Oklahoma Department of Environmental Quality

Air Quality Division

Five Year Network Assessment

The Five Year Network Assessment is being submitted to the Environmental Protection Agency (EPA) as a separate document from the Oklahoma Department of Environmental Quality (DEQ) FY11 Annual Network Review (ANR) and will address the additional requirements found in 40CFR58.10 (d). This is the first submittal of a Five Year Network Assessment by DEQ since that requirement was put into place. Oklahoma is a rural state with only two major urban areas (Oklahoma City & Tulsa), and is currently in attainment with all National Ambient Air Quality Standards (NAAQS). This document will meet the requirements posed by CFR 40 Part 58.10(d).

This assessment is divided into several sections and will follow the five steps outlined in Table 1-1 of the EPA guidance document. Each step will address a separate pollutant category, such as particulates or ozone.

STEP ONE. Included below is a regional description and discussion of important features considered in network design.

A. Climate

Oklahoma's climate is continental. Warm, moist air moves northward from the Gulf of Mexico and often exerts influence on the state's climate. This climate feature is particularly significant in the southern and eastern portions of the state, where humidity, cloudiness, and precipitation are greater than in western and northern sections. Summers in Oklahoma are long and usually hot, while winters are shorter and less rigorous than those of more northern Plains states. Periods of extreme cold are infrequent, and those lasting more than a few days are rare.

Climate often affects ozone concentrations during the summer and affects particulate concentrations in winter and spring as a result of long dry periods. Wind direction is the most important aspect of climate used in network design.

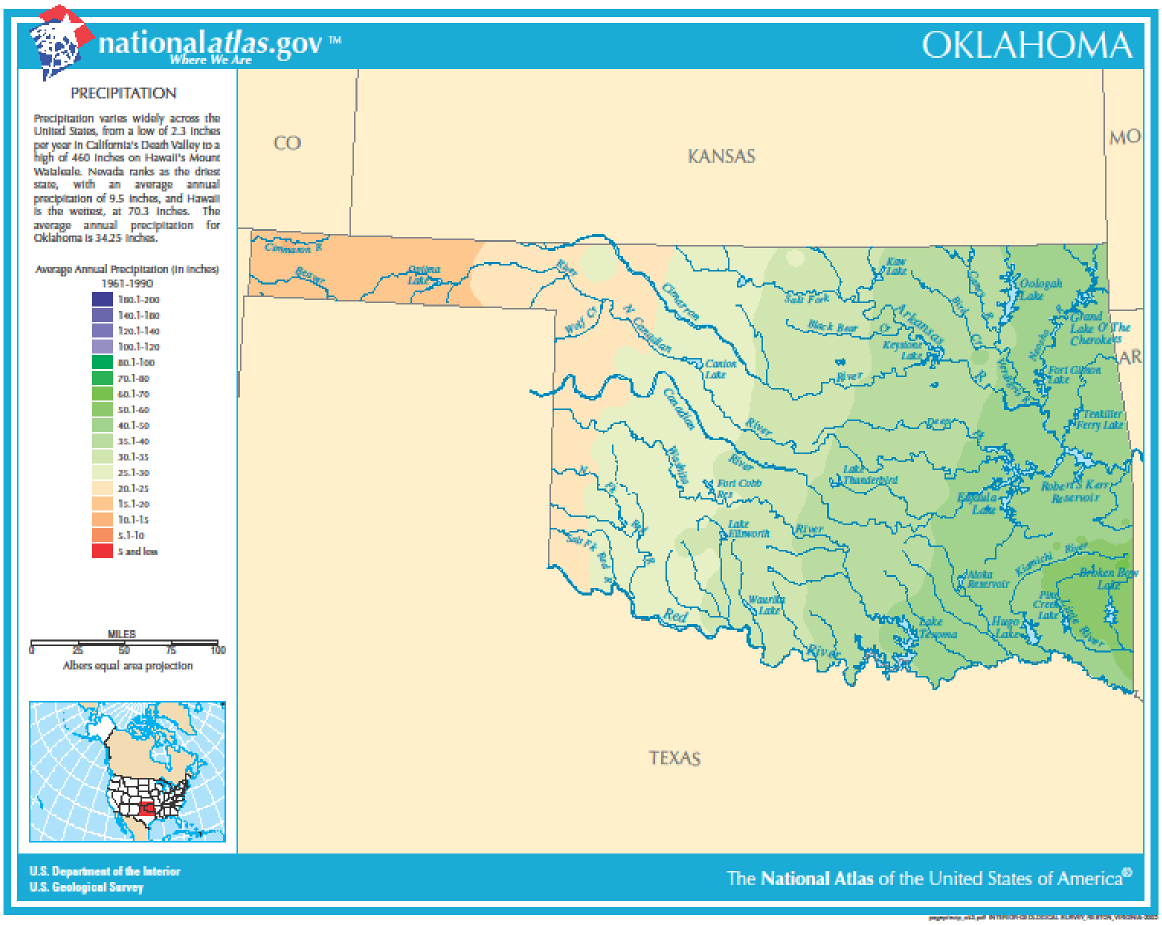
Temperature - The mean annual temperature across the state ranges from 62° F along the Red River to about 58° F along the northern border. Temperature then decreases to 56° F as you move westward into Cimarron County, Oklahoma's furthest most county in the panhandle. Temperatures of 90° F or greater occur, on average, on about 60 to 65 days per year in the western panhandle and the northeast corner of the state. In the southwest, the average is about 115 days, and in the southeast about 85 days. Temperatures of 100° F or higher occur in most years and occur frequently in some. This warmth is usually confined to the months of May through September, but may occur in April and October. The western half of the state, excluding most of the panhandle, averages 15 or more days with triple-digit temperatures. The high temperatures range from about 35 days in the southwest corner to 25 days in the northwest. In the eastern half of the state and most of the panhandle the average is less than 15 days of triple-digit temperatures. Years without 100° F temperatures are rare, found in about one of every seven years in the eastern half of the state to somewhat rarer in the west. The highest temperature ever recorded in the state was 120° F.

Temperatures of 32° F or less occur, on average, on about 60 days per year in the southeast and on about 60 days per year in the southwest. This value increases to about 110 days per year in the region where the panhandle joins the rest of the state and further to 140 days per year in the western panhandle.

Temperature is not considered heavily in terms of affecting the network design process. While the extreme heat affects ozone concentrations, it does not play a significant role in monitor site locations.

Precipitation - The dominant feature of the spatial distribution of rainfall in the state is a sharp decrease in rainfall from east to west. Although precipitation is quite variable on a year-to-year basis, average annual precipitation ranges from about 17 inches in the far western panhandle to about 56 inches in the far southeast. The climatological maximum for precipitation comes in late spring for almost all of the state east of the panhandle. On average, the month of May features more precipitation than any other month across 90 percent of Oklahoma. The frequency of days with measurable precipitation follows the same gradient as the annual accumulation, increasing from 45 days per year in western Oklahoma to 115 near the Arkansas border. On the average, more precipitation falls during the nighttime hours, while greatest rainfall intensities occur during late afternoon.

Annual Average Precipitation in Oklahoma



Flooding – Flooding of major rivers and tributaries may occur during any season, but occurs with greatest frequency during those spring and autumn months associated with greatest rainfall. Such flooding cost many lives and property damage in the first 50 year of statehood, but flood prevention programs have reduced the frequency and severity of such events. Autumn flooding is often associated with widespread heavy rains that occur due to a stalled cold front, or the interaction between a surface front and remnants of a tropical storm. Springtime flooding usually occurs in the warm sector of a slow-moving cyclone.

Flash flooding of creeks and minor streams remains a serious threat to people, especially in urban and suburban areas, where development and removal of vegetation have increased runoff.

Neither precipitation nor flooding plays a major role in network designs.

Drought – Drought is a recurring part of Oklahoma's climate cycle, as it is in all the Plains states. Almost all of Oklahoma's usable surface water comes from precipitation that falls within the state's borders, making drought in Oklahoma almost entirely tied to local rainfall patterns (i.e., the influence of upstream events on drought is very small). Western Oklahoma tends to be slightly more susceptible to drought because precipitation patterns tend to be more variable and marginal.

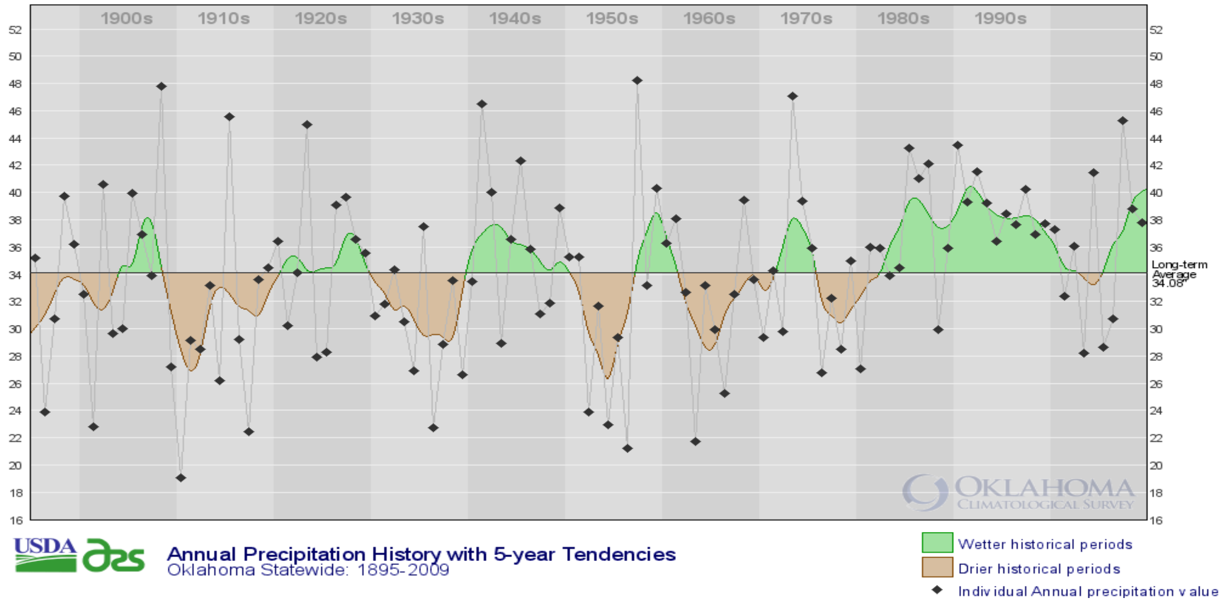
Drought episodes can last from a few months to several years. Those that last a few months can elevate wildfire danger and impact municipal water use. Short term droughts can occur at any time of the year, and those that line up with crop production cycles can cause billions of dollars of damage to the farm economy. Multi-season and multi-year episodes can severely impact large reservoirs, stream flow and ground water.

The agricultural impact of drought is increasingly mitigated on a farm-by-farm and year-by-year basis through irrigation of crops, mostly with fossil water. This practice dominates much of the panhandle and some of the rest of western Oklahoma.

Drought does have some impact on network design. While Oklahoma has not been designated as non attainment for large particulate matter (PM_{10}) in the western half of the state, daily concentrations can be affected significantly by exceptional events such as fires and windblown dust. PM_{10} sampling may need to increase in that area of the state following the next review of the particulate standard.

The Oklahoma Climatological Survey's Climate Trends graphic below shows the evolution of Oklahoma's climate history since the modern record began in 1895.

Oklahoma's Annual Precipitation History



Relative Humidity – Annual average relative humidity ranges from about 60 percent in the panhandle to just over 70 percent in the east and southeast. The average statewide dew point temperature ranges from 27° F in January to 68° F in July.

Prevailing Winds – Prevailing winds are southerly to southeasterly throughout most of the state during the spring through autumn months. Prevailing winds veer to south-to-southwest in far western Oklahoma, including the panhandle. The winter wind regime is bimodal, with a roughly equal split between northerly and southerly winds. The prevailing winds tend to oscillate from southeast to southwest to southeast from sunrise to sunset to sunrise. In the panhandle the daytime swing is more dramatic, with westerly winds prevailing. March and April are the windiest months, while July, August, and September are the calmest.

Prevailing winds is the single most important factor affecting network design. Almost all ozone monitoring sites in the DEQ network are situated downwind of likely sources of precursor emissions. Others are located to assess interstate transport. Source oriented SO_2, NO_2, and lead monitors are also sited in order to sample the maximum concentrations of an emissions area or point source.

