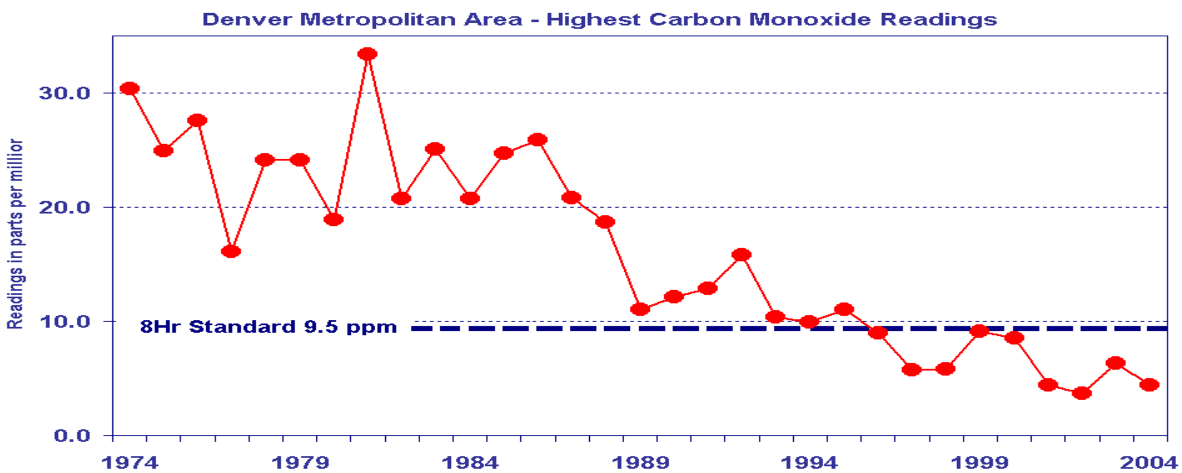
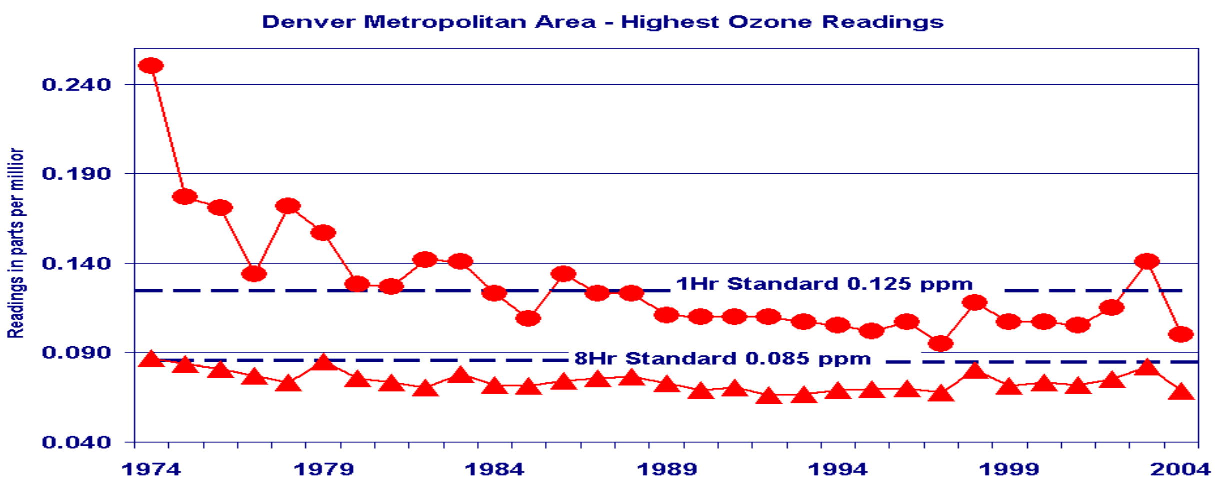
Colorado

2004 Air Quality Data Report





Air Pollution Control Division

STATE OF COLORADO
NIL SINE NUMINE
1876

Colorado Department
of Public Health
and Environment

COLORADO AIR QUALITY DATA REPORT

2004

Colorado Department of Public Health and Environment

Air Pollution Control Division
APCD-TS-B1
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September, 2005

Cover:

The two graphs on the cover show both the successes in improving air quality over the past thirty years and the reasons for concern for the future. The decline in carbon monoxide levels has been the most dramatic. Ozone has declined from the levels seen in the 1970's but as shown by the 1998 and 2003 levels the problems have not been eliminated.

