Elevated concentrations of PM_{10} have been reduced substantially since the mid-1980s, with decreases of 20 to 70 percent in the urban areas and in most smaller cities and towns. In Payson and at some industrial sites, PM_{10} concentrations have been reduced by as much as two-thirds. By 2001, monitored violations of the PM_{10} standard – a once common occurrence at many sites only ten years ago – were limited to a few sites. Fine particulates concentrations ($PM_{2.5}$) have decreased in Phoenix and Tucson since the mid 1990s, respectively; for example, at the centrally located Phoenix Supersite, the decrease has been 21 percent; at 22nd and Craycroft, in east-central Tucson, the decrease has been 24 percent. The Phoenix decreases are inconsistent with the increasing trends in light extinction, caused primarily by small particles.

In spite of the continued growth in Arizona, with the exception of Phoenix visibility in the last five years, not a single air pollutant at any site shows a consistent upward trend. Most standards are met most of the time, with the exceptions being the eight-hour ozone standard during Phoenix summers and the PM_{10} standards on both an episodic and annual basis at those sites affected by localized dense emissions. These improving air quality trends, resulting from control programs at the federal, state and local levels, have improved the respiratory health of the citizenry and can be considered a testament to the public support for a cleaner environment.

Appendix 1 – Site Index

Site Index – Ambient Air Monitoring Locations in Arizona in 2001								
City/Site and Address	Lat.	Long.	Operator	Parameters Measured	Classification	Scale	Objective	Elv. (feet)
Apache County								
Greer – Water Treatment Plant (Mt Baldy)	34° 04'	109° 26'	ADEQ, USFS	B_{scat}, MET, IMPROVE	Class I	Regional	Visibility	8255
Petrified Forest National Park (1 mile north of park headquarters)	35° 05'	109° 46'	NPS	B_{scat}, MET, IMPROVE, Pb	Class I	Regional	Visibility	5778
Springerville – Coalyard	34° 19'	109° 09'	TEP	PM_{10}	SPM	Unknown	Source Impact	6900
Springerville – Coyote Hills	34° 10'	109° 13'	TEP	NO_2, PM_{10}, SO_2	SPM	Unknown	Source Impact	6600
Cochise County								
Bisbee Airport (2 miles north of Bisbee junction)	31° 22'	109° 53'	ADEQ	MET	SPM	Urban	Population	4780
Chiricahua National Monument (3.5 miles west of monument headquarters)	32° 00'	109° 23'	NPS	CASTNET, IMPROVE, MET, O_3, Pb	Class I	Regional	Visibility	5130
Douglas – Cemetery (1505 5th St.)	31° 20'	109° 33'	ADEQ	MET	SPM	Neighbor-hood	Population	4100
Douglas – Red Cross (1445-1449 15th St.)	31° 20'	109° 30'	ADEQ	Pb, PM_{10}, $PM_{2.5}$	SLAMS	Neighbor-hood	Population	4100

Site Index – Ambient Air Monitoring Locations in Arizona in 2001								
City/Site and Address	Lat.	Long.	Operator	Parameters Measured	Classification	Scale	Objective	Elv. (feet)
Muleshoe Ranch – Muleshoe Ranch Preserve (Galiuro Wilderness)	32° 21'	110° 14'	ADEQ	B_{scat}, IMPROVE, MET	Class I	Regional	Visibility	4400
Naco – Border Patrol Crossing (2188 1st St.)	31° 20'	109° 57'	ADEQ	B_{scat}	SPM	Neighbor-hood	Population	4623
Paul Spur – Naco Road (East of Chemical Lime Plant)	31° 22'	109° 49'	ADEQ	PM_{10}, MET	SLAMS (PM_{10})	Middle	Source Impact	4192
Coconino County								
Flagstaff – ADOT (5701 E. Railroad Ave.), closed 8/05/01	35° 12'	111° 37'	ADEQ	PM_{10}	SPM	Neighbor-hood	Maximum Concentration	7000
Flagstaff – Middle School (755 N. Bonito)	35° 12'	111° 38'	ADEQ	PM_{10}, $PM_{2.5}$	SLAMS	Neighbor-hood	Population	6906
Grand Canyon National Park – Hance Camp (South Rim, 2.5 miles west of village)	35° 58'	111° 59'	NPS	O_3, Pb, MET, IMPROVE, CASTNET	Class I	Regional	Visibility	7438
Grand Canyon National Park – Indian Gardens (4.5 miles from Bright Angel trailhead)	36° 05'	112° 08'	NPS	IMPROVE, Pb	Class I	Regional	Visibility	3832
Page – Navajo Generating Station (3 miles east of Page)	36° 55'	111° 24'	SRP	O_3, NO_2, PM_{10}, SO_2	SPM	Urban	Source Impact	3648