Thunderstorms/Severe Weather - Thunderstorms occur, on average, about 55 days per year in the east, decreasing to about 45 days per year in the southwest. The general gradient relaxes in northwestern Oklahoma, where annual thunderstorm days number about 50. The annual rate increases to near 60 days in the extreme western panhandle. Late spring and early summer are the peak seasons for thunder, averaging about eight thunderstorms per month per location during these seasons. For the southeastern two-thirds of the state, thunder occurs most often in May. June is the peak month for much of the remainder of the state, while the western panhandle observes the most thunder in July. December and January, on average, feature the fewest thunderstorms, at a rate of less than one per month per location.

Frequent frontal invasions and dry line development combined with favorable upper-level support make springtime the preferred season for violent thunderstorms, although they can occur at any time of year. Severe weather threats during spring are squall lines, mesoscale convective systems, and totaling supercells that can produce very large hail, damaging winds and tornadoes. Autumn marks a secondary severe weather season, but the relative frequency of supercellular activity is much lower than during spring. General thunderstorms are quite common in the summer, but tend to be less organized storms of relatively short duration. These storms can produce locally heavy rain and some hail. Severe weather events during summer are predominantly mesoscale convective systems, these events tend to be nocturnal in nature.

Severe weather can occur at any time of day, but the maximum frequency for severe weather is from mid-afternoon to sunset. This maximum shifts from afternoon hours in western Oklahoma to late afternoon and early evening in eastern Oklahoma because severe weather is often associated with surface boundaries that move west to east during the afternoon. Diurnally, precipitation shows a maximum during the overnight hours. This can be attributed somewhat to the nocturnal nature of heavy rain associated with summertime events, and heavy rains associated with the continuance of squall lines in to eastern Oklahoma.

Tornadoes are a particular hazard in the state, in that the frequency of occurrence per unit area is among the greatest in the world. Since 1950, an average of 54 tornadoes has been observed annually within the state's borders. Tornadoes can occur at any time of year, but are most frequent during springtime. April, May and June represent the months of peak occurrence; these three months account for about three-fourths of the observations. May has the highest monthly average of 20 tornado observations per month.

While severe weather may have a significant effect on short term pollution events and concentrations, it is not considered to a great degree in the design of the networks.

Climate effects on pollution – Air pollution concentrations are greatly influenced by the climate. The prevailing south southeast winds in Oklahoma frequently transport ozone and ozone precursors from the south causing unhealthy concentrations of ozone into the southern half of the state. Inhalable particulates may also reach unhealthy concentrations when wild fires occur during the dry months of February and March.

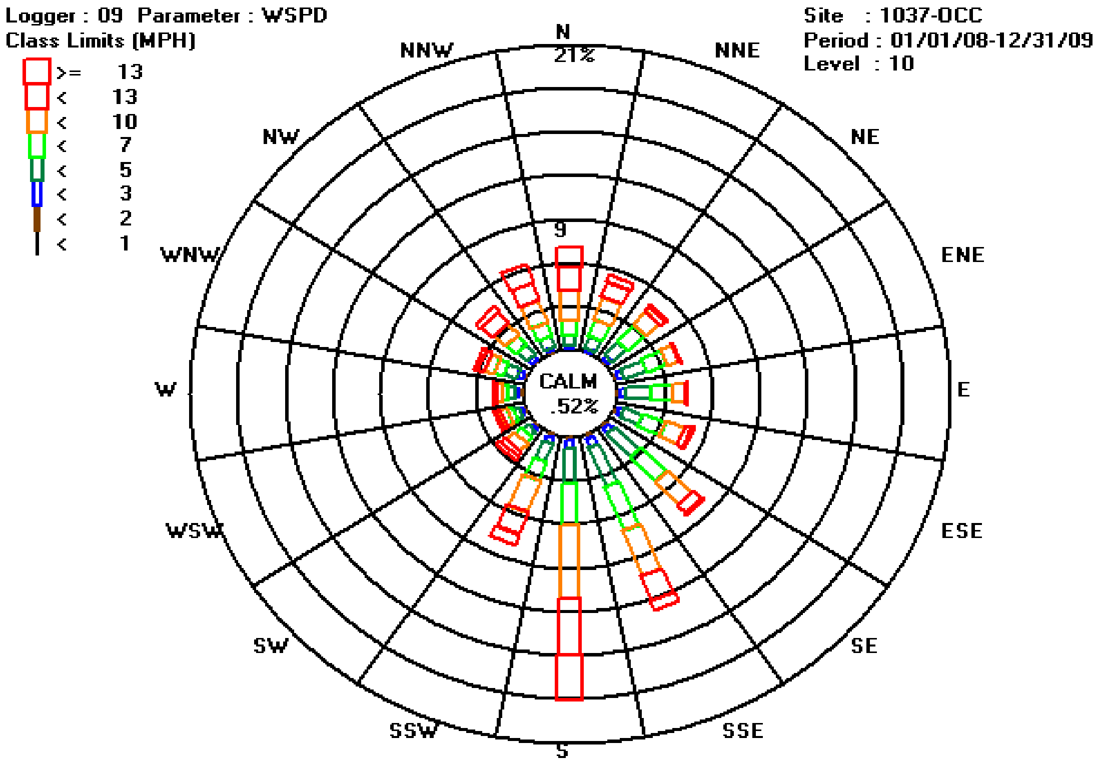
Pollution events caused by air stagnation occur frequently throughout the summer although mostly during the months of July and August. These events, along with ozone transport events, are among the easiest to predict and warn the public of through the Ozone Watch program. Staff meteorologists consult daily weather models and EPA's AIRNOW forecast models to make these determinations. While Ozone Watch predictions are not 100 percent accurate, meteorologists can make increasingly sound scientific decisions in forecasting as model accuracy improves.

While heavy rainfall events tend to clear out pollution for short periods of time, one to a few days, the events do not seem to correlate with statewide pollution concentrations. Pollution increases from west to east and statewide average annual rainfall amounts also increase from west to east.

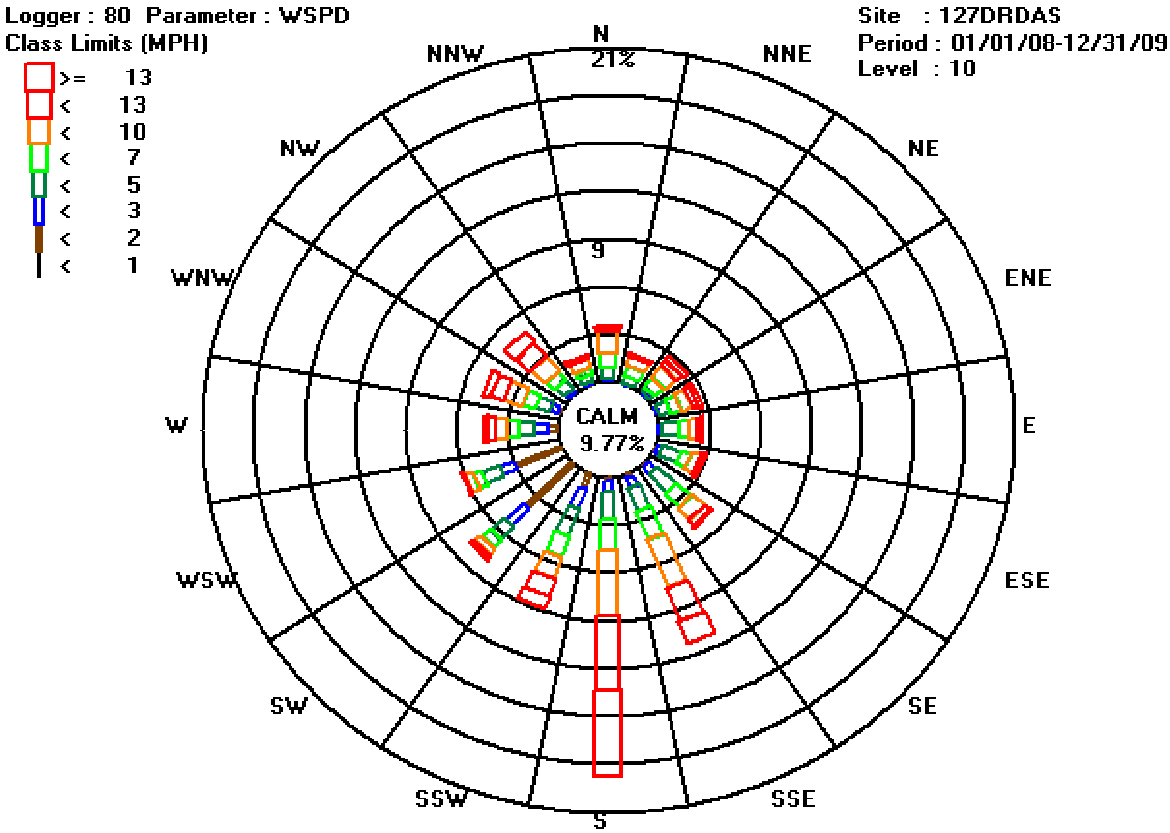
Frontal passages also affect pollution concentrations, most specifically ozone. Sometimes high pollution values are concentrated along frontal boundaries between warm moist air and cool dry air that are often found moving through the state. Predicting ozone events along frontal boundaries in terms of where they will occur and how long they will last is difficult if not impossible. Oklahoma has experienced several instances of localized high ozone concentrations as a result of this phenomenon. These events have happened in one or two local monitoring sites that registered unusually high values while the remainder of ozone sites did not. Frontal passages, which commonly move through the state from northwest to southeast, can also transport clean air masses through the state for a few days at a time.

The tables below include 2008-2009 Wind Roses for Oklahoma City, Tulsa, and Lawton to verify prevailing wind directions which often affect pollutant concentrations:

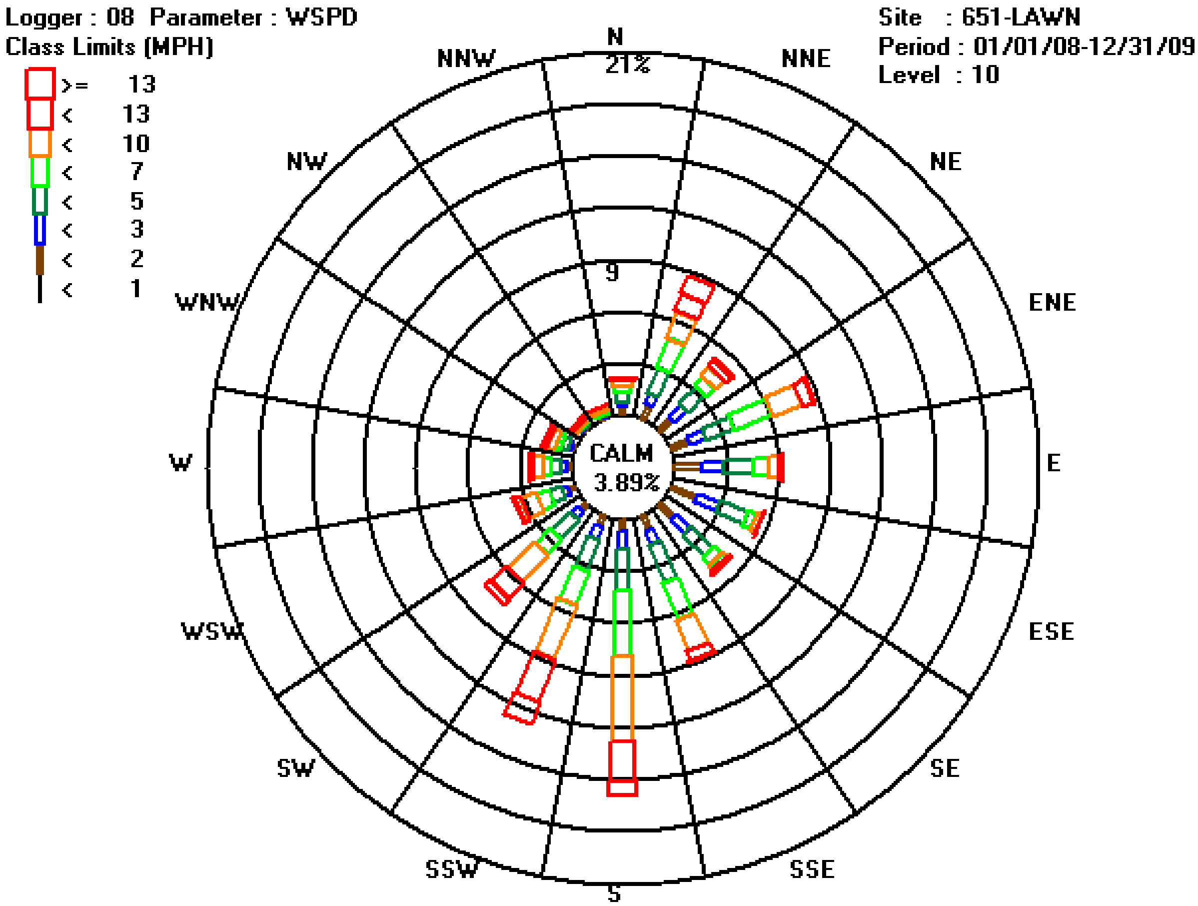
Wind Rose for Oklahoma City, OK – 2008-2009



