Special Projects

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Special Projects

Agua Prieta fire Station Monitoring Site
Douglas/Agua Prieta Special Study, 1999-2000

Introduction

In addition to ADEQ's statewide regulatory ambient air monitoring program, the Air Quality Division undertook several special projects during 2000 and the early part of 2001. Two of these projects (Douglas/Agua Prieta and Greenwood) addressed the need for more in-depth knowledge of specific sites. Two studies (Douglas/Agua Prieta and Tucson natural events) matched monitoring data to emissions inventories. Two projects (Phoenix brown cloud and agricultural best management practices) involved ADEQ working with stakeholders to define and establish control measures for specific air quality issues. Two of the projects (smoke management and ozone forecasting) are ongoing ADEQ efforts to provide timely air quality forecasting information so that proactive actions can be taken to reduce activities that impact air quality. Yet another two of the projects (PAMS and Class I visibility) leveraged established EPA programs to meet multiple objectives. One study (Phoenix ozone study) was a collaborative effort with national researchers to advance the scientific understanding of how nocturnal accumulations of ozone precursors in an urban core contribute to ozone formation later in the day. By going beyond collecting monitoring data, these studies fill gaps in science, provide a better understanding of the factors that affect the models and aid decision making by establishing and implementing control strategies to continue to improve the state's total air quality management.

Douglas/Agua Prieta

An intensive air quality monitoring study was conducted in the Douglas/Agua Prieta area from January 1999 to March 2000 to determine the temporal and spatial distribution of ambient air concentrations of toxic air pollutants and particulate matter in the region. For the same time period, meteorological data were also collected, including upper air data using a wind profiler. With guidance and assistance from a contractor who specializes in emissions inventories, ADEQ staff is developing an emissions inventory for the Douglas/Agua Prieta area. As part of the emissions inventory development, ADEQ staff is using a new approach that couples geographic information system software with satellite image processing software to analyze digital high-resolution satellite images (resolution of one meter). This method allows staff to more accurately and quickly locate land uses that contribute to air pollution, such as land with disturbed topsoil, vacant lots, agricultural land, and unpaved and paved roads.

The emissions inventory will be used to identify and quantify sources of air pollution in the Douglas/Agua Prieta area. These sources encompass many source types – from vehicle traffic to maquiladoras to disturbed land areas. The emissions inventory was completed in October 2001. The final step of assessing air quality in the Douglas/Agua Prieta area will be numerical modeling to simulate air quality concentrations. These simulated pollutant concentrations will provide the means to perform a human risk assessment and to evaluate the potential benefits of proposed control measures to reduce air emissions. The modeling is expected to begin in July 2001 and will use the emissions inventory data, meteorological data and air quality monitoring data collected by the previous two studies.

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, which was conducted from 1994 to 1999. A third border study, which will focus on Yuma and San Luis, is planned to begin in 2002.

Natural Events Policy

ADEQ assisted Pima County in developing an emissions inventory and doing dispersion modeling for their proposed natural events policy. This policy is a proposal to EPA that documents that recent 24-hour PM_{10} exceedances in the Tucson area were due to naturally-occurring wind events. The emissions inventory was developed in a similar manner to that of Douglas/Agua Prieta for the Orange Grove and South Tucson monitoring sites. Dispersion modeling of ambient PM_{10} levels at these sites showed that the principal contributing sources were dust from construction and sand and gravel activities, windblown dust from these sources, and dust from paved roads.

Greenwood Study

ADEQ conducted a short term study of particulate matter distribution in a west Phoenix neighborhood in the spring of 2000. The reason for this study was that in all of metropolitan Phoenix, only one residential area monitor has consistently violated the annual standard for $PM_{10.}$ Other sites that violate the annual standard are classified as industrial or agricultural. Called Greenwood, this monitoring site is about 100 yards south of Interstate 10 and just 30 feet west of 27th Avenue in west-central Phoenix. In the 1999 Maricopa Association of Governments' PM_{10} state implementation plan, the concentration of PM_{10} at Greenwood was the critical value that exceeded the standard and the area's request to extend the attainment deadline from 2001to 2006.

The study was designed to determine which source categories are responsible for the exceedances of the annual PM_{10} standard (50 $\mu g/m^3$) and the contribution that vehicular traffic, both nearby and regional, makes to the ambient concentrations of PM_{10}. ADEQ conducted this study, which was funded by ADEQ and by the Arizona Department of Transportation's Highway Research Council. The three sites selected for the study were Greenwood, West Phoenix (39th Avenue and Earll) and Auto Yard (33rd Avenue and Washington). With the Greenwood site as the primary site, the other two sites served as background sites. The West Phoenix site is about one mile northwest of the primary site and the Auto Yard site is located about one mile southwest of the primary site.