Site Index – Ambient Air Monitoring Locations in Arizona in 2001								
City/Site and Address	Lat.	Long.	Operator	Parameters Measured	Classification	Scale	Objective	Elv. (feet)
Sedona – Post Office (190 W. Highway 89A)	34° 52'	111° 45'	ADEQ	PM_{10}	SPM	Neighbor-hood	Population	4220
Sycamore Canyon (Camp Raymond)	35° 08'	111° 58'	ADEQ, NPS	B_{scat}, IMPROVE, MET	Class I	Regional	Visibility	6693
Gila County								
Globe Highway (Winkelman)	110°4 5'	32° 59'	ASARCO	SO_2	SPM	Regional	Source Impact	1950
Hayden – Garfield Avenue	33° 00'	110° 47'	ASARCO	SO_2	SPM	Neighbor-hood	Source Impact	2090
Hayden – Montgomery Ranch (NE, NE, Sec 4, T 5S, R 15E)	33° 00'	110° 47'	ASARCO	SO_2	SPM	Regional	Source Impact	2325
Hayden – Old Jail (Canyon Drive)	33° 00'	110° 47'	ADEQ, ASARCO	Pb, PM_{10}, SO_2	SLAMS (ADEQ SO_2 and PM_{10}) SPM (ASARCO SO_2)	Neighbor-hood	Source Impact	2050
Ike's Backbone (Pine Mountain Wilderness)	34° 20'	111° 40'	ADEQ, USFS	IMPROVE	Class I	Regional	Visibility	5232
Miami – Golf Course	33° 24'	110° 49'	PDMI	PM_{10}	SPM	Neighbor-hood	Source Impact	3320

Site Index – Ambient Air Monitoring Locations in Arizona in 2001								
City/Site and Address	Lat.	Long.	Operator	Parameters Measured	Classification	Scale	Objective	Elv. (feet)
Miami – Jones Ranch (Cherry Flats Road)	33° 23'	110° 51'	PDMI	SO_2	SPM	Neighbor-hood	Source Impact	4094
Miami – Ridgeline (4030 Linden St.)	33° 23'	110° 52'	ADEQ, PDMI	PM_{10}, SO_2	SLAMS (ADEQ SO_2) SPM (PDMI PM_{10})	Neighbor-hood	Source Impact	3560
Miami – Town Site (Sullivan Street)	33° 23'	110° 52'	PDMI	SO_2	SPM	Neighbor-hood	Source Impact	3390
Payson (204 W. Aero Dr.)	34° 14'	111° 20'	ADEQ	PM_{10}, $PM_{2.5}$, Pb	SLAMS	Neighbor-hood	Population	4910
Pleasant Valley – Ranger Station (Sierra Ancha USFS Wilderness)	34° 05'	110° 56'	ADEQ, USFS	IMPROVE, B_{scat}, MET	Class I	Regional	Visibility	5133
Tonto National Monument – Maintenance Station (Tonto NF)	33° 39'	111° 07'	ADEQ, USFS	IMPROVE, Pb	Class I	Regional	Visibility	2579
Graham County								
Safford (523 Tenth Ave.)	32° 49	109° 43'	ADEQ	PM_{10}	SLAMS	Neighbor-hood	Population	2950

Site Index – Ambient Air Monitoring Locations in Arizona in 2001								
City/Site and Address	Lat.	Long.	Operator	Parameters Measured	Classification	Scale	Objective	Elv. (feet)
Maricopa County								
Blue Point (Usery Pass and Bush Highway)	33° 33'	111° 36'	MCESD	MET, O_3	SLAMS (MET) NAMS (O_3)	Urban	Maximum Concentration	1575
Cave Creek (37109 N. Lava Lane)	33° 49'	112° 01'	MCESD	MET, O_3	SLAMS	Urban	Maximum Concentration	1916
Central Phoenix (1845 E. Roosevelt)	33° 27'	112° 02'	MCESD	CO, MET, NO_2, O_3, PM_{10}, SO_2	SLAMS (MET) NAMS (CO, NO_2, O_3, PM_{10}, SO_2)	Neighbor-hood	Population	1116
Chandler (1475 E. Pecos Road)	33° 17'	111° 49'	MCESD	MET, PM_{10}	SLAMS (MET) NAMS (PM_{10})	Neighbor-hood	Population	1171
Estrella (15099 W. Casey Abbott Dr., Goodyear)	33° 23'	112° 22'	ADEQ	PM_{10}	SPM (Urban Haze)	Neighbor-hood	Population	1000
Falcon Field (4530 E. McKellips, Mesa)	33° 27'	112° 04'	MCESD	MET, O_3	SLAMS	Urban	Population	1017
Fountain Hills (16426 E. Palisades)	33° 37'	111° 43'	MCESD	MET, O_3	SLAMS (MET) NAMS (O_3)	Neighbor-hood	Maximum Concentration	1444
Gilbert (535 N. Lindsay Road), closed 12/31/01	33° 22'	111° 46'	MCESD	PM_{10}	SLAMS	Neighbor-hood	Population	1214