Wind Rose for Tulsa, OK – 2008-2009



Wind Rose for Lawton, OK – 2008-2009



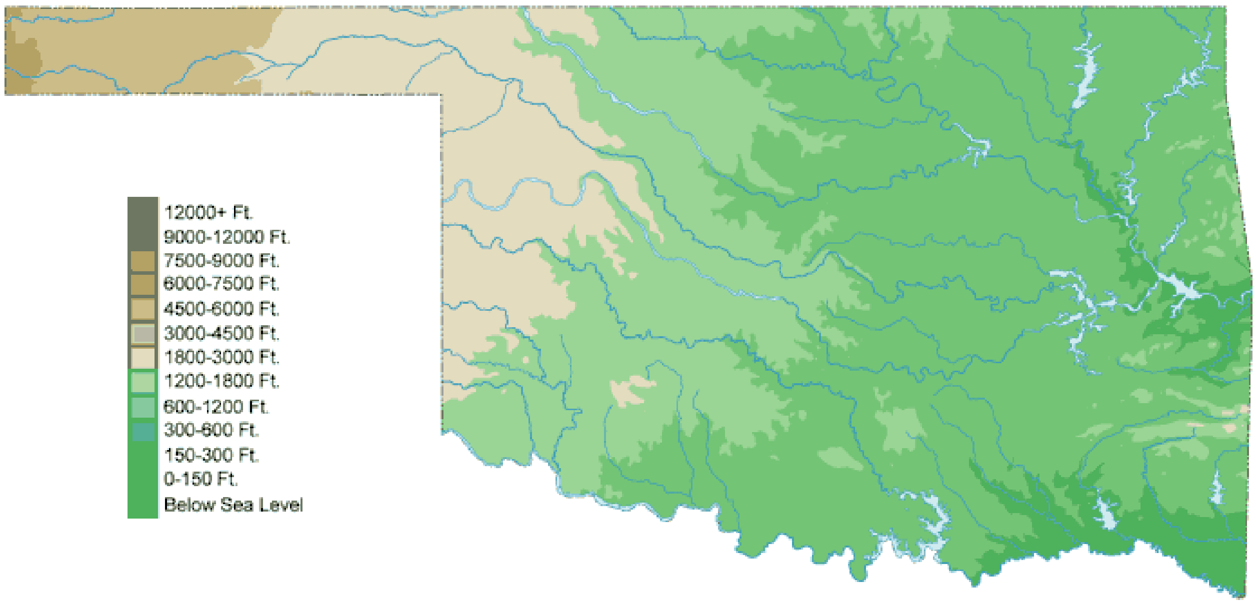
B. Topography

Oklahoma is located in the southern Great Plains. Of the 50 states, it ranks twentieth in size, with an area of 69,903 square miles, about 1,224 of which are covered by water. The state's northern boundary is about 465 miles in length while its southern boundary is 315 miles long. The greatest distance from north to south is 222 miles.

The terrain in Oklahoma is mostly plains, varying from nearly flat in the west to rolling hills in the central and near east, with a general slope upward from east to west. The plains are broken by scattered hilly areas where most points are 600 feet or less above the adjacent countryside. These hilly areas include the Wichita Mountains in the southwest, and the Arbuckle Mountains in the south-central. The Ouachita Mountains dominate much of the southeast, with peaks that rise as much as 2,000 feet above their base. Extreme east central Oklahoma features the mountains of the Arkansas River Valley, which rise several hundred feet above the plains. Extreme northeastern counties are part of the Ozark Plateau, which is marked by steep, rocky river valleys between large areas of hills and rolling plains. The western tip of the panhandle features part of the Black Mesa complex, a fractured terrain featuring large mesas overlooking seasonal creeks and riverbeds. Elevations range from 287 feet above sea level where the Little River exits in southeastern Oklahoma to 4,973 feet on the Black Mesa near the New Mexico border.

Oklahoma lies entirely within the drainage basin of the Mississippi River. The two main rivers in the state are the Arkansas, which drains the northern two-thirds of the state, and the Red, which drains the southern third and serves as the state's southern border. Principal tributaries of the Arkansas are the Verdigris, Grand (Neosho), Illinois, Cimarron, Canadian and North Canadian. The Washita and Kiamichi serve as the Red's principal tributaries in Oklahoma, with the Little River flowing into the Red after it crosses into Arkansas.

Topographical Map of the State of Oklahoma



Topographical effect on pollution - Oklahoma has relatively few deep river basins or valleys which could trap air pollution for any extended period of time. Therefore, ozone episodes tend to be of short duration. The relatively flat terrain in central and western Oklahoma makes it easier for the prevailing south winds to transport ozone from the Dallas area. The terrain also allows ozone transport events to persist for a day or a few days at a time. Tulsa can be affected by these transport events also.

On a more localized scale, the Arkansas River valley west of Tulsa winds through an area of small hills which can funnel ozone and precursors toward the Keystone Lake recreation area on days when the wind is from the east. This type of transport event is rare and usually only lasts a day. Transport events differ from stagnation events by the wind speeds. Stagnation events usually happen when average wind speeds do not exceed 5 miles per hour with variable wind direction and for extended periods of time. The ozone that is created in this scenario is due to pre-cursors emitted from the local area. Stagnation events lasting more than a week occur about once every ten years, usually during the middle of summer when high pressure in the atmosphere causes clear skies, heat and calm conditions. During stagnation events, the ozone levels at all monitoring sites in a Metropolitan Statistical Area (MSA) can reach unhealthy levels.

Transport events occur when high ozone levels are detected in Oklahoma because wind brings ozone and ozone precursors from another location, such as the Dallas/Ft. Worth and/or Houston areas.

Regional Scale $PM_{2.5}$ pollution is highest in the lower elevations of eastern Oklahoma, and concentrations gradually decrease to very low levels as you move west to higher elevations. High concentrations of fine particulate values in Eastern Oklahoma are mostly related to secondary sulfates that probably originate from the Midwestern U.S. When evaluating $PM_{2.5}$ speciated data from the National Trends Speciation site in Tulsa, sulfate values represent a much higher percentage of the values in eastern Oklahoma than in the data collected from the western monitoring sites in Oklahoma City and Arnett.

In terms of network design, sites are usually not located in microscale environments such as river valleys or mountain tops, but in locations that are representative of larger areas. Occasionally however, it is necessary to perform special purpose monitoring in the locations where people reside and there are special circumstances where one or a few sources might be affecting a small area such as a river valley.

C. Population and Demographic Trends

Oklahoma is a rural state of just over 3.5 million people, with three Metropolitan Statistical Areas (MSA):

1. Oklahoma City: ~1.21 million people with a 10.1 percent increased growth rate (2000-2008).

2. Tulsa: ~916 thousand people with a 6.6 percent increased growth rates.

3. Lawton: ~112 thousand people with a 2.8 percent decrease in growth rate.

There are 17 Micropolitan Statistical Areas. The three largest are Stillwater (78K, +14.8%), Muskogee (71K, +2.6%) and Shawnee (69K, +6.3%). Three others have populations greater than 50K: Enid (58K, +0.6%), Ardmore (57K, +4.9%) and Bartlesville (50K, +3.0%). The remaining areas range from 20-45K population. Of those, only three show significant population decline: Altus (-11.3%), Ponca City

(-5.1%) and Miami (-4.0%). The others show some small positive growth. Rural areas generally continue to decline.

The demographic trend is a gradual decrease of population in the western section of the state, slow growth in the eastern portion, and moderate growth in the two largest MSAs. These trends lead the DEQ to consider maintaining or increasing the network size in OKC, Tulsa, and the eastern half of the state. Monitoring site coverage for the western half of the state appears more than adequate.

Concerning the state's largest population areas, air pollution concentrations for NAAQS pollutants have not increased, and in fact have decreased, in recent years. Only general population trends are used in this assessment to determine whether the network meets population requirements. An in-depth analysis of Oklahoma demographic trends is available in the *Demographic State of the State: Age, Gender, and Industry Differences Reported among Oklahoma Jobholders 2000 and 2006*, found at: www.OKcommerce.gov.

D. Major Emission Sources

Oklahoma has a diverse industrial base dating back to the oil boom era of the early twentieth century. Although early in the state's history many refineries sprung up, only six remain and five of them are located in the eastern half of the state. The refineries' throughput has remained constant for the past several years and should remain so for the foreseeable future. Several oil storage facilities reside within the State, with the largest located in Cushing in east central Oklahoma. The state has an abundance of natural gas, so generation is split between gas and coal fired facilities. Oklahoma plays host to five coal fired power plants, all located in the eastern half of the State. Over ten natural gas fired power plants are located throughout the State with the majority situated in the eastern half.

Industry in Oklahoma has been in decline in general over the past several years. One of the three former tire manufacturing plants and two of the five glass manufacturing plants have closed. Metallurgy (Sheffield Steel in Sand Springs), foundries in Blackwell, and aerospace manufacturing are in decline as well. The increase of major criteria or precursor pollutants doesn't appear likely for the next five years as the state continues to shift to a service based economy.

