Colorado

2008 Air Quality Data Report

Colorado Department of Public Health and Environment

Air Pollution Control Division

Cover photo

View of Mount Evans, from Highway 119 north of Black Hawk and Central City.

COLORADO
AIR QUALITY
DATA REPORT

2008

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of Public Health
and Environment

Air Pollution Control Division
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1.0 Purpose of the Annual Data Report

The Colorado Department of Public Health and Environment, Air Pollution Control Division (APCD) publishes the Colorado Air Quality Data Report as a companion document to the Colorado Air Quality Control Commission Report to the Public. The Air Quality Data Report addresses changes in ambient air quality measured by Division monitors. The Report to the Public discusses the policies and programs designed to improve and protect Colorado's air quality.

1.1 Symbols and Abbreviations

The following symbols and abbreviations have been used throughout this report:

- APCD – Air Pollution Control Division
- CDPH&E – Colorado Department of Public Health and Environment
- CO – Carbon monoxide
- EPA – U.S. Environmental Protection Agency
- Met – meteorological measurements, wind speed, wind direction, temperature, relative humidity and standard deviation of horizontal wind direction
- NAAQS – National Ambient Air Quality Standard
- NO – Nitric oxide
- NO_2 – Nitrogen dioxide
- NO_X – Oxides of Nitrogen
- O_3 – Ozone
- PM_{10} – Particulate matter less than 10 microns in aerometric diameter
- $PM_{2.5}$ – Particulate matter less than 2.5 microns in aerometric diameter
- Pb – Lead
- ppm – parts per million – used with gaseous pollutants
- SO_2 – Sulfur dioxide
- SO_X – Sulfur oxides
- TSP – Total suspended particulates
- $\mu g/m^3$ – micrograms per cubic meter – used with particulate pollutants

1.2 Description of Monitoring Areas in Colorado

The state has been divided into five multi-county areas that are generally based on topography. The areas are: Eastern Plains; Northern Front Range; Southern Front Range; Mountain and Western Counties. These divisions are a somewhat arbitrary grouping of monitoring sites with similar characteristics.

The Eastern Plains consist of those counties east of the I-25 corridor to the Eastern border of Colorado from the Northern to the Southern border. These counties are generally rolling agricultural plains below the elevation of 6000 feet.

The Front Range counties are generally those along the I-25 corridor from the Northern border to the Southern Border. They are split into north and south areas with the Palmer Ridge being the dividing line. While the northern counties all have a direct association with I-25, that association is not as well defined in the southern counties. Teller, Fremont, Custer, Alamosa and Costilla counties are included with the Southern Front Range Counties because they have more in common with that group than they do with the Mountain Counties.

The Mountain Counties are generally those counties along the Continental Divide. The Western Counties are the ones adjacent to the Utah border. Other divisions can and have been made, but these five divisions seemed appropriate for this report. Figure 1 shows the boundaries of these areas.

1.2.1 Eastern Plains Counties

The Air Pollution Control Division has only monitored for particulates and meteorology in the Eastern Plains Counties. (The Eastern Plains Counties do not have the pollution sources that can generate health-impacting concentrations of the criteria pollutants with the exception of particulates.)

The Division has monitored for particulates in the communities along I-76, I-70 and along US Highway 50. However, the only monitors currently in operation are in Lamar. The other monitors were discontinued after a review of the data showed that levels of particulates were well below the standard and were declining.

1.2.2 Northern Front Range Counties

The Northern Front Range Counties are those along the urbanized I-25 corridor from the Colorado/Wyoming border to just south of the city of Castle Rock. This area has the majority of the population in the state. It also contains the majority of the monitors, with the Denver-metro area being the most heavily monitored. Other monitors are located in or near Fort Collins, Greeley, Longmont, Platteville and Boulder.

1.2.3 Southern Front Range Counties

The Southern Front Range Counties are those along the urbanized I-25 corridor from South of the city of Castle Rock to the southern Colorado border. The cities with monitoring include Colorado Springs, Pueblo, Cañon City and Alamosa. Alamosa is included because it shares more in common with the other cities in this group than it does with the mountain counties. Colorado Springs is the only city in the area that is monitored for carbon monoxide and ozone; the other cities are only monitored for particulates. In the past the Division has conducted particulate monitoring in both Walsenburg and Trinidad. The monitoring in those cities was discontinued after a review of the data showed that levels of particulates were below the standard and was declining.

1.2.4 Mountain Counties

The Mountain Counties are those counties along the Continental Divide. The cities are usually located in tight mountain valleys where nighttime temperature inversions trap any pollution near the ground. Their primary monitoring concern is with particulate pollution from wood burning and road sanding. These communities range from Steamboat Springs in the north to Pagosa Springs in the south and include Breckenridge in the I-70 corridor as well as Aspen, Crested Butte and Mt. Crested Butte in the central mountains.

1.2.5 Western Counties

The Western Counties generally contain smaller towns located in fairly broad river valleys. Grand Junction is the only large city in the area and the only location that monitors for carbon monoxide on the western slope. The other Western Slope monitors are located in the cities of Clifton, Parachute, Delta, Durango, Rifle and Telluride.

A special study on ozone conducted in the summer of 2008 looked at ozone concentrations in two areas of the Western Counties. These areas were along the border with New Mexico near Cortez and along the I-70 corridor from Glenwood Springs to Grand Junction. The result of this study is that in May and June of 2008 new ozone monitoring sites were established at Rifle, Palisade and Cortez.

Table 1 - Statewide Continuous Monitors in Operation For 2008
X - Monitors continued in 2008 A - Monitors added in 2008
D - Monitors discontinued in 2008

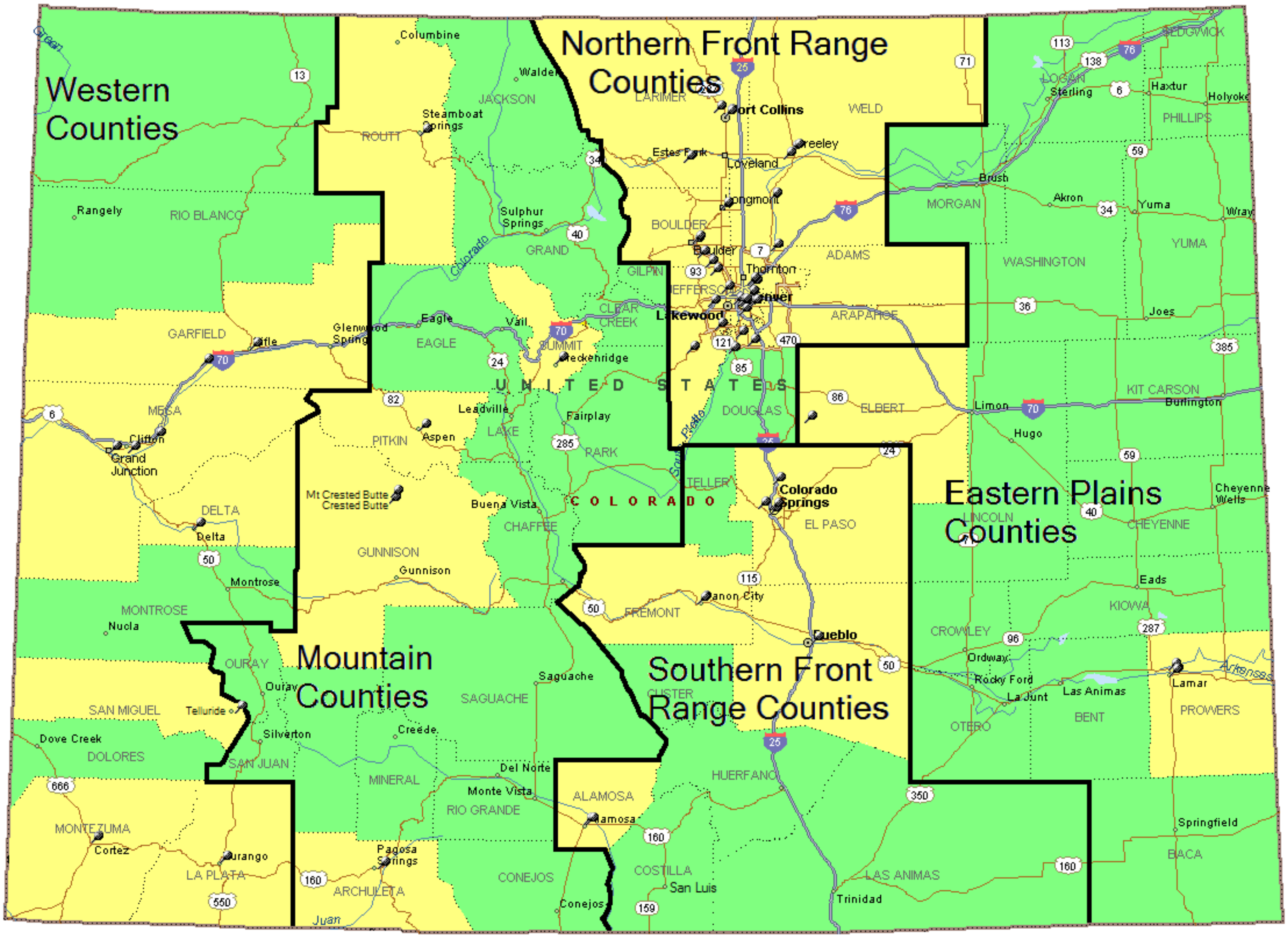
County	Site Name	Location	CO	SO_2	NO_X	O_3	Met
Eastern Plains Counties							
Prowers	Lamar - POE	7100 Hwy 50					X
Northern Front Range Counties							
Adams	Commerce City	7101 Birch St.					X
	Welby	3174 E. 78th Ave.	X	X	X	X	X
Arapahoe	Highland Res.	8100 S. University Blvd.				X	X
Boulder	Boulder	1405½ S. Foothills Hwy.				X	
	Longmont	440 Main St.	X				
Denver	Auraria Lot R	12th St. & Auraria Parkway					X
	Denver CAMP	2105 Broadway	X	X	X		X
	Denver Carriage	2325 Irving St.				X	X
	DESCI Building	1901 13th Ave. (Visibility)					
	Firehouse #6	1300 Blake St.	X				
	Denver Animal Shelter	678 S. Jason St				A	A
Douglas	Chatfield Res.	11500 N. Roxborough Pk. Rd.				X	X
Jefferson	Arvada	9101 W. 57th Ave.				X	X
	NREL	2054 Quaker St.				X	
	Rocky Flats - N	16600 W. Hwy. 128				X	X
	Rocky Flats - SE	9901 Indiana St.					X
	Welch	12400 W. Hwy. 285				X	X
Larimer	Fort Collins - Mason	708 S. Mason St.	X			X	X
	Fort Collins - Viz	300 Remington St. (Visibility)					
	Fort Collins - West	3416 W. La Porte Ave.				X	
Weld	Greeley - West	905 10th Ave.	X				
	Weld County Tower	3101 35th Ave.				X	
Southern Front Range Counties							
El Paso	Colorado Springs	USAFA Rd. 640				X	
		690 W. Hwy. 24	X				
	Manitou Springs	101 Banks Pl.				X	
Western Counties							
Garfield	Rifle - Health	195 W. 14th Ave.				A	
Mesa	Grand Junction	645¼ Pitkin Ave.	X				X
	Palisade Water Treatment	865 Rapid Creek Dr.				A	A
Montezuma	Cortez	106 W. North Ave.				A	

Table 2 - Statewide Particulate Monitors in Operation For 2008
X - Monitors continued in 2008 A - Monitors added in 2008
D - Monitors discontinued in 2008 H - Hourly particulate monitor S - Chemical Speciation

County	Site Name	Location	TSP	Pb	PM_{10}	$PM_{2.5}$
Eastern Plains Counties						
Elbert	Elbert	24950 Ben Kelly Rd				X
Prowers	Lamar – Power Plant	100 2nd St.			X	
	Lamar- Municipal	104 Parmenter St.			X	
Northern Front Range Counties						
Adams	Commerce City	7101 Birch St.			X	X/H/S
	Welby	3174 E. 78th Ave.			X/H	
Arapahoe	Arapahoe Comm. College	6190 S. Santa Fe Dr.				X
Boulder	Longmont	350 Kimbark St.			X	X/H
	Boulder - Chamber	2440 Pearl St.			X	X
	Boulder - CU/Athens	2102 Athens St.				H
Denver	Denver CAMP	2105 Broadway			X/H	X/H
	Denver NJH	14th Ave. & Albion St.				H
	Denver Visitor Center	225 W. Colfax Ave.			X	
	Denver Animal Shelter	678 S. Jason St.	X	X	X/H	X/H
	Swansea Elementary Sch.	4650 Columbine St.				X
Douglas	Chatfield Reservoir	11500 Roxborough Park Rd.				X/H
Larimer	Fort Collins - CSU	251 Edison St.			X	X
Weld	Greeley - Hospital	1516 Hospital Rd.			X	X/H
	Platteville	1004 Main St.				X/S
Southern Front Range Counties						
Alamosa	Alamosa - ASU	208 Edgemont Blvd.			X	
	Alamosa- Municipal	425 4th St.			X	
El Paso	Colorado Springs - RBD	101 W. Costilla St.			D	D
	Colorado College	130 W. Cache la Poudre			X	A/H
Fremont	Cañon City	128 Main St.			X	
Pueblo	Pueblo	211 E. D St.			X	X
Mountain Counties						
Archuleta	Pagosa Springs	309 Lewis St.			X	
Gunnison	Crested Butte	603 6th St.			X	
	Mt. Crested Butte	19 Emmons Rd.			X	
Pitkin	Aspen	120 Mill St.			X/H	
Routt	Steamboat Springs	136 6th St.			X	
Summit	Breckenridge	501 N. Park Ave.			X	
Western Counties						
Delta	Delta	560 Dodge St.			X	
Garfield	Parachute	100 E. 2nd St.			X	
	Rifle – Henry Building	144 E. 3rd Ave.			X	
La Plata	Durango	1235 Camino del Rio			X	
Mesa	Grand Junction - Powell	650 South Ave.			X	X/H/S
	Grand Junction - Pitkin	645 ¼ Pitkin Ave.			H	
	Clifton	141 & D St.			X	
Montezuma	Cortez	106 W. North St.				A
San Miguel	Telluride	333 W. Colorado Ave.			X	

Figure 1

Monitoring Areas in Colorado



Counties with monitors are in yellow and the pin symbols on the map show the approximate location of the monitors within the county.

2.0 Criteria Pollutants

Criteria pollutants are those for which the federal government has established ambient air quality standards in the Federal Clean Air Act and its amendments. There are six criteria pollutants. They are: carbon monoxide, ozone, sulfur dioxide, nitrogen dioxide, lead and particulate matter. The standards for criteria pollutants are established to protect the most sensitive members of society. These are usually defined as those with respiratory problems, the very young and the infirm. The standards for each of the criteria pollutants are discussed in the following sections. A summary of these levels are presented in Table 3.

Table 3 - National Ambient Air Quality Standards[1]

	Primary Standards		Secondary Standards	
Pollutant	**Level**	**Averaging Time**	**Level**	**Averaging Time**
Carbon Monoxide	9 ppm ($10\ mg/m^3$)	8-hour (1)	None	
	35 ppm ($40\ mg/m^3$)	1-hour (1)		
Lead	$0.15\ \mu g/m^3$ (2)	Rolling 3-Month Average	Same as Primary	
Nitrogen Dioxide	0.053 ppm ($100\ \mu g/m^3$)	Annual (Arithmetic Mean)	Same as Primary	
Particulate Matter (PM_{10})	$150\ \mu g/m^3$	24-hour (3)	Same as Primary	
Particulate Matter ($PM_{2.5}$)	$15.0\ \mu g/m^3$	Annual (4) (Arithmetic Mean)	Same as Primary	
	$35\ \mu g/m^3$	24-hour (5)	Same as Primary	
Ozone	0.075 ppm (2008 std)	8-hour (6)	Same as Primary	
	0.08 ppm (1997 std)	8-hour (7)	Same as Primary	
	0.12 ppm	1-hour (8)	Same as Primary	
Sulfur Dioxide	0.03 ppm	Annual (Arithmetic Mean)	0.5 ppm	3-hour (1)
	0.14 ppm	24-hour (1)		

(1) Not to be exceeded more than once per year.
(2) Final rule signed October 15, 2008.
(3) Not to be exceeded more than once per year on average over 3 years.
(4) To attain this standard, the 3-year average of the weighted annual mean $PM_{2.5}$ concentrations from single or multiple community-oriented monitors must not exceed $15.0\ \mu g/m^3$.
(5) To attain this standard, the 3-year average of the 98th percentile of 24-hour concentrations at each population-oriented monitor within an area must not exceed $35\ \mu g/m^3$ (effective December 17, 2006).
(6) To attain this standard, the 3-year average of the fourth-highest daily maximum 8-hour average ozone concentrations measured at each monitor within an area over each year must not exceed 0.075 ppm. (effective May 27, 2008)
(7) (a) To attain this standard, the 3-year average of the fourth-highest daily maximum 8-hour average ozone concentrations measured at each monitor within an area over each year must not exceed 0.08 ppm.
(b) The 1997 standard—and the implementation rules for that standard—will remain in place for implementation purposes as EPA undertakes rulemaking to address the transition from the 1997 ozone standard to the 2008 ozone standard.
(8) (a) The standard is attained when the expected number of days per calendar year with maximum hourly average concentrations above 0.12 ppm is ≤ 1.
(b) As of June 15, 2005 EPA has revoked the 1-hour ozone standard in all areas except the fourteen 8-hour ozone nonattainment Early Action Compact (EAC) Areas. For one of the 14 EAC areas (Denver, CO), the 1-hour standard was revoked on November 20, 2008. For the other 13 EAC areas, the 1-hour standard was revoked on April 15, 2009.

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2.0.1 Exceedance Summary Table

Table 4 is a summary of the sites with exceedances of the ambient air quality standards for Colorado for 2007 and 2008. This table does not show sites in violation of the standard but sites that have exceeded the level of the standard in the year. The violation of a standard is generally based on a multi-year average or multiple exceedances of the standard per year. The PM_{10} standard is discussed in section 2.5.1. The changes in the ozone standard are discussed in section 2.2.1.

Table 4 - 2007/2008 Exceedance Summaries

Location	2007		2008	
	Ozone*	PM10	Ozone*	PM10
Alamosa ASC		X		
Alamosa Municipal		X		X
Mt. Crested Butte		X		
New Castle		X		
Parachute				X
Lamar Power Plant				X
Welby			X	
Highland Reservoir	X			
Boulder Foothills	X		X	
Denver Carriage	X			
Chatfield Reservoir	X		X	
Arvada	X			
Welch	X			
Rocky Flats-N	X		X	
NREL	X		X	
Fort Collins-W	X		X	

* - The ozone exccedances listed are those where the 4th maximum 8-Hr concentration for the year is greater than 0.075 ppm.

2.0.2 Emissions Inventories for Significant Pollutants

The US EPA produces a National Emissions Inventory every three years. The latest complete inventory is for 2005. A partial inventory has been done for 2008 however the lead inventory has not been completed. The emissions trends graphs and tables have been developed with the 2008 data except for lead which still reflects the 2005 inventory.

The tables and graphs have been standardized for each of the parameters used in the graphs. This change has resulted in an increased number of catagories. Not all of the catagories are equally important for each pollutant but are included for consistecy.

2.1 Carbon monoxide - Sources

Carbon monoxide is a colorless and odorless gas, formed when carbon in fuel is not burned completely. It is a component of motor vehicle exhaust, which contributes about 50 percent of all carbon monoxide emissions nationwide. Non-road vehicles account for the remaining carbon monoxide emissions from transportation sources. High concentrations of carbon monoxide generally occur in areas with heavy traffic congestion. In cities, as much as 85 percent of all carbon monoxide emissions may come from automobile exhaust. Peak carbon monoxide concentrations typically occur during the colder months of the year when carbon monoxide automotive emissions are greater and nighttime inversion conditions (where air pollutants are trapped near the ground beneath a layer of warm air) are more frequent.[2]

2.1.1 Carbon monoxide - Standards

The U.S. Environmental Protection Agency (EPA) has developed two national standards for carbon monoxide. They are 35 ppm averaged over a 1-hour period and 9 ppm averaged over an 8-hour period. These values are not to be exceeded more than once in a year at the same location. A site will violate the standard with a second exceedance of either the 1-hour or 8-hour standard in the same calendar year. The EPA directive states that comparison with the carbon monoxide standards will be made in integers. Fractions of 0.5 or greater are rounded up, thus, actual concentrations of 9.5 ppm and 35.5 ppm or greater are necessary to exceed the 8-hour and 1-hour standards, respectively.[3]

2.1.2 Carbon monoxide - Health Effects

Carbon monoxide affects the central nervous system by depriving the body of oxygen. It enters the body through the lungs, where it combines with hemoglobin in the red blood cells. Normally, hemoglobin carries oxygen from the lungs to the cells. The oxygen attached to the hemoglobin is exchanged for the carbon dioxide generated by the cell's metabolism. The carbon dioxide is then carried back to the lungs where it is exhaled from the body. Hemoglobin binds approximately 240 times more readily with carbon monoxide than with oxygen.

The health effects of carbon monoxide vary with concentration. At low concentrations, fatigue in healthy people and chest pain in people with heart disease. At higher concentrations, impaired vision and coordination; headaches; dizziness; confusion; nausea. It can cause flu-like symptoms that clear up after leaving the polluted area. Carbon monoxide is fatal at very high concentrations.

Acute effects are due to the formation of carboxyhemoglobin in the blood, which inhibits oxygen intake. At moderate concentrations, angina, impaired vision, and reduced brain function may result. At higher concentrations, CO exposure can be fatal.[4]

The EPA has concluded that the following groups may be particularly sensitive to carbon monoxide exposures: angina patients, individuals with other types of cardiovascular disease, persons with chronic obstructive pulmonary disease, anemic individuals, fetuses and pregnant women. Concern also exists for healthy children because of increased oxygen requirements that result from their higher metabolic rate.[5]

How quickly the carboxyhemoglobin builds up is a factor of the concentration of the gas being inhaled (measured in parts per million or PPM) and the duration of the exposure. Compounding the effects of the exposure is the long half-life of carboxyhemoglobin in the blood. Half-life is a measure of how quickly levels return to normal. The half-life of carboxyhemoglobin is approximately 5 hours. This means that for a given exposure level, it will take about 5 hours for the level of carboxyhemoglobin in the blood to drop to half its current level after the exposure is terminated.[6]

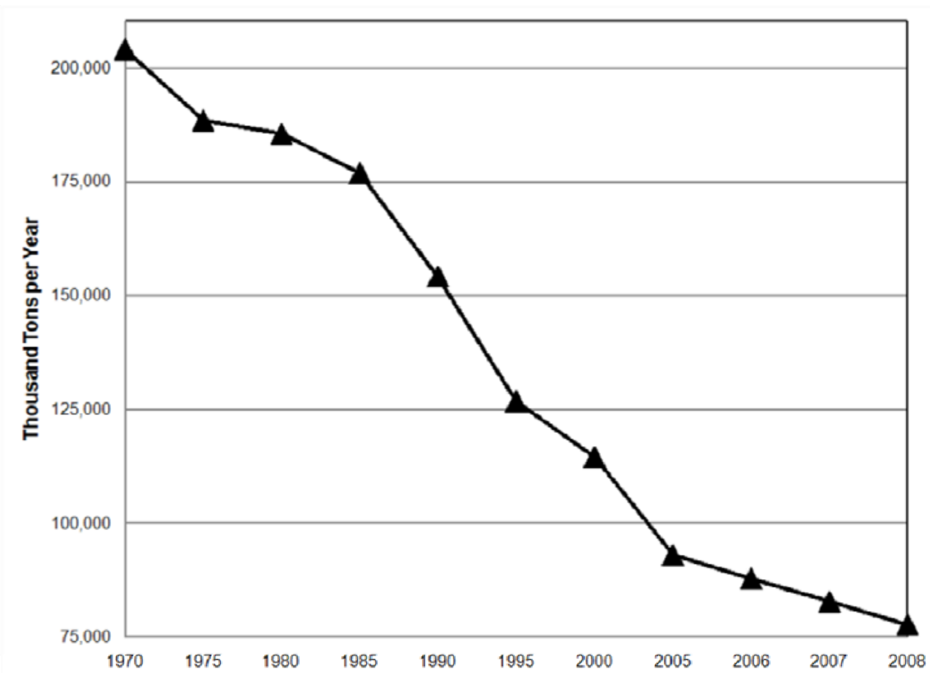
2.1.3 Carbon monoxide - Emissions

The 2008 National Emissions Inventory estimates that 50 percent of carbon monoxide emissions are from highway vehicle sources. They also estimate that off-highway sources contribute an additional 23 percent of emissions.

Table 5 - Carbon Monoxide National Emissions For 2008[7]

Description	National	
	Thousand-Tons/Year	**Percent**
Fuel Combustion – Electrical Utilities	699	0.9
Fuel Combustion - Industrial	1,216	1.6
Fuel Combustion - Other	3,369	4.3
Chemical Processing/Mfg	265	0.3
Metal Processing	947	1.2
Petroleum Processing	355	1.5
Other Industrial Processes	500	0.6
Solvent Utilization	2	0.0
Storage & Transportation	115	0.2
Waste Disposal & Recycling	1,584	2.0
Highway Vehicles	38,866	50.0
Off- Highway	18,036	23.2
Miscellaneous	11,731	15.1
Total	**77,685**	**100.0**

Figure 2 - Changes in National Carbon Monoxide Emissions From 1970 – 2008[8]



2.2 Ozone

"Ozone (O_3) is a gas composed of three oxygen atoms. It is not usually emitted directly into the air, but at ground-level is created by a chemical reaction between oxides of nitrogen (NO_X) and volatile organic compounds (VOC) in the presence of sunlight. Ozone has the same chemical structure whether it occurs miles above the earth or at ground-level and can be "good" or "bad," depending on its location in the atmosphere.

In the earth's lower atmosphere, ground-level ozone is considered "bad." Motor vehicle exhaust and industrial emissions, gasoline vapors, and chemical solvents as well as natural sources emit NO_X and VOC's that help form ozone. Ground-level ozone is the primary constituent of smog. Sunlight and hot weather cause ground-level ozone to form in harmful concentrations in the air. As a result, it is known as a summertime air pollutant. Many urban areas tend to have high levels of "bad" ozone, but even rural areas are also subject to increased ozone levels because wind carries ozone and pollutants that form it hundreds of miles away from their original sources.

In the troposphere, the air closest to the Earth's surface, ground-level or "bad" ozone is a pollutant that is a significant health risk, especially for children with asthma. It also damages crops, trees and other vegetation. It is a main ingredient of urban smog.

In the stratosphere the "good" ozone layer extends upward from about 6 to 30 miles and protects life on Earth from the sun's harmful ultraviolet (UV) rays. This natural shield has been gradually depleted by man-made chemicals like chlorofluorocarbons (CFCs). A depleted ozone shield allows more UV from the sun to reach the ground, leading to more cases of skin cancer, cataracts, and other health problems."[9]

2.2.1 Ozone - Standards

In May 2008, the U.S. Environmental Protection Agency established a new ozone standard. The reasons for these changes were:

"Based on its review of the air quality criteria for ozone (O_3) and related photochemical oxidants and national ambient air quality standards (NAAQS) for O_3, EPA is making revisions to the primary and secondary NAAQS for O_3 to provide requisite protection of public health and welfare, respectively. With regard to the primary standard for O_3, EPA is revising the level of the 8-hour standard to 0.075 parts per million (ppm), expressed to three decimal places. With regard to the secondary standard for O_3, EPA is revising the current 8-hour standard by making it identical to the revised primary standard. "[10]

DATES: *This final rule is effective on May 27, 2008.*

2.2.2 Ozone - Health Effects

Exposure to ozone has been linked to a number of health effects, including significant decreases in lung function, inflammation of the airways, and increased respiratory symptoms, such as cough and pain when taking a deep breath. Exposure can also aggravate lung diseases such as asthma, leading to increased medication use and increased hospital admissions and emergency room visits. Active children are the group at highest risk from ozone exposure because they often spend a large part of the summer playing outdoors. Children are also more likely to have asthma, which may be aggravated by ozone exposure. Other at-risk groups include adults who are active outdoors (e.g., some outdoor workers) and individuals with lung diseases such as asthma and chronic obstructive pulmonary disease. In addition, long-term exposure to moderate levels of ozone may cause permanent changes in lung structure, leading to premature aging of the lungs and worsening of chronic lung disease. Ozone also affects vegetation and ecosystems, leading to reductions in agricultural crop and commercial forest yields, reduced growth and survivability of tree seedlings, and increased plant susceptibility to disease, pests, and other environmental stresses (e.g., harsh weather). In long-lived species, these effects may become evident only after several years or even decades and may result in long-term effects on forest ecosystems. Ground level ozone injury to trees and plants can lead to a decrease in the natural beauty of our national parks and recreation areas.[11]

2.2.3 Ozone - Sources

Ozone is not emitted directly from a source, as are other pollutants, but forms as a secondary pollutant. Its precursors are certain reactive hydrocarbons and nitrogen oxides, which react chemically in sunlight to form ozone. The main sources for these reactive hydrocarbons are automobile exhaust, gasoline, oil storage and transfer facilities, industrial paint solvents, degreasing agents, cleaning fluids and ink solvents. High temperature combustion combines nitrogen and oxygen in the air to form oxides of nitrogen. Vegetation can also emit reactive hydrocarbons such as terpenes from pine trees, for example.[12]

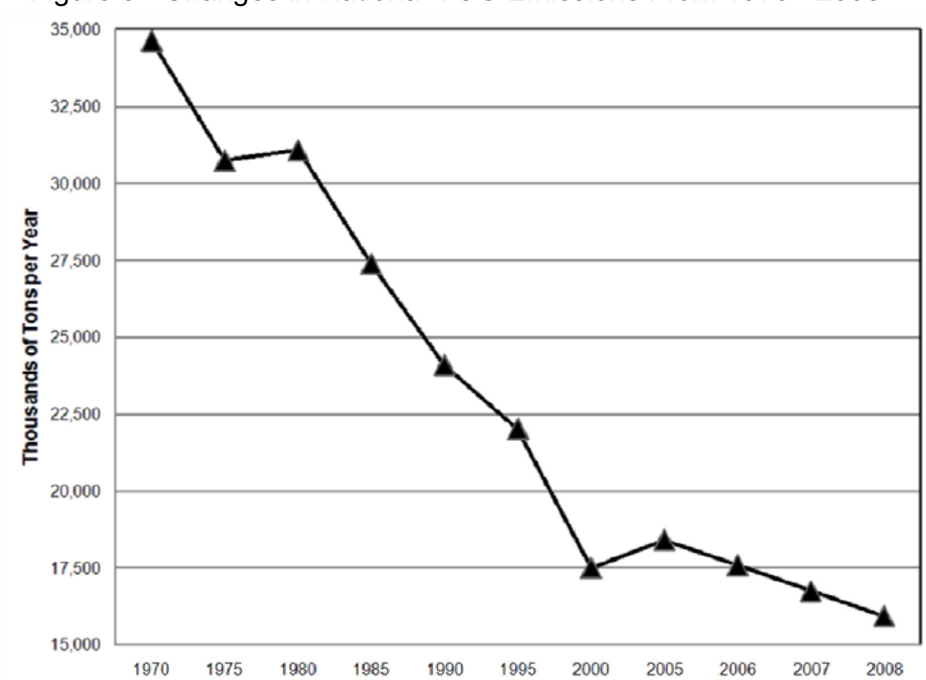
Although some ozone is produced all year, the highest concentrations usually occur in the summer. The stagnant air and intense sunlight on hot, bright summer days provide the conditions for the precursor chemicals to react and form ozone. The ozone produced under these stagnant summer conditions remains as a coherent air mass and can be transported many miles from its point of origin.