Site Index – Ambient Air Monitoring Locations in Arizona in 2001								
City/Site and Address	Lat.	Long.	Operator	Parameters Measured	Classification	Scale	Objective	Elv. (feet)
Glendale (6000 W. Olive)	33° 33'	112° 12'	MCESD	CO, MET, O_3, PM_{10}	SLAMS (CO, MET, O_3), NAMS (PM_{10})	Neighbor-hood	Population	1171
Higley (15500 S. Higley Road)	33° 18'	111° 43'	MCESD	MET, PM_{10}	SLAMS (MET)SPM (PM_{10})	Neighbor-hood	Population	1250
Humboldt Mountain (Pine Mountain wilderness)	33° 58'	111° 47'	ADEQ, MCESD	B_{scat}, IMPROVE, MET, O_3	Class I, SLAMS(O_3 MCESD	Regional	Background/ Transport, Visibility	5230
Lake Pleasant (41402 N. 87th Ave.), closed 6/01/01	33° 51'	112° 19'	MCESD	O_3	SLAMS	Regional	Population	1919
Maryvale (6180 W. Encanto)	33° 28'	112° 20'	MCESD	CO, O_3, PM_{10}	SLAMS	Neighbor-hood	Population	1050
Mesa (370 S. Brooks)	33° 24'	111° 51'	MCESD	CO, MET, O_3, PM_{10}	SLAMS	Neighbor-hood	Population	1221
Mount Ord (Mazatzal Mountains) Closed 10/30/01	33° 55'	111° 25'	ADEQ	MET, O_3	SLAMS (O_3)	Regional	Background/ Transport	7130
North Phoenix (601 E. Butler)	33° 33'	112° 04'	MCESD	CO, MET,O_3, PM_{10},	SLAMS	Neighbor-hood	Population	1243
Palo Verde (36248 W. Elliot Road)	33° 20'	112° 50'	ADEQ	NO_2, O_3, Pb, PM_{10}	SLAMS	Regional	Background	870

Site Index – Ambient Air Monitoring Locations in Arizona in 2001								
City/Site and Address	Lat.	Long.	Operator	Parameters Measured	Classification	Scale	Objective	Elv. (feet)
Phoenix – ASU West (4701 W. Thunderbird Road), closed 8/01/01	33° 37'	112° 09'	ADEQ	PM_{10}	SPM (Urban Haze)	Neighbor-hood	Population	1179
Phoenix – Bank One (201 N. Central), closed 1/01/02	33° 15'	112° 02'	ADEQ	MET	SPM	Regional	Upper Air Temperature	499
Phoenix – Desert West Rec Center (6501 W. Virginia Ave.), closed 5/13/02	33° 28'	112° 12'	ADEQ	$PM_{2.5}$	SPM	Neighbor-hood	Maximum Concentration	1110
Phoenix – Durango Complex (2702 AC Esterbrook Blvd.)	33° 25'	112° 07'	MCESD	MET, PM_{10}	SLAMS	Middle	Maximum Concentration	1575
Phoenix – Emergency Management (2035 N. 52nd St.), closed 6/01/01	33° 26'	111° 57'	MCESD	O_3	SLAMS	Neighbor-hood	Population	1312
Phoenix – Grand Avenue (Grand Ave/27th Ave/Thomas Road)	33° 28'	112° 07'	ADEQ	CO	SLAMS	Microscale	Maximum Concentration	1110
Phoenix – Greenwood (I-10 and 27th Avenue)	33° 28'	112° 07'	ADEQ, MCESD	CO, MET, NO_2, PM_{10}	SPM (ADEQ PM_{10}) SLAMS (MCESD CO, MET,NO_2, PM_{10})	Microscale	Maximum Concentration	1110