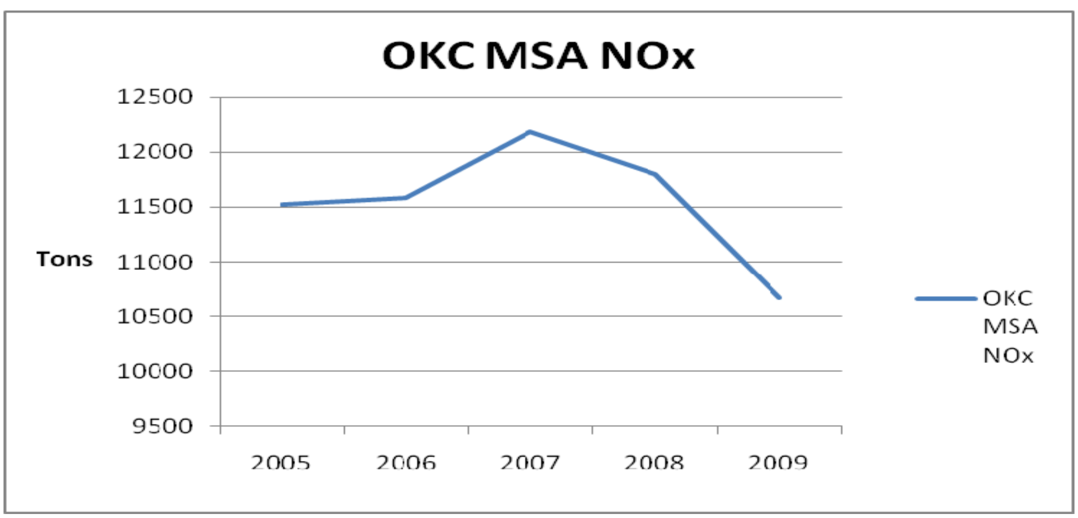
E. Current Air Quality Conditions

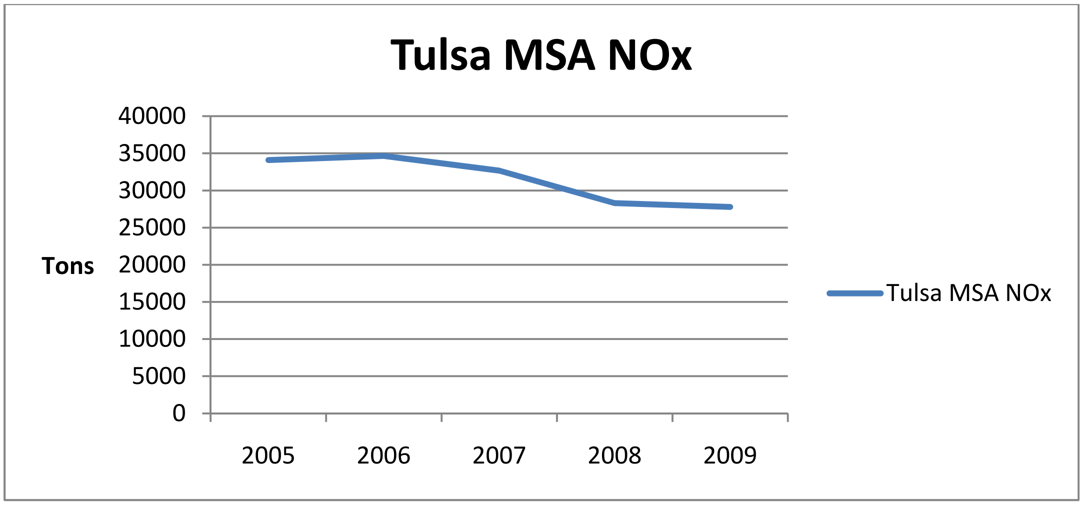
Oklahoma is currently, and has been for many years, in attainment of all NAAQS. Ozone and PM (both 10 and 2.5) concentrations have been the primary pollutants of concern. Ozone sites in both OKC and Tulsa have approached (but not exceeded) the standard occasionally for the last two decades. While concentrations of $PM_{2.5}$ at some sites could be considered high, levels have not been as concerning as ozone levels. If the $PM_{2.5}$ NAAQS were lowered, however, it could trigger non-attainment designation. Oklahoma's current attainment designation with regard to each criteria pollutant is discussed in more detail in the following sections.

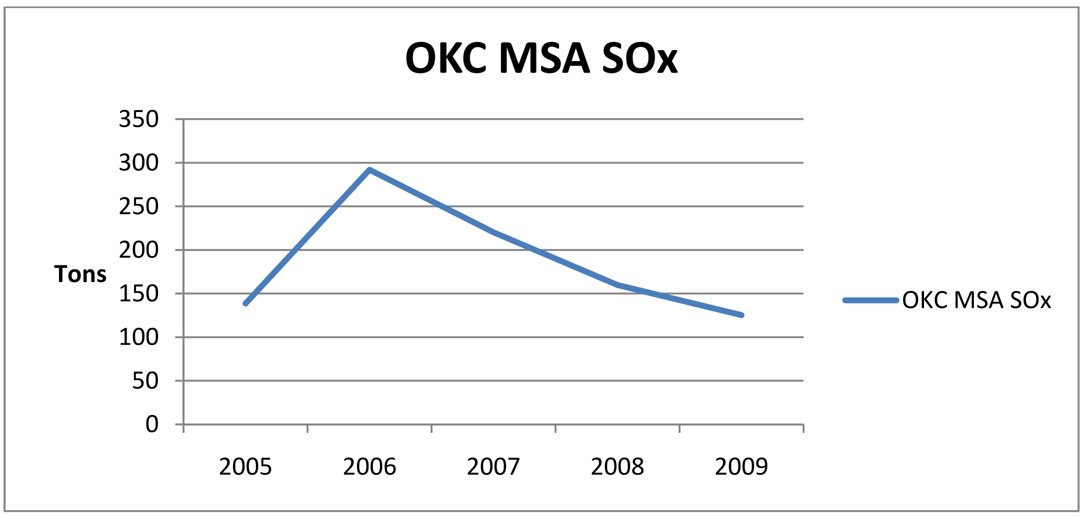
F. Stationary Source Emission Trends

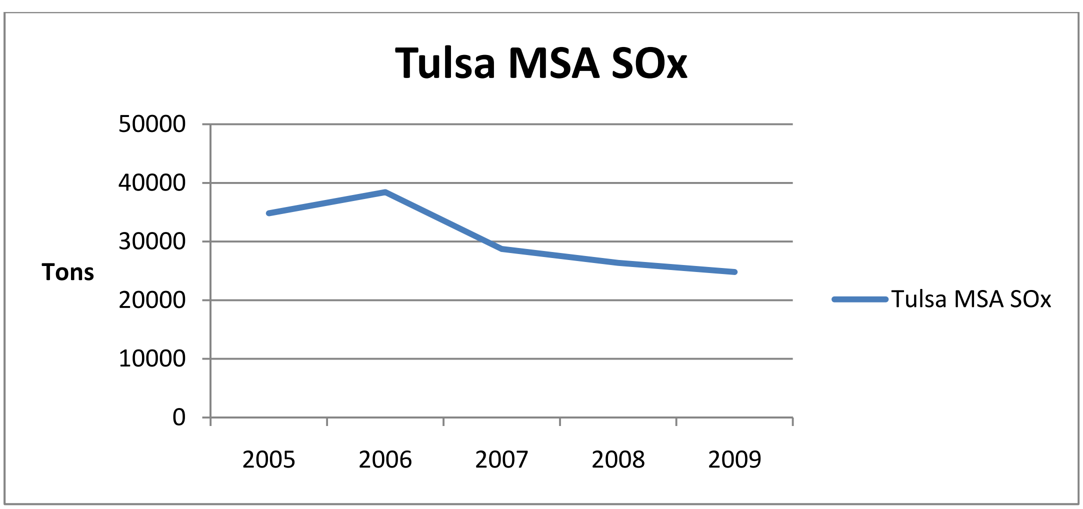
Both of the large metropolitan statistical areas in the state, Oklahoma City and Tulsa, are experiencing downward trends for criteria emissions from stationary sources. The following graphs show the trends for carbon monoxide (CO), oxides of nitrogen (NO_x), and oxides of sulfur (SO_x) in tons of emissions for each calendar year.

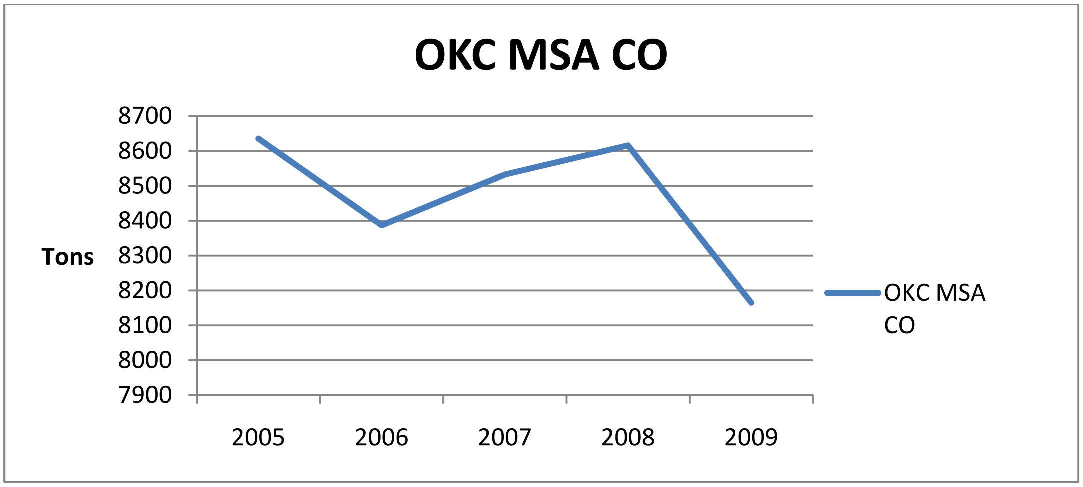
Trend Graphs for Pollutants in Oklahoma City and Tulsa

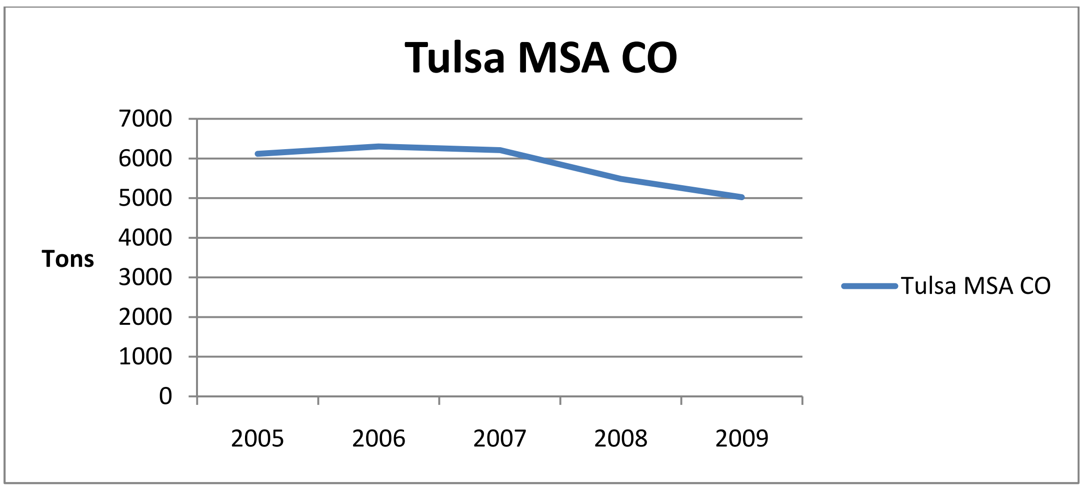



Tulsa MSA NOx
40000
35000
30000
25000
20000
15000
10000
5000
0
Tons
2005
2006
2007
2008
2009
Tulsa MSA NOx


OKC MSA SOx
350
300
250
200
150
100
50
0
Tons
2005
2006
2007
2008
2009
OKC MSA SOx


Tulsa MSA SOx
50000
40000
30000
20000
10000
0
Tons
2005
2006
2007
2008
2009
Tulsa MSA SOx





STEP TWO. Included below is a network history explaining the development of the air monitoring network over time and the motivations for network alterations, such as shifting needs or resources.

A. PM/Lead

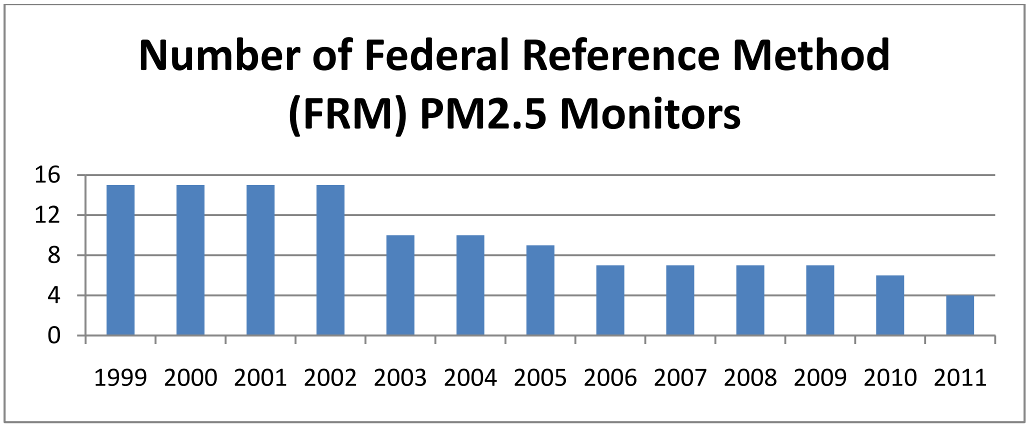
Particulate Matter (PM) monitoring began in 1958 with one Total Suspended Particulate (TSP) monitor in Oklahoma City. After the TSP and Lead NAAQS were promulgated in 1971, the network grew and samples were taken at many locations throughout Oklahoma. TSP and Lead are discussed together because when the program was initiated, both pollutants were measured by the same monitors and filter media. After the filter media was weighed for TSP, it was analyzed for lead. TSP monitoring gradually gave way to Particulate Matter <

10μm (PM_{10}) monitoring which was found to be a better indicator of health effects. Lead monitoring was discontinued as was TSP in the late 1990s after lead monitoring network requirements were relaxed nationally. The new requirements called for only one population based site per EPA region and source oriented sites for facilities emitting >5 tons/year. Before this rule was passed, several years of samples showed concentrations mostly below detectable limits. Area source lead concentrations in ambient air trended downward drastically throughout the nation following the ban on leaded gasoline in the early 1970s.