For real-time air monitoring data and additional information, please visit http://apcd.state.co.us. Webcam images are also available on this site.

This report is available electronically at http://apcd.state.co.us/documents/techdocs.html

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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 Design of the Annual Air Quality Data Report

The format of the Air Quality Data Report has changed to reflect the requests that it should show pollutant concentrations by region rather than by pollutant. This change will also bring the Air Quality Data Report into better organizational alignment with the Air Quality Control Commission's Annual Report to the Public, although the geographical divisions used in this report were created to represent roughly similar types of monitoring requirements and needs. As a result of this redesign, other sub-sections have been moved to their own sections in the report. For example, information on summarized state trends and national trends appear in Sections 4 and 5, respectively. Detailed monitoring results by area appear in Section 6, including graphs of data from individual sites where three or more years of data are available.

1.2 Description of Monitoring Areas in Colorado

The state has been divided into five areas that are generally based on topography. The areas are: the Eastern Plains; the Northern Front Range; the Southern Front Range; the Mountain Communities and the Western Communities. These divisions are a somewhat arbitrary grouping of monitoring sites with similar characteristics. The Front Range used in this definition is not defined by the Continental divide that would place Leadville in the same area as Colorado Springs or Denver as opposed to Breckenridge and Aspen. Spatially, Telluride could be included with the Western Communities but it seems to have more in common with the Mountain Communities of Gunnison and Crested Butte. Other divisions can and have been made, but these five divisions seemed appropriate for this report. Figure 1 depicts these areas.

1.2.1 Eastern Plains Communities

The Eastern Plains Communities are those east of the urbanized I-25 corridor. Historically there have been a number of communities that were monitored for particulates. 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. In the southeast, the US-50/Arkansas River corridor, only Lamar is currently monitored for particulates. The communities of La Junta and Rocky Ford have been monitored in the past, but like the other communities that have been monitored on the Eastern Plains, the monitoring was discontinued when the concentrations were shown to be well below the air quality standards.

1.2.2 Northern Front Range Communities

The Northern Front Range Communities 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 remaining monitors are located in or near Fort Collins, Greeley, Longmont and Boulder.

1.2.3 Southern Front Range Communities

The Southern Front Range Communities 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 include Colorado Springs, Pueblo, Cripple Creek, 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 with the Mountain Communities. 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 APCD has conducted particulate monitoring in both Walsenburg and Trinidad but that monitoring was discontinued in 1979 and 1985 respectively.

1.2.4 Mountain Communities

The Mountain Communities are generally the towns near the Continental Divide and usually 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 Telluride in the southwest and include Silverthorne and Breckenridge in the I-70 corridor; Aspen, Leadville, Crested Butte, Mt. Crested Butte, Vail and Gunnison in the central mountains.

1.2.5 Western Communities

The Western Communities 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 Western Slope monitors are located in the cities of Parachute, Delta, Montrose, Durango and Pagosa Springs. These locations monitor only for particulates.