Site Index – Ambient Air Monitoring Locations in Arizona in 2001								
City/Site and Address	Lat.	Long.	Operator	Parameters Measured	Classification	Scale	Objective	Elv. (feet)
Phoenix – JLG Supersite (4530 N. 17 Ave.)	33° 30'	112° 05'	ADEQ	CO, NO_2, Met, O_3, PM_{10}, $PM_{2.5}$	SPM (Urban Haze) SLAMS (CO, NO_2, O_3, $PM_{2.5}$) PAMS (Type 2)	Neighbor-hood	Population	1115
Phoenix – North Mountain Summit (North Mountain)	33° 35'	112° 05'	ADEQ	Visibility	SPM (Urban Haze)	Urban	Urban Haze	1640
Phoenix – Salt River (3045 S. 22nd Ave.)	33° 21'	112° 06'	ADEQ, MCESD	PM_{10}	SPM	Middle	Maximum Concentration	984
Phoenix – Transmissometer (Phoenix Baptist Hospital)	33° 29'	112° 04'	ADEQ	B_{ext}	SPM/ Urban Haze	Urban	Urban Haze	1115
Phoenix – Transmissometer Receiver (Quality Hotel)	33° 29'	112° 04'	ADEQ	B_{ext}	SPM (Urban Haze)	Urban	Urban Haze	1115
Phoenix – Vehicle Emissions Laboratory (600 N. 40th St.)	33° 27'	112° 00'	ADEQ	MET	SPM	Urban	Meteorology	1050
Phoenix – West Indian School (3315 W. Indian School Road)	33°30'	112° 08'	MCESD	CO, MET	NAMS (CO) SLAMS (MET)	Micro	Maximum Concentration/ Source Impact	1115
Pinnacle Peak (25000 N. Windy Walk)	33° 42'	111° 51'	MCESD	MET, O_3	SLAMS	Urban	Maximum Concentration	2625
Rio Verde (25608 N. Forest Road)	33° 43'	111° 40'	MCESD	O_3	SLAMS	Urban	Maximum Concentration	1640

Site Index – Ambient Air Monitoring Locations in Arizona in 2001								
City/Site and Address	Lat.	Long.	Operator	Parameters Measured	Classification	Scale	Objective	Elv. (feet)
South Phoenix (33 W. Tamarisk)	33° 24'	112° 04'	MCESD	CO, MET, O_3, PM_{10}	NAMS (PM10) SLAMS (CO, MET, O_3)	Neighbor-hood	Population	1083
South Scottsdale (2857 N. Miller)	33° 28'	111° 55'	MCESD	CO, MET, NO_2, O_3, PM_{10}, SO_2	SLAMS (CO, MET) NAMS (NO_2, O_3, PM_{10}, SO_2)	Urban\ Neighbor-hood	Population	1227
Surprise (18600 N. Reems)	33° 39'	112° 33'	MCESD	CO, O_3, PM_{10}	SPM	Neighbor-hood	Population	1312
Tempe – Daley Park (College Avenue)	33° 35'	111° 55'	MCESD	CO, MET, NO_2, O_3	SPM	Neighbor-hood	Population	1181
Tempe – Community Center (3340 S. Rural Road)	33° 23'	111° 55'	ADEQ	PM_{10}, $PM_{2.5}$	SLAMS/ Urban Haze	Neighbor-hood	Population	1110
West Chandler (163 S. Price)	33° 18'	111° 53'	MCESD	CO, MET, O_3, PM_{10}	SLAMS	Neighbor-hood	Population	1120
West Phoenix (3847 W. Earll)	33° 29'	112° 08'	ADEQ, MCESD	CO, MET, NO_2, O_3, PM_{10}, $PM_{2.5}$	SPM (ADEQ $PM_{2.5}$) SLAMS (MET, NO_2, O_3) NAMS (CO, PM_{10})	Neighbor-hood	Population	1096

Site Index – Ambient Air Monitoring Locations in Arizona in 2001								
City/Site and Address	Lat.	Long.	Operator	Parameters Measured	Classification	Scale	Objective	Elv. (feet)
Mohave County								
Bullhead City – ADEQ (990 Hwy 95)	35° 09'	114° 33'	ADEQ	PM_{10}	SLAMS	Neighbor-hood	Population	560
Bullhead City – SCE (1285 Alonas Way)	35° 07'	114° 35'	SCE	NO_2, PM_{10}, SO_2	SPM	Neighbor-hood	Population	560
Fort Mohave (2230 Joy Ln), closed 10/01/01	34" 59'	114° 34'	ADEQ	PM_{10}	SPM	Neighbor-hood	Maximum Concentration	600
Kingman – Praxair NE (I-40 and Griffith Road)	35" 01'	114° 08'	Praxair	PM_{10}	SPM	Middle	Source Impact	3000
Kingman – Praxair SW (I-40 and Griffith Road)	35" 01'	114° 09'	Praxair	PM_{10}	SPM	Middle	Source Impact	3000
Navajo County								
Show Low (Deuce of Clubs Avenue)	34° 15'	110° 02'	ADEQ	PM_{10}	SLAMS	Neighbor-hood	Population	1924
Pima County								
Ajo – ADOT (Well Road)	32° 25'	112° 50'	ADEQ	PM_{10}, MET	SLAMS (PM_{10})	Neighbor-hood	Population	1800
Green Valley (601 N. La Canada Dr.), address change 2/13/2001	31° 52'	110° 59'	PDEQ	PM_{10}	SLAMS	Neighbor-hood	Population Explosure	2903