The first Oklahoma PM_{10} site was opened in Tulsa in 1962. In 1987, the TSP NAAQS was replaced by a PM_{10} NAAQS. Originally, PM_{10} samplers in Oklahoma City and Tulsa were operated by the City/County Health Departments. Responsibility for these monitors was transferred to DEQ in 1995. Overall, the state of Oklahoma has operated 23 different sites collecting these data. With the exception of one source oriented PM_{10} site near Muskogee, DEQ has never found any PM_{10} values indicating that more than the minimum number of required samplers are necessary in Oklahoma. DEQ's current network and proposed changes are described in the FY11 Annual Network Review (Attached). DEQ anticipates that the PM_{10} network will continue as proposed until the current NAAQS is vacated or its requirements are changed in the upcoming review. Should the standards be lowered, monitoring requirements increase, and funding becomes available, DEQ will increase the network size as appropriate.

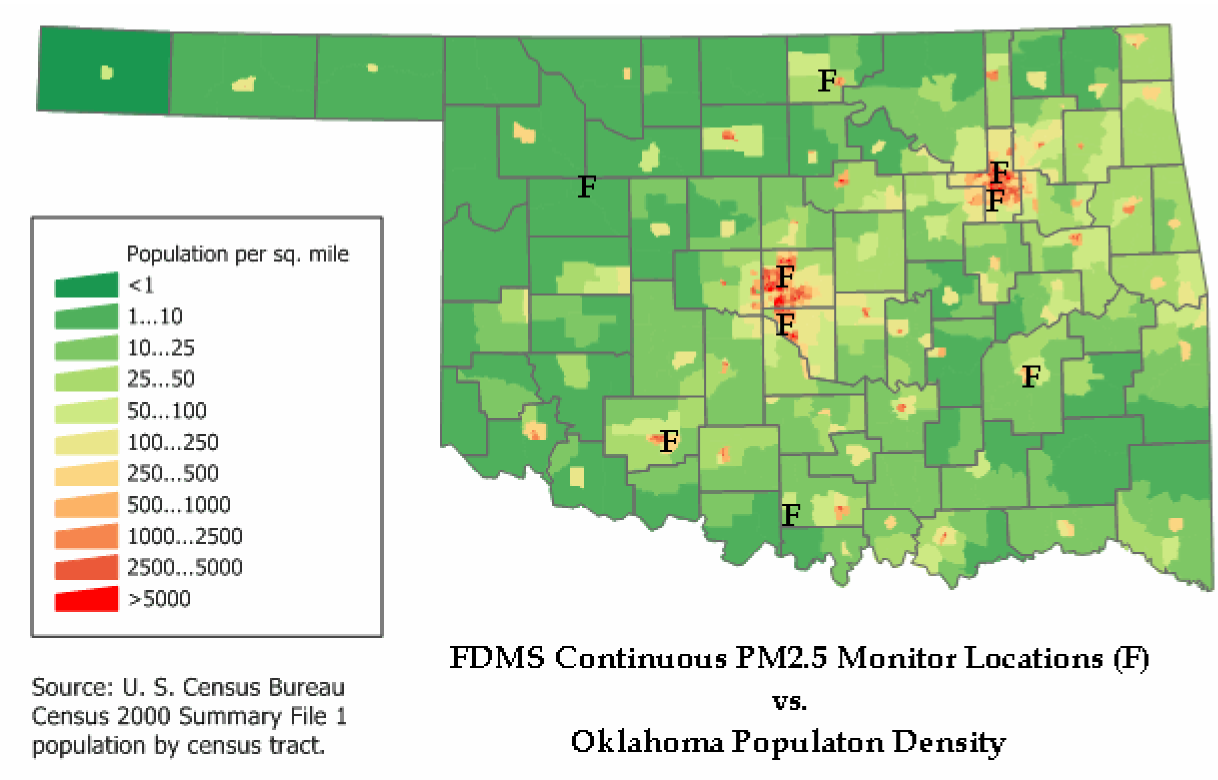
Particulate Matter < 2.5μm ($PM_{2.5}$) monitoring began with the promulgation of the $PM_{2.5}$ NAAQS in 1996. DEQ was tasked by EPA with installing 20 sites for the initial $PM_{2.5}$ network that started sampling in 1997. After several years of data collection, it was apparent that Oklahoma fell well below the NAAQS and DEQ proceeded with network reductions. As with PM_{10}, the agency has not found any data suggesting that more than the minimum number of samplers required by EPA is needed in Oklahoma. DEQ's current network and proposed changes are described in the DEQ FY11 Annual Network Review. The following graph indicates the trend of $PM_{2.5}$ network reductions over the last 12 years.

Trend of $PM_{2.5}$ Network Reductions in Oklahoma



DEQ also operates a network of $PM_{2.5}$ monitors that continuously measure the pollutant as described in the DEQ FY11 Annual Network Review. DEQ uses the TEI (formerly R&P) TEOM/FDMS monitors. This network supports the agency's daily Air Quality Index reporting and Health Advisory program for protecting public health. These monitors have recently been designated by the EPA as a (FRM) Federal Equivalent Method for $PM_{2.5}$ monitoring in their standard configuration. Because of high temperature and humidity issues during the Oklahoma summertime, DEQ has found that these monitors must be operated in a non-FEM configuration. As such, the agency is not satisfied with the correlation between FDMS and FRM data to the point of using it for NAAQS comparison. The map below indicates the location of continuous $PM_{2.5}$ monitors in relation to population density.

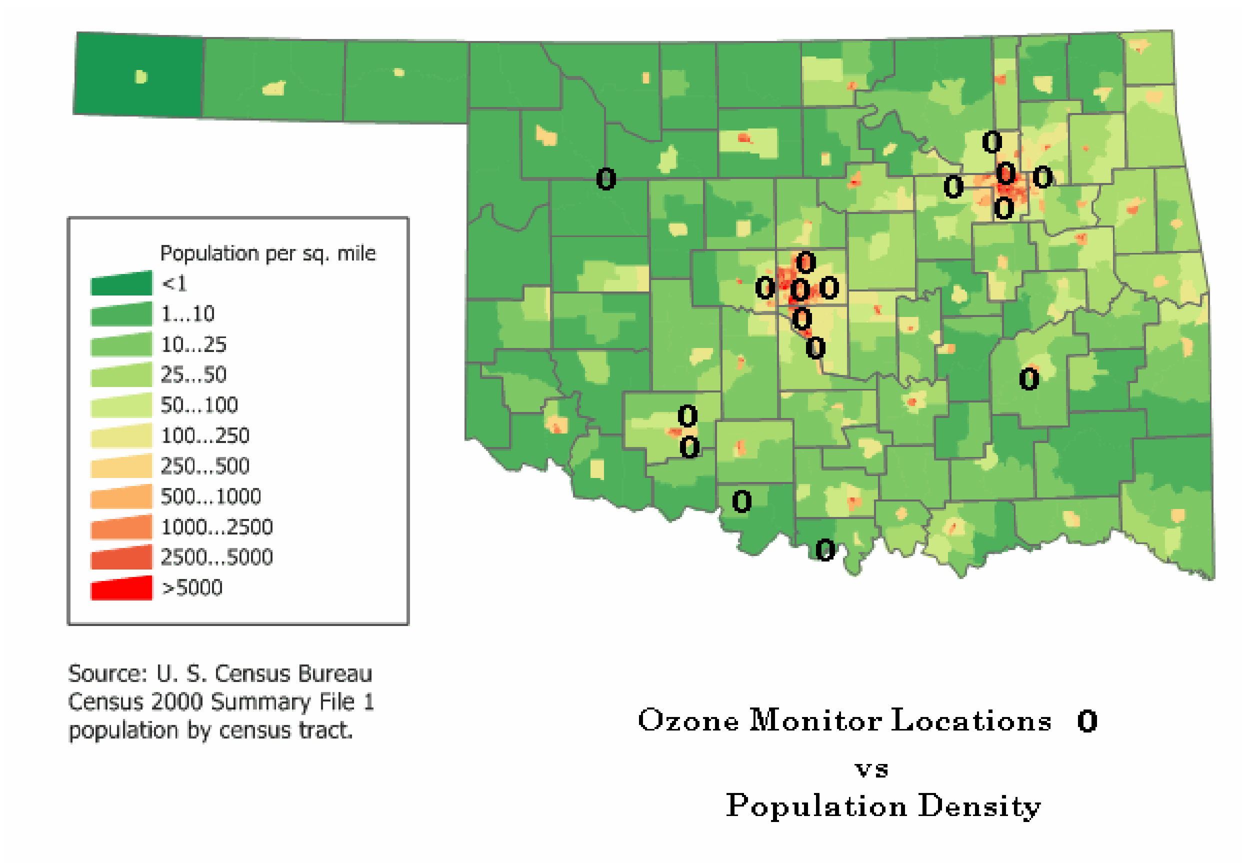
$PM_{2.5}$ Monitor Locations and Population Density in Oklahoma



Until the current FDMS $PM_{2.5}$ continuous instrument technology advances to the point that DEQ is comfortable with the quality of data produced, the agency will postpone the purchase of additional instruments. If the technology becomes available to produce FRM quality data, it should be incorporated into the network to produce data for NAAQS comparison. In the mean time, FDMS data will only be used in the Health Advisory program. DEQ is currently attempting the purchase of a newer continuous PM2.5 technology for evaluation in the near future.

B. Ozone

Ozone Monitor Locations and Population Density in Oklahoma



The Oklahoma ozone monitoring network began operating with only seven sites in the early 1970s. Many of the original sites are still in operation and are situated upwind and downwind of the prevailing wind direction of the two major metropolitan areas, Oklahoma City and Tulsa. The prevailing winds in both locations are from the south southeast. Sites in Edmond and Skiatook are located in ideal positions to sense the maximum downwind ozone concentrations from Oklahoma City and Tulsa, while sites in Moore and Glenpool are located upwind of the prevailing wind direction and serve as background monitors for those cities on most days. The Oklahoma State Department of Health site (AQS #40-109-0033) and Central Tulsa Site (AQS #40-143-1127) are located in the downtown areas of OKC and Tulsa respectively. These sites are population oriented and are in areas that could be considered environmental justice sites.

The ozone monitoring network currently consists of seventeen sites. Eleven of those sites are situated in and around the two major metropolitan areas of the state, Oklahoma City and Tulsa. The original network of seven sites was expanded as a result of the EMPACT grant from EPA in 2002 and 2003. Four additional monitors were sited to the west and east of the Oklahoma City and Tulsa downtown areas. Oklahoma City has an additional, background site to the south near the town of Goldsby.

Lawton, the third largest populated area of the state, has two ozone monitors. McAlester, located in southeast Oklahoma, and Seiling, located in the northwest, each have an ozone monitoring site. The remaining two sites, situated just north of the Red River near Burneyville and Waurika, are considered special purpose monitors. These monitors will alternate locations every other year with sites near Healdton and Walters. All of the sites are used primarily to supply real-time data to EPA's AIRNOW ozone mapping program, DEQ's Health Advisory Program and to determine background and transport pollutant concentrations. The sites in Seiling and McAlester were chosen to fill large geographical gaps between monitors in certain parts of the state and to determine rural background pollutants.

In terms of the number of monitors per population, Oklahoma has one of the more dense networks in the region. The chart below evaluates number of monitors per population and per square mile for area states.

State Monitor Network Comparisons

Evaluation of Ozone monitors per State*

State	Number of Ozone Monitors	Population	People per Ozone Monitor	Size (square miles)	Square Miles per Ozone Monitor
Arkansas	7	2,855,390	407,913	53,182	7597.42
Kansas	9	2,802,134	311,348	82,282	9142.44
Louisiana	26	4,410,796	169,646	51,843	1993.96
Missouri	20	5,911,605	295,580	69,709	3485.45
New Mexico	26	1,984,356	76,321	121,593	4676.65
Oklahoma	17	3,642,361	214,257	69,903	4111.94
Texas	62	24,326,974	392,371	268,601	4332.27

*All values in the above table are based on 2008 data.