The study consisted of intensive sampling of ambient fine (0-2.5 microns) and coarse particulates (2.5-10.0 microns), ambient PM_{10} (0-10.0 microns), measurement of carbon monoxide (CO) and measurements of wind speed, wind direction and delta temperature. Twenty-four hour particulate samples (both quartz and Teflon filters) were taken on an every-sixth-day cycle beginning March 19, 2000 and four six-hour samples (both quartz and Teflon filters) were taken on an every-sixth-day cycle beginning March 22, 2000. All filter samples were sent to the Desert Research Institute for analysis. The fine and coarse quartz sample filters will be analyzed for carbon and for ions (Cl^-, NO_3^{--} and SO_4^{--}). The fine and coarse Teflon sample filters will be analyzed by x ray fluorescence analysis to determine their elemental constituents.

The analytical results will be used for chemical mass balance (CMB) modeling to attribute the fine, coarse and PM_{10} particulates collected into general source categories of a regional nature; i.e., vegetative burning (only during March), combustion, primary geological, secondary aerosols, etc. The profiles that will be used in the CMB modeling are geological profiles developed from the 1989-90

Phoenix Brown Cloud Study and motor vehicle and combustion profiles from the Northern Front Range Air Quality Study.

ADEQ will create an emission inventory for the area and use it for dispersion modeling analysis. The dispersion analysis will be used to determine the contributions of the nearby versus the regional traffic.

Agricultural Best Management Practices

A large portion of Maricopa County does not meet the standards for PM_{10} set by the federal Clean Air Act. Agricultural activities were identified as one of several significant source categories that contribute to PM_{10}. To address agriculture's contribution to $PM_{10,}$ the Governor's Agricultural Best Management Practices Committee was created by law in 1998 and charged with developing a general permit regulating agricultural operations.

The committee developed a list of best management practices (BMPs) for control of PM_{10} from agricultural land. The new permit requires that farmers implement at least one BMP for each of the following three categories: tillage and harvest activities, non-cropland (areas like farm roads) and cropland (between the time one crop is harvested and the next crop emerges from the soil). The general permit was adopted in May 2000 and each commercial farmer has until Dec. 31, 2001 to put in place the BMPs selected for that farm**.**

Phoenix Ozone Study

An interdisciplinary team of atmospheric scientists from a variety of government and academic institution conducted an intensive field experiment in Phoenix in June 2001 to determine certain features of the urban ozone phenomenon. Assisted by ADEQ Air Assessment Section personnel who provided logistical support, labor and instruments, this team performed extensive meteorological and air pollutant measurements with an instrumented aircraft. Sites were loacated at the top of and halfway up the Bank One building in downtown Phoenix and in the far west valley near Cotton Lane and Greenway Road. In contrast to the Arizona 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 in the night and during the evolution of the convective boundary layer in the morning. With this 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.

Ozone Alert Program

The ozone alert program has been in existence for more than 10 years and is a vital part of the Governor's Clean Air Campaign efforts to minimize ozone formation and exposure in Maricopa County during the summer season. Ozone is a gaseous compound that can cause adverse respiratory effects. It is formed when pollutants called precursors, which are mainly byproducts of internal combustion engines, react with sunlight. Under certain weather conditions, ozone can reach concentrations that are unhealthful.

The ozone alert program is in effect from May 15 to Oct. 15, which is the time of the year during which solar radiation is greatest. The program consists of two parts: forecasts and alerts. Using numerical guidance, climatology and case studies, ADEQ air quality meteorologists predict what maximum ozone value could be reached the following day at any of the two dozen monitoring sites within the county. If the prediction indicates that the maximum value would approach unhealthful concentrations, an ozone alert is called and contact is made with personnel coordinators representing both government agencies and the private sector. The coordinators activate theit Clean Air Campaign plans, which are intended to minimize employees' use of automobiles the following day by carpooling, using mass transit, telecommuting or using flex day options. Media outlets are advised and the Arizona Department of Transportation posts the alert message on electronic sign boards above the urban freeway system. By anticipating potential high concentrations, the ozone alert program has been highly successful in initiating proactive responses to reduce unhealthful air quality due to this pollutant.