The way to reduce ozone in the atmosphere is to reduce the compounds that react to form it. Table 6 and Figure 3 are included in the ozone section because of the importance of volatile organic compounds (VOC's) in the formation of ozone. Emissions of oxides of nitrogen, which are the other key items for ozone formation, are shown in Table 8 and Figure 5.

Table 6 - VOC National Emissions For 2008[13]

Description	National	
	Thousand-Tons/Year	Percent
Fuel Combustion – Electrical Utilities	50	0.3
Fuel Combustion - Industrial	130	0.8
Fuel Combustion - Other	1,269	8.0
Chemical Processing/Mfg	228	1.4
Metal Processing	46	0.3
Petroleum Processing	561	3.5
Other Industrial Processes	404	2.5
Solvent Utilization	4,226	26.5
Storage & Transportation	1,303	8.2
Waste Disposal & Recycling	374	2.3
Highway Vehicles	3,418	21.5
Off- Highway	2,586	16.2
Miscellaneous	1,332	8.4
Total	**15,927**	**100.0**

Figure 3 - Changes in National VOC Emissions From 1970 - 2008[14]



2.3 Sulfur dioxide

Sulfur dioxide (SO_2), belongs to the family of sulfur oxide gases. These gases dissolve easily in water. Sulfur is prevalent in all raw materials, including crude oil, coal, and ore that contains common metals like aluminum, copper, zinc, lead, and iron. Sulfur dioxide gases are formed when fuel containing sulfur, such as coal and oil, is burned, and when gasoline is extracted from oil, or metals are extracted from ore. Sulfur dioxide dissolves in water vapor to form acid, and interacts with other gases and particles in the air to form sulfates and other products that can be harmful to people and their environment.[15]

2.3.1 Sulfur dioxide - Standards

There are two primary standards for sulfur dioxide. The first is a long-term, one year arithmetic average not to exceed 0.03 ppm. The second is a short-term, 24-hour average where concentrations are not to exceed 0.14 ppm more than once per year. The secondary standard is a 3-hour average not to exceed 0.5 ppm more than once per year.[16]

2.3.2 Sulfur dioxide - Health Effects

High concentrations of sulfur dioxide can result in temporary breathing impairment for asthmatic children and adults who are active outdoors. Short-term exposures of asthmatic individuals to elevated sulfur dioxide levels during moderate activity may result in breathing difficulties that can be accompanied by symptoms such as wheezing, chest tightness, or shortness of breath. Other effects that have been associated with longer-term exposures to high concentrations of sulfur dioxide, in conjunction with high levels of particulate matter, include aggravation of existing cardiovascular disease, respiratory illness, and alterations in the lungs' defenses. The subgroups of the population that may be affected under these conditions include individuals with heart or lung disease, as well as the elderly and children.[17]

Sulfur dioxide also is a major precursor to $PM_{2.5}$, which is a significant health concern, and a main contributor to poor visibility.[18]

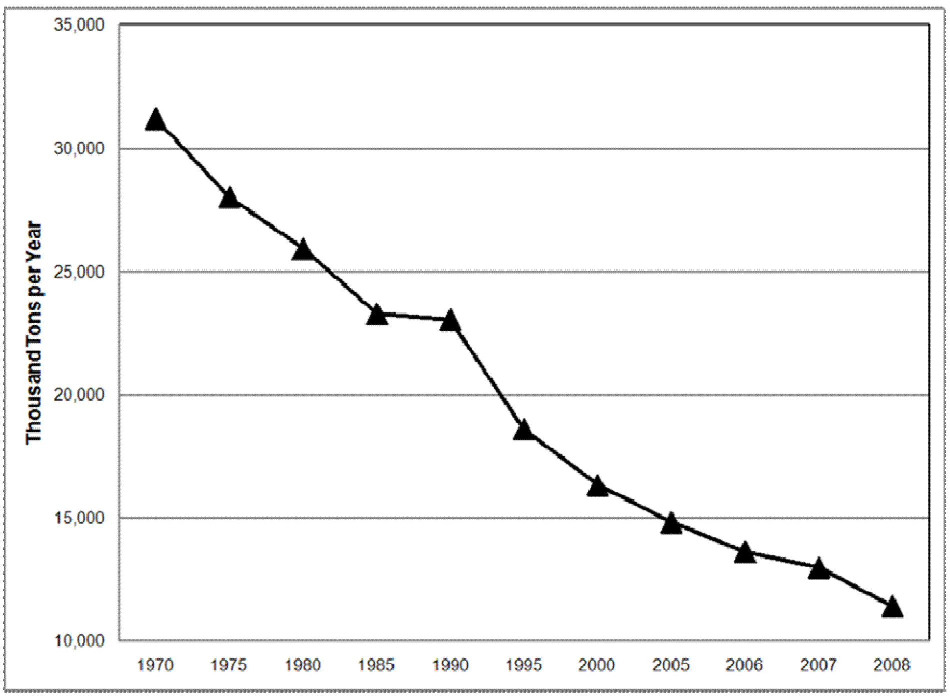
2.3.3 Sulfur dioxide - Sources

Nationwide, over 66 percent of sulfur dioxide released to the air, or more than 7 million tons per year, comes from electric utilities, especially those that burn coal. Other sources of sulfur dioxide are industrial facilities that derive their products from raw materials like metallic ore, coal, and crude oil, or that burn coal or oil to produce process heat. Examples are petroleum refineries, cement manufacturing, and metal processing facilities. Also, locomotives, large ships, and some nonroad diesel equipment currently burn high sulfur fuel and release sulfur dioxide emissions to the air in large quantities.[19]

Table 7 - Sulfur Dioxide National Emissions For 2008[20]

Description	National	
	Thousand-Tons/Year	Percent
Fuel Combustion – Electrical Utilities	7,552	66.1
Fuel Combustion - Industrial	1,670	14.6
Fuel Combustion - Other	578	5.1
Chemical Processing/Mfg	255	2.1
Metal Processing	203	1.8
Petroleum Processing	206	21.8
Other Industrial Processes	329	2.9
Solvent Utilization	0	0.0
Storage & Transportation	4	0.0
Waste Disposal & Recycling	27	0.2
Highway Vehicles	64	0.6
Off- Highway	456	4.0
Miscellaneous	85	0.7
Total	**11,472**	**100.0**

Figure 4 - Changes in National Sulfur Dioxide Emissions From 1970 - 2008[21]



2.4 Nitrogen dioxide

In its pure state, nitrogen dioxide is a reddish brown gas with a characteristic pungent odor. It is corrosive and a strong oxidizing agent. As a pollutant in ambient air, however, it is virtually colorless and odorless. Nitrogen dioxide can be an irritant to the eyes and throat. Oxides of nitrogen (nitric oxide and nitrogen dioxide) are formed when the nitrogen and oxygen in the air are combined in high temperature combustion.

2.4.1 Nitrogen dioxide - Standards

The standard for NO_2 was first established by the EPA in 1971. Both the primary standard, to protect public health, and the secondary standard, to protect public welfare, were set as an annual average of 0.053 ppm or 53 ppb.

On June 26, 2009, EPA proposed to strengthen the primary National Ambient Air Quality Standards for nitrogen dioxide. The proposed changes would protect public health, especially the health of sensitive populations, people with asthma, children and the elderly.

EPA is proposing to establish a new 1-hour nitrogen dioxide standard at a level between 80 – 100 ppb. This standard would protect against health effects associated with short-term exposures to nitrogen dioxide, which are generally highest on and near major roads. The Agency is taking comment on alternative levels for the 1-hour standard down to 65 ppb and up to 150 ppb. EPA is also proposing to retain the current annual average nitrogen dioxide standard of 53 ppb.[22]

2.4.2 Nitrogen dioxide - Health Effects

Elevated concentrations of nitrogen dioxide cause respiratory distress, degradation of vegetation, clothing and visibility, and increased acid deposition. Nitrate aerosols, which result from nitric oxide and nitrogen dioxide combining with water vapor in the air, have been consistently linked to Denver's visibility problems.

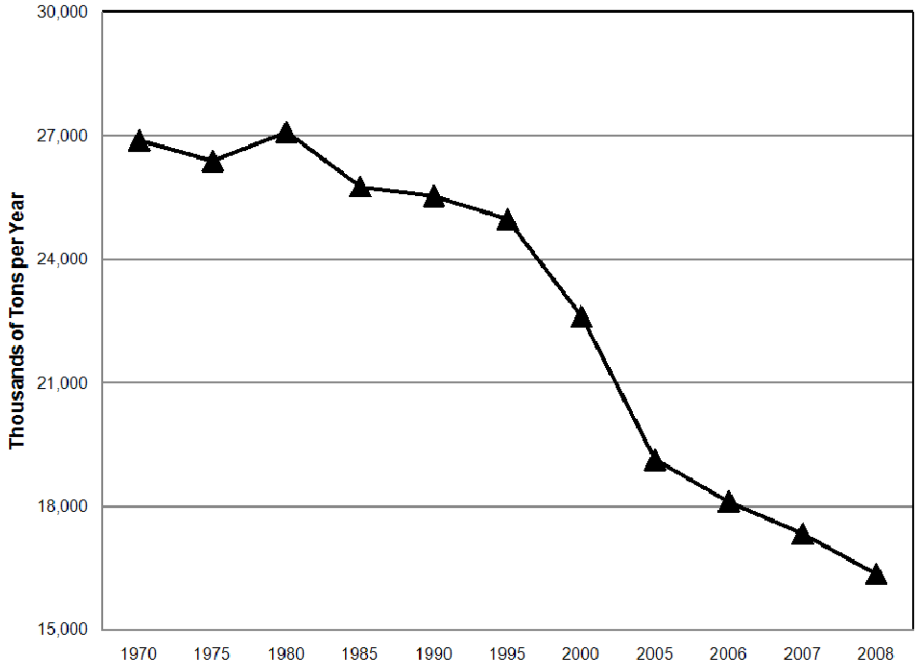
2.4.3 Nitrogen dioxide - Sources

Nationally, about 58 percent of the oxides of nitrogen emissions come from on and off-road vehicles and about 36 percent come from industrial sources.[23] In Denver, about 44 percent of the emissions of nitrogen dioxide in the Denver area come from large combustion sources such as power plants. Almost 33 percent comes from motor vehicles, 15 percent from space heating, 3 percent from aircraft and 5 percent from miscellaneous off-road vehicles. Minor sources include fireplaces and woodstoves and high temperature combustion processes used in industrial work.[24]

Table 8 - Oxides of Nitrogen National Emissions For 2008[25]

Description	National	
	Thousand-Tons/Year	Percent
Fuel Combustion – Electrical Utilities	3,006	18.4
Fuel Combustion - Industrial	1,838	11.2
Fuel Combustion - Other	727	4.4
Chemical Processing/Mfg	67	0.4
Metal Processing	68	0.4
Petroleum Processing	350	2.1
Other Industrial Processes	418	2.6
Solvent Utilization	6	0.0
Storage & Transportation	18	0.1
Waste Disposal & Recycling	120	0.7
Highway Vehicles	5,206	31.9
Off- Highway	4,255	26.0
Miscellaneous	260	1.6
Total	**16,339**	**100.0**

Figure 5 - Changes in National Oxides of Nitrogen Emissions From 1970 - 2008[26]



2.5 Particulate Matter - PM_{10}

Particle pollution is a mixture of microscopic solids and liquid droplets suspended in air. This pollution, also known as particulate matter, is made up of a number of components, including acidic aerosols (such as nitrates and sulfates), organic chemicals, metals, soil or dust particles, and allergens (such as fragments of pollen or mold spores).

The size of particles is directly linked to their potential for causing health problems. Small particles, less than 10 micrometers in diameter, pose the greatest problems. The smallest particles can get deep into the lungs, and some may even get into the bloodstream. Exposure to such particles can affect both the lungs and heart. Larger particles are of less concern, although they can irritate the eyes, nose, and throat.[27]

2.5.1 Particulate Matter - PM_{10} - Standards

The nation's air quality standards for particulate matter were first established in 1971 and were not significantly revised until 1987, when EPA changed the indicator of the standards to regulate inhalable particles smaller than, or equal to, 10 micrometers in diameter (that's about 1/4 the size of a single grain of table salt).

Ten years later, in 2006, the EPA revised the particulate matter standards, setting separate standards for fine particles ($PM_{2.5}$) and for PM_{10} based on their link to serious health problems ranging from increased symptoms, hospital admissions and emergency room visits for people with heart and lung disease, to premature death in people with heart or lung disease. They decided to retain the existing 24-hour PM_{10} standard of 150 $\mu g/m^3$. The EPA revoked the annual PM_{10} standard, because available evidence does not suggest a link between long-term exposure to PM_{10} and health problems.

2.5.2 Particulate Matter - PM_{10} - Health Effects

According to American Lung Association's paper The Perils of Particulates:

"The health risk from an inhaled dose of particulate matter depends on the size and concentration of the particulate. Size determines how deeply the inhaled particulate will penetrate into the respiratory tract where they can persist and cause respiratory damage. Particles less than 10 microns in diameter are easily inhaled deep into the lungs. In this range, larger particles tend to deposit in the tracheobronchial region and smaller ones in the alveolar region. Particulates deposited in the alveolar region can remain in the lungs for long periods because the alveoli have a slow mucociliary clearance system."

"Fine particulate pollution does not affect the health of exposed persons with equal severity. Certain subgroups of people potentially exposed to air pollutants can be identified as potentially 'at risk' from adverse health effects of air borne pollutants. There is very strong evidence that asthmatics are much more sensitive (i.e., respond with symptoms at relatively low concentrations) to the effects of particulates than the general healthy population."[28]

The welfare effects of particulate exposure may be the most widespread of all the pollutants. No place on earth has been spared from the particulate pollution generated by urban and rural sources. This is due to the potential for extremely long-range transport of fine particles and chemical reactions that occur. The effects of particulates range from visibility degradation to climate changes and vegetation damage. General soiling, commonly thought to be just a nuisance, can have long-term adverse effects on building paints and other materials. Acid deposition as particulates can be detected in the most remote areas of the world.

2.5.3 Particulate Matter - PM_{10} - Sources

"Particulate matter," also known as particle pollution or PM, is a complex mixture of extremely small particles and liquid droplets. Particle pollution is made up of a number of components, including acids (such as nitrates and sulfates), organic chemicals, metals, and soil or dust particles.

The size of particles is directly linked to their potential for causing health problems. EPA is concerned about particles that are 10 micrometers in diameter or smaller because those are the particles that generally pass through the throat and nose and enter the lungs. Once inhaled, these particles can affect the heart and lungs and cause serious health effects. EPA groups particle pollution into two categories:

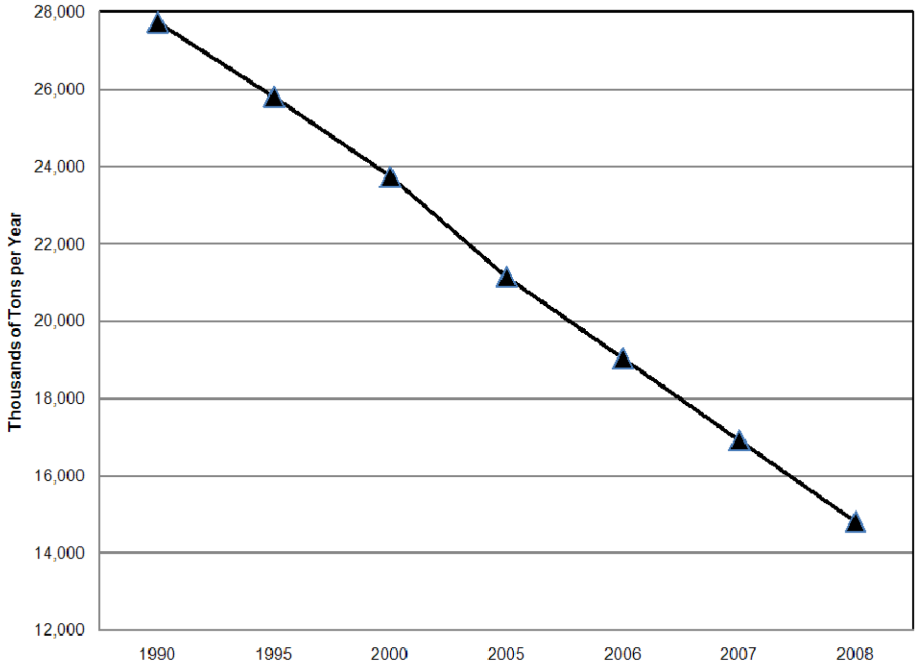
"Inhalable coarse particles," such as those found near roadways and dusty industries, are larger than 2.5 micrometers and smaller than 10 micrometers in diameter.

"Fine particles," such as those found in smoke and haze, are 2.5 micrometers in diameter and smaller. These particles can be directly emitted from sources such as forest fires, or they can form when gases emitted from power plants, industries and automobiles react in the air.

Table 9 - PM_{10} National Emissions For 2008[29]

Description	National	
	Thousand-Tons/Year	Percent
Fuel Combustion – Electrical Utilities	5.34	3.6
Fuel Combustion - Industrial	330	2.2
Fuel Combustion - Other	466	3.1
Chemical Processing/Mfg	39	0.3
Metal Processing	78	0.5
Petroleum Processing	24	0.2
Other Industrial Processes	967	6.5
Solvent Utilization	8	0.1
Storage & Transportation	57	0.4
Waste Disposal & Recycling	288	1.9
Highway Vehicles	171	1.2
Off- Highway	304	2.1
Miscellaneous	11,540	77.9
Total	**14,806**	**100.0**

Figure 6 - Changes in National PM_{10} Emissions From 1990 - 2008[30]



2.6 Particulate Matter - $PM_{2.5}$

According to the Environmental Protection Agency's Latest Findings on National Air Quality: 2000 Status and Trends, Particulate Matter, "$PM_{2.5}$ is composed of a mixture of particles directly emitted into the air and particles formed in the air by the chemical transformation of gaseous pollutants. The principle types of secondary pollutants are ammonium sulfate and ammonium nitrate formed in the air from gaseous emissions of sulfur dioxide and oxides of nitrogen, reacting with ammonia. The main source of sulfur dioxide is combustion of fossil fuels in boilers and the main source of oxides of nitrogen are the combustion of fossil fuels in boilers and mobile sources. Some secondary particles are also formed from semi-volatile organic compounds which are emitted from a wide range of combustion sources."

2.6.1 Particulate Matter - $PM_{2.5}$ - Standards

In 1997, the EPA added 24- hour and annual fine particle standards, $PM_{2.5}$, to the existing PM_{10} standards. EPA added an annual $PM_{2.5}$ standard set at a concentration of 15 micrograms per cubic meter ($\mu g/m^3$) and a 24-hour $PM_{2.5}$ standard set at 65 $\mu g/m^3$. The annual component of the standard was set to provide protection against typical day-to-day exposures as well as longer-term exposures, while the daily component protects against more extreme short-term events.

EPA revised the air quality standards for particle pollution in 2006. The 2006 standards tighten the 24-hour fine particle standard from the current level of 65 micrograms per cubic meter ($\mu g/m^3$) to 35 $\mu g/m^3$, and retain the current annual fine particle standard at 15 $\mu g/m^3$.

2.6.2 Particulate Matter - $PM_{2.5}$ - Health Effects

The health effects of $PM_{2.5}$ are not just a function of their size, about 1/20th the size of a human hair, which allows them to be breathed deeply into the alveoli the lungs, but of their composition. These particles can remain in the lungs for a long time and cause a great deal of damage to the lung tissue. They can reduce lung function as well as cause or aggravate respiratory problems. They can increase the long-term risk of lung cancer or lung diseases such as emphysema or pulmonary fibrosis.[31]

2.6.3 Particulate Matter - $PM_{2.5}$ - Sources

Figure 7 shows the nationwide changes in emissions of $PM_{2.5}$ particulates from 1990 through 2008.

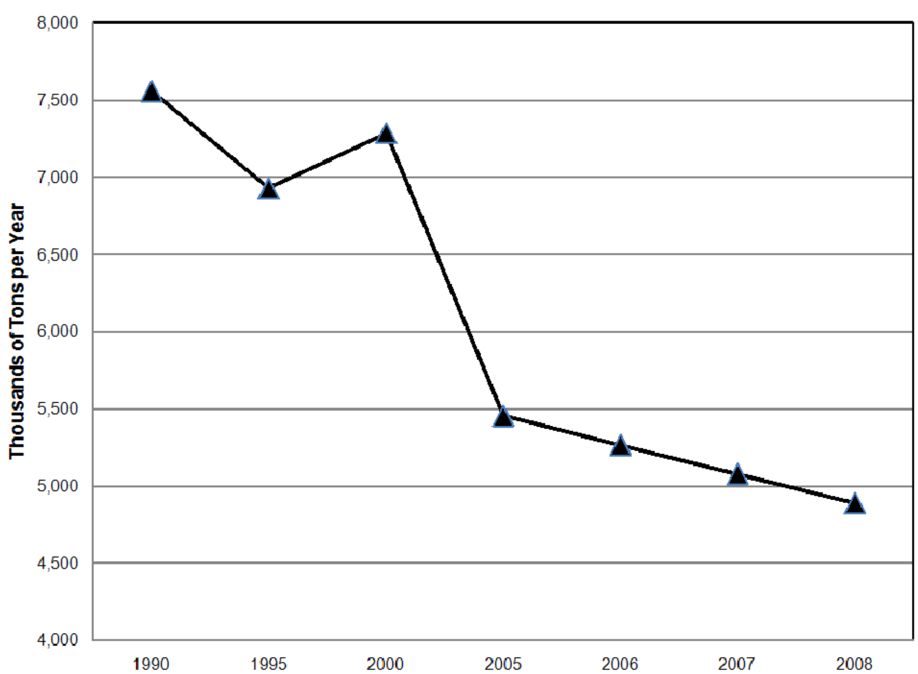
The primary source of fine particles emitted directly into the air is carbonaceous material from combustion sources such as cars, trucks and industrial boilers. Secondary particles are another large source of "fine" particulates. Secondary particles are those that are created in the atmosphere by chemical reactions of gaseous pollutants and water vapor to form a semi-solid particle.[32]

Particles less than 2.5 microns in diameter, or $PM_{2.5}$, are the major contributors to visibility problems because of their ability to scatter or absorb light. In Denver, the effects of this particulate pollution can be seen as the "Brown Cloud" or more appropriately, the "Denver Haze" because it is frequently neither brown nor an actual cloud.

Table 10 - $PM_{2.5}$ National Emissions For 2008[33]

Description	National	
	Thousand-Tons/Year	Percent
Fuel Combustion – Electrical Utilities	410	8.4
Fuel Combustion - Industrial	175	3.6
Fuel Combustion - Other	421	8.6
Chemical Processing/Mfg	29	0.6
Metal Processing	52	1.1
Petroleum Processing	11	0.3
Other Industrial Processes	355	7.3
Solvent Utilization	7	0.1
Storage & Transportation	22	0.1
Waste Disposal & Recycling	267	5.5
Highway Vehicles	110	2.2
Off- Highway	283	5.8
Miscellaneous	2,742	56.1
Total	**4,890**	**100.0**

Figure 7 - Changes in National $PM_{2.5}$ Emissions From 1990 - 2008[34]



2.7 Lead

Lead is a metal found naturally in the environment as well as in manufactured products. The major sources of lead emissions have historically been motor vehicles (such as cars and trucks) and industrial sources. Due to the phase out of leaded gasoline for automobiles, piston engine aircraft and metals processing are the major source of lead emissions to the air today. The highest levels of lead in air are generally found near lead smelters and general aviation airports. Other stationary sources are waste incinerators, utilities, and lead-acid battery manufacturers.[35]

2.7.1 Lead - Standards

The Clean Air Act requires EPA to review the latest scientific information and standards every five years. Before new standards are established, policy decisions undergo rigorous review by the scientific community, industry, public interest groups, the general public and the Clean Air Scientific Advisory Committee (CASAC).

On October 15, 2008, EPA strengthened the National Ambient Air Quality Standards for lead. The level for the previous lead standard was 1.5 $\mu g/m^3$, not to be exceeded as an average for a calendar quarter, based on an indicator of lead in total suspended particles (TSP). The new standard, also in terms of lead in TSP, has a level of 0.15 $\mu g/m^3$, not to be exceeded as an average for any three-month period within three years. In conjunction with the revision of the lead standard, EPA also modified the lead air quality monitoring rules. Ambient lead monitoring is now required near lead emissions sources emitting one or more tons per year, and also in urban areas with a population equal to or greater than half a million people. Monitoring sites are required to sample every sixth day.[36]

2.7.2 Lead - Health Effects

Exposure to lead occurs mainly through inhalation of air and ingestion of lead in food, water, soil, or dust. It accumulates in the blood, bones, and soft tissues and can adversely affect the kidneys, liver, nervous system, and other organs. Excessive exposure to lead may cause neurological impairments such as seizures, mental retardation, and behavioral disorders. Even at low doses, lead exposure is associated with damage to the nervous systems of fetuses and young children, resulting in learning deficits and lowered IQ. Recent studies also show that lead may be a factor in high blood pressure and subsequent heart disease. Lead can also be deposited on the leaves of plants, presenting a hazard to grazing animals and humans through ingestion.[37]

2.7.3 Lead - Sources

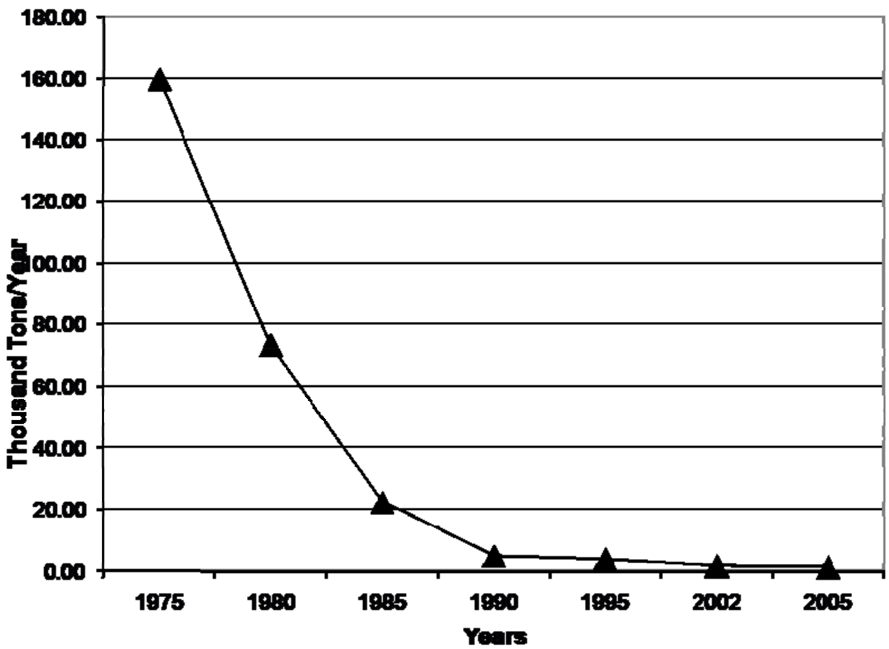
"Because of the phase-out of leaded gasoline, lead emissions and concentrations decreased sharply during the 1980s and early 1990s. Emissions of lead decreased 96 percent over the 24-year period 1980–2004. These large reductions in long-term lead emissions from transportation sources have changed the nature of the ambient lead problem in the United States. Because industrial processes are now responsible for all violations of the lead NAAQS, the lead monitoring strategy currently focuses on emissions from these point sources."[38]

Figure 8 shows the decline in lead emissions in the past 30 years.

Table 11 - Lead National Emissions For 2005[39]

Description	National	
	Tons/Year	Percent
Aviation Gasoline	561	45
Metallurgical Industries	283	23
Manufacturing	171	14
Incineration	94	8
Boilers	70	6
Miscellaneous smaller categories	57	5
Total	**1236**	**100**

Figure 8 - Changes in National Lead Emissions From 1975 - 2005[40]



3.0 Non-Criteria Pollutants

Non-criteria pollutants are those pollutants for which there are no current national ambient air quality standards. These include but are not limited to the pollutants that impair visibility, total suspended particulates, certain oxides of nitrogen species and air toxics. Meteorological measurements of wind speed, wind direction, temperature and humidity are also included in this group.

3.1 Visibility

Visibility is unique among air pollution effects in that it involves human perception and judgment. It has been described as the maximum distance that an object can be perceived against the background sky. Visibility also refers to the clarity with which the form and texture of distant, middle and near details can be seen as well as the sense of the trueness of their apparent coloration. As a result, measures of visibility serve as surrogates of human perception. There are several ways to measure visibility but none of them tell the whole story or completely measure visibility as human beings experience it.

3.1.1 Visibility - Standards

The Colorado Air Quality Control Commission established a visibility standard in 1990 for the Front Range cities from Fort Collins to Colorado Springs. The standard, an atmospheric extinction of 0.076 per kilometer, was based on the public's definition of unacceptable amounts of haze as judged from slides of different haze levels taken in the Denver area. At the standard, 7.6 percent of the light in a kilometer of air is blocked. The standard applies from 8 A.M. to 4 P.M. each day, during those hours when the relative humidity is less than 70 percent. Visibility, along with meteorology and concentrations of other pollutants for which National Ambient Air Quality Standards exist, is used to determine the need for mandatory woodburning and voluntary driving restrictions.

There is no quantitative visibility standard for Colorado's pristine and scenic rural areas. However, in the 1977 amendments to the Federal Clean Air Act, Congress added Section 169a[41] and established a national visibility goal that created a qualitative standard of "the prevention of any future and the remedying of any existing, impairment of visibility in mandatory Class I federal areas which impairment results from manmade air pollution." The implementation of Section 169a has led to federal requirements to protect visual air quality in large national parks and wilderness areas.[42] Colorado has 12 of these Class I areas. Federal and state law prohibits visibility impairment in national parks and wildernesses due to large stationary sources of air pollution.