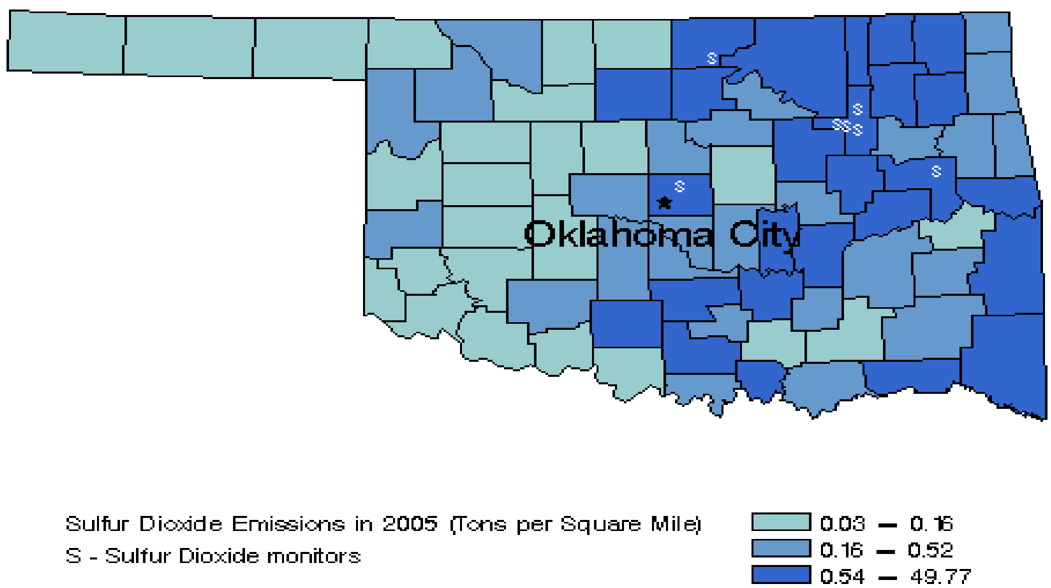
DEQ is satisfied that the existing ozone network is more than adequate to protect the citizens of Oklahoma, meet agency program objectives, and satisfy federal air quality requirements. Based on the current proposed NAAQS rule DEQ would only need to make minor network adjustments in the coming years. Changes would likely only be necessary for those Micropolitan Statistical areas that might increase in population to over 50,000 people.

For data collected from the monitoring sites near the Red River, DEQ believes that resources used to maintain these sites is well spent and will be continued.

C. Sulfur Dioxide (SO_2)

The sulfur dioxide monitoring network was originally developed using a source specific strategy, sites located near a SO_2 source, and then expanded to include sites correlated with population exposure. Currently two monitors are source specific, one monitor is population based, and four monitors are a combination of both. The SO_2 monitor in Oklahoma City at the Oklahoma Christian University site (AQS #40-109-1037) is population based and is retained to assist with determination of background, or baseline, levels for the Prevention of Significant Deterioration (PSD) program. The monitors in Ponca City (AQS# 40-071-0602) and Muskogee (AQS# 40-101-0167) are source based and the four monitors in Tulsa are both source and population based and include NCore.

Sulfur Dioxide Emissions in Oklahoma by County



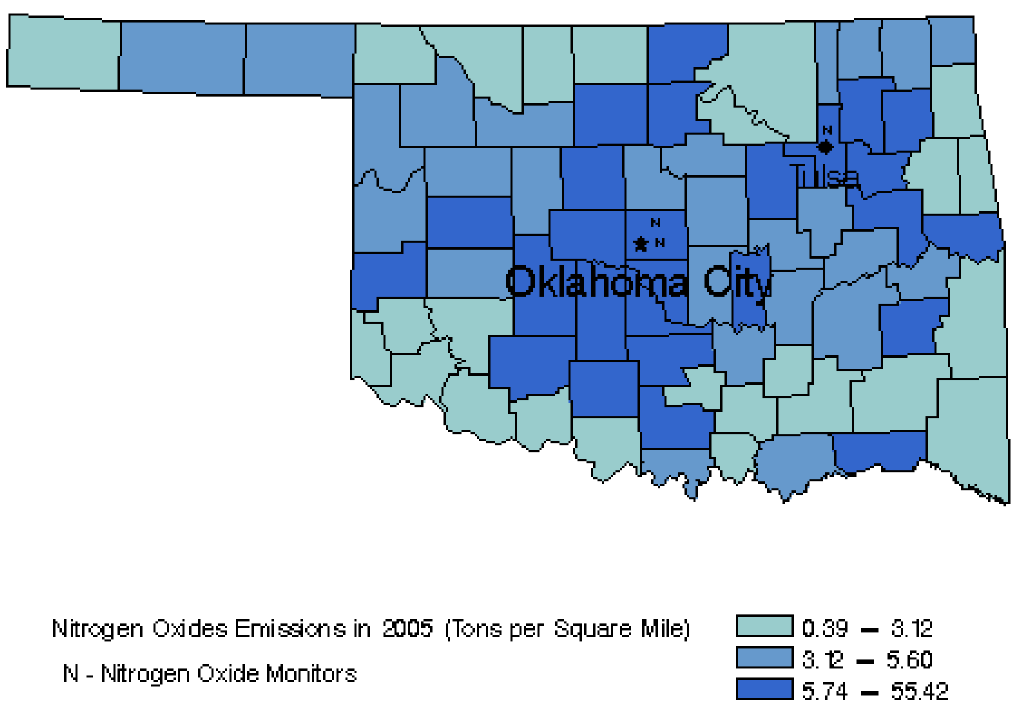
D. Nitrogen Dioxide (NO_2)

The nitrogen dioxide monitoring network was set up to collect data for NAAQS comparison under the old Part 58 monitoring regulations and may also be valuable as a supplement to the ozone network. Data from the NO_2 monitoring has also been useful for determination of background concentrations in the PSD program. At its peak in the mid 70s, the NO_2 network consisted of over 20 sites. Over the years that network has been reduced dramatically. Only three NO_2 sites currently comprise the entire network. Most of the deleted sites were removed because they measured low values in terms of concentrations compared to the annual NAAQS. Readings of annual means rarely exceeded 0.008 parts per million.

Two of the remaining NO_2 sites are located in Oklahoma City at the Oklahoma State Department of Health site (AQS# 40-109-0033) and the Oklahoma Christian University site (AQS# 40-109-1037). One is located in Tulsa at the NCore site

(AQS# 40-143-1127). Because annual mean concentrations collected from all sites were low when compared to the 0.053 annual mean standard, the network was reduced to a required minimum. The reduction freed up resources for new programs such as $PM_{2.5}$ and the expanding ozone network. These adjustments, were in accordance with EPA's Ambient Air monitoring strategy that was published in 2002. Although the current network is adequate under the new hourly NO_2 standard of 100 parts per billion for population requirements, the agency will address new requirements to monitor for NO_2 near roads by adding sites in Tulsa and Oklahoma City. DEQ plans to coordinate with EPA Region 6 to conduct passive monitoring in hopes of locating the best possible roadside sites in each MSA. The agency does not anticipate expansion of the population portion of the network. See map below for map of current network versus NOx emissions.

Nitrogen Oxides Emissions in Oklahoma by County



E. Carbon Monoxide

The carbon monoxide monitoring network was originally designed as a population exposure based effort. Oklahoma achieved attainment for the NAAQS for carbon monoxide in the late 1980s. Attainment was reached only after automobile controls were improved by the manufacturers and older, more polluting models of fleet vehicles were removed from service. The state had more carbon monoxide monitors that were situated using microscale site location criteria, i.e. close to neighborhoods and busy automobile traffic areas. Only one site from the older network measured non-attainment conditions. The nonattainment site was located near a dangerous, high traffic intersection at NW 10th and Pennsylvania in Oklahoma City. This monitor was destroyed when it was accidently hit by a runaway, unmanned garbage truck. It was then relocated to a different microscale site due to concern for the safety of operators. While this site was in attainment at the time of the move, it collected the highest CO concentrations in the state.

The state currently has three sites, one in Oklahoma City (AQS# 40-109-0033) and two in Tulsa (AQS# 40-143-1127 and AQS# 40-143-0191). The monitors are used for NAAQS comparison. Since microscale siting requirements were eliminated in 2006 with changes in the CO monitoring rule, reductions in the CO network resulted in the current configuration of these three sites.

STEP THREE. Included below is a simple analysis of potential redundancies and determination of the adequacy of existing monitoring sites/networks.

A. $PM_{2.5}$

The NAAQS-comparable $PM_{2.5}$ monitoring sites as described in DEQ's FY11 Annual Network Review are adequate for Oklahoma at this time. The network consists of 2 monitoring sites each in Oklahoma City & Tulsa, and a background site in McAlester. DEQ is well below the annual standard of 15 $\mu g/m^3$ and the daily standard of 35 $\mu g/m^3$ at all sites.

The highest $PM_{2.5}$ values are registered at the Tulsa NCore site (AQS #40-143-1127). For the years 2007 through 2009, the annual average was 11.41 $\mu g/m^3$ and the average ninety-eighth percentile daily MAX was 26 $\mu g/m^3$. The annual arithmetic mean has shown a significant decreasing trend over this three year period, from 12.17, to 11.40 and to 10.67.

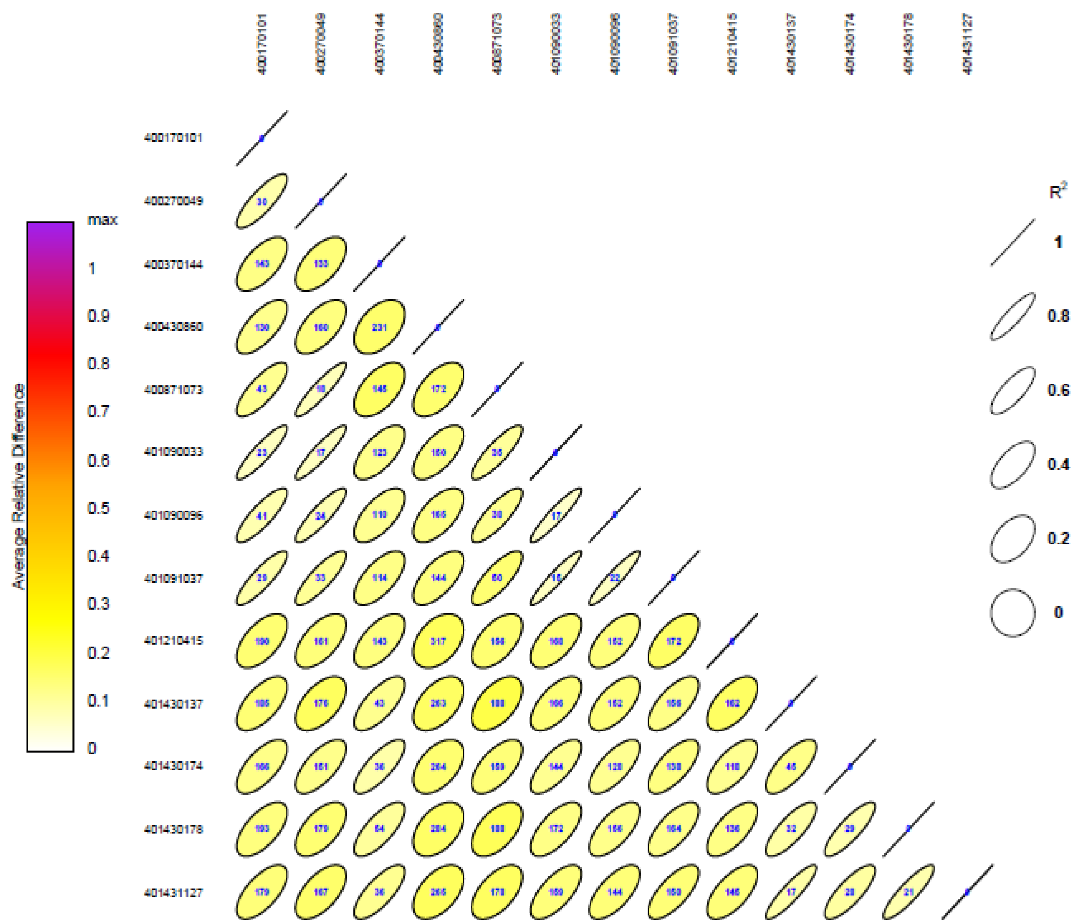
Using EPA provided tools, DEQ attempted to analyze network redundancy. The tools were not used in this assessment because the Oklahoma network is too small and the data is not complete at one site. A look at the spatial distribution of $PM_{2.5}$ sites, however, implies the network has no redundancies.