Site Index – Ambient Air Monitoring Locations in Arizona in 2001								
City/Site and Address	Lat.	Long.	Operator	Parameters Measured	Classification	Scale	Objective	Elv. (feet)
Organ Pipe Cactus National Monument (1 mile SSW of visitor center)	31° 58'	112° 48'	ADEQ	Pb, PM_{10}, IMPROVE	SLAMS (PM_{10})	Regional	Background/ Transport, Visibility	1847
Rillito (8820 W. Water)	32° 25'	111° 10'	ADEQ, APCC	PM_{10}	SLAMS (ADEQ) SPM (APCC)	Neighbor-hood	Source Impact	2055
Saguaro Nation Park – East (Old Spanish Trail)	32° 11'	110° 44'	PDEQ	O_3, IMPROVE	SPM, Class I	Urban	Visibility	3081
South Tucson (1810 S. 6 Ave.)	32° 12'	110° 58'	ADEQ, PDEQ	PM_{10}	SLAMS, Urban Haze	Neighbor-hood	Population	2440
Tucson – Alvernon (22nd and Alvernon)	32° 12'	110° 54'	PDEQ	CO	NAMS	Micro	Maximum Concentration	2516
Tucson – Broadway and Swan (4625 E. Broadway)	32° 13'	110° 53'	PDEQ	PM_{10}	NAMS	Middle	Maximum Concentration	2532
Tucson – Cherry (2745 N. Cherry)	32° 15'	110° 56'	PDEQ	CO	SPM	Neighbor-hood	Population	2400
Tucson – Children's Park (400 W. River Road)	32° 17'	110° 58'	ADEQ, PDEQ	CO, NO_2, O_3, $PM_{2.5}$	SPM (ADEQ $PM_{2.5}$) SLAMS (PDEQ NO_2, O_3) NAMS (CO)	Urban Haze, Neighbor-hood	Population	2286

Site Index – Ambient Air Monitoring Locations in Arizona in 2001								
City/Site and Address	Lat.	Long.	Operator	Parameters Measured	Classification	Scale	Objective	Elv. (feet)
Tucson – Corona De Tucson (22000 S. Houghton Road)	32° 00'	110° 47'	ADEQ, PDEQ	PM_{10}	SPM (ADEQ) SLAMS (PDEQ)	Regional	Background	3078
Tucson – Craycroft (22nd Avenue and Craycroft)	32° 12'	110° 52'	ADEQ	B_{scat}, CO, O_3, NO_2, SO_2, PM_{10}	SPM (ADEQ PM_{10} Urban Haze) SLAMS (PDEQ B_{scat}, CO, O_3, NO_2, SO_2	Neighbor-hood	Population	2582
Tucson – Downtown (190 W. Pennington)	32° 13'	110° 58'	PDEQ	CO, O_3	SLAMS	Neighbor-hood	Population	2365
Tucson – Fairgrounds (11330 S. Houghton)	32° 03'	110°46'	PDEQ	O_3	SLAMS	Neighbor-hood	Population	3078
Tucson – Geronimo (2498 N. Geronimo)	32° 15'	110° 57'	PDEQ	PM_{10}	SPM (AQI Purposed Only)	Neighbor-hood	Population	2580
Tucson – Mountain (Saguaro National Park, west)	32° 14'	111° 10'	ADEQ	B_{scat}, MET, IMPROVE	Class I	Regional	Visibility	2473
Tucson – Orange Grove (3401 W. Orange Grove Road)	32° 19'	111° 02'	ADEQ, PDEQ	PM_{10}, $PM_{2.5}$	SPM (ADEQ PM_{10}, $PM_{2.5}$, Urban Haze) SLAMS (PDEQ PM_{10}, $PM_{2.5}$)	Neighbor-hood	Maximum Concentration/ Population	2175