3.1.2 Visibility - Health Effects

Visual air quality is an element of public welfare. Specifically, it is an important aesthetic, natural and economic resource of the state of Colorado. EPA, the US Forest Service and the US Park Service have made studies that show that good visibility is something that people undeniably value. They have also shown that impaired visibility affects the enjoyment of a recreational visit to a scenic mountain area. The Division believes although the worth of visibility is difficult to measure, people prefer to have clear views from their homes and offices. These concerns are reflected in residential property values and office rents. Any loss in visual air quality may contribute to corresponding losses in tourism and usually make an area less attractive to residents, potential newcomers and industry.

Researchers have found this link strongest with concentrations of fine particles, which also contribute to visibility impairment. In July 1997, the EPA developed a National Ambient Air Quality Standard for particulate matter less than 2.5 microns in diameter ($PM_{2.5}$). See the Section 2.6 for more information on $PM_{2.5}$. Any control strategies to lower ambient concentrations of fine particulate matter for health reasons will also improve visibility.

3.1.3 Visibility - Sources

The cause of visibility impairment in Colorado is most often fine particles in the 0.1 to 2.5 micrometer size range (one micrometer is a millionth of a meter). Light passing from a vista to an observer is either scattered away from the sight path or absorbed by the atmospheric fine particulate. Sunlight entering the pollution cloud may be scattered into the sight path adding brightness to the view and making it difficult to see elements of the vista. Sulfate, nitrate, elemental carbon and organic carbon are the types of particulate matter most effective at scattering and/or absorbing light. The man-made sources of these particulates include woodburning, electric power generation, industrial combustion of coal or oil, and emissions from cars, trucks and buses.

Visibility conditions vary considerably across the state. Usually, visibility in Colorado is among the best in the country. Our prized western vistas exist due to unique combinations of topography and scenic features. Air in much of the West contains low humidity and minimal levels of visibility-degrading pollution. Nevertheless, visibility problems occur periodically throughout the state. Woodburning haze is a concern in several mountain communities each winter. Denver has its "Brown Cloud." Even the national parks, monuments, and wilderness areas shows pollution related visibility impairment on occasion due to regional haze, the interstate or even regional-scale transport of visibility-degrading pollution.

The visibility problems across the state have raised public concern and spurred research. The goal of Colorado's visibility program is to protect visual air quality where it is presently good and improve visibility where it is degraded.

3.1.4 Visibility - Monitoring

There are several ways to measure visibility. Currently, the Division uses camera systems to provide qualitative visual documentation of a view. Transmissometers and nephelometers are used to measure the atmosphere's ability to attenuate light quantitatively.

A visibility site was installed in Denver in late 1990 using a long-path transmissometer. Visibility in the downtown area is monitored using a receiver located near Cheesman Park at 1901 E. 13th Avenue and a transmitter located on the roof of the Federal Building at 1929 Stout Street. This instrument directly measures light extinction, which is proportional to the ability of atmospheric particles and gases to attenuate image-forming light as it travels from an object to an observer. The visibility standard is stated in units of atmospheric extinction. Days when the visibility is affected by rain, snow or high relative humidity are termed "excluded" (as shown in Figures 27 and 29) and are not counted as violations of the visibility standard. In September 1993, a transmissometer and nephelometer were purchased by the city of Fort Collins to monitor visibility.

In Colorado, several agencies of the federal government, in cooperation with regional and nationwide state air pollution organizations, also monitor visibility in a number of national parks and wilderness areas "Class I" areas, either individually or jointly through the Inter-agency Monitoring of PROtected Visual Environments (IMPROVE) monitoring program. The goals of the monitoring programs are to establish background visibility levels, identify trends of deterioration or improvement, to identify suspected sources of visibility impairment and to track regional haze. Visibility and the atmospheric constituents that cause visibility degradation are characterized with camera systems, transmissometers and extensive fine particle chemical composition measurements by the monitoring network. There are currently monitoring sites in Rocky Mountain National Park, Mesa Verde National Park, Weminuche Wilderness, Mount Zirkel Wilderness, Great Sand Dunes National Monument and White River National Forest. These data are not contained in this report, but are available at this web site address: http://vista.cira.colostate.edu/improve/

3.1.5 Visibility - Denver Camera

The Division operates a web-based camera that can be viewed by clicking on the "Live Image of Denver" tab on the left side of the screen at the Air Pollution Control Division's web site http://www.colorado.gov/airquality. There is a great deal of other information available from this site in addition to the image from the visibility camera. The Front Range Air Quality Forecast, Air Quality Advisory, Monitoring Reports and Open Burning Forecast are also available.

The images in Figure 9 show the visibility on one of the “Best” and “Worst” days in 2008. The “Best “visibility day was April 14, 2008. The “Worst” visibility day was December 16, 2008; both pictures were taken at 2:00 PM.

These two pictures are images made by the web camera at the visibility monitor located at 1901 E. 13th Avenue in Denver. These images are centered on the Federal Building at 1929 Stout Street. The difference in these two pictures is not just the brightness but the detail that can be seen in the image in the top as compared to the image on the bottom. Look specifically at the edges of the downtown buildings and the area on the horizon at the right edge of the picture.

Figure 9 - Best and Worst Visibility Days For 2008

3.2 Nitric Oxide

Nitric oxide is the most abundant of the oxides of nitrogen emitted from combustion sources. There are no known adverse health effects at normal ambient concentrations. However, nitric oxide is a precursor, to nitrogen dioxide, nitric acid, particulate nitrates and ozone, all of which have demonstrated adverse health effects.[43] There are no federal or state standards for nitric oxide.

3.3 Total Suspended Particulates

Total suspended particulates (TSP) were first monitored in Colorado in 1960 at 414 14th Street in Denver. This location monitored particulates until 1988. The Adams City and Gates total suspended particulate monitors began operation in 1964 and the Denver CAMP monitor at 2105 Broadway began operating in 1965. Either the Federal EPA or the City of Denver operated these monitors until the mid-1970s when daily operation was taken over by the Colorado Department of Public Health and Environment. None of these sites are in operation today.

Particulate monitoring expanded to more than 70 locations around the state by the early 1980s. The primary standards for total suspended particulates were 260 $\mu g/m^3$ as a 24-hour sample and 75 $\mu g/m^3$ as an annual geometric mean. On July 1, 1987, with the promulgation of the PM_{10} standards, the old particulate standards were eliminated. Until December 2006 the Division operated six TSP samplers to measure lead. On January 1, 2007 the number of lead monitoring sites was reduced to one, at the Denver Municipal Animal Shelter located at 678 S. Jason Street. The reason for the change in the number of lead monitors is that the ambient concentrations of lead have been reduced dramatically and federal monitoring requirements have been changed.

3.4 Meteorology

The Air Pollution Control Division takes a limited set of meteorological measurements at 17 locations around the state. These measurements include wind speed, wind direction, temperature, standard deviation of horizontal wind direction and select monitoring of relative humidity. Relative humidity measurements are also taken in conjunction with the two visibility monitors. The humidity data are not summarized in this report since they are used primarily to validate the visibility measurements taken at the specific locations. The Division does not collect precipitation measurements. The wind speed, wind direction and temperature measurements are collected primarily for air quality forecasting and air quality modeling. These instruments are on ten-meter towers and the data are collected as hourly averages and sent along with other air quality data to be stored on the EPA's Air Quality Systems data base. The wind speed and wind direction data are shown as wind roses at the end of each area in Section 6.

The wind roses displayed in this report are placed on a background map that shows the approximate location of the meteorological site. The wind roses are based on the direction that the wind is blowing from. Another way of visualizing a wind rose is to picture you standing in the center of the plot and facing into the wind. The wind direction is broken down in the 16 cardinal directions (i.e. N, NNE, NE, ENE, E, ESE, SE, SSE, S, etc). The wind speed is broken down in six categories. The graphs in this report use 1-3 mph, 4-5 mph, 7-11 mph, 12-14 mph, 15-38 mph and greater than 38 mph. The length of each arm of the wind rose represents the percentage of time the wind was blowing from that direction at that speed. The longer the arm the greater percentage of time the wind is blowing from that direction. A review of the wind rose in Figure 31, on page 58, for example, shows that in Arvada the majority of the winds come from the west and west-northwest and that these winds are generally in the 1-3 mph and 4-6 mph ranges.

3.5 Air Toxics

Toxic air pollutants, or air toxics, are those pollutants that cause or may cause cancer or other serious health effects, such as reproductive effects or birth defects. Air toxics may also cause adverse environmental and ecological effects. EPA is required to reduce air emissions of 188 air toxics listed in the Clean Air Act. Examples of toxic air pollutants include benzene, found in gasoline; perchloroethylene, emitted from some dry cleaning facilities; and methylene chloride, used as a solvent by a number of industries. Most air toxics originate from man-made sources, including mobile sources (e.g., cars, trucks, construction equipment) and stationary sources (e.g., factories, refineries, power plants), as well as indoor sources (e.g., some building materials and cleaning solvents). Some air toxics are also released from natural sources such as volcanic eruptions and forest fires.[44]

People exposed to toxic air pollutants at sufficient concentrations may experience various health effects including cancer and damage to the immune system, as well as neurological, reproductive (e.g., reduced fertility), developmental, respiratory and other health problems. In addition to exposure from breathing air toxics, risks also are associated with the deposition of toxic pollutants onto soils or surface waters, where they are taken up by plants and ingested by animals and eventually magnified up through the food chain. Like humans, animals may experience health problems due to air toxics exposure.

The APCD currently monitors for air toxics in Grand Junction as part of EPA's National Air Toxics Trend Stations project. The data from this study are available in a separate report.

3.6 $PM_{2.5}$ Chemical Speciation

Chemical speciation analysis is conducted on some $PM_{2.5}$ filters. These analyses are conducted for several elements and chemical compounds, which can cause serious health effects, premature deaths, visibility degradation and regional haze. There are two broad categories of $PM_{2.5}$: primary and secondary particles. Primary $PM_{2.5}$ particles are those emitted directly to the air from crushed geologic materials to carbonaceous particles from incomplete combustion (see Section 2.6.3 for more information on $PM_{2.5}$ sources). Secondary $PM_{2.5}$ is formed from gases that combine in the atmosphere through chemical processes and form liquid aerosol droplets. If the $PM_{2.5}$ pollution needs to be controlled it is important to know the composition of $PM_{2.5}$ particles so that the appropriate sources can be targeted for control.

Numerous health effects studies have correlated negative health effects to the total mass concentration of $PM_{2.5}$ in ambient air.[45] However, it has not yet been determined if the health correlation is to total mass concentration or to concentrations of specific chemical species in the $PM_{2.5}$ mix. When the EPA promulgated the NAAQS for $PM_{2.5}$ in 1997 a compliance monitoring network based upon total $PM_{2.5}$ mass was established. Mass concentrations from the compliance network are used to determine attainment of the NAAQS. EPA soon supplemented the $PM_{2.5}$ network with the Speciation Trends Network (STN) monitoring to provide information on the chemical composition of $PM_{2.5}$. The main purpose of the Speciation Trends Network is to identify sources, develop implementation plans to reduce $PM_{2.5}$ pollution and support health effects research.

Colorado began chemical speciation monitoring at the Commerce City site in February 2001 at the state's only STN site. Four other chemical speciation sites were established in 2001 in the following areas: Colorado Springs, Durango, Grand Junction and Platteville. The Durango site was closed in September 2003. The Colorado Springs site was closed on December 31, 2006. These sites were eliminated when funding was reduced for the project.

Each air filter is analyzed for gravimetric mass, 48 elemental concentrations (sodium through lead), organic (four types) and elemental carbon and five ions (ammonium, sodium, potassium, sulfate and nitrate.) Selected filters can also be analyzed for semi-volatile organics and microscopic analyses. The results of these samples can be obtained from the APCD upon request.

4.0 Statewide Summaries for Criteria Pollutants

4.1 Carbon monoxide

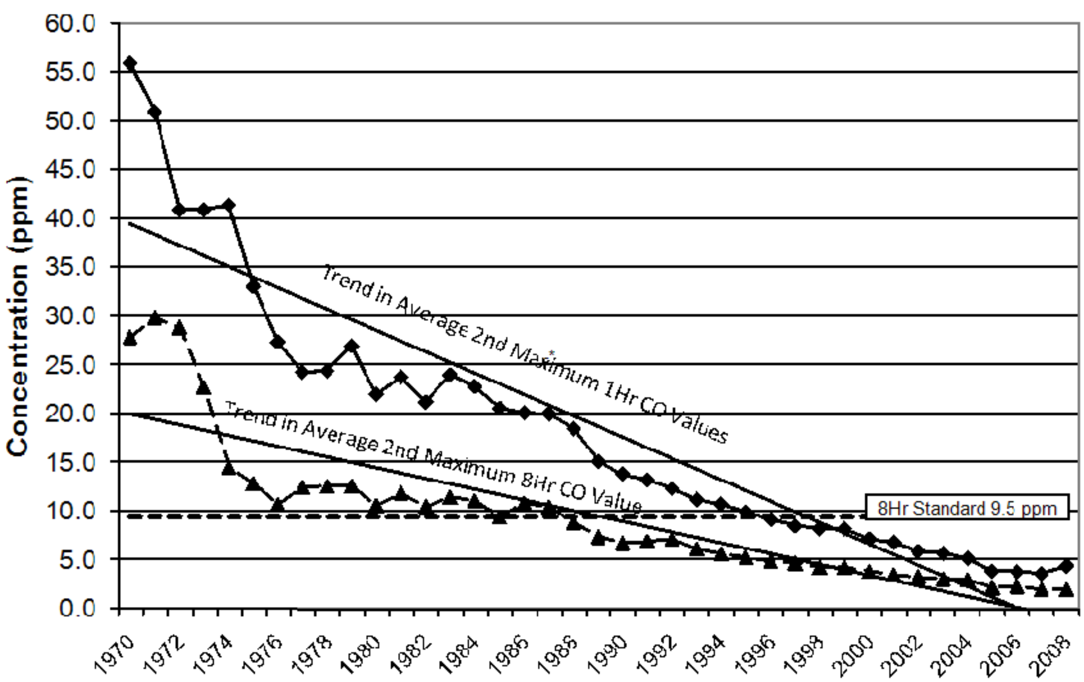
Carbon monoxide concentrations have dropped dramatically from the early 1970s. This change can be seen in both the concentrations measured and the number of monitors that exceeded the level of the 8-hour standard. In 1975, 9 of the 11 state-operated monitors exceeded the 8-hour standard. In 1980, 13 of the 17 state-operated monitors exceeded the 8-hour standard. Since 1996 none of the state-operated monitors have recorded a violation of the 8-hour standard. In 2008 the highest statewide 2nd maximum 8-hour concentration was a 3.1 ppm recorded at the Denver-CAMP monitor located at 2105 Broadway monitor.

Figure 10, shows the trend of the statewide average for the second maximum 1-hour and 8-hour concentrations for carbon monoxide for the periods from 1970 to 2008.

Two important points to note are:

1. Before 1989 the average 2nd maximum 8-hour concentration for all state-operated carbon monoxide monitors was greater than the 8-hour standard of 9.5 ppm.
2. In the last 5 years the downward trend in concentrations has continued, but at a slower rate. The statewide average 8-hour concentration is now about one quarter of the standard or 2.4 ppm.

Figure 10 - Statewide Ambient Trends - Carbon Monoxide[46]



The trend in the second maximum1-hour average carbon monoxide concentrations statewide has fallen more dramatically than the 8-hour concentrations. The maximum 1-hour concentration ever recorded at any of the state-operated monitors was a 79.0 ppm recorded at the Denver CAMP monitor in 1968. In 2008, the maximum 1-hour concentration recorded was 7.1 ppm recorded at the Denver CAMP and Grand Junction monitor. The 1-hour annual maximum concentrations have declined from more than twice the standard in the late 1960s to about one quarter of the standard in 2008. Table 12 presents the historical maximum values.

Table 12 - Historical Maximum 1-Hr and 8-Hr Carbon Monoxide Concentrations[47]

1-Hour ppm	Location	Date	Number of Annual Exceedances	8-Hour ppm	Location	Date	Number of Annual Exceedances
79.0	CAMP	11-20-68	13	48.1	CAMP	12-21-73	133
70.0	CAMP	11-21-74	15	33.9	CAMP	12-28-65	197
67.0	CAMP	12-21-73	21	33.4	CAMP	12-04-81	42
65.0	CAMP	12-21-73	21	33.2	CAMP	12-23-71	188
64.9	NJH-W	11-16-79	15	33.1	CAMP	11-20-68	98
2008 Maximum Carbon Monoxide Concentration							
7.1	CAMP	01-03-08	0	3.8	CAMP	01-03-08	0
7.1	Grand Junction	10-31-08	0	2.6	Grand Junction	10-21-08	0

4.2 Ozone

A complete analysis of the trend in ozone values over time is more complex than the simple linear regression used for this report since it must deal with variations in meteorological conditions from year to year. However, Figure 11 Statewide Ambient Trends shows that the second maximum 1-hour ozone concentrations have declined since 1985. The trend is not as clear for the 8-hour average ozone concentrations, but over the past 20 years it is essentially flat. According to the Denver Early Action Ozone Compact, February, 2004 the high values seen in 2003 were the result of "Anomalously high temperatures and anomalously low mixing heights. . . "

The Division conducted a detailed analysis of the ozone trends as a part of the Denver Early Action Ozone Compact, February, 2004. That report concluded that there had been a decline in the daily 8-hour concentrations of 1.2 percent per year for the period from 1993 through 2003. The full report is available on the web at http://www.colorado. gov/airquality.

Table 13 lists the five highest 1-hour ozone concentrations recorded in Colorado. Ozone monitoring began in 1972 at the Denver CAMP station and eight exceedances of the 1-hour standard were recorded that year. Table 14 lists the 5 highest 8-hour ozone concentrations recorded in Colorado.

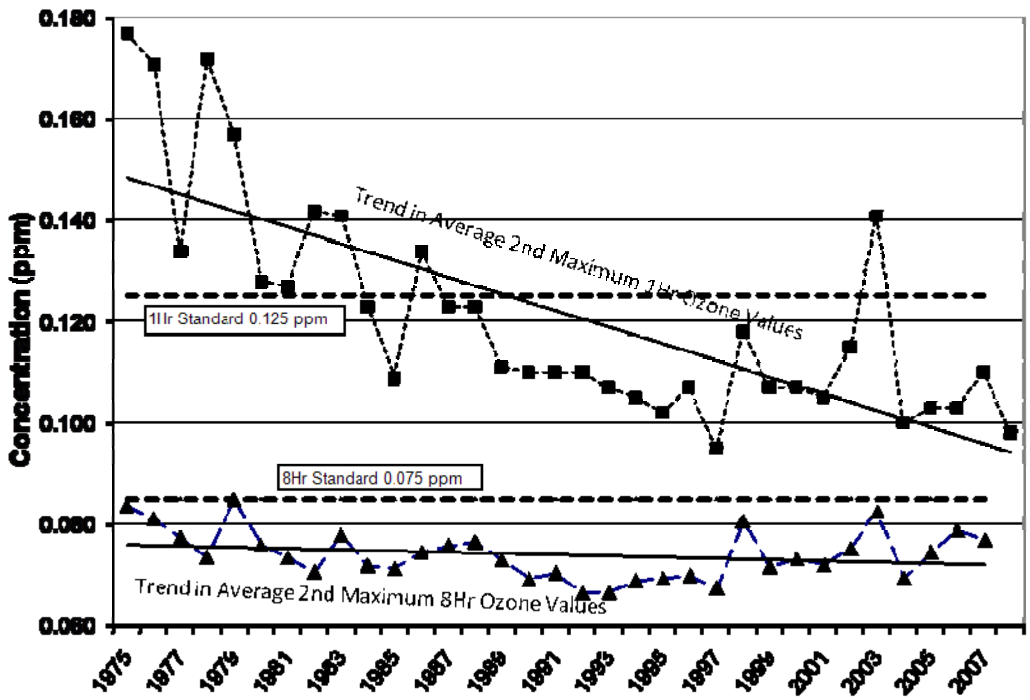
Table 13 - Historical Maximum 1-Hour Ozone Concentrations[48]

1-Hour ppm	Monitor	Date
0.265	Arvada	1973
0.250	Welby	1974
0.223	Welby	1978
0.220	Arvada	1974
0.200	Welby	1973
2008 Maximum Ozone Concentration		
0.102	Welch, 12400 W. Hwy 285	07-10-08

Table 14 - Historical Maximum 8-Hour Ozone Concentrations[49]

8-Hour ppm	Monitor	Date
0.310	Denver CAMP	1972
0.264	Denver CAMP	1973
0.198	Arvada	1973
0.194	Denver CARIH	1973
0.146	Denver CAMP	1980
2008 Maximum Ozone Concentration		
0.095	Welch, 12400 W. Hwy 285	07-10-08

Figure 11 - Statewide Ambient Trends - 1-Hr and 8-Hr Ozone Averages



4.3 Sulfur Dioxide

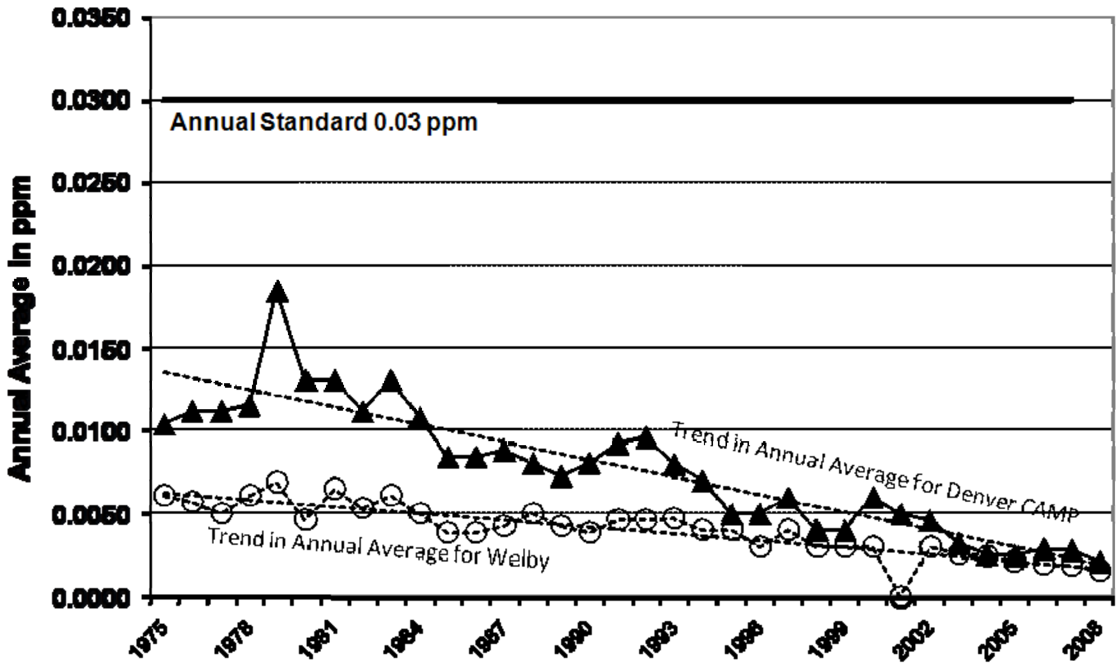
The concentrations of sulfur dioxide in Colorado have never been a major health concern since we have few industries that burn large amounts of coal. The concern in Colorado with sulfur dioxide has been associated with acid deposition and its effects on the mountain lakes and streams. Historically the maximum annual concentration recorded by APCD monitors was 0.018 ppm in 1979 at the Denver CAMP monitor. The annual standard is 0.030 ppm. Since 1990, the annual average at the Denver CAMP monitor has declined from a high in 1992 of 0.010 ppm to 0.0018 ppm in 2008.

Figure 12 shows both the declining trend in sulfur dioxide readings as well as the generally low concentrations of sulfur dioxide recorded at the APCD's monitors. This same trend is evident, although not as pronounced, in the 3-hour and 24-hour averages as well.

Table 15 - Historical Maximum Annual Average Sulfur Dioxide Concentrations[50]

Annual Average ppm	Monitor	Date
0.0182	CAMP	1979
0.0129	CAMP	1981
0.0129	CAMP	1983
0.0128	CAMP	1980
0.0106	CAMP	1984
2008 Maximum Sulfur Dioxide Concentration		
0.0021	Welby	2008

Figure 12 - Statewide Trends - Annual Average Sulfur Dioxide



4.4 Nitrogen Dioxide

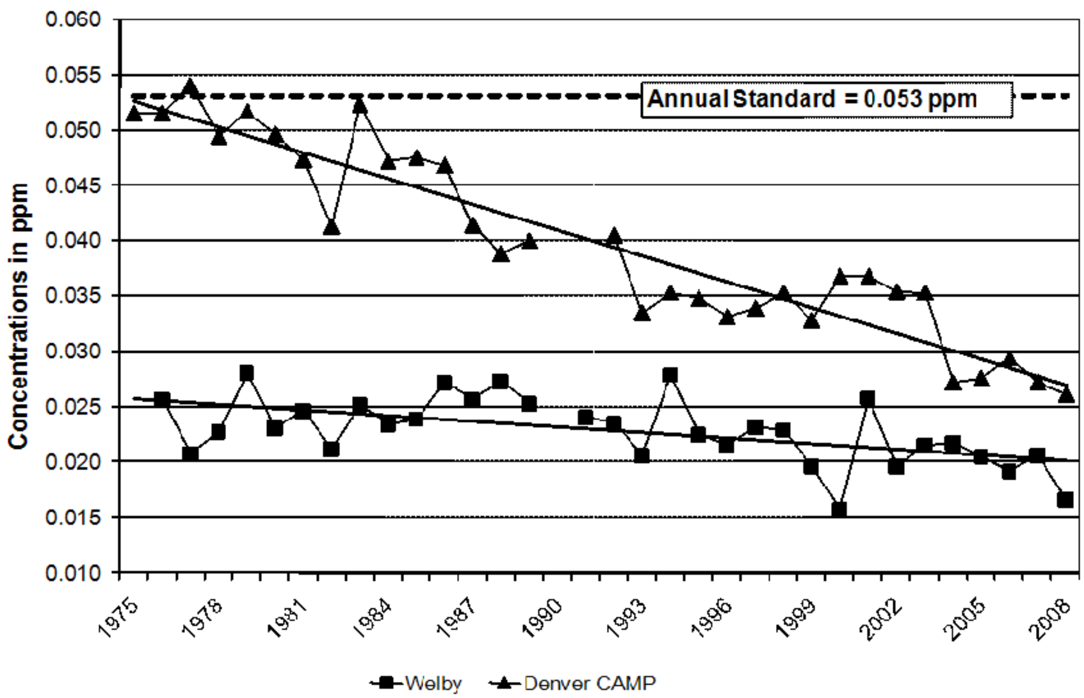
Colorado exceeded the nitrogen dioxide standard in 1977 at the Denver CAMP monitor. Concentrations have shown a gradual decline for the past 20 years. However, the trend of annual averages for the past ten years has been nearly flat.

Figure 13 shows that levels have declined at the Welby monitor over the past ten years the annual average at the Denver CAMP monitor has shown little to no change at all. The cause of this is most likely due to an increase in the number of vehicles and increased power generation associated with the increases in population in the Denver-metro area.

Table 16 - Historical Maximum Annual Average Nitrogen Dioxide Concentrations[51]

Annual Average ppm	Monitor	Date
0.0540	CAMP	1977
0.0523	CAMP	1983
0.0517	CAMP	1979
0.0515	CAMP	1975
0.0515	CAMP	1976
2008 Maximum Nitrogen Dioxide Concentration		
0.0286	CAMP	2008

Figure 13 - Statewide Trends - Annual Average Nitrogen Dioxide



4.5 Particulates - PM_{10}

Particulate matter 10 microns and smaller (PM_{10}) data have been collected in Colorado since 1985. The samplers were modified in 1987 to conform to the requirements of the new standard when it was established in July of 1987. Therefore, annual trends are only valid back to July 1987.

Since 1988, the state has had at least one monitor exceed the level of the 24-hour PM_{10} standard (150 $\mu g/m^3$) every year except 2004. By contrast, no monitor with at least 75 percent data recovery has exceeded the level of the annual standard (50 $\mu g/m^3$). As seen in Figure 14, there is a great deal more variation in the 24-hour maximum values than in the annual averages.

The data contained in Table 17 the Historical Maximum values table, include those concentrations that are the result of exceptional events. There have been several of these events documented in Colorado since PM_{10} monitoring began in 1988. In general, in order to qualify for exclusion, a value (or values) has to be associated with a regional natural or "exceptional" phenomenon.

One such event was the large wind and dust storm that occurred on March 31, 1999 when monitors from Steamboat Springs to Telluride reported high PM_{10} concentrations. Similar exceptional events have been documented in Lamar and Alamosa. These events are not included in NAAQS determinations, not because they are without any health risk but because they are natural and are not controllable or predictable.

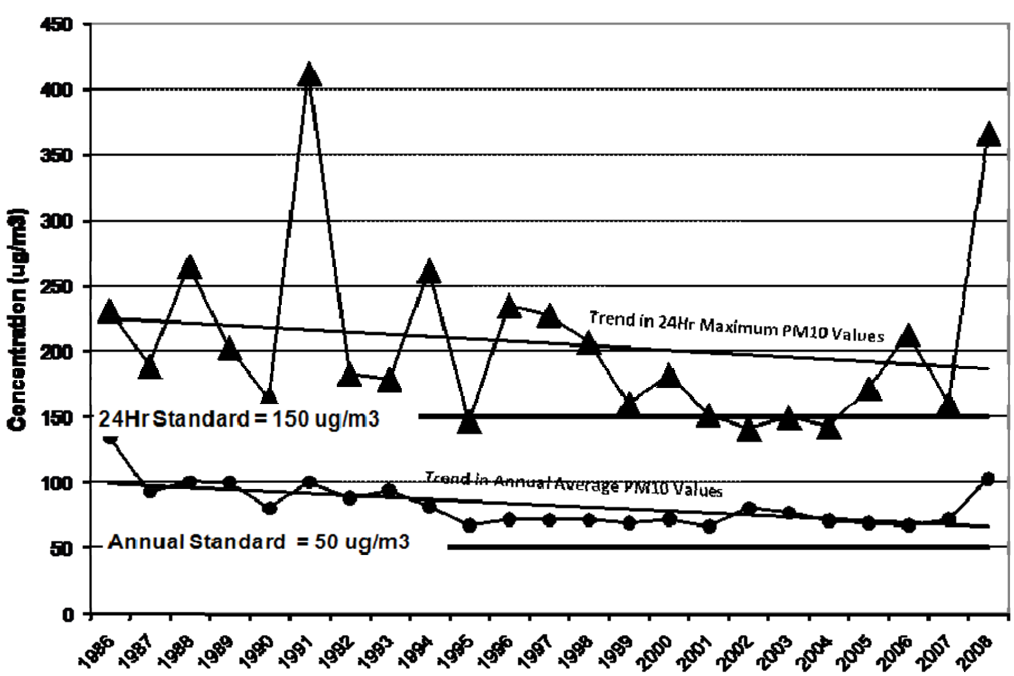
Table 17 - Historical Maximum 24-Hour PM_{10} Concentrations[52]

24-Hour Maximum μg/m³	**Monitor**	**Date**
494	Alamosa - Municipal	06-06-2007
473	Alamosa - ASC	06-06-2007
424	Alamosa - ASC	02-10-2006
412	Alamosa - ASC	04-10-1991
367	Lamar, Power Plant	05-02-2008
2008 Maximum PM_{10} Concentration		
* 367 μg/m³	Lamar, Power Plant	05-02-2008

* - This value was the result of a regional high wind event.