Class I Area Visibility Program

Visibility monitoring in the national parks and wilderness areas of Arizona continued during 2000 with the operation of aerosol (particulate) sampler and nephelometer sites. The network configuration is described beginning on Page 1 of this report. The three new sites selected to measure visibility-reducing aerosols transported from the west are Organ Pipe Cactus National Monument, Hillside and Meadview.

Photochemical Assessment Monitoring Stations (PAMS) Program Implementation

The 1990 federal Clean Air Act amendments include a provision requiring more comprehensive and representative data on ozone air pollution, described in detail in Part I. The Clean Air Act amendments called for new regulations for enhanced monitoring of ozone, its photochemical precursors (oxides of nitrogen and volatile organic compounds) and meteorology. The revised regulations call for the establishment of PAMS in those ozone nonattainment areas classified as serious, severe, or extreme. In 1997, the EPA redesignated the Phoenix metropolitan area from the "moderate" to the "serious" category for ozone nonattainment.

As a result of this redesignation, a PAMS site was established and more intensive monitoring of ozone and its precursors began in 1999 at the JLG Supersite in Phoenix. The Supersite serves as a Type 2 PAMS site, which is designed to monitor the magnitude and type of precursor emissions immediately downwind of their maximum emission density. Volatile organic compound (VOC) and carbonyl samples were collected from May through September 1999 and from May through October 2000 in both canisters (VOCs) and cartridges (carbonyl compounds). Instruments that measure concentrations of nitrogen oxides (NOx) and trace level NOy are operated on a continuous basis at the site, as are instruments that measure ozone and total nonmethane hydrocarbons. Meteorological data (wind speed and direction, temperature and relative humidity) are also collected at the Supersite.

Two additional PAMS sites were scheduled for operation in 2000. A Type 3 PAMS site was selected, which is designed to characterize ozone precursor concentrations occurring downwind from the area of maximum emissions (typically 10-30 miles from the fringe of the urban area). This site is called Queen Valley, near the edge of Tonto National Forest and north of the junction of highways 60 and 79. VOCs and nitrogen oxides will be measured at this site. The other new PAMS site is the vehicle emissions inspection station near 40th Street and Van Buren in Phoenix, where a radar wind profiler collected upper air meteorological data for determination of mixing heights. This site will also be used to measure solar radiation.

Smoke Management Program

Fire is a natural tool in forest and grassland management. Controlled open burning, also known as prescribed burning, is used to clear logged areas for planting, abate fire hazards, control disease and unwanted vegetation and improve wildlife habitats. But open burning produces smoke, which is a nuisance to neighbors and can affect public health if not properly managed. Smoke can also reduce visibility on roadways and near airports creating significant hazards. Smoke intrusion upon wilderness areas, national parks and urban centers must also be avoided.

The smoke management program minimizes the adverse effects of prescribed burning. The process begins with the requirement that all "burners" submit a detailed burn plan that includes a description of the location, duration and size of the burn, the amount, size, concentration and type(s) of fuel to be burned, and the expected direction of smoke transport. A burn permit request is then faxed to

ADEQ's Smoke Management Team, which reviews the request against the forecasted weather conditions and other requested burns and which approves the request in full, limits the request to less acreage, or denies the request. It is the ultimate responsibility of the burner to ensure that the proper conditions exist for good smoke dispersion before ignition.

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. It's 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.

Nitrogen dioxide and sulfur dioxide gases from burning of fossil fuels also contribute to the brown cloud. Nitrogen dioxide gas is brown, giving haze its color. Chemical reactions in the atmosphere convert these gases to fine particles.

Dust, principally from driving on paved roads, is also a contributor. Natural sources, like carbon particles from wild fires and dust from the Salt River bed, are small contributors to the haze.

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.

Health Effects

$PM_{2.5}$ also exacerbates health effects such as asthma attacks and other heart and lung problems that result in hospitalization and is consistently associated with higher than average death rates. Reducing the amount of $PM_{2.5}$ will make the view of more distant landmarks clearer and reduce health effects. Applying the results of recent health studies to $PM_{2.5}$ levels measured in the valley, between 250 and 1,000 additional deaths in the Phoenix area each year are currently attributed in part to $PM_{2.5}$ air pollution.

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, improved understanding of the nature of the haze throughout the valley, and improved 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 the 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 is to be conducted in the winter of 2001-2002 to ask citizens and visitors what level of haze is acceptable to them. The survey results will be used to establish a visibility index beginning in 2003. 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/.