Site Index – Ambient Air Monitoring Locations in Arizona in 2001								
City/Site and Address	Lat.	Long.	Operator	Parameters Measured	Classification	Scale	Objective	Elv. (feet)
Tucson – Prince Road (1016 W. Prince Road)	32° 16'	110° 59'	PDEQ	PM_{10}	NAMS	Micro	Source Impact	2315
Tucson – Santa Clara (6910 S. Santa Clara Ave.)	32° 07'	110° 58'	PDEQ	PM_{10}	SLAMS	Neighbor-hood	Population	2540
Tucson – Tangerine (12101 N. Camino De Oeste)	32° 25'	110° 04'	PDEQ	O_3, PM_{10}	SLAMS	Urban	Population	2638
Tucson – Tumamoc Hill (north face of Tumamoc Hill)	32° 13'	111° 12	ADEQ	Visibility	SPM (Urban Haze)	Urban	Urban Haze	2825
Tucson Transmissometer – U of A Clinical Sci.	32° 14'	110° 57'	PDEQ, ADEQ	B_{ext}	SPM (Urban Haze)	Urban	Urban Haze	2551
Tucson Transmissometer Receiver (150 W. Congress)	32° 13'	110° 58'	PDEQ, ADEQ	B_{ext}	SPM (Urban Haze)	Urban	Urban Haze	2551
Tucson – U of A Central (1100 N. Fremont Ave.)	32° 13'	110° 57'	ADEQ	B_{scat}, B_{abs}, PM_{10}	SPM (Urban Haze)	Neighbor-hood	Population	2580
Pinal County								
Apache Junction – Fire Station (3955 E. Superstition Blvd. TE)	33° 25'	111° 30'	PCAQCD	$PM_{2.5}$	Proposed (SLAMS)	Neighbor-hood	Population	1750
Apache Junction – Maintenance Yard (305 E. Superstition)	33° 25'	111° 52'	PCAQCD	CO, O_3, PM_{10}, MET	Proposed (SLAMS)	Neighbor-hood	Population	1750

Site Index – Ambient Air Monitoring Locations in Arizona in 2001								
City/Site and Address	Lat.	Long.	Operator	Parameters Measured	Classification	Scale	Objective	Elv. (feet)
Casa Grande – Airport (660 W. Aero Dr.)	32° 54'	111° 46	PCAQCD	CO ,O_3, MET	Proposed (SLAMS)	Neighbor-hood	Population/ Transport	1410
Casa Grande – Downtown (401 Marshall Road)	32° 52'	111° 45'	PCAQCD	PM_{10}, $PM_{2.5}$	Proposed (SLAMS)	Neighbor-hood	Population	1378
Casa Grande – Eleven Mile Corner (Fairgrounds, 512 E. Eleven Mile Corner Road)	32° 52'	111° 34	PCAQCD	MET, PM_{10}	SPM	Microscale	Source Impact	1410
Coolidge – Maintenance Yard (212 E. Broadway)	32° 58'	111° 30'	PCAQCD	PM_{10}	Proposed (SLAMS)	Neighbor-hood	Population	1444
Eloy – City Complex (620 N. Main Street)	32° 45'	111° 33'	PCAQCD	PM_{10}	Proposed (SLAMS)	Neighbor-hood	Population	1562
Hayden Junction (Hwy 177)	33° 00'	110° 50'	ASARCO	SO_2	SPM	Unknown	Source Impact	2080
Mammoth – County Complex (118 S. Catalina)	32° 43'	110° 39'	PCAQCD	PM_{10}	Proposed (SLAMS)	Neighbor-hood	Population/ Background	2920
Pinal Air Park (Water Well # 2, Marana)	32° 31'	111° 20'	PCAQCD	PM_{10}	Proposed (SLAMS)	Regional	Background/ Transport	1870
Queen Valley (10 S. Queen Anne Dr.)	32° 17'	111° 17'	ADEQ	IMPROVE, O_3	Class I	Regional	Visibility	2080
Stanfield (36697 W. Papago Dr.)	32° 53'	111° 57	PCAQCD	PM_{10}	SPM	Neighbor-hood	Population	1296

Site Index – Ambient Air Monitoring Locations in Arizona in 2001								
City/Site and Address	Lat.	Long.	Operator	Parameters Measured	Classification	Scale	Objective	Elv. (feet)
Santa Cruz								
Nogales – Post Office (300 N. Morley Ave.)	31° 20'	110° 56'	ADEQ	Pb, PM_{10}, $PM_{2.5}$, MET	SLAMS	Neighbor-hood	Population	3858
Yavapai County								
Clarkdale – School (1615 Main St.), closed 4/23/02	34° 46'	112° 03'	ADEQ	Pb, PM_{10}	SLAMS (PM_{10})	Neighbor-hood	Population	3500
Clarkdale – NW (#2) (northwest of cement plant)	34° 45'	112° 05'	PCC	Pb, PM_{10}	SPM	Unknown	Source Impact	3500
Clarkdale – SE (#1) (southeast of CTI flyash silo)	34° 45'	112° 05'	PCC	Pb, PM_{10}	SPM	Unknown	Source Impact	3500
Hillside (Sheriff's Repeater Station)	34° 25'	112° 57'	ADEQ	O_3, Pb, PM_{10} IMPROVE	SPM, ClassI	Regional	Background/ Transport, Visibility	4918
Nelson – East (1/2 mile east of Flintkote lime plant)	35° 31'	113°17'	ADEQ	MET	SPM	Neighbor-hood	Source Impact	5472
Nelson – West (3/4 mile west of Flintkote Lime Plant), closed 8/11/01	35° 30'	113°19'	ADEQ	PM_{10}	SLAMS	Neighbor-hood	Source Impact	5100
Prescott (221 S. Cortez)	34° 32'	112° 28'	ADEQ	PM_{10}	SPM	Neighbor-hood	Population	5210