Figure 14-Statewide Ambient Trends shows a decline in both the 24-hour and the annual average concentrations since 1987. This graph has been modified from previous years in that the exceptional events have been excluded from the trend data. The 412 μg/m³ in 1991 occurred at the Alamosa – ASC monitor and may have been a high wind event as well. The overall trend remains the same whether the 1991 value is included or not. The trend in the 24-hour concentrations over the past three years is increasing but the trend in the annual average concentrations has continued to decline.

Figure 14 - Statewide Ambient Trends - PM_{10}



4.6 Particulates - $PM_{2.5}$

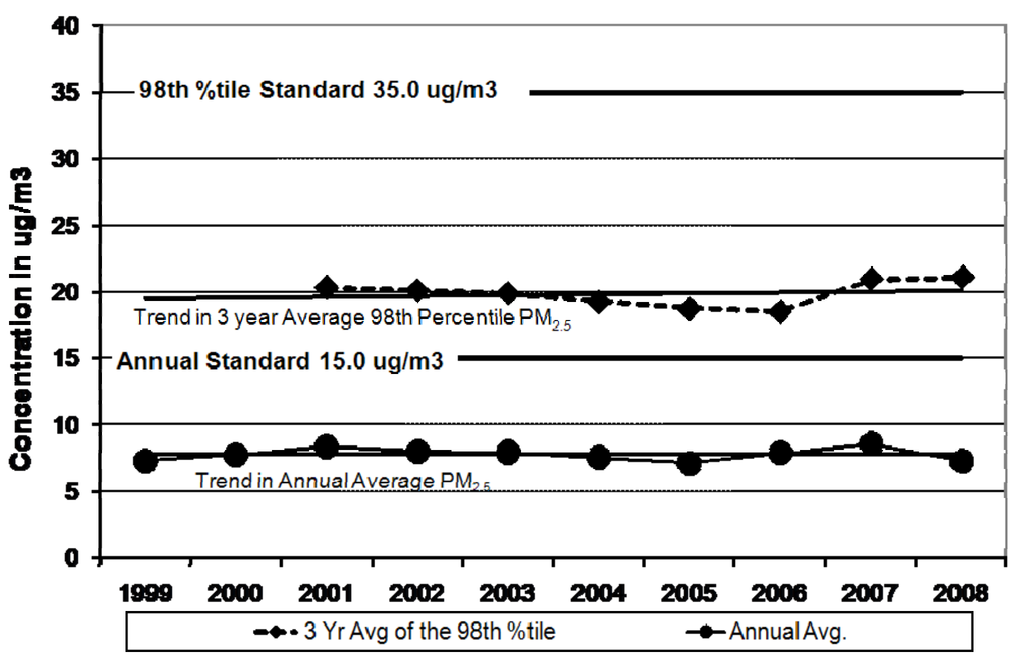
Monitoring for $PM_{2.5}$ in Colorado began with the establishment of sites in Denver, Grand Junction, Steamboat Springs, Colorado Springs, Greeley, Fort Collins, Platteville, Boulder, Longmont and Elbert County in 1999. Additional sites were established nearly every month until full implementation of the base network was achieved in July of 1999. In 2004, there were 20 $PM_{2.5}$ monitoring sites in Colorado. Thirteen of the 20 sites were selected based on the population of the metropolitan statistical areas. This is a federal selection criterion that was developed to protect the public health in the highest population centers. In addition, there were seven special purpose-monitoring (SPM) sites. These sites were selected due to historically elevated concentrations of PM_{10} or because citizens or local governments had concerns of possible high $PM_{2.5}$ concentrations in their communities. All SPM sites were removed as of December 31, 2006 due to low concentrations and a lack of funding.

Table 18 - Historical Maximum Quarterly $PM_{2.5}$ Concentrations[53]

24-Hour Maximum µg/m^3	Monitor	Date
68.4	Denver CAMP	2-15-2001
68.0	Denver CAMP	2-17-2001
60.5	Denver CAMP	2-08-2007
60.2	Arapahoe Community College	2-08-2007
57.3	Commerce City	2-17-2001
2008 Maximum $PM_{2.5}$ Concentration		
34.4	Commerce City	2-15-2008

The EPA lowered the 24-hour standard to 35 µg/m^3 September 20, 2006. The EPA used the 2004-2006 $PM_{2.5}$ data to compare sites to the new 24-hour standard. Several sites have exceeded the level of the new standard. However, no sites have violated the 3-year average for the standard in 2007. However, there were no exceedances of any standard in 2008.

Figure 15 - Statewide Ambient Trends - $PM_{2.5}$



4.7 Lead

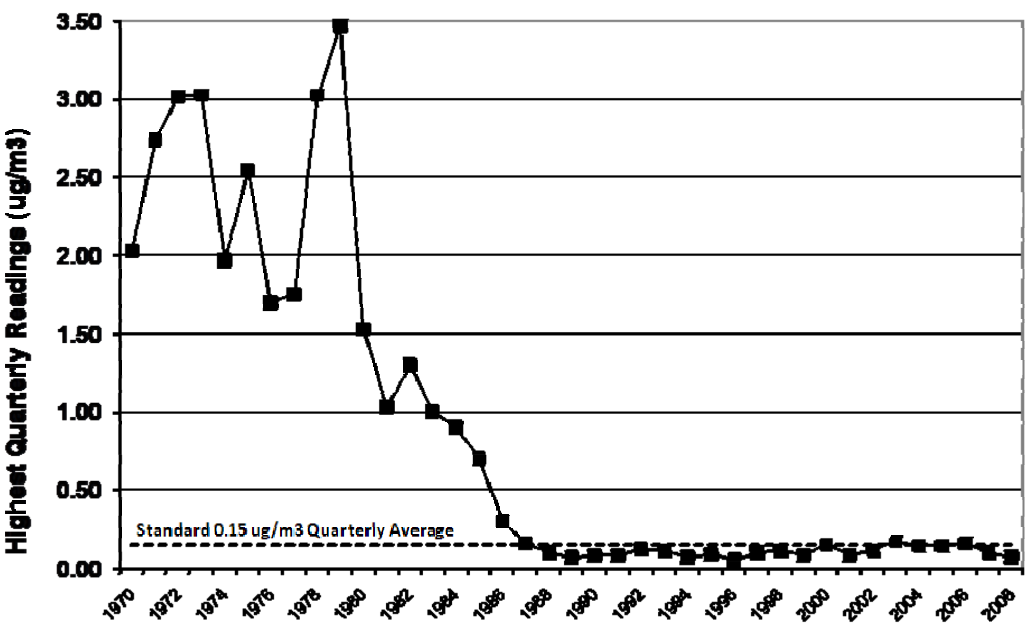
In Colorado the last violation of the old 1.5 µg/m^3 lead standard occurred in the first quarter of 1980 at the Denver CAMP monitor. Since then, the concentrations recorded at all monitors have shown a steady decline. This decline is the direct result of the use of unleaded gasoline and replacement of older cars with newer ones that do not require leaded gasoline. The reduction in atmospheric lead shows what pollution control strategies can accomplish. In 2006, monitoring for lead by the APCD was reduced from six locations to one. In 2007 that lead monitor was moved from the Denver CAMP location to the Denver Municipal Animal Shelter at 678 S. Jason St.

The EPA established a new level for the lead standard on October 15, 2008. A more complete discussion of the new standard is covered in Section 2.7.1. Colorado currently operates only one lead monitor but as a result of the requirements in the new standard a second monitor will be established at the Centennial Airport in 2010.

Table 19 - Historical Maximum Quarterly Lead Concentrations[54]

Quarterly Maximum µg/m^3	**Monitor**	**Date**
3.47	Denver CAMP, 2105 Broadway	1st Qtr 1979
3.40	Denver, 414 14th St.	4th Qtr 1969
3.03	Denver, 414 14th St.	1st Qtr 1973
3.03	Denver CAMP, 2105 Broadway	4th Qtr 1978
3.02	Denver, 414 14th St.	4th Qtr 1972
2008 Maximum Quarterly Lead Concentration		
0.01	Denver Animal Shelter	1st Qtr 2008

Figure 16 - Statewide Ambient Trends - Lead



5.0 National Comparisons for Criteria Pollutants

5.1 Carbon monoxide

According to the Environmental Protection Agency's emissions trends report: Between 1980 and 2008, national average ambient carbon monoxide concentrations decreased 79 percent.[55] The National Ranking of Carbon Monoxide monitors in 1998 showed that the top sixteen monitors recorded at least one exceedance of the 8-hour carbon monoxide standard with nine monitors reporting two or more exceedances.[56] In 2008 only a single monitor reported an exceedance of the level of the standard.

Table 20 - 2008 National Ranking of Carbon Monoxide Monitors by 8-Hr Concentrations in ppm[57]

Nationwide (365 monitors)					Colorado (13 Monitors)				
National Rank	City/Area	Max	2nd Max	# ≥9.5	National Rank	City/Area	Max	2nd Max	# ≥9.5
1	Birmingham, AL	10.7	8.1	1	21	Longmont	3.2	2.7	0
2	Ogden, UT	8.8	6.4	0	24	CAMP	3.1	3.1	0
3	Huston, TX	5.9	5.2	0	25	Welby	3.1	2.4	0
4	Calexico, CA	5.3	4.1	0	27	Fort Collins	3.0	2.9	0
5	El Paso, TX	4.9	3.2	0	28	Firehouse #6	3.0	2.4	0

5.2 Ozone

Between 1990 and 2007, NO_X and VOC emissions have declined 33 percent and 35 percent respectively. These are two of the primary factors in ozone production. This decline has been accomplished in spite of increases in energy consumption, up 20 percent; population, up 21 percent; vehicle miles traveled, up 45 percent and gross national product, up 63 percent.[58]

Table 21 - 2008 National Ranking of Ozone Monitors by 1-Hr Concentration in ppm[59]

Nationwide (1,189 Monitors)					Colorado (15 Monitors)				
National Rank	City/Area	Max	2nd Max	Days ≥0.125	National Rank	City/Area	Max	2nd Max	Days ≥0.125
1	Crestline, CA	0.176	0.162	16	334	Welch	0.102	0.090	0
2	Anadarko, OK	0.169	0.160	2	374	Chatfield Reservoir	0.101	0.098	0
3	Folsom, CA	0.166	0.161	5	379	Denver Animal Shelter	0.100	0.098	0
4	Fontana, CA	0.162	0.149	7	392	Welby	0.100	0.095	0
5	Santa Clara, CA	0.160	0.150	7	451	NREL	0.097	0.093	0

Table 22 - 2008 National Ranking of Ozone Monitors by 8-Hr Concentration in ppm[60]

Nationwide (1,189 Monitors)					Colorado (15 Monitors)				
National Rank	City/Area	Max	4th Max	Days ≥0.075	National Rank	City/Area	Max	4th Max	Days ≥0.075
1	Fresno, CA	0.132	0.108	47	150	Welch	0.095	0.073	3
2	Santa Clara, CA	0.131	0.103	55	248	Chatfield Reservoir	0.090	0.080	6
3	Turlock, CA	0.130	0.106	29	349	Denver Animal Shelter	0.086	0.070	1
4	Clovis, CA	0.127	0.108	24	382	NREL	0.085	0.076	5
5	Crestline, CA	0.126	0.120	91	383	Welby	0.085	0.076	4

5.3 Sulfur Dioxide

"Nationally, average sulfur dioxide ambient concentrations have decreased 71 percent from 1980 to 2008 and 37 percent over the more recent 10-year period of 1999 to 2008. Reductions in sulfur dioxide concentrations and emissions since 1990 are due, in large part, to controls implemented under EPA's Acid Rain Program beginning in 1995."[61]

Table 23 - 2008 National Ranking of Sulfur Dioxide Monitors by 24-Hr Concentration in ppm[62]

Nationwide (508 Monitors)					Colorado (2 Monitors)				
National Rank	City/Area	Max	2nd Max	#>0.14	Nat'l Rank	City/Area	Max	2nd Max	#>0.14
1	Hawaii VNP, HI	0.353	0.341	23	299	Denver CAMP	0.010	0.008	0
2	3150 Pikake St. HI	0.311	0.311	31	349	Welby	0.007	0.006	0
3	Council Bluffs, IA	0.184	0.129	1					
4	Mountain View, HI	0.159	0.105	1					
5	Herculaneum, MO	0.131	0.084	0					

5.4 Nitrogen Dioxide

Between 1980 and 2008 nitrogen dioxide concentrations have decreased 40 percent. The maximum annual average concentration for nitrogen dioxide in 2008 was 0.036 ppm recorded at 288 E. 57th Street, Manhattan New York. The Denver CAMP monitor at 2105 Broadway recorded a 0.0286 ppm as an annual average. While this did place the CAMP monitor as the nineth highest reporting monitor in the nation, it is still approximately one half of the annual standard of 0.053 ppm.

"Since 1983, monitored levels of nitrogen dioxide have decreased 21 percent. These downward trends in national nitrogen dioxide levels are reflected in all regions of the country. Nationally, average nitrogen dioxide concentrations are well below the NAAQS and are currently at the lowest levels recorded in the past 20 years. All areas of the country that once violated the NAAQS for nitrogen dioxide now meet that standard. Over the past 20 years, national emissions of oxides of nitrogen have declined by almost 15 percent. The reduction in emissions for oxides of nitrogen presented here differs from the increase in oxides of nitrogen emissions reported in previous editions of this report. In particular, this report's higher estimate of oxides of nitrogen emissions in the 1980s and early 1990s reflects an improved understanding of emissions from actual driving conditions. While overall oxides of nitrogen emissions are declining, emissions from some sources such as nonroad engines have actually increased since 1983. These increases are of concern given the significant role oxides of nitrogen emissions play in the formation of ground-level ozone (smog) as well as other environmental problems like acid rain and nitrogen loadings to water bodies described above. In response, EPA has proposed regulations that will significantly control oxides of nitrogen emissions from nonroad diesel engines."[63] Nonroad diesel engines are construction and mining vehicles as well as power generators.

Table 24 - 2008 National Ranking of Nitrogen Dioxide Monitors by 1-Hr Concentration in ppm[64]

Nationwide (424 Monitors)					Colorado (2 Monitors)				
National Rank	City/Area	1-hr Max	2nd Max	Ann. Avg.	National Rank	City/Area	1-hr Max	2nd Max	Ann. Avg.
1	Anacortes, WA	0.374	0.332	0.011	20	Denver CAMP	0.098	0.097	0.0286
2	Boston, MA	0.310	0.071	0.022	35	Welby	0.085	0.085	0.0173
3	Albuquerque, NM	0.261	0.175	0.009					
4	Chicago, IL	0.188	0.165	0.031					
5	Phoenix, AZ	0.138	0.126	0.026					

5.5 Particulates

The particulate monitoring areas have been divided into two groups. These groups are: th PM_{10} monitoring and the $PM_{2.5}$ monitoring. The reason for ths division is two fold. First, the data is collected on separate monitors and second, the monitors are not located in the same places. Therefore, the deserve and have their own sub sections.

5.5.1 Particulates - PM_{10}

In the past several years the top five locations on the list have generally included Keeler, CA; Olancha, CA; the sites around Owens Lake, CA and sites around Mono Lake, CA. This is the first year that Deming, NM has made the top five especially with a value of over 1,000 $\mu g/m^3$. All of these levels are associated with hot dry winds. The levels around Owens Lake are associated with the high winds that blow across the dry bed. In the past several years monitors in that area have recorded levels in excess of 20,000 $\mu g/m^3$ as a 24-hour average.[65]

Table 25 - 2008 National Ranking of PM_{10} Monitors by 24-Hr Maximum Concentration in $\mu g/m^3$ [66]

Nationwide (1,033 Monitors)					Colorado (41 Monitors)				
National Rank	City/Area	1st Max	2nd Max	Annual Mean	National Rank	City/Area	1st Max	2nd Max	Annual Mean
1	Lee Vining, CA	2,769	2,563	69	22	Lamar Power	367*	227*	30.0
2	Deming, NM	1,034	870	56	61	Parachute	210*	136	(46.0)
3	Keeler, CA	781	530	30	92	Alamosa - Municipal	157	155	(26.4)
4	Olancha, CA	693	498	23	101	Grand Junction - Pitkin	149	110	35.1
5	Owens Lake, CA	633	423	22	102	Pagosa Springs	149	74	23.6

() – Values within parentheses have been included but have less than 75% data recovery for the year.
* - These have been classified as exceptional events by the APCD. They are the result of high winds and blowing dust or construction activities.

5.5.2 Particulates - $PM_{2.5}$

"In 2008, the highest annual average $PM_{2.5}$ concentrations were in California, Arizona, Alabama, and Pennsylvania. The highest 24-hour $PM_{2.5}$ concentrations were in California, New Jersey as shown in Table 26. Even though California showed the greatest improvement since the start of the decade, they had some of the highest concentrations in 2008.

Some sites had high 24-hour $PM_{2.5}$ concentrations but low annual $PM_{2.5}$ concentrations, and vice versa. Sites that have high 24-hour concentrations but low or moderate annual concentrations exhibit substantial variability from season to season."[67]

Table 26 - 2008 National Ranking of $PM_{2.5}$ Monitors by 24-Hr Maximum Concentrations in µg/m^3 [68]

Nationwide (1,118 Monitors)					Colorado (19 Monitors)				
National Rank	City/Area	1st Max	2nd Max	Annual Mean	National Rank	City/Area	1st Max	2nd Max	Annual Mean
1	New Brunswick, NJ	765.0	23.5	40.37	425	Commerce City	34.4	26.7	9.55
2	Ukiak, CA	210.0	31.6	12.81	487	CAMP	32.7	30.3	7.90
3	Redding, CA	200.2	97.1	16.97	589	Swansea	30.7	29.0	7.98
4	Quincy, CA	142.2	133.0	14.69	605	Colo Spgs-RBD	30.4	15.0	7.71
5	Yuba City, CA	127.3	105.5	10.57	738	Grand Junction	27.8	27.3	8.33

5.6 Lead

"On October 15, 2008, EPA strengthened the National Ambient Air Quality Standards for lead. The level for the previous lead standards was 1.5 µg/m^3, not to be exceeded as an average for a calendar quarter, based on an indicator of lead in total suspended particles (TSP). The new standards, also in terms of lead in TSP, have a level of 0.15 µg/m^3, not to be exceeded as an average for any three-month period within three years."[69]

Table 27 - 2008 National Ranking of Lead Monitors by 24-Hr Maximum Concentration in µg/m^3 [70]

Nationwide (162 Monitors)					Colorado (1 Monitors)				
National Rank	City/Area	24-hr Max	Max Qtr	Running 3 Month Average >0.15	National Rank	City/Area	24-hr Max	Max Qtr	Running 3 Month Average >0.15
1	Muncie, IN	40.22	2.19	9	103	DMAS	0.019	0.009	0
2 (3)	Herculaneum, MO	39.08	2.33	10					
3 (7)	Iron County, MO	9.73	1.02	10					
4 (21)	Troy, AL	4.04	1.12	10					
5 (23)	Frisco, TX	3.42	1.19	10					

In Table 27 the rankings are shown as the highest five cities or areas. The number in parentheses is the national rank for the monitor. This method was chosen because the monitors around Herculaneum, MO, Iron County, MO and Muncie, IN account for the top twenty values in the United States. The monitors around Herculaneum, MO account for nineteen of the highest thirty values alone.

6.0 Monitoring Results by Area in Colorado

6.1 Eastern Plains Counties

The Eastern Plains Counties are those east of the urbanized I-25 corridor. Historically, there have been a number of communities that were monitored for particulates and meteorology but not for any of the gaseous pollutants. In the northeast along the I-76 corridor, the communities of Sterling, Brush and Fort Morgan have been monitored. Along the I-70 corridor only the community of Limon has been monitored for particulates. Along the US-50/Arkansas River corridor the Division has monitored for particulates in the communities of La Junta, Rocky Ford and Trinidad. These monitors were discontinued in the late 1970's and early 1980's after a review showed that the concentrations were well below the standard and trending downward.

Currently, there are two PM_{10} monitoring sites in Lamar and a background $PM_{2.5}$ monitor in Elbert County. The Lamar monitors have recorded exceedances of the 24-hour PM_{10} standard. These have been associated with high winds and dry conditions that can occur in springtime. The Elbert County monitor operates as a background $PM_{2.5}$ monitor. This monitor provides baseline $PM_{2.5}$ readings away from any influence of manmade particulate sources.

Table 28 - Eastern Plains Monitors in Operation For 2008

X - Monitors continued in 2008 A - Monitors added in 2008

D - Monitors discontinued in 2008 H - Hourly particulate monitor

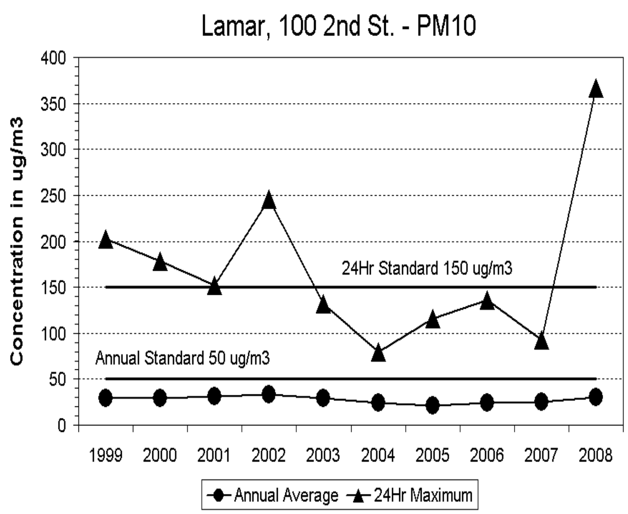
Site Name	Location	PM_{10}	$PM_{2.5}$	Met
Elbert				
Elbert	24950 Ben Kelly Rd.		X	
Prowers				
Lamar	100 2nd St.	X		
	104 Parmenter St.	X		
Lamar Port of Entry	7100 US Hwy 50			X

Table 29 - Eastern Plains Particulate Values For 2008

Location	PM_{10} (µg/m³)		$PM_{2.5}$ (µg/m³)	
	Annual Average	24-hour Maximum	Annual Average	24-hour Maximum
Elbert				
Elbert			4.32	10.9
Prowers				
100 2nd St.	30.0	367		
104 Parmenter St.	21.3	123		

() indicates <75 percent data recovery in one or more quarters.

Figure 17 - Eastern Plains PM_{10} Particulate Graphs



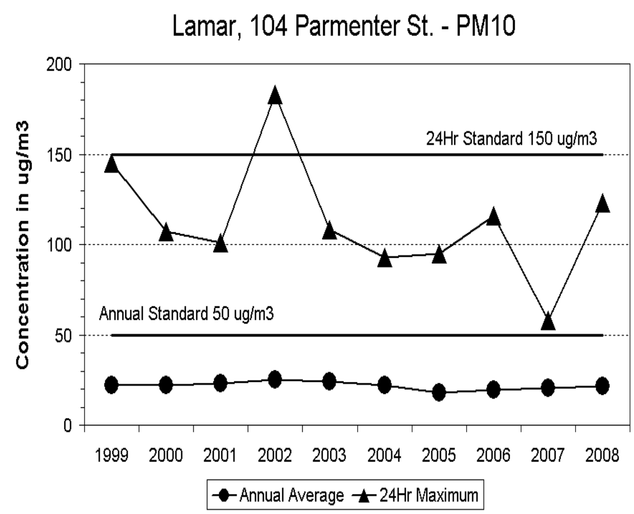


Figure 18 - Eastern Plains $PM_{2.5}$ Particulate Graph

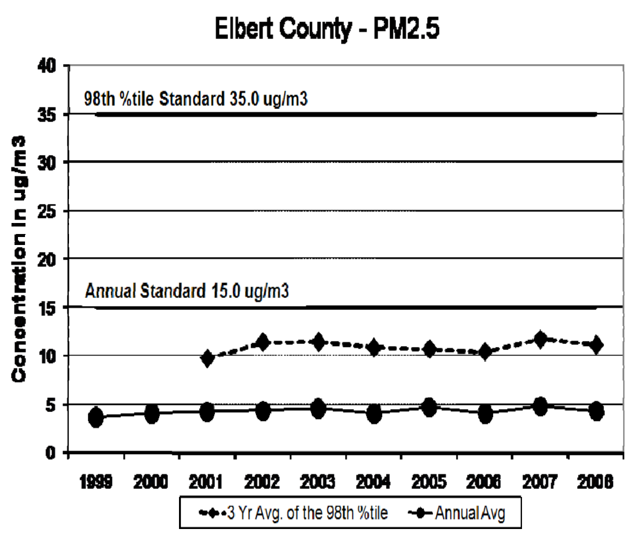
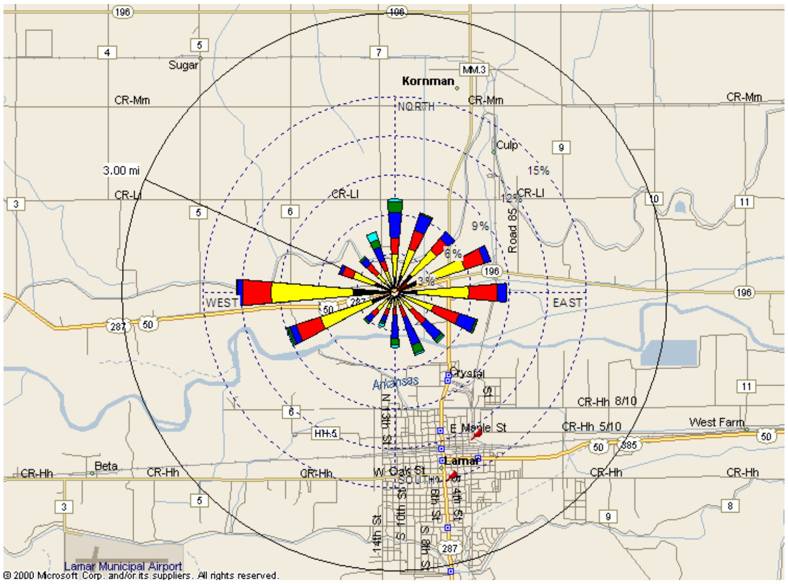


Figure 19 - Eastern Plains Wind Rose Graph
Lamar Port of Entry, 7100 US Hwy 50



6.2 Northern Front Range Counties

The Northern Front Range Counties are those along the urbanized I-25 corridor from the Colorado/Wyoming border to just south of the city of Castle Rock. This area has the majority of the larger cities in the state. The majority of monitors are located in the Denver-metro area and the rest are located in or near Fort Collins, Greeley, Longmont and Boulder.

Table 30 - Northern Front Range Particulate Monitors in Operation For 2008
X - Monitors continued in 2008 A - Monitors added in 2008
D - Monitors discontinued in 2008 H - Hourly particulate monitor S - Chemical Speciation

Site Name	Location	TSP	Pb	PM_{10}	$PM_{2.5}$
Adams					
Commerce City	7101 Birch St			X	X/H/S
Welby	3174 E. 78th Ave.			X/H	
Arapahoe					
Arapahoe Community Coll.	6190 S. Santa Fe Dr.				X
Boulder					
Boulder	2440 Pearl St			X	X
	2102 Athens St.				H
Longmont	350 Kimbark St.			X	X/H
Denver					
Denver-CAMP	2105 Broadway			X/H	X/H
Denver NJH	14th Ave. & Albion St.				H
Denver Visitor Center	225 W. Colfax Ave.			X	
Denver Animal Shelter	678 Jason St.	X	X	X/H	X/H
Swansea Elementary Sch.	4650 Columbine St.				X
Douglas					
Chatfield Reservoir	11500 Roxborough Rd				X/H
Larimer					
Fort Collins	251 Edison St.			X	X
Weld					
Greeley	1516 Hospital Rd.			X	X/H
Platteville	1004 Main St.				X/S

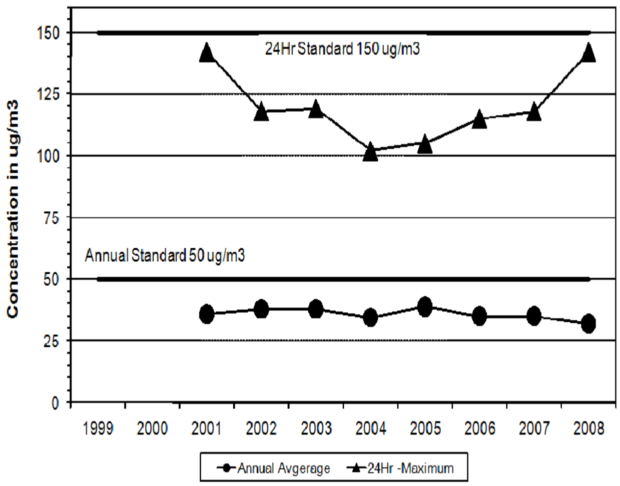
Table 31 - Northern Front Range Particulate Values For 2008

Site Name	PM_{10} (µg/m^3)		$PM_{2.5}$ (µg/m^3)	
	Annual Average	**24-hour Maximum**	**Annual Average**	**24-hour Maximum**
Adams				
Commerce City	32.0	142	9.46	34.4
(Continuous)			6.74	21.5
Welby	25.6	70		
(Continuous)	26.0	68		
Arapahoe				
Arapahoe Comm. College			7.18	21.1
Boulder				
Longmont	20.9	60	7.69	27.0
(Continuous)			8.09	89.4
Boulder, 2440 Pearl St,	20.2	52	6.48	24.9
Boulder, 2102 Athens St. (Continuous)			(6.43)	60.0
Denver				
Denver CAMP	28.7	57	8.04	32.7
(Continuous)	22.7	66	7.68	20.5
			8.67	66.0
Denver – NJH (Continuous)			7.35	45.6
Denver Visitor Center	25.8	76		
Denver Animal Shelter	26.4	57	8.08	26.9
(Continuous)	(26.4)	63	10.51	58.0
Swansea School			8.21	30.7
Douglas				
Chatfield Reservoir			5.80	15.1
(Continuous)			9.63	51.9
Larimer				
Fort Collins	18.7	68	6.66	24.8
Weld				
Greeley	21.2	68	7.67	25.2
(Continuous)			5.68	46.2
Platteville			8.23	25.5

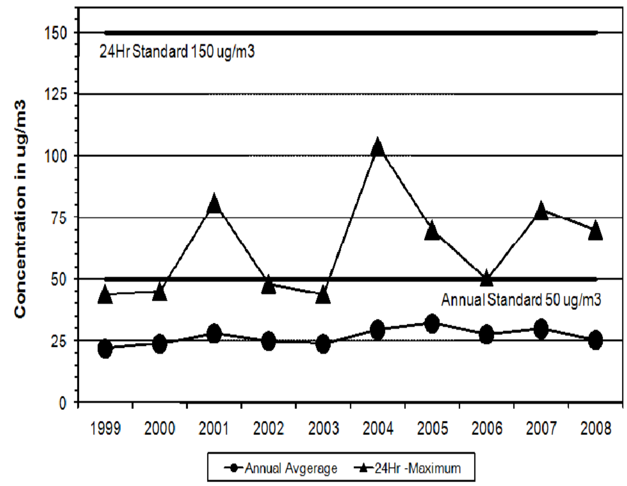
() Indicates less than 75 percent data for one or more quarters.