If EPA lowers the standard after the next EPA Particulate standards review, Oklahoma anticipates an increase in the $PM_{2.5}$ network requirements. DEQ will make the necessary network adjustments if a lowering occurs and the requisite funding becomes available.

B. Ozone (O_3)

The six ozone monitoring sites in and around Oklahoma City and five ozone monitoring sites in and around Tulsa are positioned in an effort to detect any high ozone concentrations in highly populated areas. While some sites may be redundant on days when the ozone concentrations are low, the agency takes into account how sites differ on high ozone days. The chart below shows the possible redundancies between DEQ permanent ozone monitoring sites. While some of the sites in the Oklahoma City area and some of the sites in the Tulsa area have values of 0.08 parts per million or greater, the days that show the four highest concentrations are never the same. Current site configuration has been very beneficial and necessary for supplementing EPA's ozone mapping program and gives DEQ the ability to alert the public of harmful concentrations in near-real time on high ozone days using the Air Quality Health Advisories.

Possible Redundancies at Ozone Monitoring Sites



Numbers in Ellipses Represent Distance Between Sites in km

The other ozone monitoring sites within the state are located far enough apart to improve our ability to track ozone with little if any signs of redundancy. The only possible exception would be the Lawton North, Lawton South and Walters sites. Lawton North and Lawton South are located less than 10 miles from each other. The Lawton South site and the Walters site are located 12.5 miles apart. The data recorded during 2007 and 2008 indicated very little difference in ozone levels between the two sites on high and low ozone days. During 2008, the highest three ozone readings from both sites occurred on the same days. Walters had higher concentrations of ozone but by only 2 and 3 parts per billion on those days. The fourth highest concentrations measured were on different days but were only different by 2 parts per billion. In 2007, for both sites, all four of the highest concentration days occurred on the same dates. Walters was the higher of the two on all occasions but by no more than 2 parts per billion. DEQ believes that the existing Walters site can better serve as a Special Purpose Monitor along the Red River to determine ozone concentrations in the area between DFW and Lawton. In the next few years, Walters will then alternate with the Lake Waurika site in gathering ozone data while Lawton South should be discontinued.

C. Sulfur Dioxide (SO_2)

The agency has extensive coverage in Tulsa with four monitors in the metropolitan statistical area. Two of the monitors were placed in relation to two oil refineries near the downtown area and a third monitor is at the NCore site. In response to complaints, an additional monitor was placed near the downtown refinery area. With co-located hydrogen sulfide (H_2S) monitors in place, two of the sites serve multiple purposes. One of the SO_2 monitors could be removed without compromising the integrity of the network, but occasional episodes can affect one site while not affecting either of the other two sites. The H_2S sites will likely remain to determine compliance with the Oklahoma H_2S standard. While there may be some redundancy in the Tulsa SO_2 network, DEQ is hesitant to remove any of the monitors in this area because they serve a densely populated, environmental justice area and provide an enforcement tool to monitor the sources located there.

The SO_2 site in Oklahoma City is not source oriented but is maintained for modeling, trends analysis, and PSD background determination. There is no possibility of redundancy in the Oklahoma City MSA because there is only one monitor.

The Ponca City site is nearby large SO_2 sources and will be retained to meet the needs of changing emission trends for those sources. While hourly values at this site have not yet approached the new standard in the last 10 years of data collection, this area has the potential to reach that threshold. The exact location of the current site (AQS #40-071-0602) has been compromised by large trees that affecting the siting criteria. DEQ will evaluate a potential new site location that meet siting criteria and better capture concentrations for the SO_2 emissions in that area.

An additional source oriented SO_2 monitor is located north of a large electric generating facility on the East side of Muskogee. This site has been operational for over 20 years and is monitoring one of the state's largest SO_2 sources.

DEQ works to provide good network coverage, with little redundancy, to meet population and source oriented requirements under the new standard. The agency will likely continue the network as it is for the next few years.

D. Nitrogen dioxide (NO_2)

The Oklahoma City metropolitan statistical area has two NO_2 monitoring sites and it is not likely that one could be eliminated. The Oklahoma Christian University site (AQS #40-109-1037) is located on the North side of Oklahoma City. The Oklahoma State Dept. of Health Building (AQS site #40-109-0033) is located in the city center. The agency would not consider these sites to be redundant as the Oklahoma Christian site measures urban scale concentrations and the Health Department site measures more local scale concentrations near the I-40, I-235 and I-35 interstate systems. DEQ may however, consider relocating the Department of Health site in coming years, possibly even relocating it to make it one of the near road NO_2 sites.

Tulsa has the only other NO_2 monitor in the state, located at the Tulsa NCore site. It will remain as it is a required monitor.

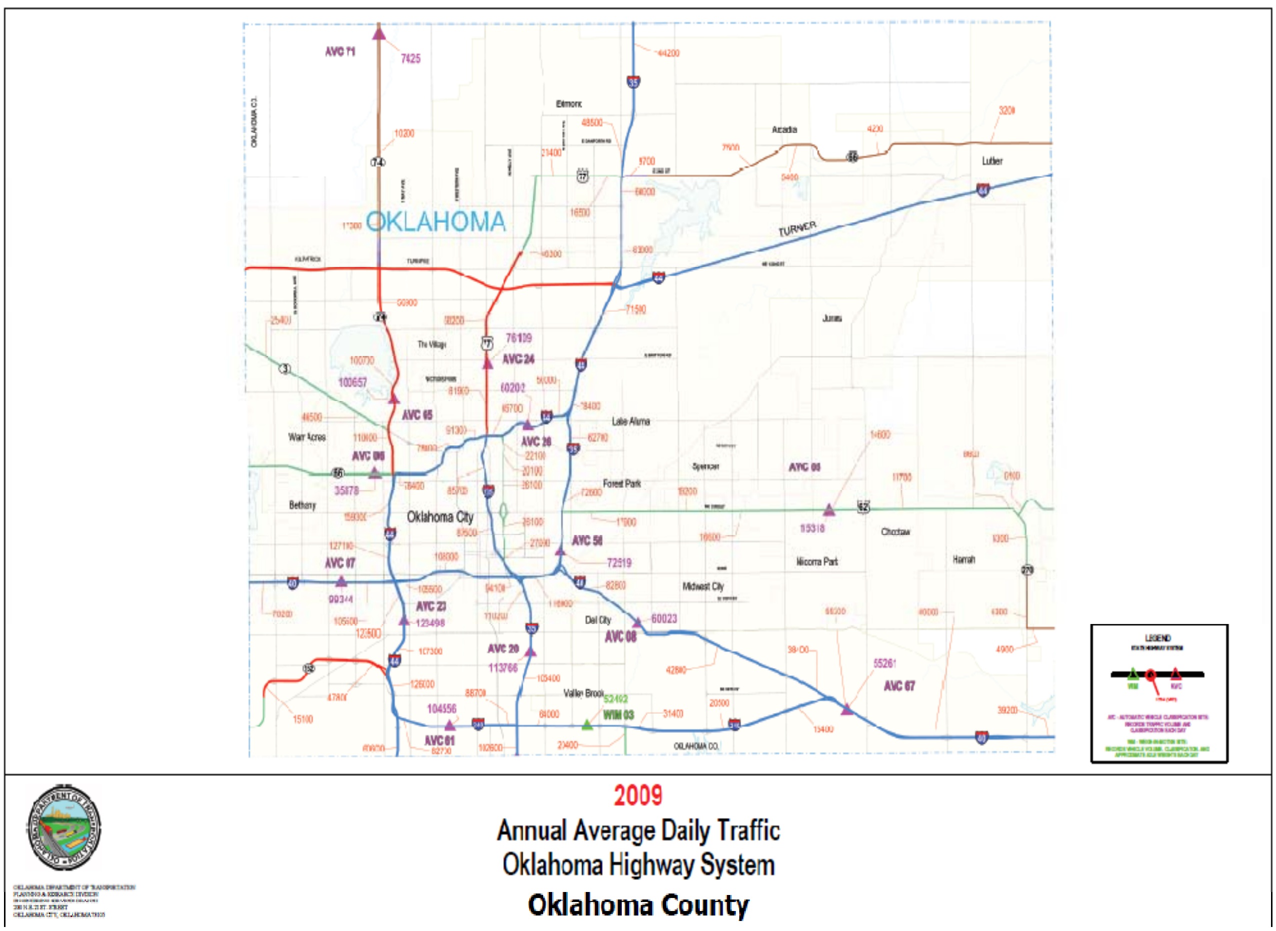
Near-roadway NO_2 monitoring will be required in the Oklahoma City and Tulsa areas along the busiest roadways as both MSAs exceed the required 500,000 population monitoring threshold. Neither MSA exceeds 2.5 million people or has traffic counts exceeding 250,000 Average Daily Traffic, thus, DEQ will only be required to add one monitor per city.

In Oklahoma City, possible site locations for a near roadway monitor are along I-44 between SW 59 and NW 36. In Tulsa, possible site locations are along the US-169 between I-44 and the Broken Arrow Expressway. Between late 2011 and late 2012, DEQ has plans to participate in a NO_2 passive monitoring study assisted by EPA Region 6 to help evaluate potential near road site locations as high impact areas.

If ample resources become available in the future, DEQ might consider adding additional neighborhood scale sites in the Oklahoma City and Tulsa areas. In the past three to four years the agency has collected maximum hourly values in the 60 plus ppb range using the current network. ODEQ could identify areas with concentrations close to the standard by conducting additional surveys through passive monitoring.

Traffic count maps for Oklahoma's two largest MSAs are provided below and will be used to determine the most applicable near road site locations.

Traffic Count Maps for Oklahoma and Tulsa Counties



2009

Annual Average Daily Traffic
Oklahoma Highway System
Tulsa County

E. Carbon Monoxide (CO)

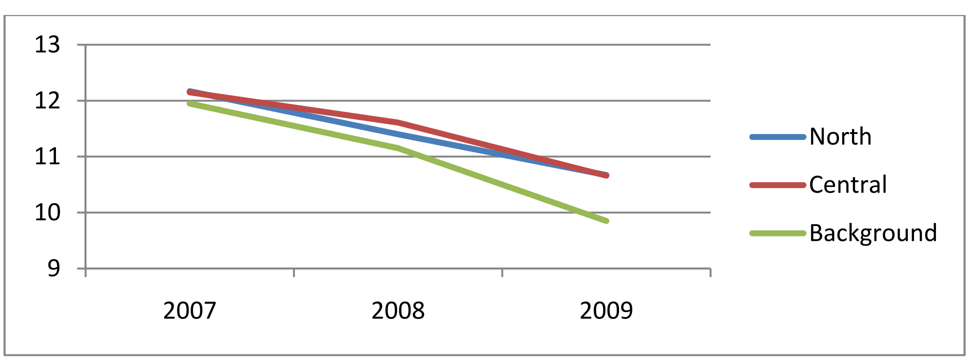
The Oklahoma CO network currently consists of three sites, two in Tulsa and one in Oklahoma City. The Tulsa sites have not registered significant 8 hour CO concentrations in years. While it is difficult to determine the redundancy of these sites because of the low values, the DEQ recommends the removal of the Tulsa site (AQS #40-143-0191) in the most recent Annual Network Review. The review is currently pending approval from EPA Region 6. The agency is aware of the scheduled review of the CO NAAQS and will address any network expansion following finalization of the rule. We do not anticipate changes in the network until that time.

STEP IV. Included below is a situational analysis of the network.