Site Index – Ambient Air Monitoring Locations in Arizona in 2001								
City/Site and Address	Lat.	Long.	Operator	Parameters Measured	Classification	Scale	Objective	Elv. (feet)
Yuma County								
Yuma – AZ Western College, closed 11/01/02	32° 40'	114° 38'	ADEQ	O_3	SLAMS	Neighbor-hood	Maximum Concentration	210
Yuma – Juvenile Center (2795 Ave. B), closed 7/28/02	32° 40'	114° 39'	ADEQ	PM_{10}	SLAMS	Neighbor-hood	Population	210
Mexico								
Agua Prieta – Fire Station (Calle 6 and Avenue 15)	31°19'	109°33'	ADEQ	CO, PM_{10}, $PM_{2.5}$	SPM	Neighbor-hood	Population	3937
Nogales – Fire Station (northwest corner of Lopaz and Mantels)	31°20'	110°57'	ADEQ	PM_{10}, MET	SPM	Neighbor-hood	Population	3945

Sites shown in the site index table are based on the best information available at the date of publication.

Appendix 2 – Acronyms and Abbreviations

ADEQ	Arizona Department of Environmental Quality
ADOT	Arizona Department of Transportation
APCC	Arizona Portland Cement Co.
APS	Arizona Public Service
Area A	Designated Phoenix metropolitan area
ASARCO	ASARCO, Inc.
ASU	Arizona State University
B_{abs}	Light absorption
B_{ag}	Light absorption by gasses
B_{ap}	Light absorption by particles
B_{ext}	Light extinction
B_{scat}	Light scattering
B_{sg}	Light scattering by basses
B_{sp}	Light scattering by particles
BHP	BHP Copper, Inc.
CAAA	1990 Clean Air Act Amendments
CASTNET	Clean Air Status and Trends Network
CFR	Code of Federal Regulations
Class I	Federally designated park or wilderness area with mandated visibility protection
CMSA	Consolidated metropolitan statistical area
CO	Carbon monoxide
CTOC	Cap and Trade Oversight Committee
Delta T	Difference between two levels of temperature measurements
EPA	U.S. Environmental Protection Agency
FMIC	Ft. McDowell Indian Community
FRM	Federal reference method
GRIC	Gila River Indian Community
HAPs	Hazardous air pollutants
HART	Hazardous Air Response Team
HC	Hydrocarbon
IMPROVE	Interagency Monitoring of Protected Visual Environments
km	Kilometers
m	Meters
MCESD	Maricopa County Environmental Services Department

MET	Meteorological measurements (wind, temperature, relative humidity)
mm	Millimeter
Mm^{-1}	Inverse megameter
MSA	Metropolitation statistical area
$\mu g/m^3$	Microgram per cubic meter
NAAQS	National Ambient air quality standards
NAMS	National air monitoring station
NM	National monument
NO	Nitric oxide
NO_2	Nitrogen dioxide
NO_X	Sum of NO and NO_2
NPS	National Park Service
O_3	Ozone
PAMS	Photochemical assessment monitoring station
Pb	Lead
PCC	Phoenix Cement Company
PDEQ	Pima County Department of Environmental Quality
PDMI	Phelps Dodge Miami Inc.
PCAQCD	Pinal County Air Quality Control Division
PM	Particulate matter
$PM_{2.5}$	Particulate matter $\leq$ 2.5 microns
PM_{10}	Particulate matter $\leq$ 10 microns
ppb	Parts per billion
ppm	Parts per million
Pressure	Barometric air pressure
RH	Relative humidity
SCE	Southern California Edison
SIP	State implementation plan
SLAMS	State and local air monitoring station
SO_2	Sulfur dioxide
SO_4^{--}	Sulfate
SPM	Special purpose monitor
SRP	Salt River Project
SRPMIC	Salt River Pima-Maricopa Indian Community
TEOM	Tapered element oscillating microbalance
TEP	Tucson Electric Power
TSP	Total suspended particulate

U of A	University of Arizona
USFS	U.S. Forest Service
VOC	Volatile organic compounds
VIOC	Visibility Index Oversight Committee
Wind	Wind speed and direction
WMAT	White Mountain Apache Tribe

Appendix 3 – Related Web Sites

AirWeb: Protecting Air Quality (http://www2.nature.nps.gov/ard/)
Learn about how the National Park Service Air Resources Division and the Fish and Wildlife Service Air Quality Branch strive to preserve, protect, enhance and understand the air quality and other resources of our national parks and refuges.