Figure 20 - Northern Front Range PM_{10} Particulate Graphs

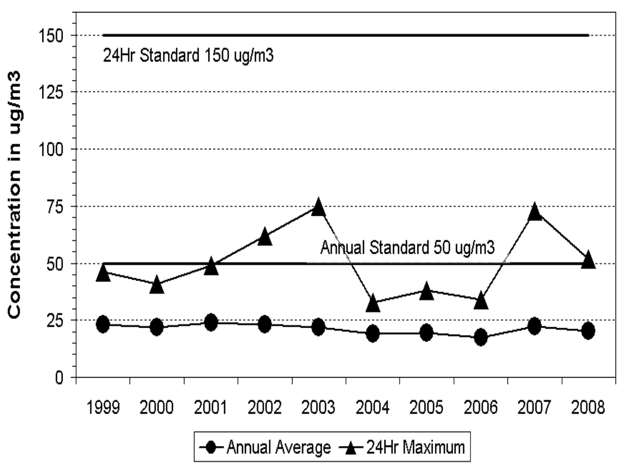
Commerce City, 7101 Birch St. - PM10



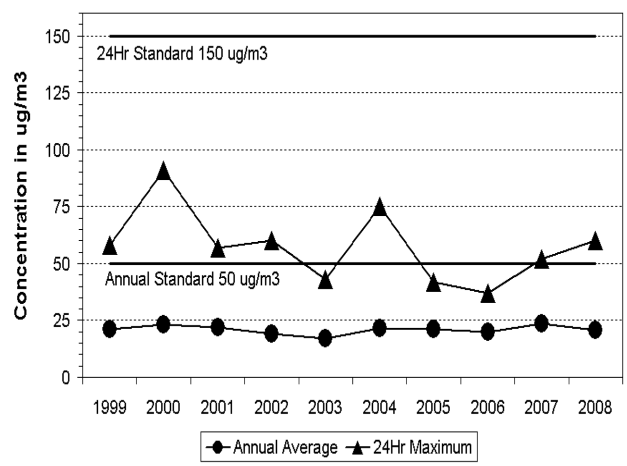
Welby, 3174 E. 74th Ave. - PM10



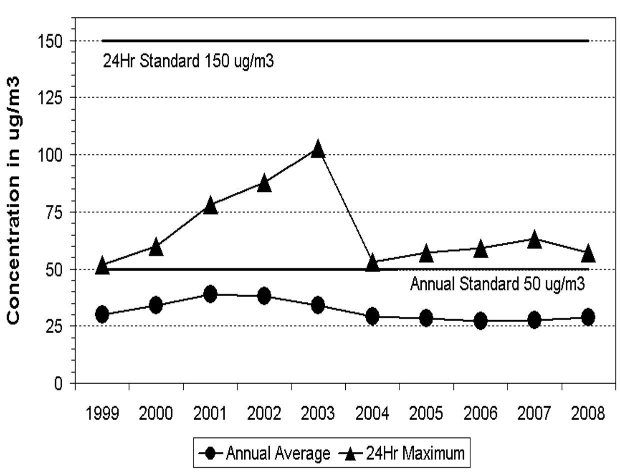
Boulder, 2440 Pearl St. - PM10



Longmont, 350 Kimbark St. - PM10



Denver CAMP, 2150 Broadway - PM10



Denver Gates/Animal Shelter - PM10

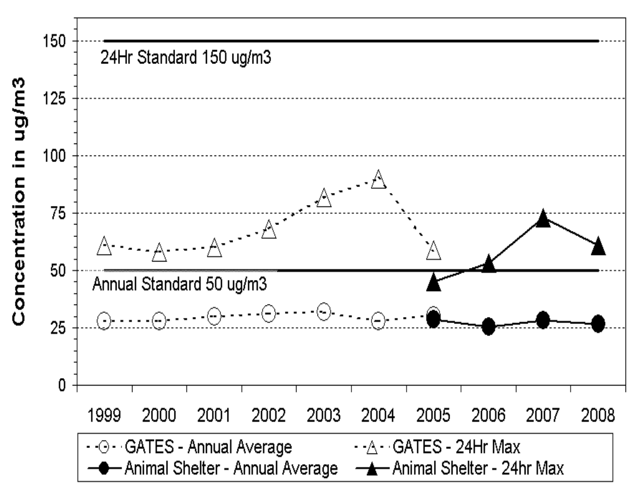
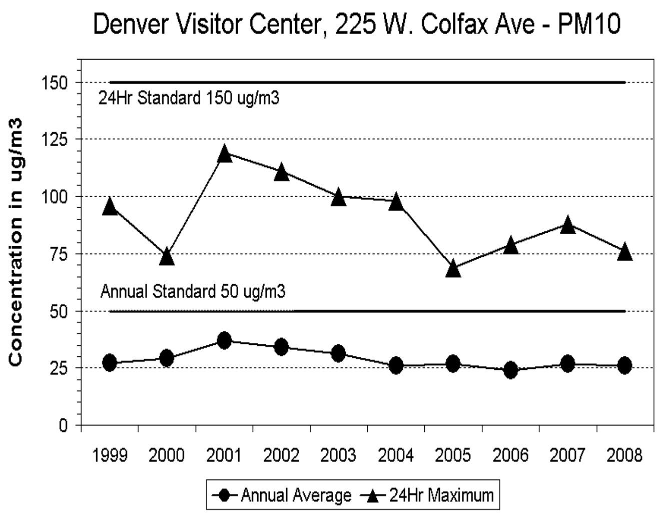
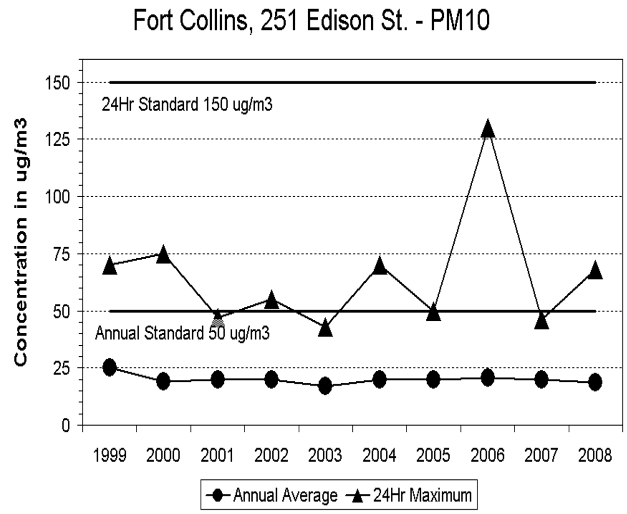


Figure 20 - Northern Front Range PM_{10} Particulate Graphs (continued)





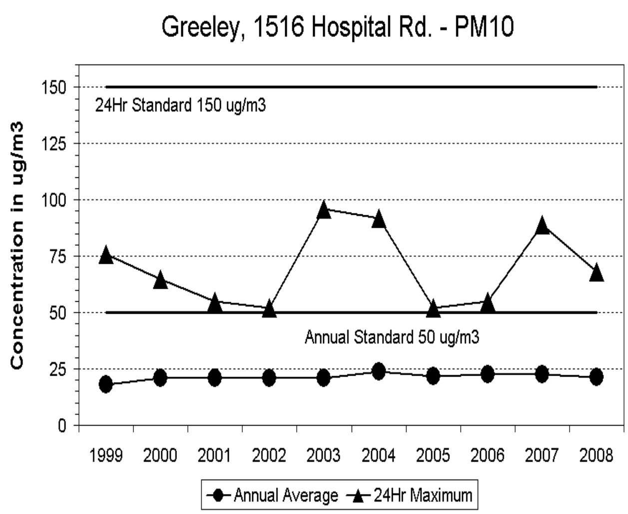
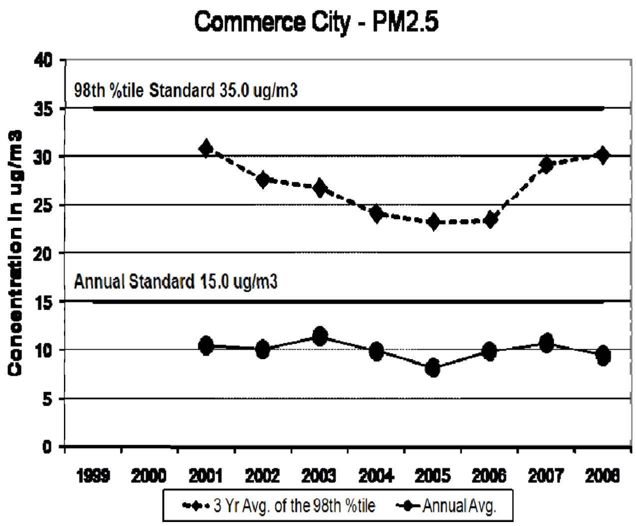
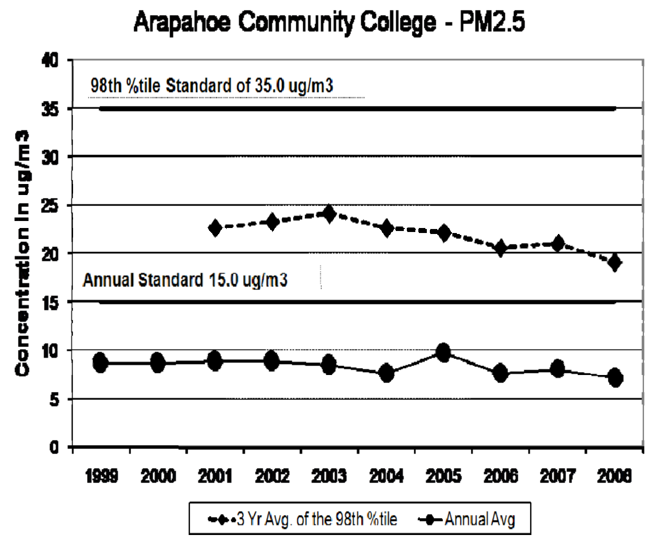
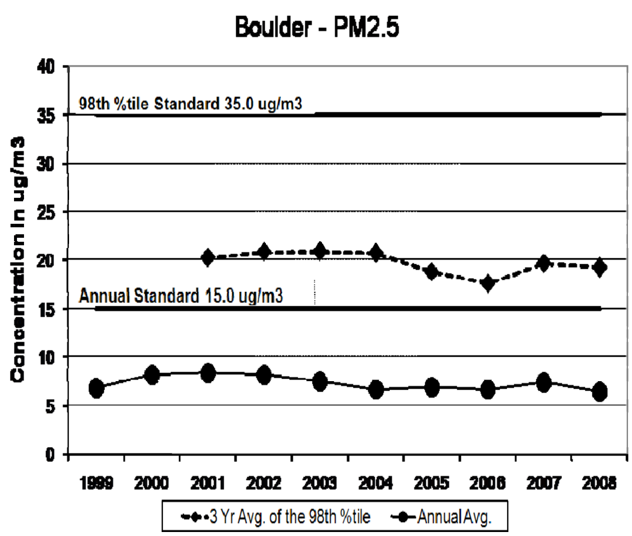
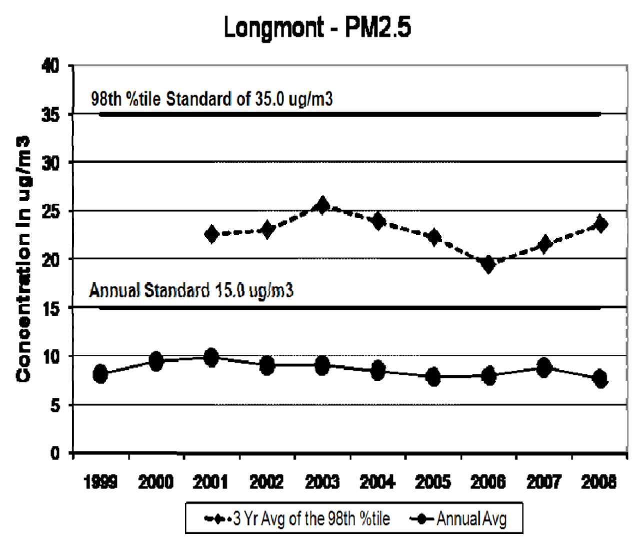


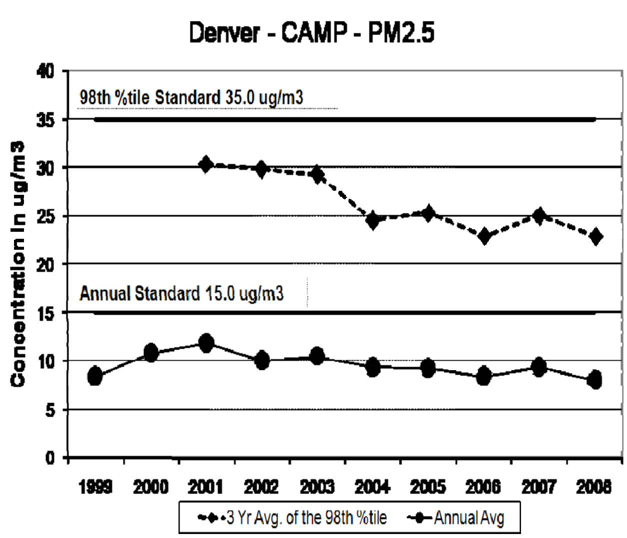
Figure 21 - Northern Front Range $PM_{2.5}$ Particulate Graphs











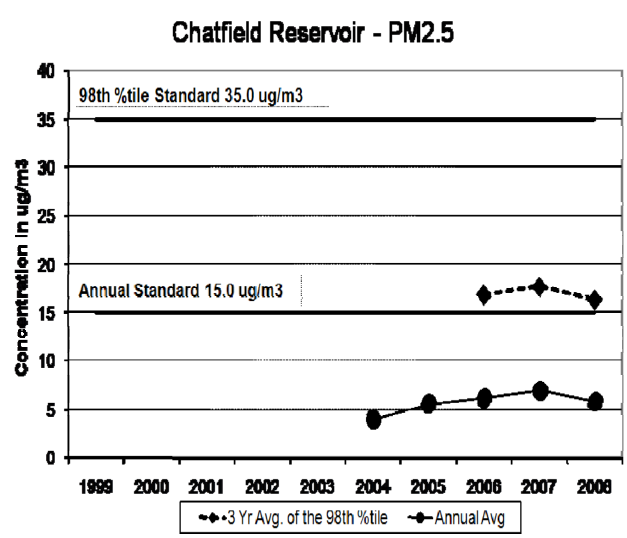
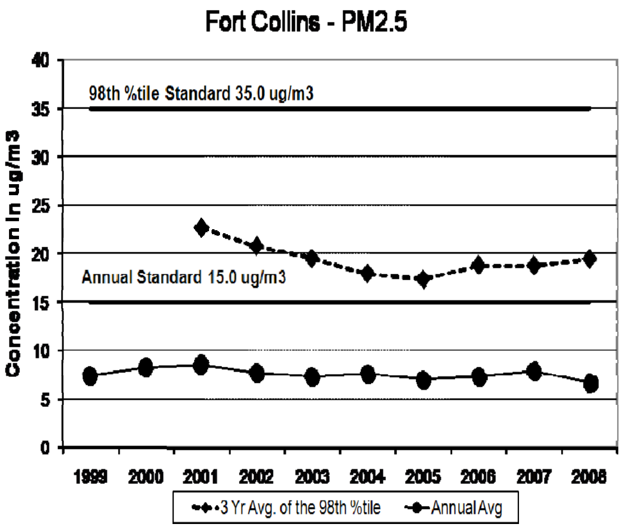
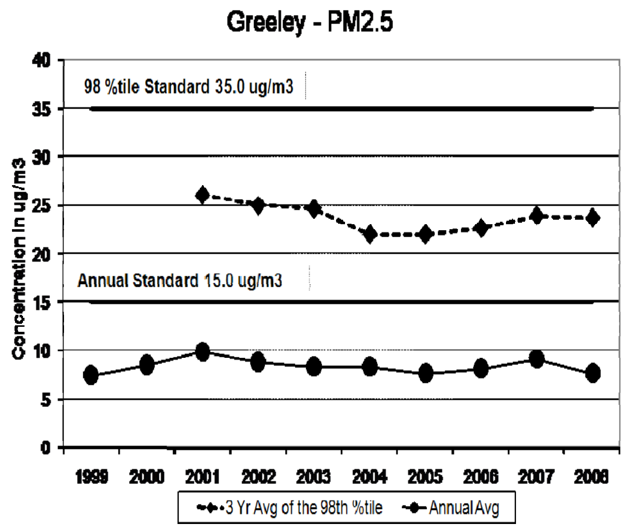


Figure 21 - Northern Front Range $PM_{2.5}$ Particulate Graphs (Continued)





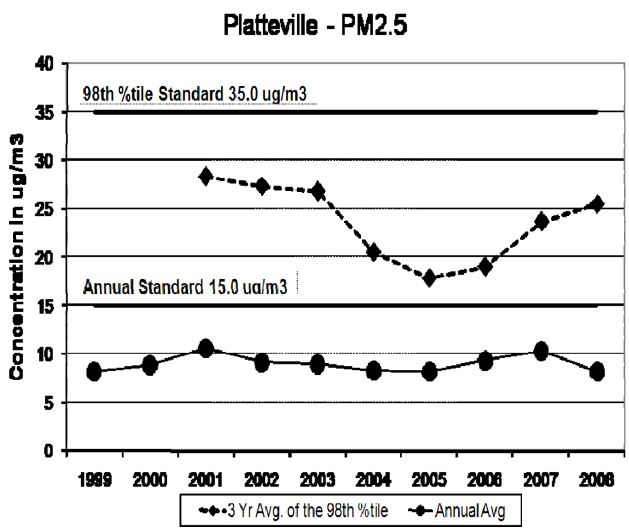


Table 32 - Northern Front Range TSP and Lead Values For 2008

Site Name	Location	TSP (µg/m³)		Lead (µg/m³)	
		Annual Geometric Mean	24-hour Maximum	Maximum Quarter	24-hour Maximum
Denver					
Denver Animal Shelter	678 S. Jason St.	59.7	126	0.0091	0.0186

() indicates less than 75 percent data for one or more quarters.

Figure 22 - Northern Front Range Lead Graphs

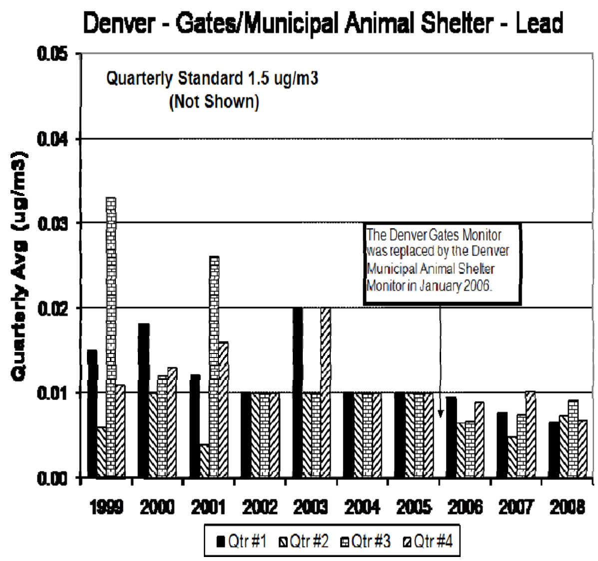


Table 33 - Northern Front Range Continuous Monitors In Operation For 2008

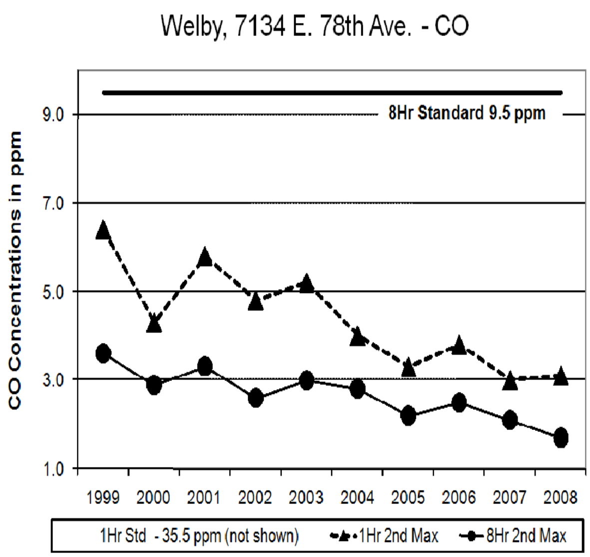
X - Monitors continued in 2008 A - Monitors added in 2008 D - Monitors discontinued in 2008

Site Name	Location	CO	SO_2	NO_X	O_3	Met
Adams						
Commerce City	7101 Birch St.					X
Welby	3174 E. 74th Ave.	X	X	X	X	X
Arapahoe						
Highlands Reservoir	8100 S. University Blvd				X	X
Boulder						
Boulder	1405 ½ S. Foothills Hwy				X	
Longmont	440 Main St.	X				
Denver						
Auraria Lot R	12th St. & Auraria Parkway					X
Denver CAMP	2105 Broadway	X	X	X	D	X
Denver Carriage	2325 Irving St.				X	X
Firehouse #6	1300 Blake St.	X				
Denver Animal Shelter	678 S. Jason St.				A	A
Douglas						
Chatfield Reservoir	11500 N. Roxborough Rd.				X	X
Jefferson						
Arvada	9101 W. 57th Ave				X	X
NREL	2054 Quaker St.				X	
Rocky Flats-N	16600 W. Hwy 128				X	X
Rocky Flats-SE	9901 Indiana St.					X
Welch	12400 W. Hwy 285				X	X
Larimer						
Fort Collins	708 S. Mason St.	X			X	X
	3416 W. La Porte Ave.				X	
Weld						
Greeley	905 10th Ave.	X				
Weld County Tower	3105 35th Ave.				X	

Table 34 - Northern Front Range Carbon Monoxide Values For 2008

Site Name	Location	CO 1-hour Avg. (ppm)		CO 8-hour Avg. (ppm)	
		1st Maximum	2nd Maximum	1st Maximum	2nd Maximum
Adams					
Welby	3174 E. 78th Ave.	4.1	3.9	3.1	2.4
Boulder					
Longmont	440 Main St.	4.2	3.5	3.2	2.7
Denver					
Denver-CAMP	2105 Broadway	7.1	7.0	3.8	3.1
Firehouse #6	1300 Blake St.	4.8	4.5	3.1	3.0
Larimer					
Fort Collins	708 S. Mason St	5.1	5.0	3.8	3.0
Weld					
Greeley	905 10th Ave.	5.0	3.7	2.3	2.2

Figure 23 - Northern Front Range Carbon Monoxide Graphs



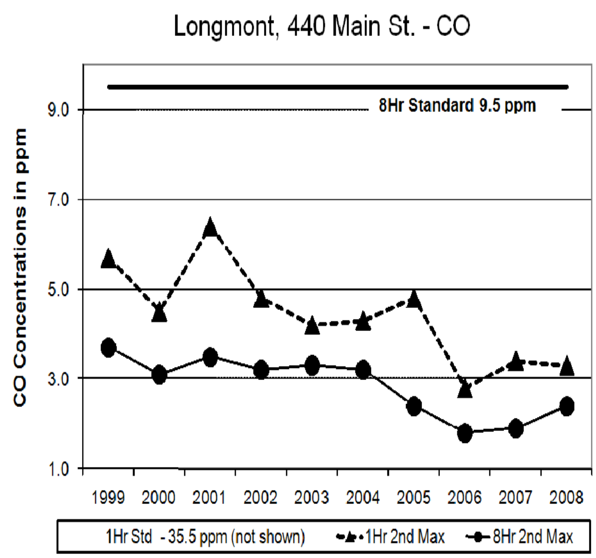
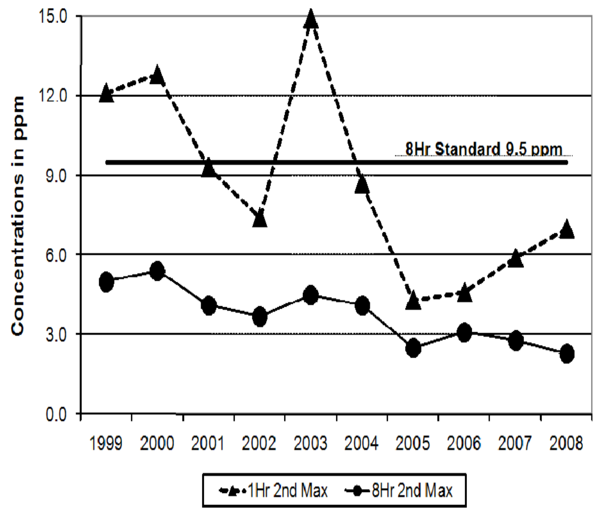
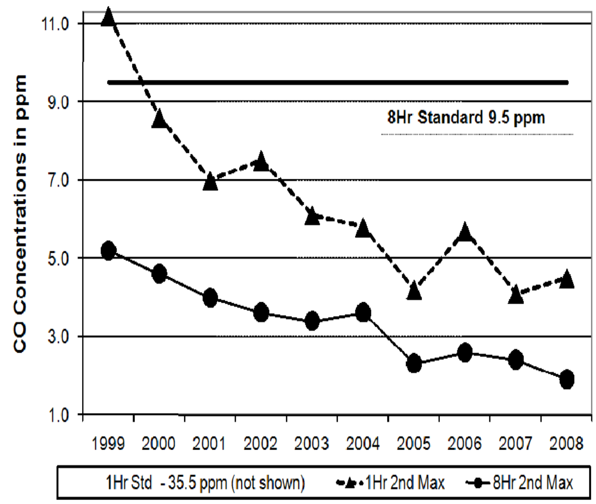


Figure 23 - Northern Front Range Carbon Monoxide Graphs (continued)

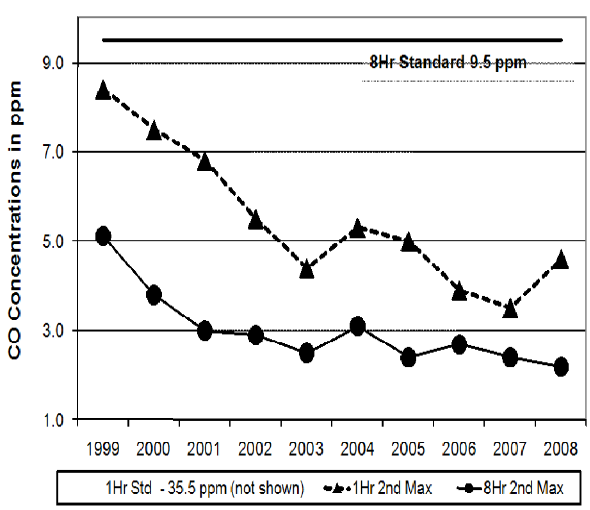
Denver CAMP, 2105 Broadway - CO



Denver Firehouse #6, 1300 Blake St. - CO



Fort Collins, 708 S. Mason St. - CO



Greeley - CO

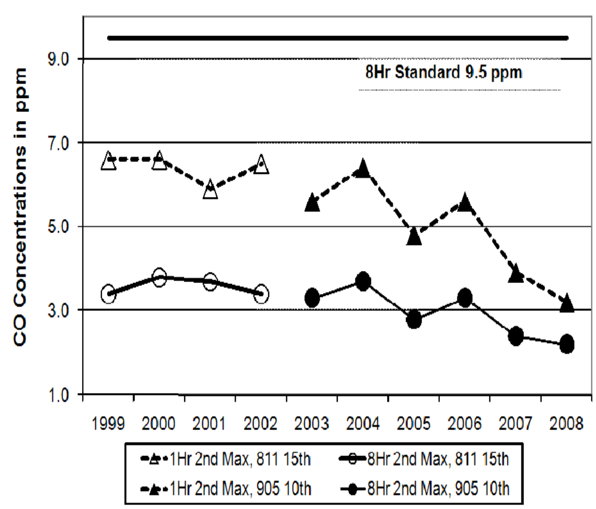
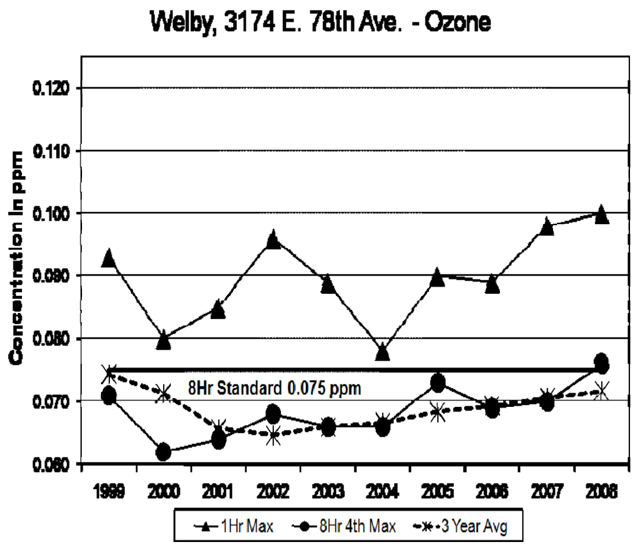
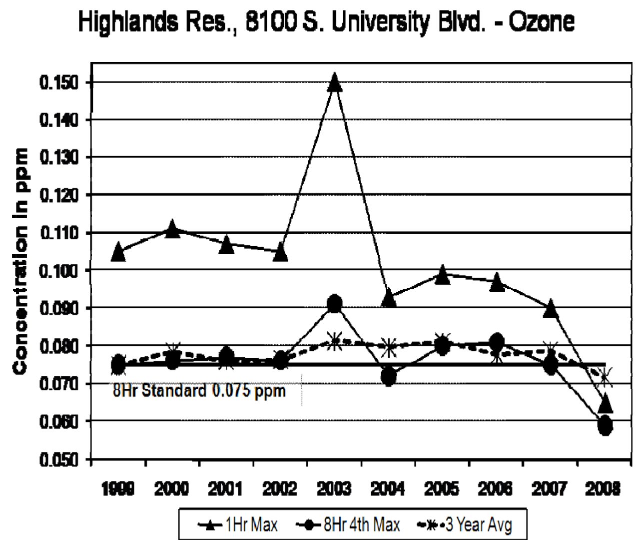