A. $PM_{2.5}$

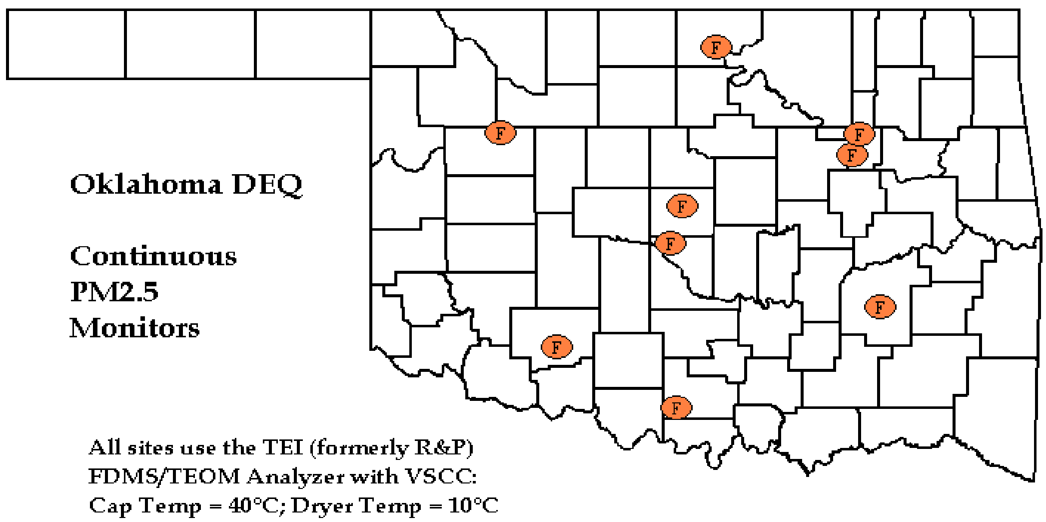
In both Oklahoma City and Tulsa one of the $PM_{2.5}$ monitors is located near the city center and the other at some distance to the north. In terms of the state's annual mean concentration, the DEQ background monitor in McAlester measures only slightly less $PM_{2.5}$ than the Tulsa monitors and slightly more than the Oklahoma City monitors. This indicates that most of the $PM_{2.5}$ measured is coming from regional or even national sources and not locally generated. The graph below, however, implies that there may be some local contribution of $PM_{2.5}$.

Comparison of Tulsa (North & Central sites) & McAlester (Background site)



DEQ's continuous $PM_{2.5}$ network is spread out across the state, as shown on the map below, and allows DEQ to issue real-time health advisories with reasonable confidence. These monitors have been particularly useful during wildfire season.

Map of Continuous $PM_{2.5}$ Monitors in Oklahoma



DEQ has two monitors in the largest metropolitan areas of Oklahoma City and Tulsa, and one in the next largest city, Lawton. The remaining four sites are in small cities of less than 50,000 people. Concentrations from monitors in the smaller cities are representative of concentrations found in nearby counties. All sites are designated as neighborhood scale or larger and are population oriented to monitor public health. The McAlester site is considered regional scale and also measures background and transport.

As indicated in the first part of this document, general air flow enters the state from the South and Southeast. Given the regional nature of $PM_{2.5}$, decreasing $PM_{2.5}$ concentrations as we evaluate data moving from the Eastern sites to the Western sites is expected. Highest pollution concentrations enter into the state from the Midwest and southern regions of the country where a significant number of old electric generating units are still operating. This also explains higher SO_2 contributions that are seen in the speciation data from our National

Trends monitoring site located in Tulsa when compared to SO_2 contributions from the IMPROVE Protocol site located in Arnett.

If resources stay the same, ODEQ plans to maintain all western Oklahoma sites to support the Health Advisory program. Although annual mean concentrations in this area are not of serious concern in terms of meeting the current standard, DEQ will continue to monitor the sometimes extensive, short term episodes of agricultural burning in the region. These episodes can be the result of controlled and intentional burns or due to extremely dry climate conditions. The agency places importance on maintaining the current network coverage of continuous $PM_{2.5}$ monitors for this reason.

B. Ozone

The expansion of the ozone monitoring network in 2002 and 2003 through funding from EPSCORE and EMPACT grants greatly improved the ozone mapping capabilities of the network. The monitors added in sites in Yukon, Choctaw, Lynn Lane and Mannford, which are strategically situated to the east and west of the Oklahoma City and Tulsa downtown areas. The new monitor placement combined with the existing north/south oriented monitors gives each metro area monitors for each of the four compass points approximately ten to fifteen miles from the center of downtown, plus one near downtown. This siting design increases the chances of sensing high ozone concentrations regardless of wind direction, or stagnation events. The small communities that surround both Tulsa and Oklahoma City in all directions benefit greatly from these monitor locations.

The monitoring sites near the Red River are designated as Special Purpose Monitors (SPM). In recent years these monitors have been moved every two years, but ODEQ will consider moving them every other year. The data collected has been very useful in determining ozone transport and enhancing ozone mapping. Transport of ozone and ozone precursors from the Dallas/Ft Worth metro occurs frequently in the area served by these monitors. Though sparsely populated, the people of southern Oklahoma have benefitted from the data collected by these monitors. Near-real time notifications of high ozone events are available to these residents by subscription to the DEQ Health Advisory Program.

STEP V. Below is a summary list of suggested changes to monitoring network.

Listed below are the changes expected within the next 18 months through the suggestions of the Annual Network Review. This document and this section will look at the two to five year time frame.

A. Fine Particulate ($PM_{2.5}$)

DEQ would like to replace the $PM_{2.5}$ manual FRM monitors in Oklahoma City, Tulsa, and McAlester with $PM_{2.5}$ FRM continuous methods. This is not possible, however, since DEQ has not found a unit capable of operating reliably in Oklahoma's climate. The problem is not that the data doesn't correlate but that the monitors breakdown frequently (primarily FDMS units of the R&P TEOMs) due to high humidity and it becomes difficult to meet the data completeness requirements. The new equipment also carries a lengthy turn-around time on factory repairs, often more than a month, and the DEQ cannot afford to acquire and keep an adequate supply of spare monitors.

The DEQ will evaluate a new unit from Thermo-Fisher, the SHARP 5030, which could replace the FRM and TEOM/FDMS units at the five monitored sites. The agency also plans to study the Kimono monitor from Tisch Environmental and others. DEQ's goal is to acquire FRM/FEM approved continuous monitors that serve the dual purpose of collecting NAAQS-comparable data and supporting the Air Quality Health Advisory program.

Another significant reason to move away from the TEOM/FDMS is that the technology is becoming obsolete and requires significant resources to remain operational, including the time and travel necessary for operation. DEQ is looking for replacement monitors which will be easier to maintain, need fewer repairs, and require fewer site visits while sustaining the current quality of data.

The long term goal, in the next two to five years, is to identify and purchase instrumentation that will fulfill multiple network needs. The DEQ is researching all options at this time.

B. Particulate Matter <10µg/m³ (PM_{10})

The goal for the PM_{10} network is to simplify operation by gradually replacing existing manual samplers with sequential manual samplers that will reduce travel expense significantly. The sequential samplers will allow the quality of data to be maintained and efficiency to be increased.

Sequential samplers taken from the reduced $PM_{2.5}$ network can be used in the PM_{10} network by simply removing the sharp cut cyclone. DEQ maintains a number of decommissioned low-volume sequential samplers that could eventually replace all of the current high-volume samplers in the network with very little additional increase in budget.

The agency does not plan to expand the monitoring network in the next few years; at least until after new rules are promulgated as a result of the upcoming NAAQS review. DEQ will re-evaluate its network at that time.

C. Particulate Matter Coarse Fraction ($PM_{10-2.5}$)

DEQ has no plans to install any additional PM Coarse sampling platforms beyond NCore requirements. As analysis methods are enhanced and guidance becomes available, the agency may implement speciated analysis of these filters. DEQ hopes additional national guidance and funding will become available for this program in the coming years.

D. Ozone (O_3)

For the near term, DEQ suggested changes to the O_3 monitoring network include discontinuance of the Lawton South site and designating the Walters site as SPM, as previously discussed. Regarding the upcoming five year term, DEQ is aware of the proposed new rule to monitor in cities with a population of 50,000 or greater. While Oklahoma has no cities that currently fall into this category, six cities, Enid, Stillwater, Bartlesville, Muskogee, Shawnee and Ardmore, are close to the 50,000 population monitoring threshold. The populations of these cities will be reviewed annually and ozone monitoring would commence in areas meeting the threshold if rule is finalized as proposed.

The Special Purpose monitors located near the Red River will likely continue operation for several years, alternating locations annually. DEQ does not anticipate major alterations in the network during the next five year period.

E. Sulfur Dioxide (SO_2)

The most recent sulfur dioxide rule change requires SO_2 to be monitored at each NCore site and at sources which meet the PWI (Population Weighted Index) values. The regulations will, however, allow closure of one of the three remaining Tulsa MSA sites. Emissions from local SO_2 sources and a history of complaints from residents in the West Tulsa/refinery area of the city warrant that the Tulsa sites remain operational for the foreseeable future.

DEQ will evaluate the changing emissions pattern for the Ponca City area in order to determine a better location for the existing monitor (AQS #40-071-0602). A move will likely occur in the next two to three years. The remaining sites in the network will see no additional changes within the next three years. The current SO_2 network meets all requirements of the newest monitoring rule for SO_2 while filling DEQ's own specific needs. The portion of the monitoring network in West Tulsa also provides excellent monitoring coverage in a significant environmental justice area.

F. Nitrogen Dioxide (NO_2)

As previously mentioned, the Oklahoma State Health Building site (AQS #40-109-0033) would be a possible monitoring location to eliminate or relocate. This would leave the multi-pollutant site at Oklahoma Christian (AQS #40-109-1037) as the lone NO_2 monitor in the Oklahoma City MSA. The Oklahoma Christian site alone would meet the minimum population-based portion of the monitoring requirement. The roadside monitoring portion of the new rule will necessitate the relocation/installation of one roadside site each in the Oklahoma City and Tulsa MSAs by January 1, 2013. DEQ is evaluating potential monitoring sites that meet roadside siting requirements, and the agency plans to have the monitors operational by the stated deadline. Installation of the newly required sites will also be subject to the availability of adequate new funding. One of these required sites could possibly be a re-location of an existing site (likely the State Health Building AQS #40-109-0033) to the proposed area.

DEQ does not anticipate any significant expansion of the NO_2 network, in the next five year period, beyond newly implemented minimum requirements unless or until addition grant funding is provided from the federal level.

G. Carbon Monoxide (CO)

In the time frame of this assessment, no changes to the network are expected. The DEQ will attempt to maintain adequate backup instrumentation for the current network while focusing on maintenance and operation of the trace gas CO instrument at the Tulsa NCore site. Under the current standard DEQ has not seen any data concentrations of concern. The agency expects the network to remain static until a new standard with new monitoring requirements is implemented.

H. Lead (Pb)

The most recent revision of the lead rule required the installation of lead monitoring sites on sources that emit more than one ton per year. That rule initiated the installation of DEQ's first and only required source oriented site in years, located adjacent to the US Army Ammunition Plant near Savanna, Oklahoma. The site was chosen after considering dispersion modeling results, population exposure points and potential site locations. Lead monitoring began at the site in January 2010.

As a result of the recently finalized revised lead rule, DEQ will evaluate potential new sites. Specifically, the agency is making room for the required NCore population sampler at the NCore platform in North Tulsa. Rather than use the required, existing PM_{10} sampler for coarse PM, this site and all others will be located using standard high-volume sampler technology. Filters will be analyzed, as they are currently for the Savannah site, by a private lab using Federal Reference or Equivalent analysis methods.

For the immediate future, DEQ is not planning to use the EPA National contract available for lead analysis. The agency will evaluate data from the NCore site and other source sites in the coming years before determining whether the network should be expanded beyond minimum requirements. ODEQ does, however, intend to add the required NCore and source sites by the required time frame.

I. Toxics

The toxics network was first implemented in 2003 and 2004 with one Ponca City site that was funded as a pilot project by EPA. This site was a short term project and is no longer operational.

The network grew slowly over the next few years to its current form with two sites in Oklahoma City, two sites in Tulsa, and one site in Pryor. These sites are a combination of source and population oriented in purpose. All sites currently sample for volatile organic compounds (VOCs), carbonyls, and metals, and have been funded exclusively using state appropriations. Recently, these appropriations were cut by 80 percent. Funding for the toxics program is expected to remain static or may cease altogether. While DEQ is pursuing a fee increase that could help maintain the network, expansion in the next few years is unlikely.

Summary

This network assessment represents the DEQ's vision for the next five years to the extent that adequate funding mechanisms remain in place. The agency has made every effort to implement the network to meet state goals first, while also considering EPA's long term ambient air monitoring strategy, rolled out in 2005. With numerous recent and projected changes in the NAAQS, vast technological changes in air sampling instrumentation, and static resources, air quality staff and management continue to face challenges to operate adequate networks. DEQ continues to make a commitment to do the best job possible to protect citizens by collecting the best quality of data possible through continual network evaluation and re-structuring. DEQ also makes a commitment to work with agency counterparts on the federal level to meet all of our shared challenges.