Arizona Department of Environmental Quality (www.adeq.state.az.us)
ADEQ's Web site contains information on air quality, news releases, public meetings and many other services that can provided that help to protect a safe and healthy environment.

Earth 911: Making Every Day Earth Day! (www.earth911.org)
That's their mission "to make every day an earth day!" so you can act on today's environmental issues, in order to preserve and maintain for today and tomorrow.

Earth's Biggest Environment Search Engine (www.webdirectory.com)
This Web site is a directory to numerous environmental subjects, from air to wildlife.

Environmental Protection Agency (www.epa.gov)
On EPA's Web site, you can find information about the federal government's role in environmental protection.

EPA – Air and Radiation (www.epa.gov/oar/oaqps)
You'll breathe easier when you see EPA's air quality planning and standards Web site. They have from what's new in air to the latest projects, programs and contracts.

EPA's Air Quality Database (www.epa.gov/air/data/index.html)
EPA's air quality database contains extensive air data. On this site, you can find the sources that contribute to emissions, the equipment and facilities that monitor the air, maps on any air-related information, and contact information for experts on specific issues regarding air and environment.

FirstGov (www.firstgov.gov)
Through this Web site, you can find more than 1,000 federal and state environmental

agencies with details about the environment and how you can be a political environmental advocate.

The Governor's Brown Cloud Summit
(www.adeq.state.az.us/environ/air/browncloud/index.html)
The Brown Cloud Summit was established to better understand and control the Valley's pollution situation; see how you can get involved for a cleaner today and tomorrow.

The Interagency Monitoring of Protected Visual Environments Project
(http://vista.cira.colostate.edu/improve/)
On this site, you can take a look at photos of what haze (pollution) can do to the beautiful views of our nation. You can also take a look at what is being done and how you can get involved to improve the views of our nation.

Maricopa County Air Quality Information (www.maricopa.gov/envsvc/airqual.asp)
Maricopa County's Environmental Services' Web site has specific descriptions plus current and historical data on the county's air monitors.

National Tribal Environmental Council (www.ntec.org)
NTEC is a tribal government membership organization with 160 member tribes that work to protect and preserve the reservation environment.

National Weather Service (www.nws.noaa.gov)
Dive into the latest occurrences and studies of your weather and atmosphere. There are links to local weather service agencies in each state.

Pima County Air Quality Information (www.deq.co.pima.az.us)
The Pima County Department of Environmental Quality's Web site has information about air, water and waste programs, and the latest news and regulations that affect Pima County.

Pinal County Air Quality Information (http://co.pinal.az.us/airqual/monitoring.asp)
Current air quality information from the Pinal County Air Quality Control District.

Pollen Information (www.pollen.com)
Does it feel like something is in the air? Visit pollen.com to find out about what kinds of allergens are in your air and when they are there.

The United States National Park Service (www.nps.gov)
Information about our national parks.

Weather and Air Quality in the Southwest (www.weathersmith.com)
This site contains weather forecasts and air quality information for Phoenix and

Tucson.

Western States Air Resources Council (www.westar.org)
WESTAR is composed of 15 western states that have come together to discuss and exchange information on western regional air quality issues.

Appendix 4 – Maps

A map of the Class I visibility areas is available on Page 9. Maps showing the locations of monitors statewide for each criteria pollutant have been included with the criteria pollutant data tables throughout the section on monitoring data, which begins on Page 18. Additional maps included in this section are listed below.

Ambient Air Monitoring Locations by Monitor Operator
Arizona's Ambient Air Quality Monitoring Networks are in place throughout Arizona. This map shows the location of monitors operated by ADEQ, county agencies, private industry and federal agencies.

Air Quality Monitor Networks – Phoenix and Tucson Metropolitan Areas
These maps identify the locations of monitors of criteria pollutants in Arizona's two largest metropolitan areas.

Air Quality Division Nonattainment Areas
This map identifies the areas in Arizona that are nonattainment for PM_{10}, SO_2, CO and O_3.