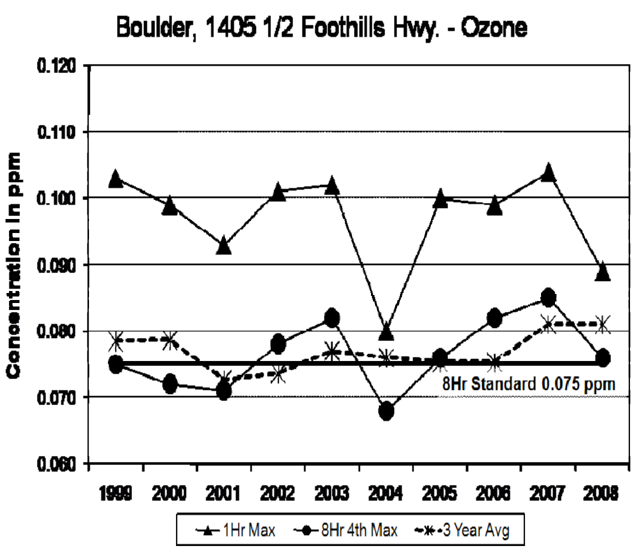
Table 35 - Northern Front Range Ozone Values For 2008

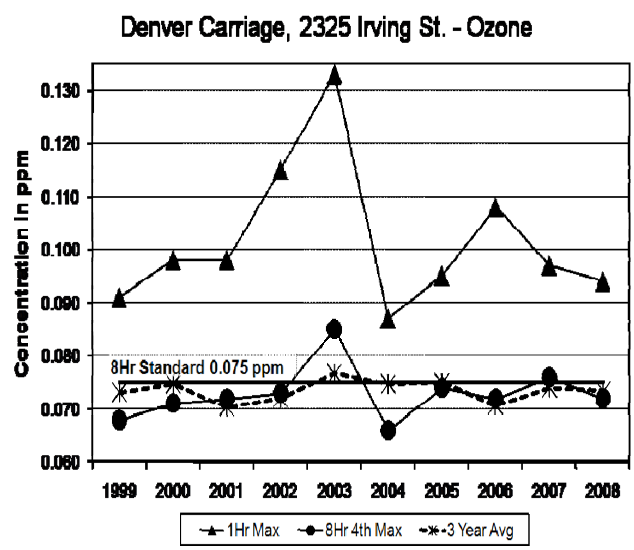
Site Name	Location	Ozone 1-hour Avg. (ppm)		Ozone 8-hour Avg. (ppm)	
		1st Maximum	2nd Maximum	1st Maximum	4th Maximum
Adams					
Welby	3174 E. 78th Ave.	0.100	0.095	0.085	0.076
Arapahoe					
Highland Reservoir	8100 S. University Blvd	0.065	0.064	0.062	0.059
Boulder					
Boulder	1405½ Foothills Parkway	0.089	0.089	0.080	0.076
Denver					
Denver Carriage	2325 Irving St.	0.094	0.090	0.081	0.072
Denver Animal Shelter	678 S. Jason St.	0.100	0.098	0.086	0.070
Douglas					
Chatfield Reservoir	11500 N. Roxborough Park Rd.	0.101	0.098	0.090	0.080
Jefferson					
Arvada	9101 W. 57th Ave.	0.093	0.093	0.081	0.074
Welch	12400 W. Hwy 285	0.102	0.090	0.095	0.073
Rocky Flats-N	16600 W. Colorado 128	0.088	0.088	0.083	0.079
NREL	2054 Quaker St.	0.097	0.093	0.085	0.076
Larimer					
Fort Collins	708 S. Mason St.	0.082	0.080	0.070	0.066
Fort Collins-W	3416 La Porte Ave.	0.093	0.092	0.081	0.076
Weld					
Weld County Tower	3101 35th Ave.	0.094	0.092	0.077	0.073

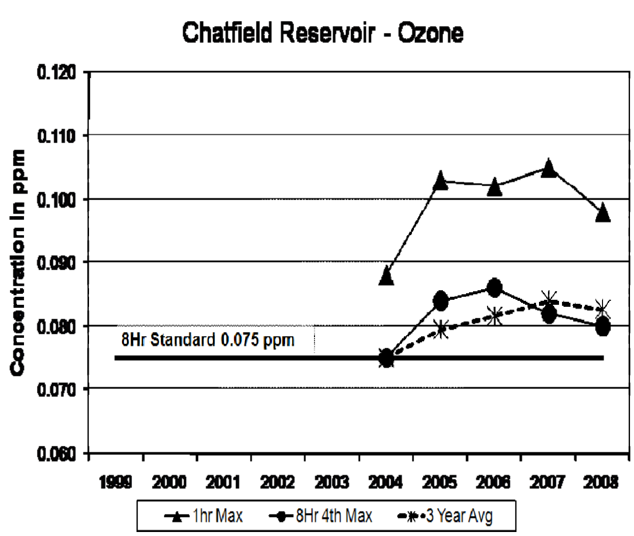
Figure 24 - Northern Front Range Ozone Graphs











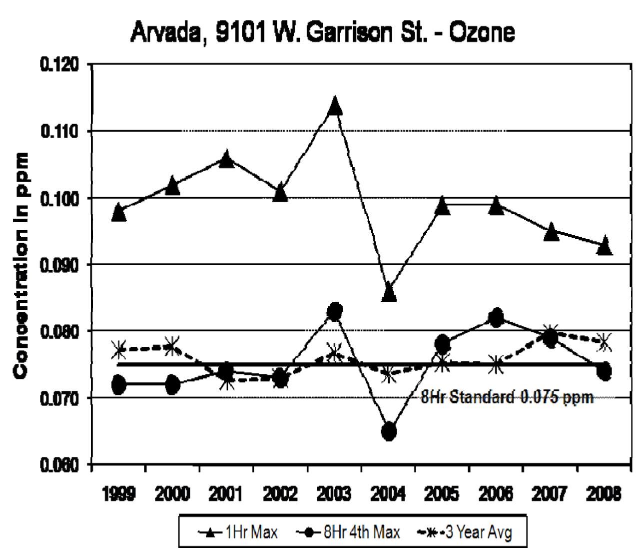
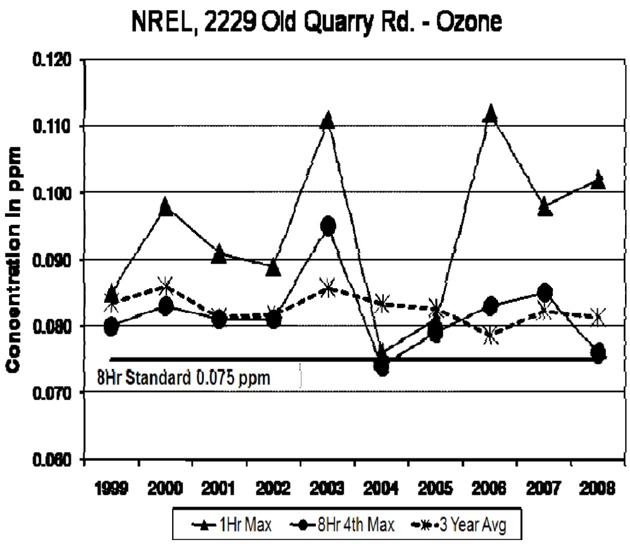
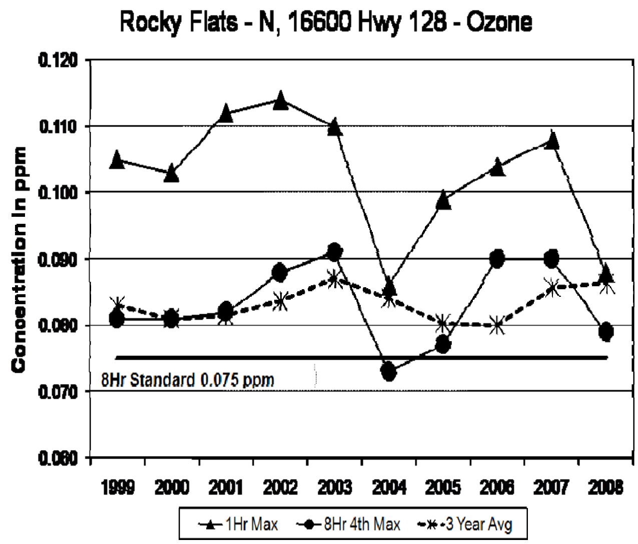
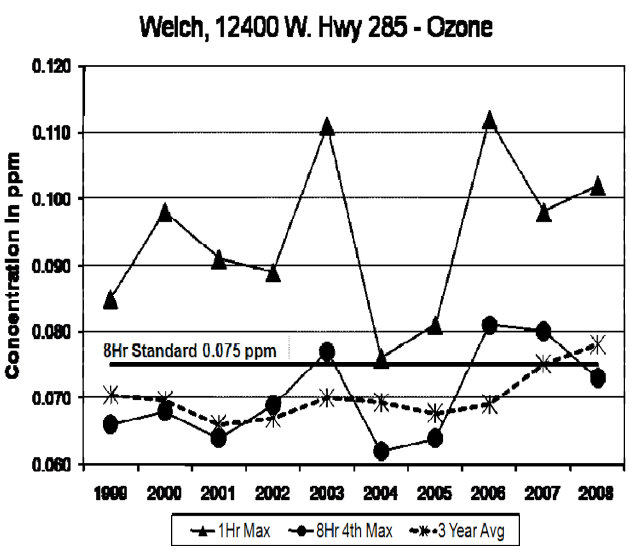
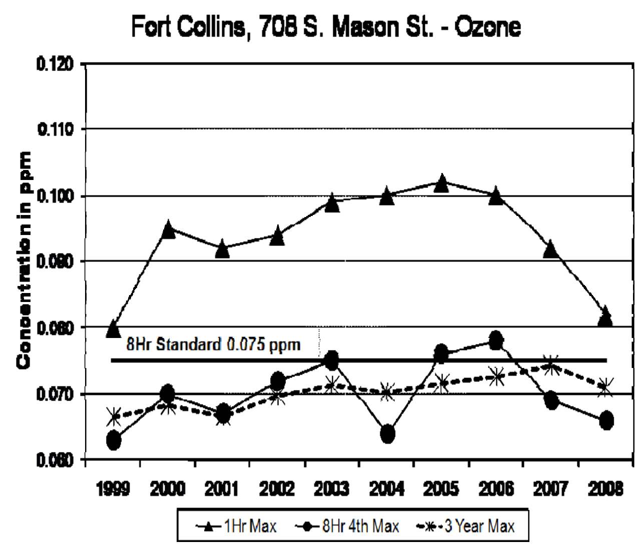


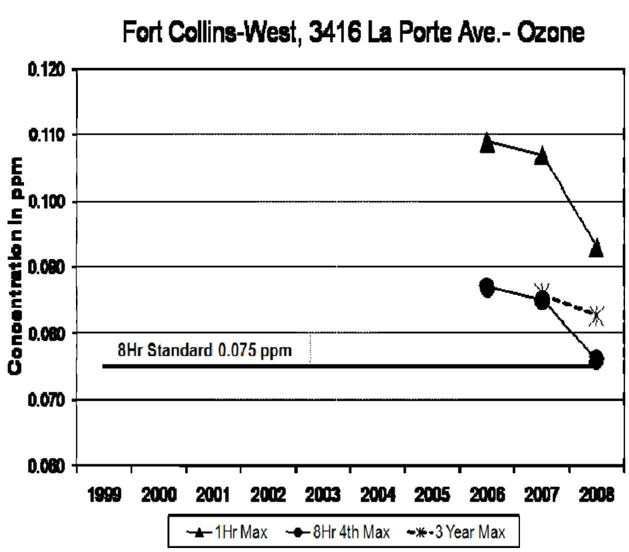
Figure 24 - Northern Front Range Ozone Graphs (continued)











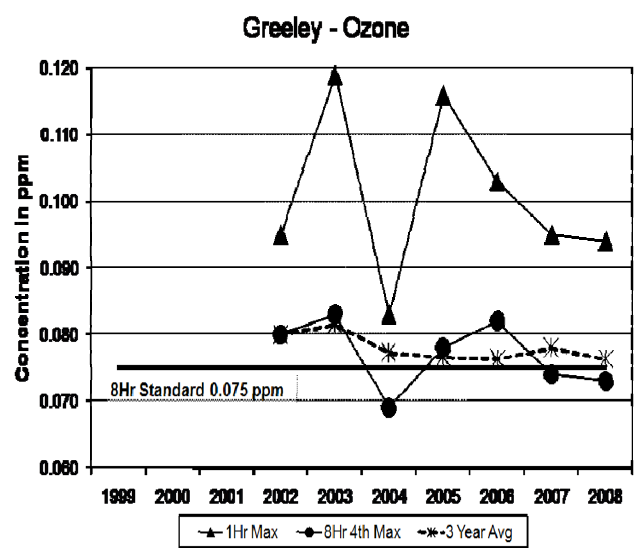


Table 36 - Northern Front Range Oxides of Nitrogen and Sulfur Dioxide Values For 2008

Site Name	Location	Nitrogen Dioxide	Nitric Oxide	Sulfur Dioxide		
		Annual Avg. (ppm)	Annual Avg. (ppm)	3-hour 2nd Max (ppm)	24-hour 2nd Max (ppm)	Annual Avg. (ppm)
Adams						
Welby	3174 E 78th Ave.	0.0173	0.0212	0.017	0.007	0.0021
Denver						
Denver CAMP	2105 Broadway	0.0286	0.0348	0.030	0.010	0.0018

Figure 25 - Northern Front Range Nitrogen Dioxide Graphs

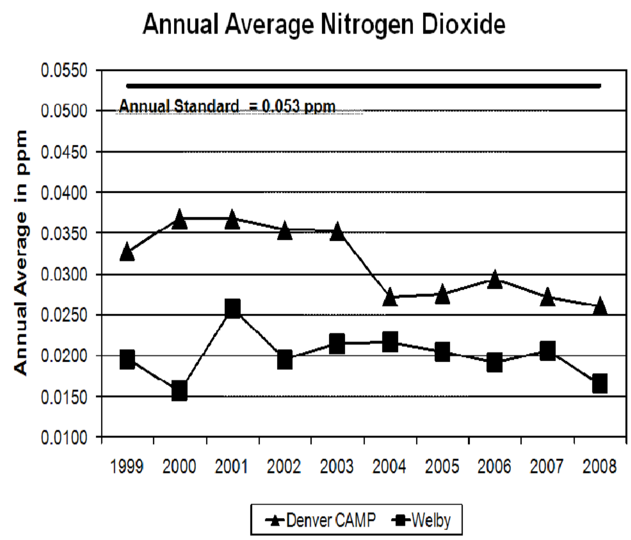


Figure 26 - Northern Front Range Sulfur Dioxide Graphs

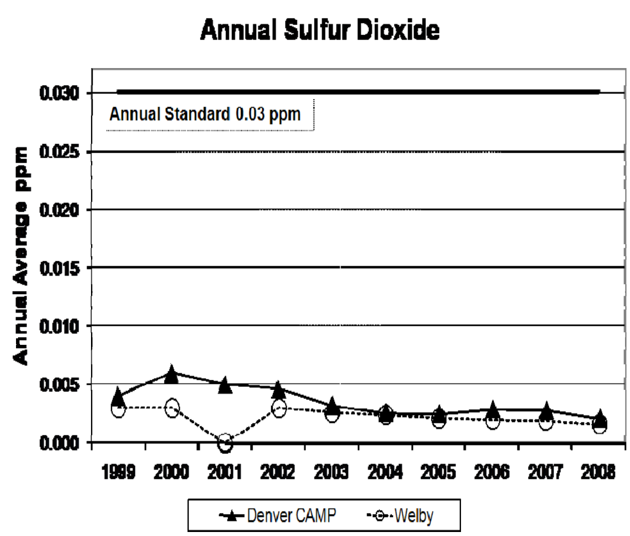
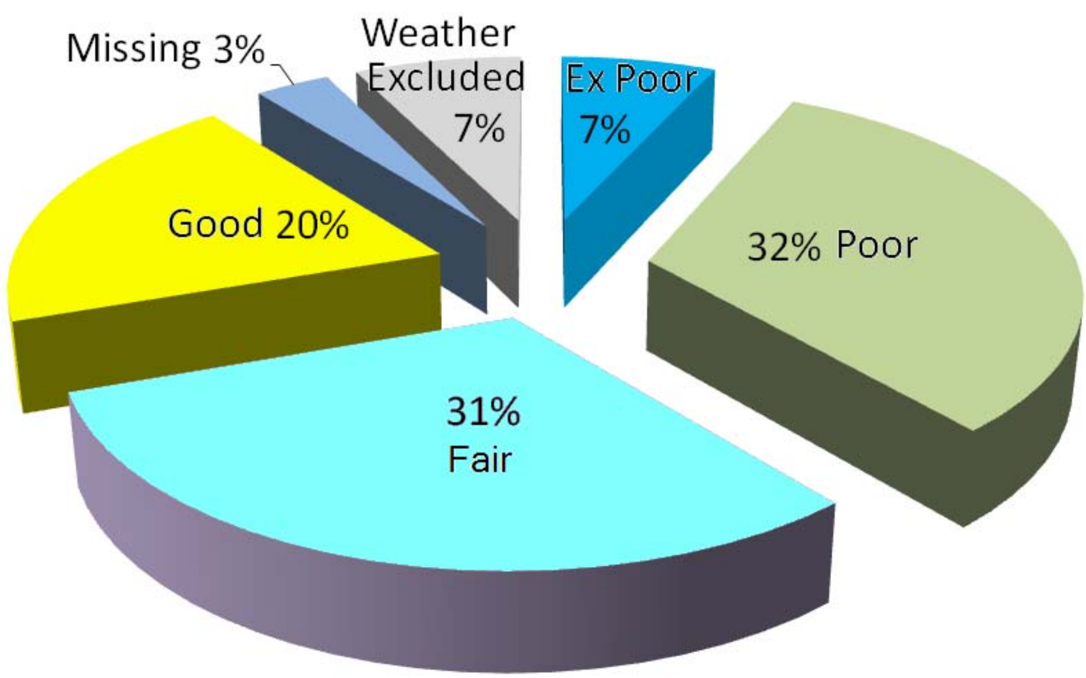


Table 37 - Denver Visibility Standard Exceedance Days
(Transmissometer Data)
January 2008 - December 2008

Month	Days	EX POOR	POOR	FAIR	GOOD	Missing	(>70% RH)
January	31	3	7	6	14	1	3
February	29	2	9	8	7		3
March	31	1	10	15	2		2
April	30	1	6	6	14	1	5
May	31	7	7	5	1	6	1
June	30		11	6	11	1	
July	31		14	13	4		3
August	31	3	12	9	2	2	2
September	30	1	12	12	3		4
October	31	1	14	11	1		2
November	30	1	7	16	3	1	2
December	31	5	8	6	10		
Totals	366	25	117	113	72	12	27

Figure 27 shows that only 3 percent or of the visibility data for 2008 was listed as "Missing."

Figure 27 - Denver Visibility Data (January 2008 to December 2008)



In Figures 28 and 30, days above the standard are shown as positive numbers and days below the standard are shown as negitive numbers. In 2008 in Denver, for example there were 117 days in the "Poor" category and 25 in the "Ex Poor" category.

Figure 28 - Denver Visibility Comparison (1999 to 2008)

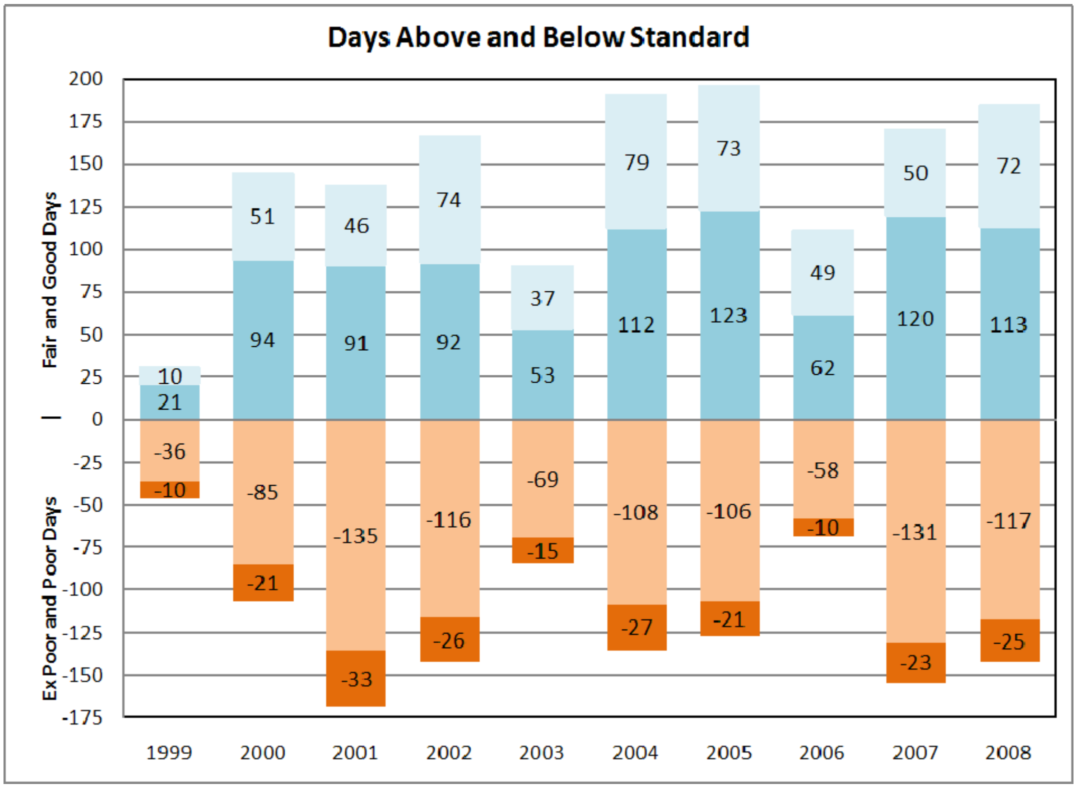


Table 38 - Fort Collins Visibility Standard Exceedance Days
(Transmissometer Data)
January 2008 - December 2008

Month	Days	EX POOR	POOR	FAIR	GOOD	Missing	(>70% RH)
January	31		2	9	11	5	4
February	29		7	5	14	2	1
March	31		4	10	5	12	
April	30		10	9	7	4	
May	31		7	17	2	5	
June	30		6	12	6	6	
July	31		11	10	9	1	
August	31		7	10	9	4	
September	30		2	10	15	3	
October	31	1	2	11	12	6	
November	30			7	19	3	1
December	31		1	6	8	13	3
Totals	366	1	59	116	117	64	9

Figure 29 - Fort Collins Visibility Data (January 2008 to December 2008)

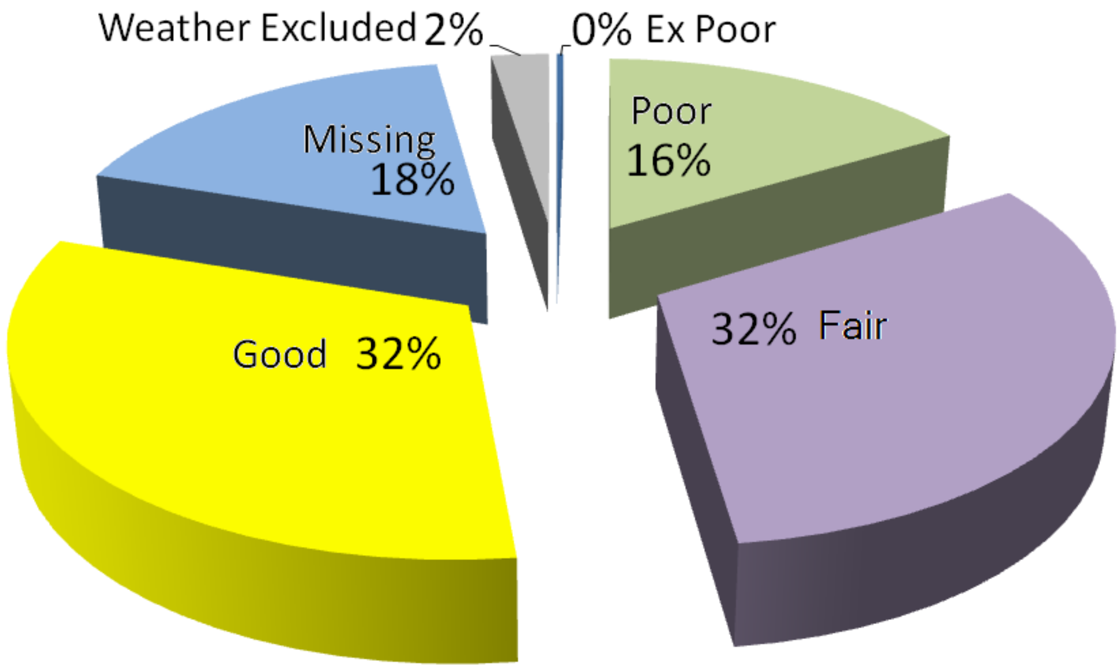


Figure 30 shows that since 1999, Fort Collins has averaged 176 days per year where the visibility was either "Fair" or "Good" and only 97 days where the visibility was either "Poor" or "Ex Poor." The missing days are lost due to either high relative humidity (greater than 70 percent) or machine maintenance.

Figure 30 - Fort Collins Visibility Data (1999 to 2008)

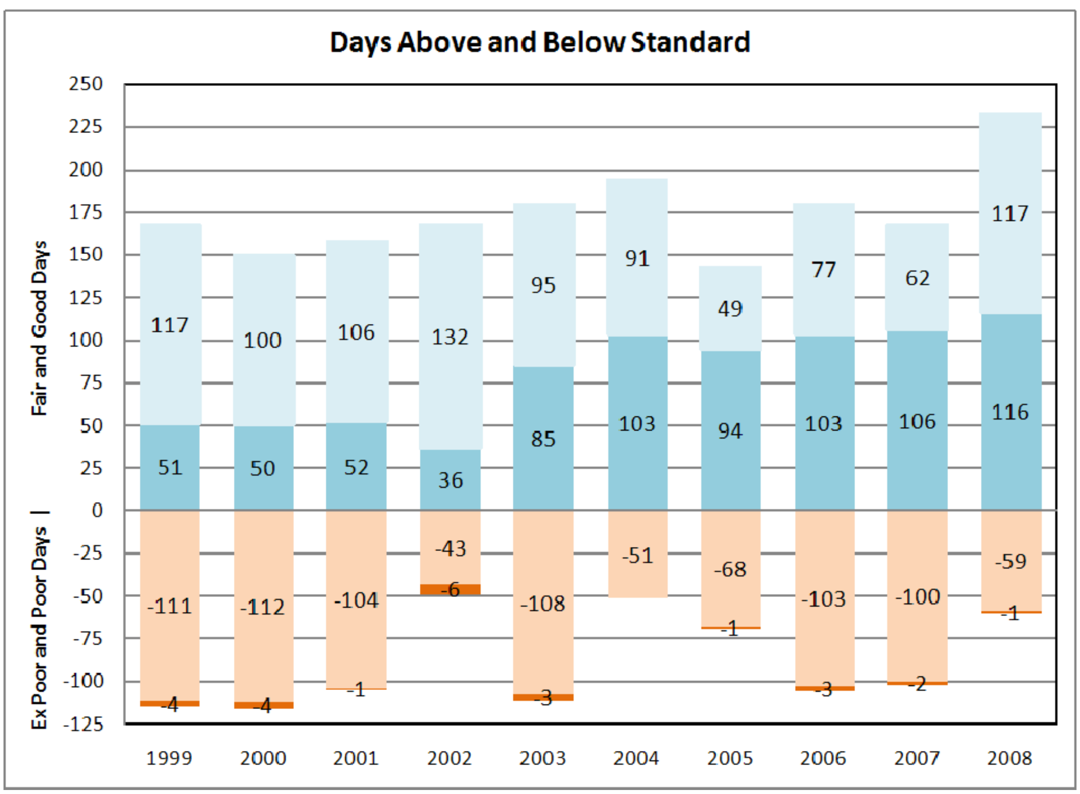
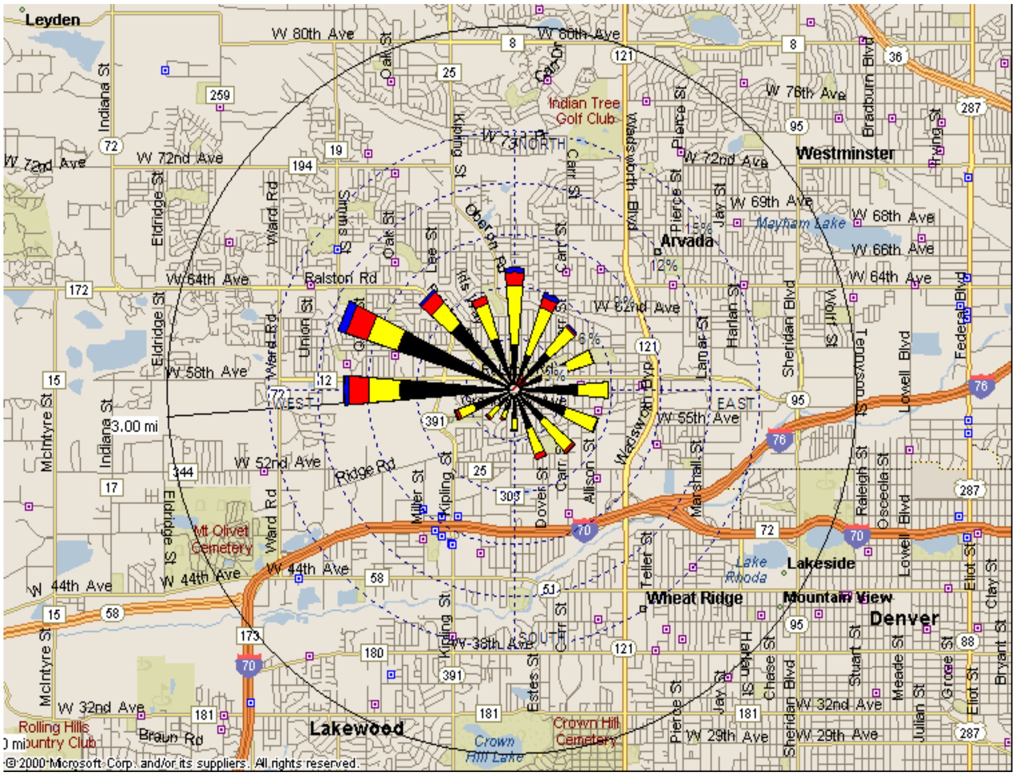


Figure 31 - Northern Front Range Wind Roses

Arvada, 9101 W. 57th Ave.



Auraria, Parking Lot R

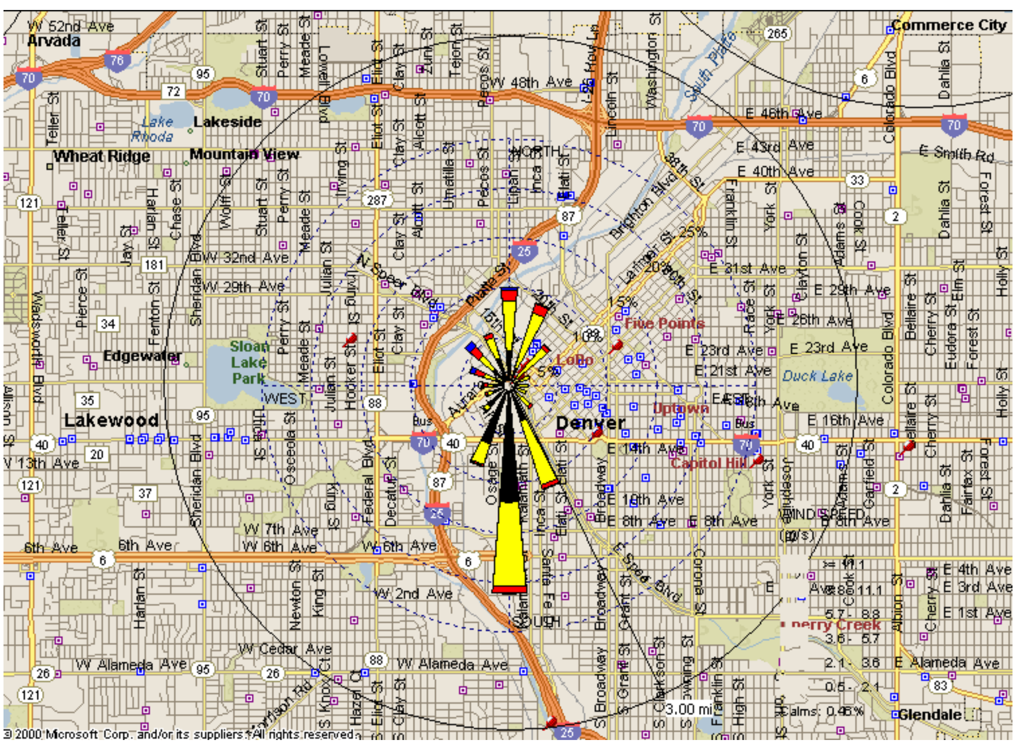
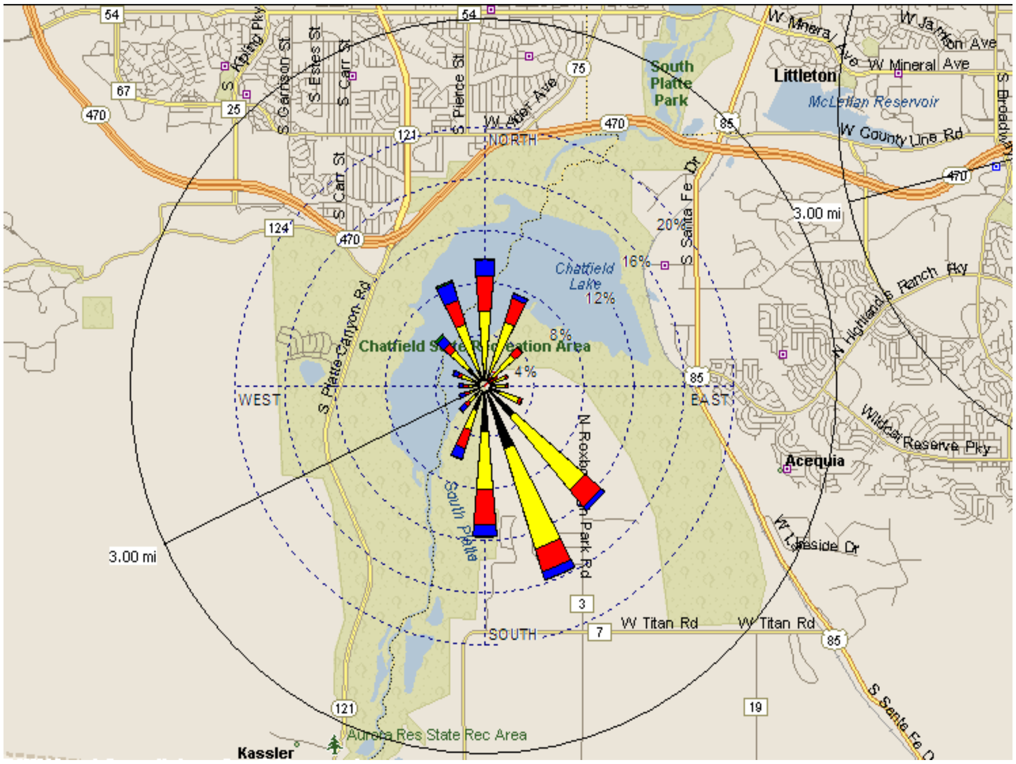


Figure 31 - Northern Front Range Wind Roses (continued)
Chatfield Reservoir, 11500 N. Roxborough Pk. Rd.



Commerce City, 7101 Birch St.

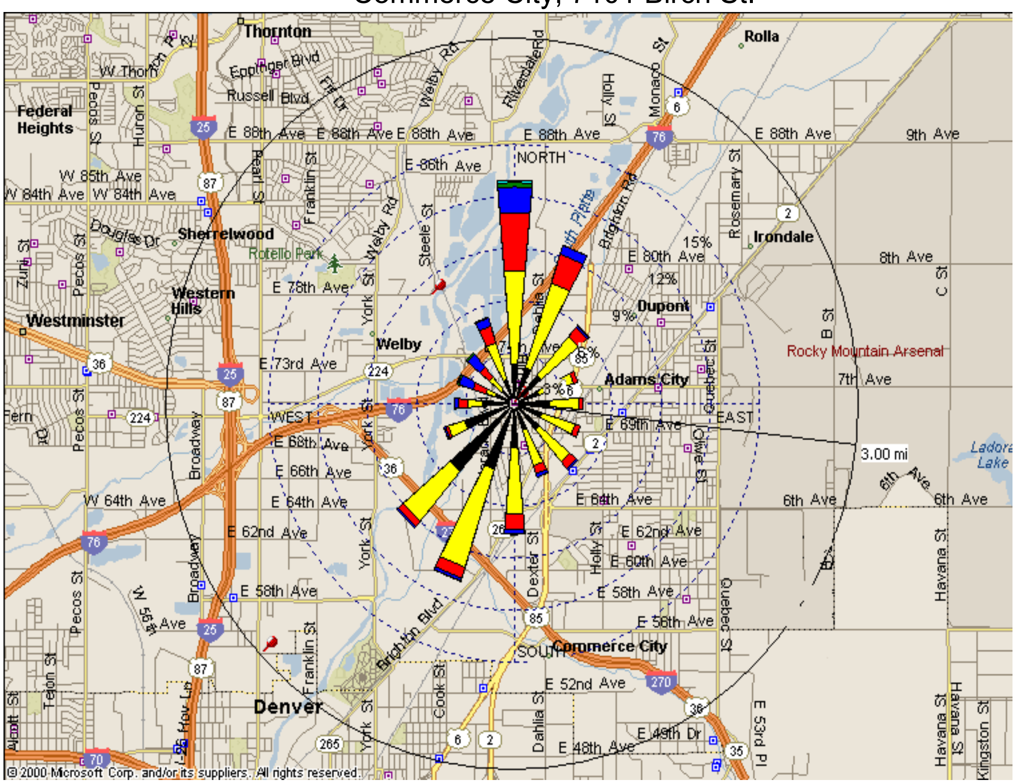
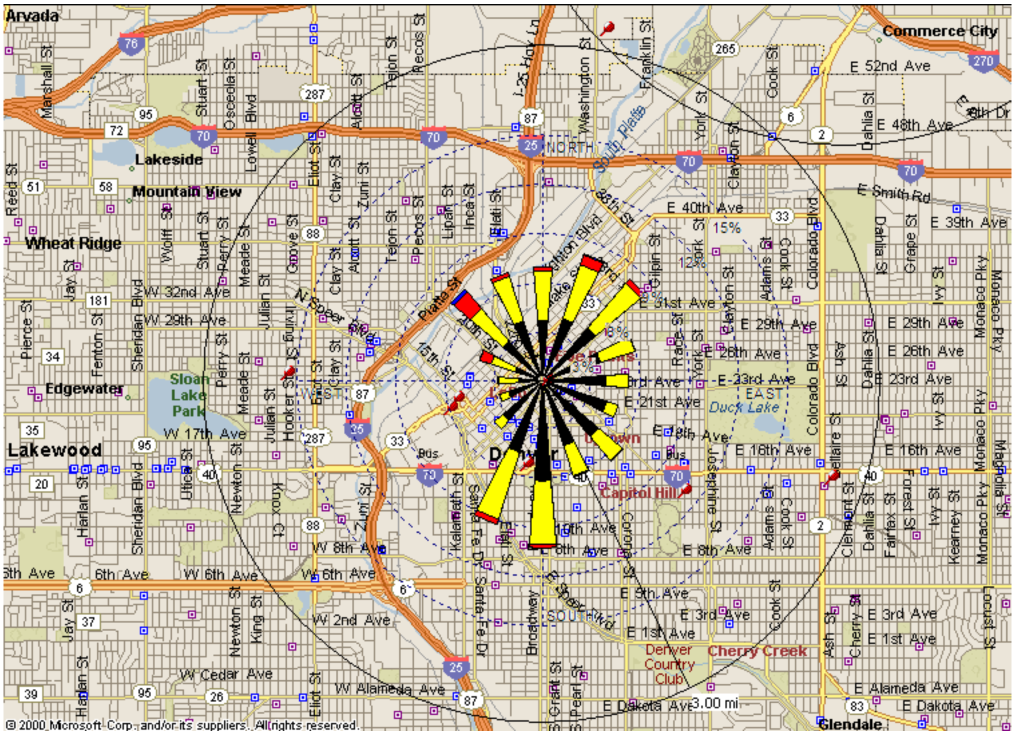


Figure 31 - Northern Front Range Wind Roses (continued)
Denver CAMP, 2105 Broadway



Denver Carriage, 2325 Irving St.

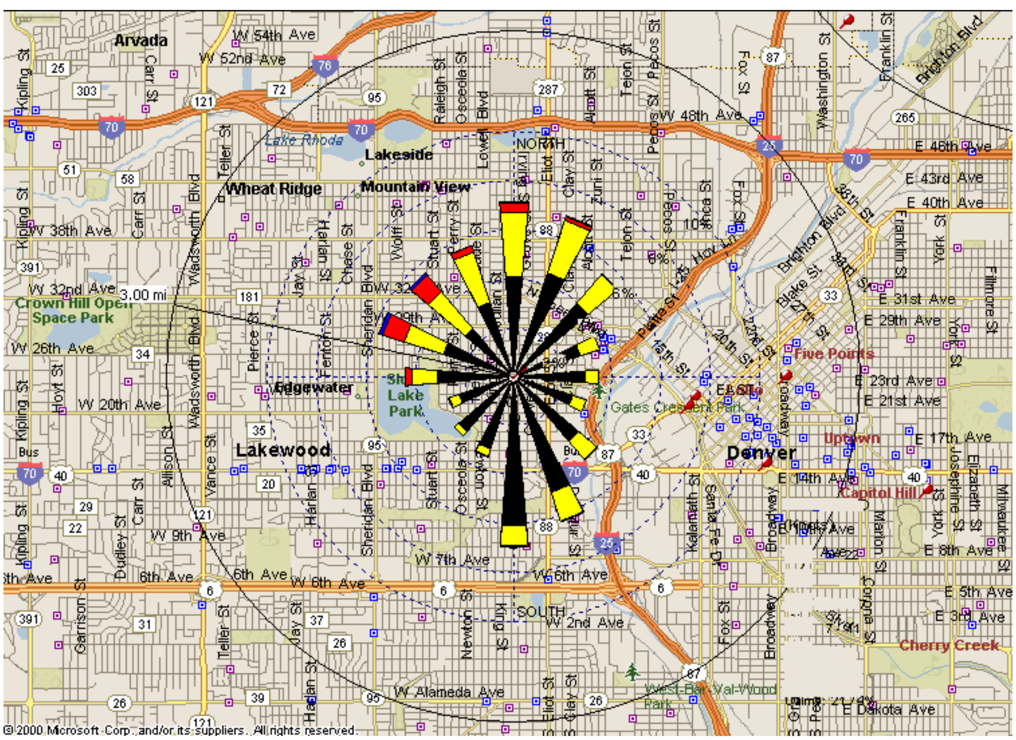
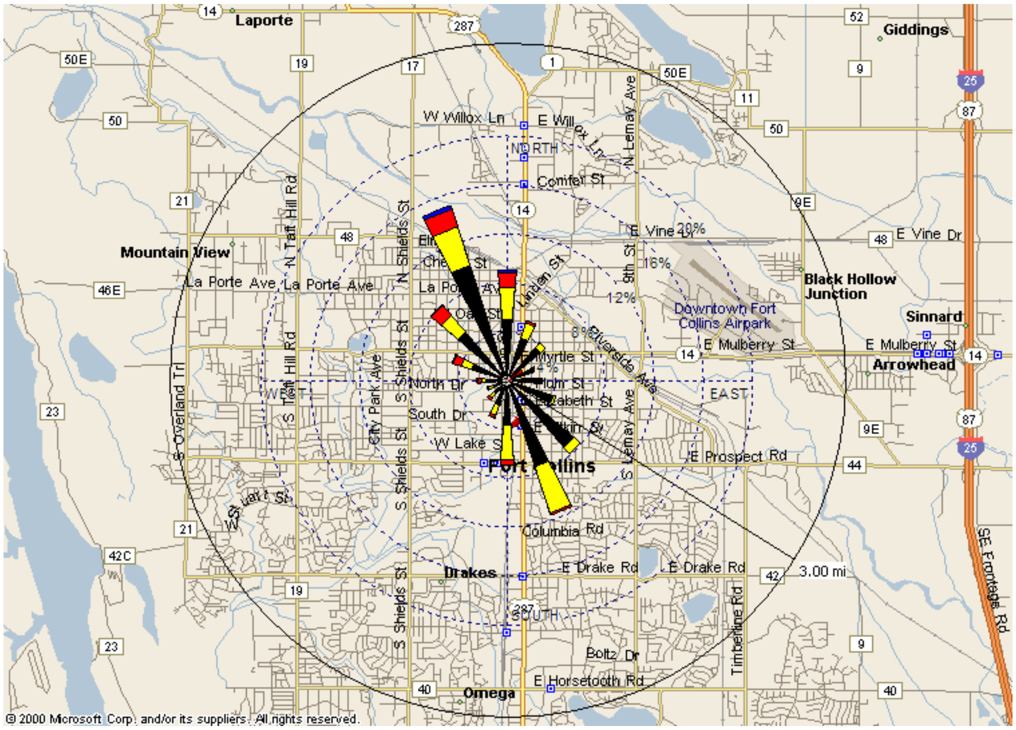


Figure 31 - Northern Front Range Wind Roses (continued)
Fort Collins, 708 S. Mason St.



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Rocky Flats-N, 16600 W. Hwy. 128

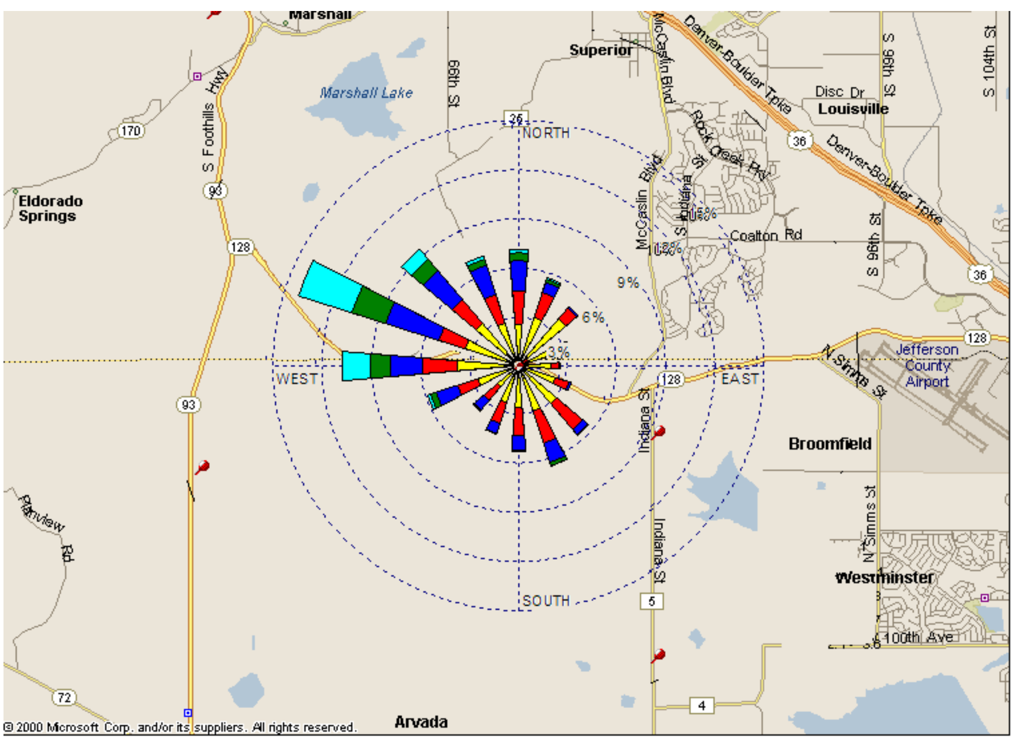

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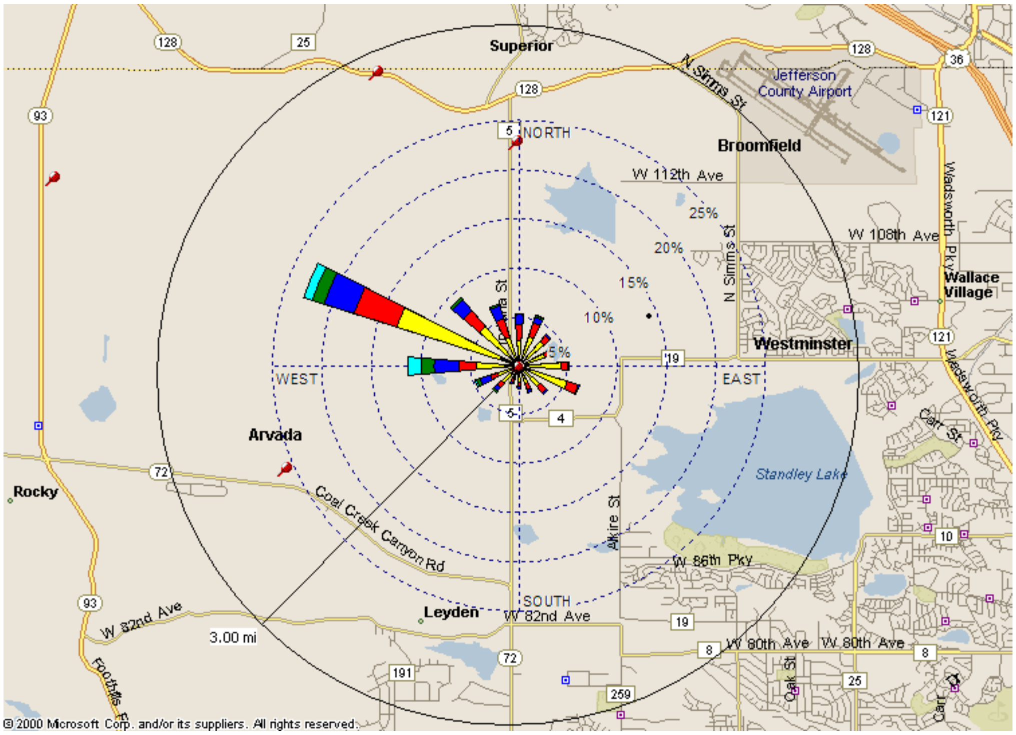
Figure 31 - Northern Front Range Wind Roses (continued)

Rocky Flats- SE, 9901 Indiana St.



Welby, 3174 E. 78th Ave.

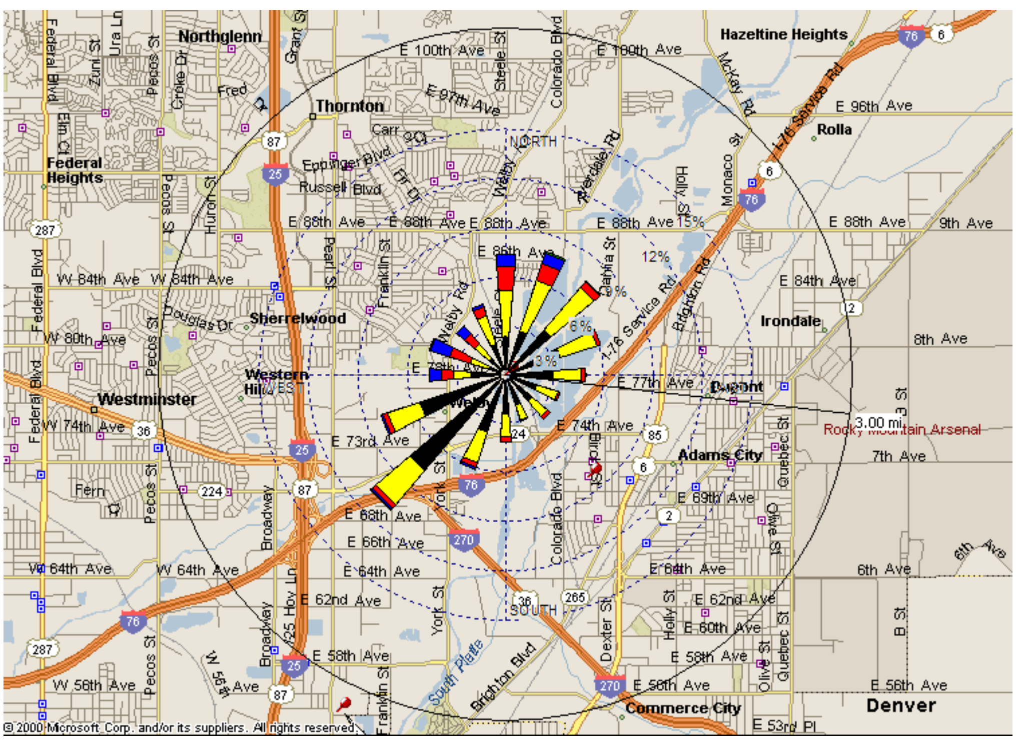
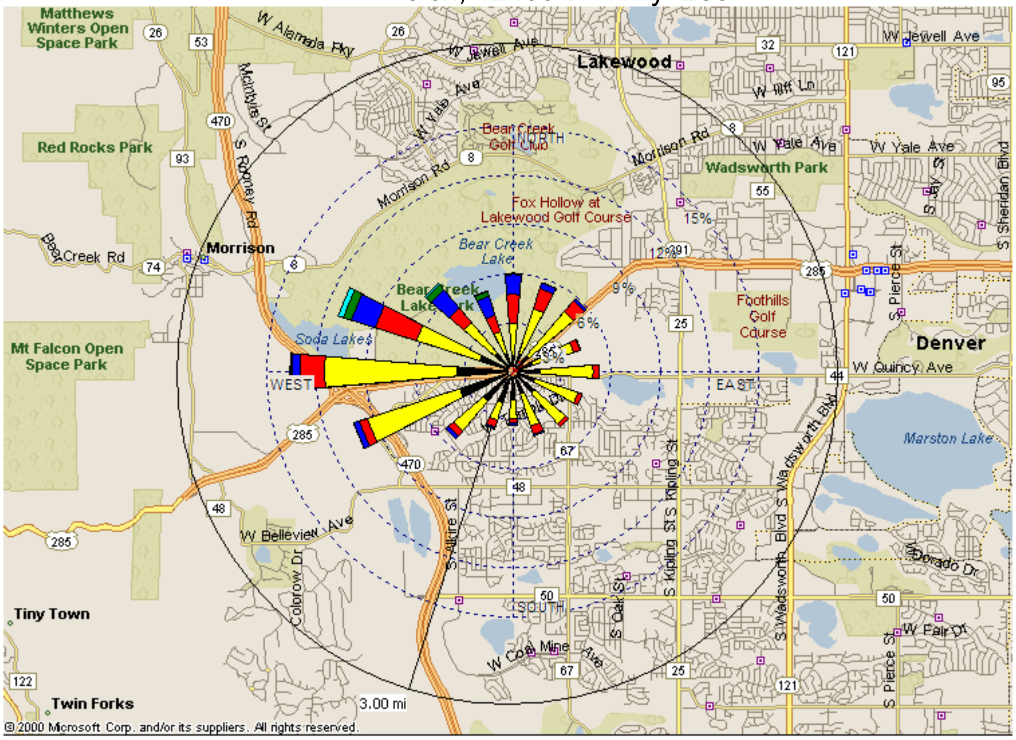


Figure 31 - Northern Front Range Wind Roses (continued)
Welch, 12400 W. Hwy. 285



6.3 Southern Front Range Counties

The Southern Front Range Counties are those along the urbanized I-25 corridor from south of the city of Castle Rock to the southern Colorado border. The cities with monitoring in the area are Colorado Springs, Pueblo, Cañon City and Alamosa. These last three cities are not strictly in the Front Range I-25 corridor but fit better with those cities than they do the Mountain Counties. Colorado Springs is the only city in the area that is monitored for carbon monoxide and ozone by the APCD. The other cities are only monitored for particulates. In the past the APCD has conducted particulate monitoring in both Walsenburg and Trinidad but that monitoring was discontinued in 1979 and 1985 respectively.

Table 39 - Southern Front Range Monitors in Operation For 2008

X - Monitors continued in 2008 A - Monitors added in 2008

D - Monitors discontinued in 2008 H - Hourly particulate monitor S - Chemical Speciation

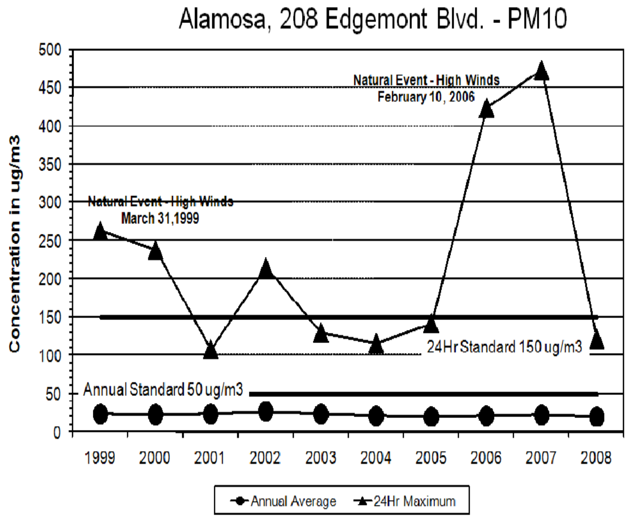
Site Name	Location	CO	O_3	PM_{10}	$PM_{2.5}$
Alamosa					
Alamosa-ASU	208 Edgemont Blvd			X	
Alamosa Municipal	425 4th St.			X	
El Paso					
Colorado Springs	USAFA Rd. 640		X		
	690 W. Hwy 24	X			
	101 W. Costilla St.			D	D
	130 W. Cache la Poudre			X	X/H
Manitou Springs	101 Banks Pl.		X		
Fremont					
Caňon City	128 Main St.			X	
Pueblo					
Pueblo	211 E. D St.			X	X

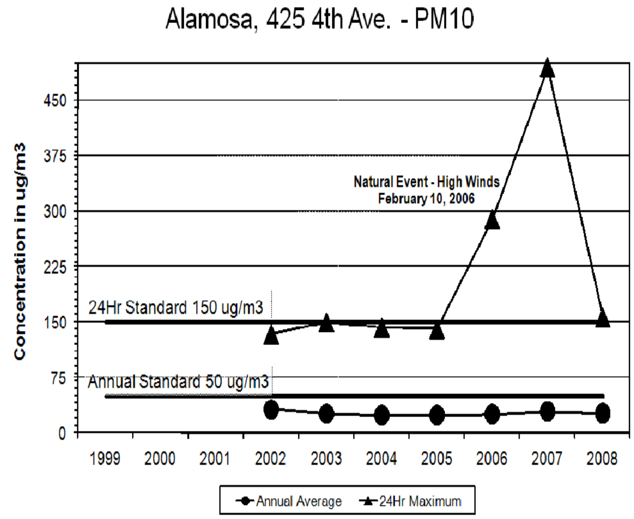
Table 40 - Southern Front Range Maximum Particulate Values For 2008

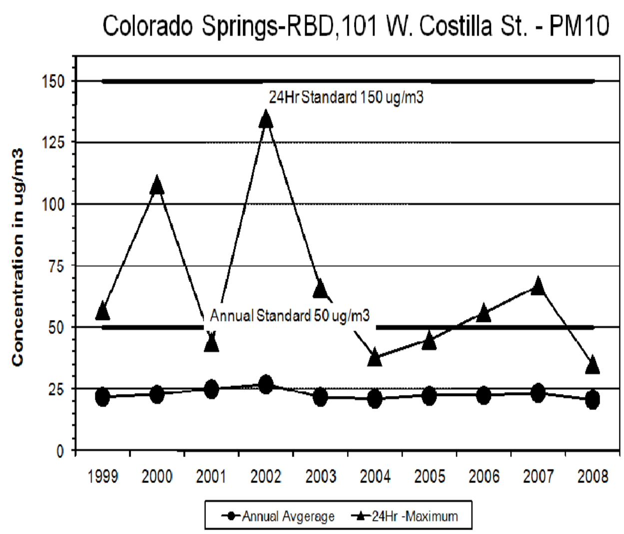
Site Name	Location	PM_{10} (µg/m^3)		$PM_{2.5}$ (µg/m^3)	
		Annual Average	24-Hr Maximum	Annual Average	24-Hr Maximum
Alamosa					
Alamosa	208 Edgemont Blvd.	(20.2)	121		
	425 4TH St.	(26.4)	157		
El Paso					
Colorado Springs	101 W. Costilla St.	(20.1)	36	(7.71)	30.4
	130 W Cache la Poudre	21.5	100	(6.12)	15.4
	(Continuous)			(10.19)	68.9
Fremont					
Caňon City	128 Main St.	16.6	54		
Pueblo					
Pueblo	211 D St.	28.7	120	7.37	18.5

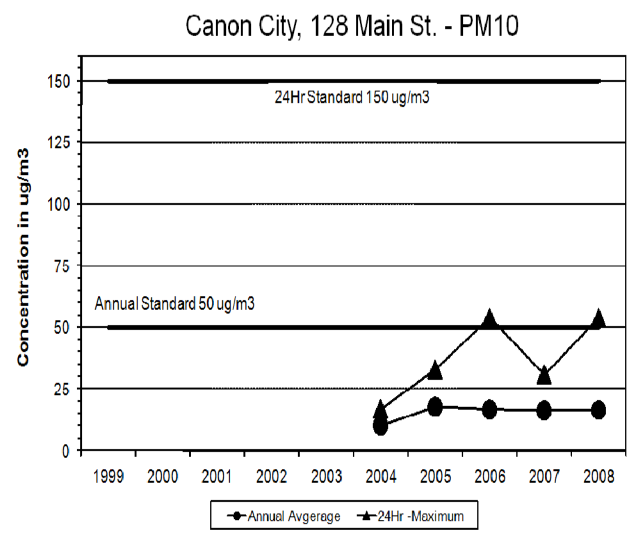
() Indicates less than 75 percent data for one or more quarters.

Figure 32 - Southern Front Range PM_{10} Particulate Graphs









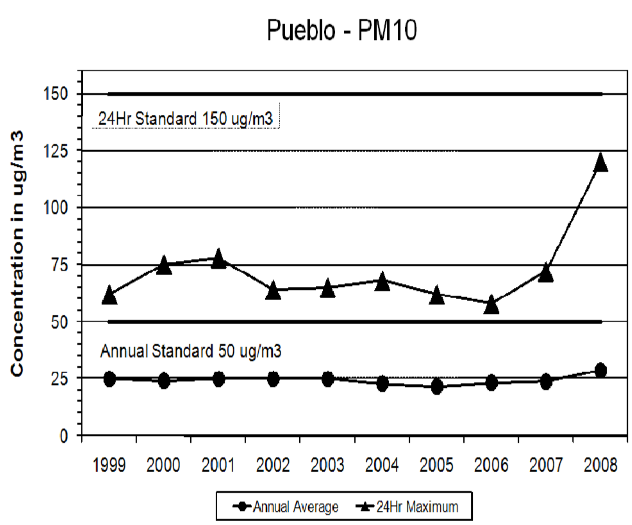
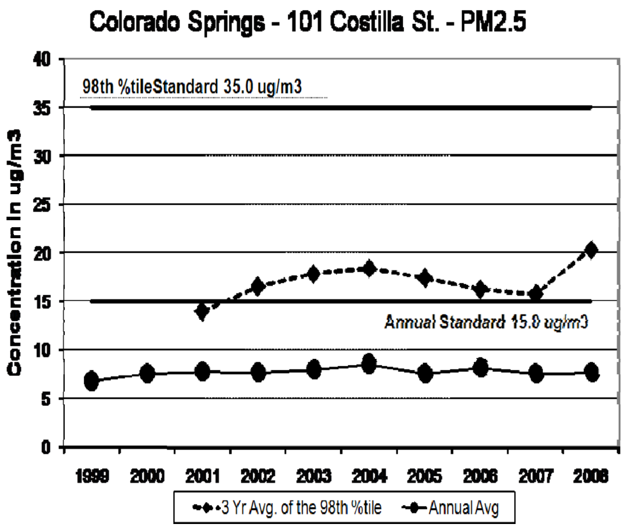


Figure 33 - Southern Front Range $PM_{2.5}$ Particulate Graphs



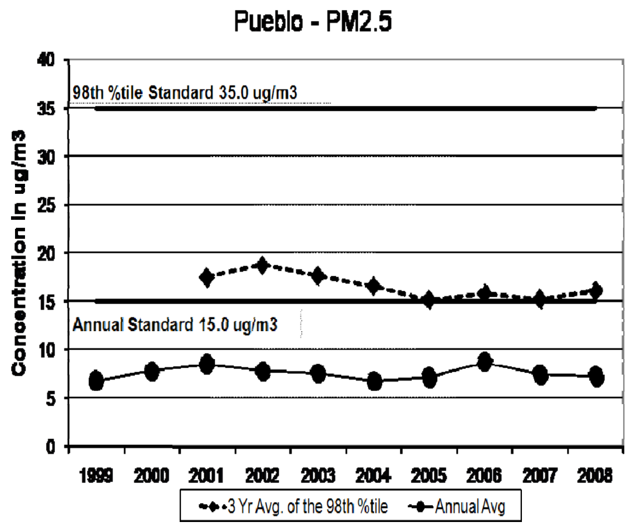


Table 41 - Southern Front Range Carbon Monoxide Values For 2008

Site Name	Location	CO 1-hour Avg. (ppm)		CO 8-hour Avg. (ppm)	
		1st Maximum	2nd Maximum	1st Maximum	2nd Maximum
El Paso					
Colorado Springs	690 W. Hwy 24	4.0	3.5	2.6	2.3

Figure 34 - Southern Front Range Carbon Monoxide Graphs

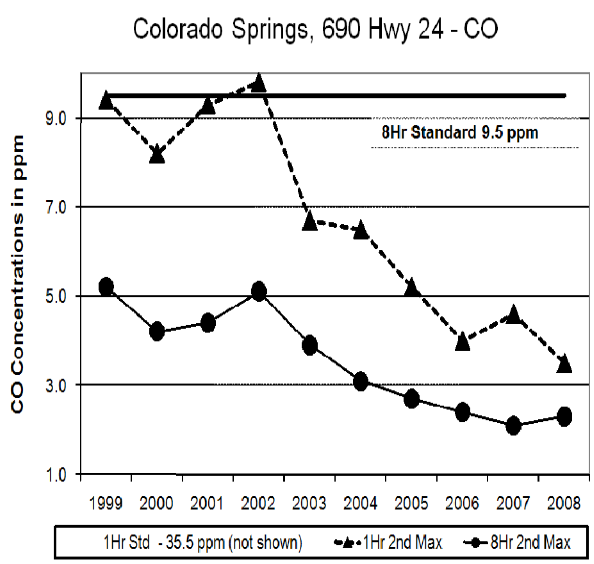
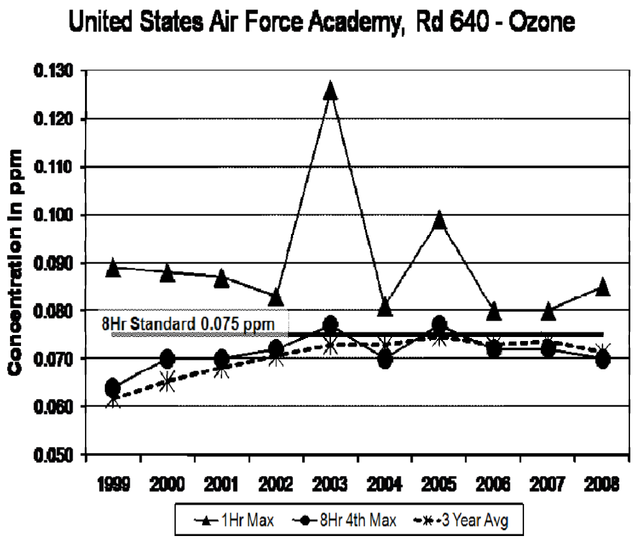
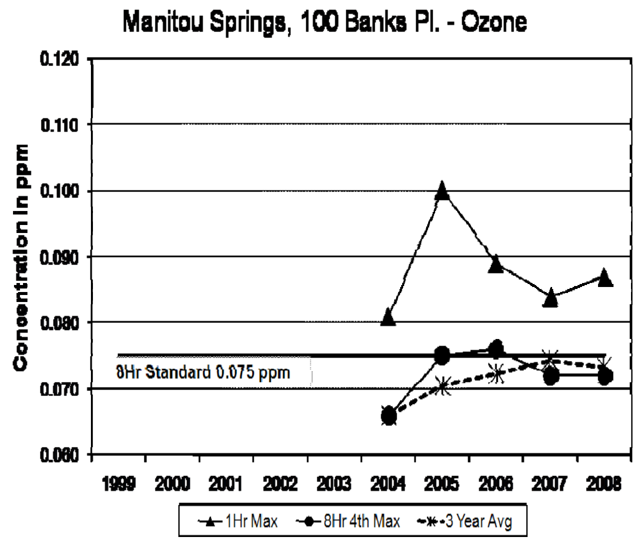


Table 42 - Southern Front Range Ozone Values For 2008

Site Name	Location	Ozone 1-hour Avg. (ppm)		Ozone 8-hour Avg. (ppm)	
		1st Maximum	2nd Maximum	1st Maximum	4th Maximum
El Paso					
USAFA	USAFA Rd 640	0.085	0.083	0.078	0.070
Manitou Springs	101 Banks Pl.	0.087	0.085	0.080	0.072

Figure 35 - Southern Front Range Ozone Graph





6.4 Mountain Counties

The Mountain Counties are generally the towns near the Continental Divide. They are mostly small towns in tight mountain valleys. Their primary monitoring concern is with particulate pollution from wood burning and road sanding. These communities range from Steamboat Springs in the north to Breckenridge in the I-70 corridor, as well as Aspen, Crested Butte and Mt. Crested Butte in the central mountains and Pagosa Springs in the south.

Table 43 - Mountain Counties Monitors in Operation For 2008
X - Monitors continued in 2008 A - Monitors added in 2008
D - Monitors discontinued in 2008 H - Hourly particulate monitor

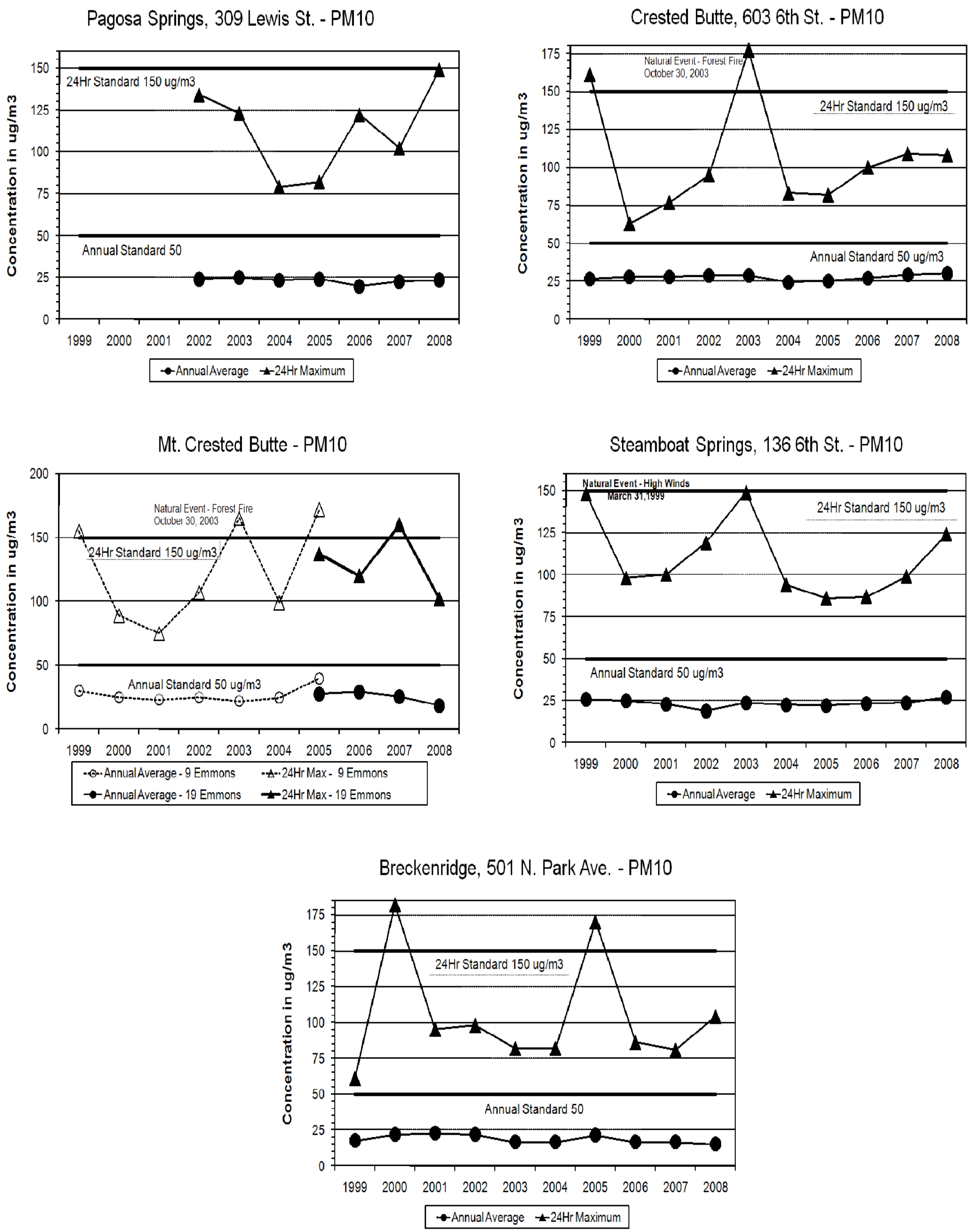
Site Name	Location	PM_{10}
Archuleta		
Pagosa Springs	309 Lewis St.	X
Gunnison		
Crested Butte	603 6th St.	X
Mt Crested Butte	19 Emmons Loop	X
Pitkin		
Aspen	120 Mill St.	X
Routt		
Steamboat	Springs136 6th St.	X
Summit		
Breckenridge	501 N. Park Ave.	X

Table 44 - Mountain Counties Particulate Values For 2008

Site Name	Location	PM_{10} (µg/m^3)	
		Annual Average	24-Hr Maximum
Archuleta			
Pagosa Springs	309 Lewis St.	23.6	149
Gunnison			
Crested Butte	603 6th St.	30.4	108
Mt. Crested Butte	19 Emmons Loop	18.5	102
Pitkin			
Aspen	120 Mill St	16.9	65
Routt			
Steamboat Springs	136 6th St.	(26.5)	124
Summit			
Breckenridge	501 N. Park Ave.	15.3	104

() Indicates less than 75 percent data for one or more quarters.

Figure 36 - Mountain Counties PM10 Particulate Graphs



6.5 Western Counties

The Western Counties are generally smaller towns in fairly broad river valleys. Grand Junction is the only large city in the area and the only location that monitors for carbon monoxide on the western slope. The other locations monitor only for particulates. They are located in Parachute, Delta, Durango, Rifle, Palisade, Cortez and Telluride.

Table 45 - Western Counties Monitors in Operation For 2008
X - Monitors continued in 2008 A - Monitors added in 2008
D - Monitors discontinued in 2008 H - Hourly particulate monitor S - Chemical Speciation

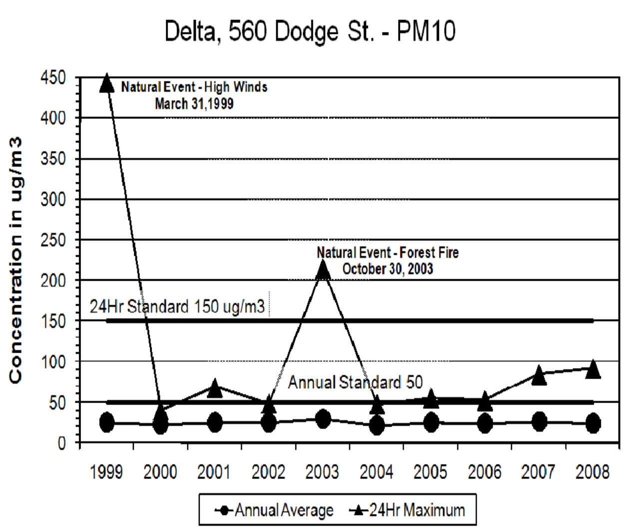
Site Name	Location	CO	O_3	PM_{10}	$PM_{2.5}$	Met
Delta						
Delta	560 Dodge St.			X		
Garfield						
Parachute	100 E. 2nd St.			X		
Rifle	144 E. 3rd Ave.			X		
	195 14th St.		A			
La Plata						
Durango	1235 Camino del Rio			X		
Mesa						
Grand Junction	650 South Ave.			X	X/H/S	
	645 ¼ Pitkin Ave.	X		H		X
Palisade Water Treatment	865 Rapid Creek Dr.		A			A
Clifton	141 & D St.			X		
Montezuma						
Cortez	106 W. North Ave.		A		A	
San Miguel						
Telluride	333 W. Colorado Ave.			X		

Table 46 - Western Counties Particulate Values For 2008

Site Name	Location	PM10 (µg/m³)		PM2.5 (µg/m³)	
		Annual Average	24-Hr Maximum	Annual Average	24-Hr Maximum
Delta					
Delta	560 Dodge St.	24.7	92		
Garfield					
Parachute	100 E. 2nd Ave.	(45.7)	210		
Rifle	144 E. 3rd Ave.	31.5	114		
La Plata					
Durango	1235 Camino del Rio	20.3	125		
Mesa					
Grand Junction	650 South Ave.	29.2	116	9.11	27.8
	(Continuous)			(10.51)	168.1
	645 ¼ Pitkin Ave.	35.1	149		
Clifton	141 & D St.	30.7	125		
Montezuma					
Cortez	106 W. North St.			(6.01)	25.3
San Miguel					
Telluride	333 W. Colorado Ave.	18.3	82		

() Indicates less than 75 percent data for one or more quarters.

Figure 37 - Western Counties PM_{10} Particulate Graphs



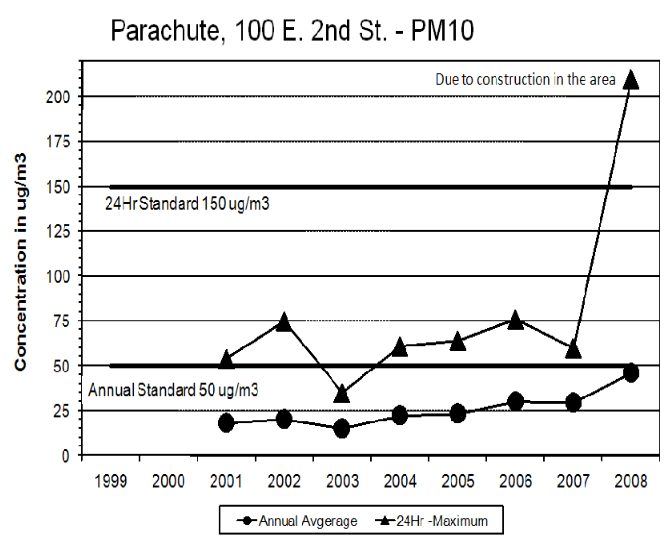
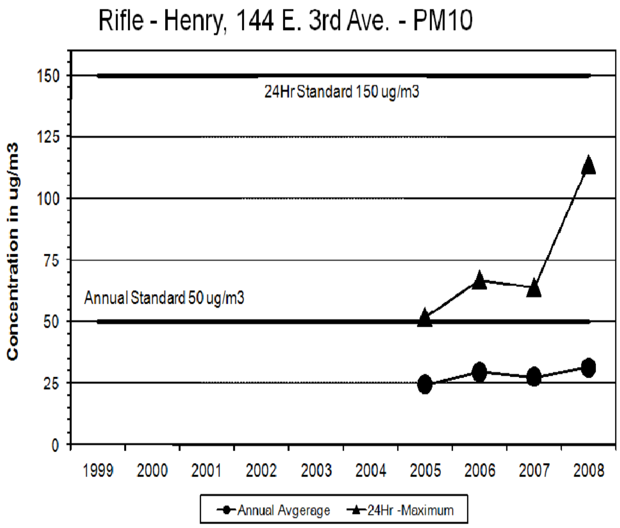
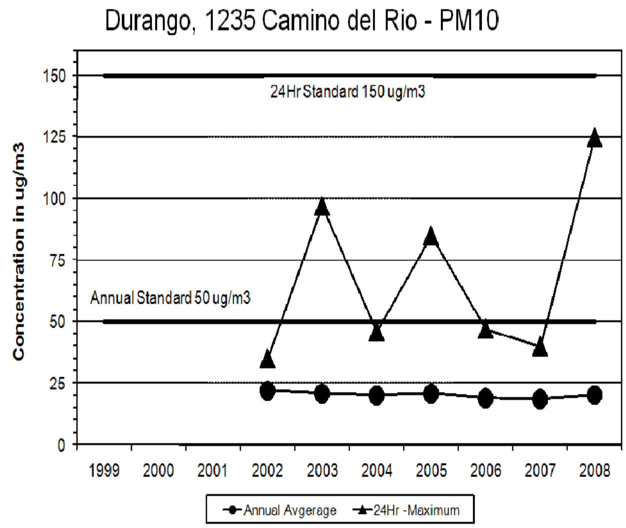
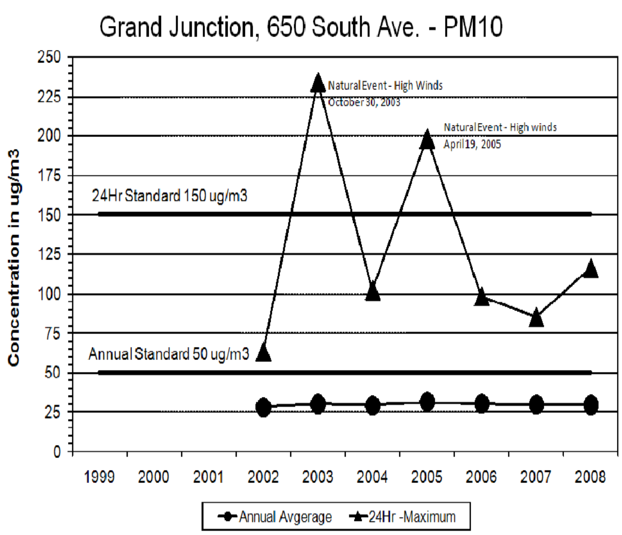


Figure 37 - Western Counties PM_{10} Particulate Graphs (continued)







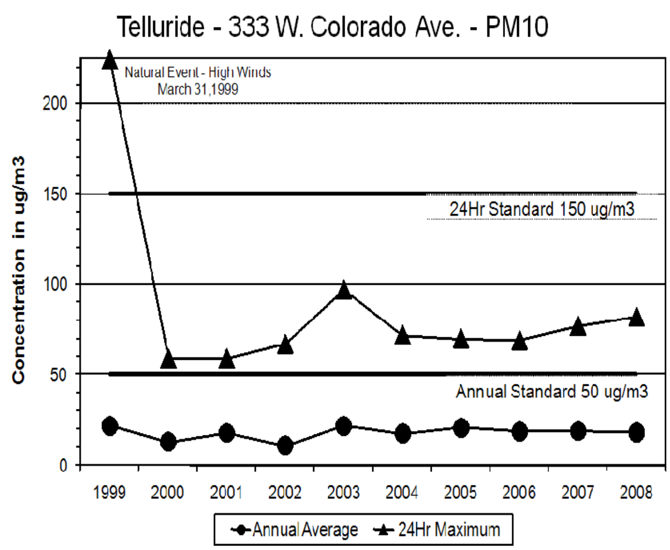


Figure 38 - Western Counties PM2.5 Particulate Graph

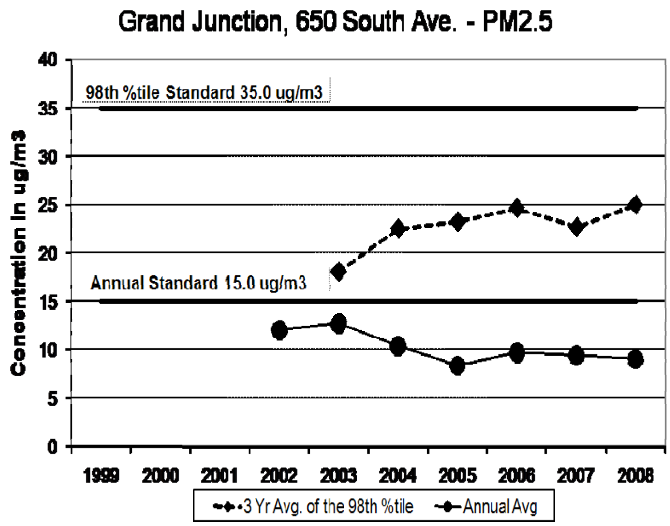


Table 47 - Western Counties Carbon Monoxide Values For 2008

Site Name	Location	CO 1-hour Avg.(ppm)		CO 8-hour Avg.(ppm)	
		1st Maximum	2nd Maximum	1st Maximum	2nd Maximum
Mesa					
Grand Junction	645 ½ Pitkin Ave.	7.1	6.8	2.6	1.5

Figure 39 - Western Counties Carbon Monoxide Graph

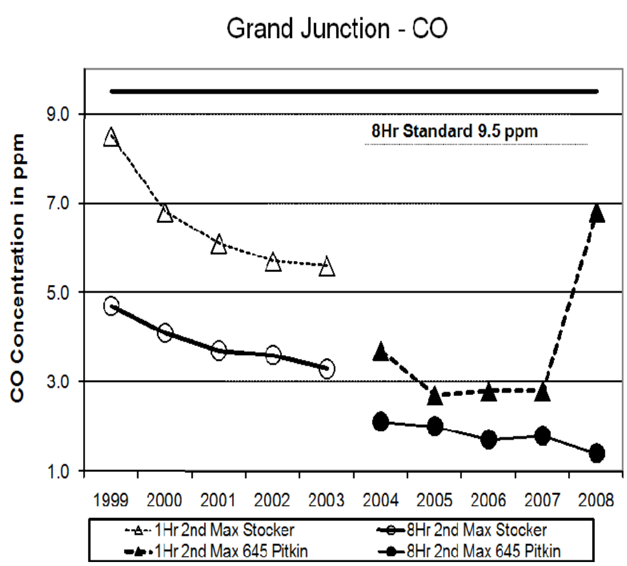


Table 48 - Western Ozone Values For 2008

Site Name	Location	Ozone 1-hour Avg. (ppm)		Ozone 8-hour Avg. (ppm)	
		1st Max	2nd Max	1st Max	4th Max
Garfield					
Rifle	195 W. 14th St.	0.081	0.080	0.076	0.066
Mesa					
Palisade Water Treatment	865 Rapid Creek Dr.	0.081	0.079	0.077	0.070
Montezuma					
Cortez	106 W. North Ave.	0.078	0.074	0.067	0.064

Figure 40 - Western Counties Wind Roses
Grand Junction, 645¼ Pitkin Ave.

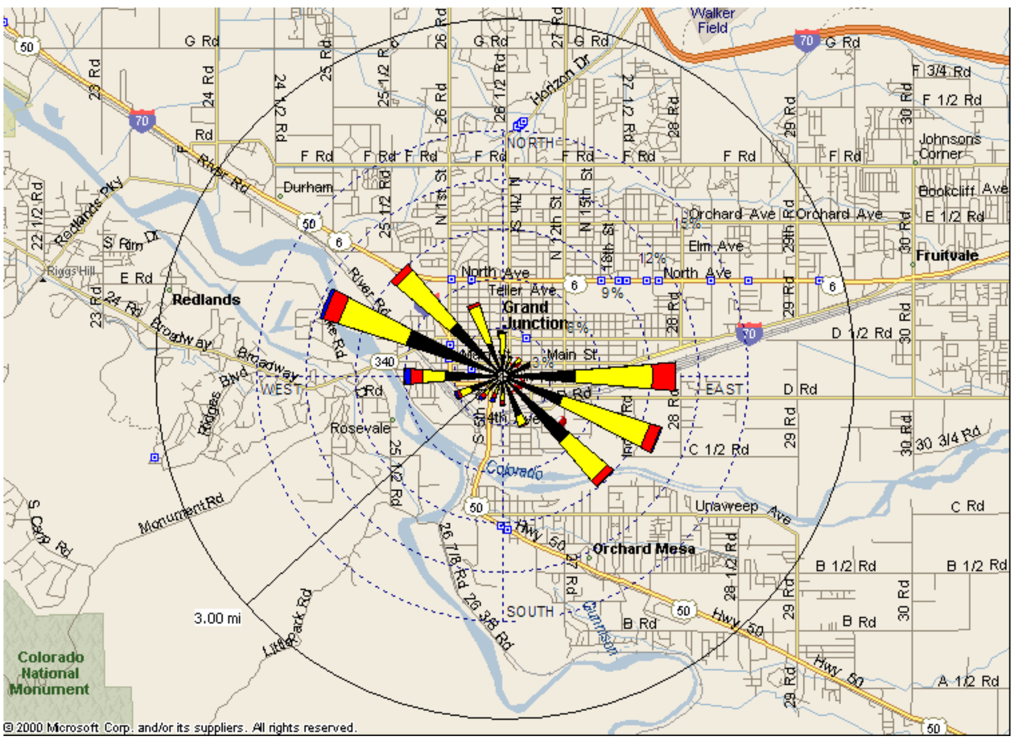
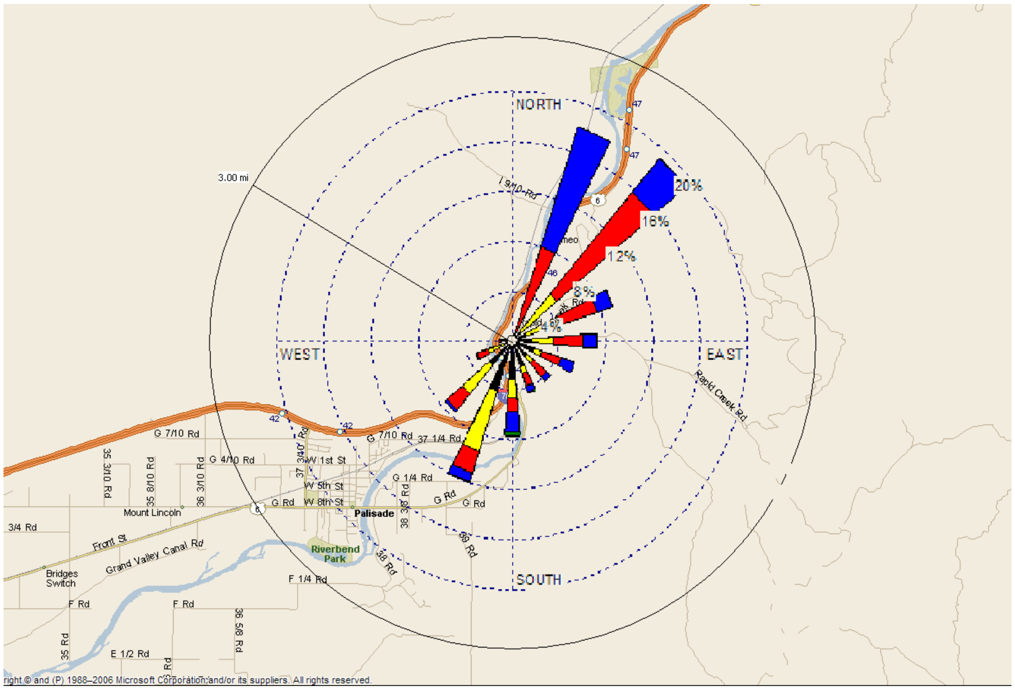


Figure 40 - Western Counties Wind Roses (Continued)
Palisade Water Treatment



The Palisade meteorological monitor began operation on May 30, 2008 so the data from this site does not represent a complete year of data. This wind rose is included because of the monitoring concerns for Mesa county.

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