Table 1- Statewide Continuous Monitors In Operation For 2004

X - Monitors continued in 2004   A – Monitors added in 2004

D – Monitors discontinued in 2004

County	Site Name	Location	CO	SO_2	NO_X	O_3	Met
Northern Front Range Communities							
Adams	Commerce City	7101 Birch St.					X
	South Adams	5580 Niagara St.		D			
	Welby	78th Ave. & Steele St.	X	X	X	X	X
Arapahoe	Highland Res.	8100 S. University Blvd.				X	X
Boulder	Boulder	2150 28th St.	X				
		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	23rd Ave. & Julian St.	X			X	X
	Denver NJH	14th Ave. & Albion St.	X				
	DESCI Building	1901 13th Ave. (Visibility)					
	Firehouse #6	1300 Blake St.	X				
Douglas	Chatfield Res.	Roxborough Park Rd.				D	
		11500 N. Roxborough Pk Rd				A	A
Jefferson	Arvada	W. 57th Ave. & Garrison St.	X			X	X
	Golden	636 Lookout Mtn. Rd.				A/D	
	NREL	2054 Quaker St.				X	
	Rocky Flats	16600 W. Hwy. 128				X	X
		11501 Indiana St.					X
		9901 Indiana St.					X
		18000 W. Hwy. 72					X
		11190 N. Hwy. 93					X
	Welch	12400 W. Hwy. 285				X	X
Larimer	Fort Collins	708 S. Mason St.	X			X	X
		300 Remington St. (Visibility)					
		4407 S. College Ave.	X				
Weld	Greeley	905 10th Ave.	X				
		3101 35th Ave.				X	
Southern Front Range Communities							
El Paso	Colorado Springs	I-25 & Uintah St.	X				
		USAF Rd. 640				X	
		690 W. Hwy. 24	X				
	Manitou Springs	101 Banks Pl.				A	
Fremont	Cripple Creek	Warren Ave. & 2nd St.					X
Mountain Communities							
Routt	Steamboat Springs	137 10th St.					X
Western Communities							
Mesa	Grand Junction	645 ¼ Pitkin Ave.	A				A

Table 2 - Statewide Particulate Monitors In Operation For 2004

X - Monitors continued in 2004 A – Monitors added in 2004

D – Monitors discontinued in 2004 H – Hourly particulate monitor

County	Site Name	Location	TSP	Pb	PM_{10}	$PM_{2.5}$
Eastern Plains Communities						
Elbert	Elbert	Wright-Ingraham Inst.				X
Prowers	Lamar	100 2nd St.			X	
		104 Parmenter St.			X	
		415 Camino de Santa Fe			A/D	
		3445 W. Road HH			A/D	
Northern Front Range Communities						
Adams	Brighton	22 S. 4th Ave.			X	
	Commerce City	7101 Birch St.	X	X	X	X/H
	Globeville	5400 Washington St.	X	X		
	Welby	78th Ave. & Steele St.			X/H	
Arapahoe	Arapahoe Comm. College	6190 S. Santa Fe Dr.				X
Boulder	Longmont	3rd Ave. & Kimbark St.			X	X
	Boulder	2440 Pearl St.			X	X
		2102 Athens St.				A/H
Denver	Denver CAMP	2105 Broadway	X	X	X/H	X/H
	Denver Gates	1050 S. Broadway	X	X	X	
	Denver NJH	14th Ave. & Albion St.				H
	Denver Visitor Center	225 W. Colfax Ave.			X	
	Lowry	8100 Lowry Blvd.			X	
	Swansea Elementary Sch.	4650 Columbine St.				A
Douglas	Chatfield Reservoir	11500 Roxborough Rd				A/H
Larimer	Fort Collins	251 Edison St.			X	X
Weld	Greeley	1516 Hospital Rd.			X	X/H
	Platteville	1004 Main St.				X
Southern Front Range Communities						
Alamosa	Alamosa	359 Poncha Ave.			X	
		425 4th St.			X	
El Paso	Colorado Springs	3730 Meadowlands			X	X
		101 W. Costilla St.	X	X	X	X
Fremont	Cañon City	7th Ave. & Macon St.			D	
		128 Main St.			A	
Pueblo	Pueblo	211 D St.			X	X
Teller	Cripple Creek	209 Bennett Ave.			X	
Mountain Communities						
Archuleta	Pagosa Springs	309 Lewis St.			X	X
Gunnison	Crested Butte	Colo.135 & Whiterock			X	
	Mt. Crested Butte	9 Emmons Loop			X	X
	Gunnison	221 N. Wisconsin Ave.			X	
Lake	Leadville	510 Harrison St.	X	X		
Pitkin	Aspen	120 Mill St.			X/H	
Routt	Steamboat Springs	136 6th St.			X	X
San Miguel	Telluride	333 W Colorado Ave.			X	X
Summit	Breckenridge	County Justice Center			X	

Table 2 (continued) - Statewide Particulate Monitors In Operation For 2004

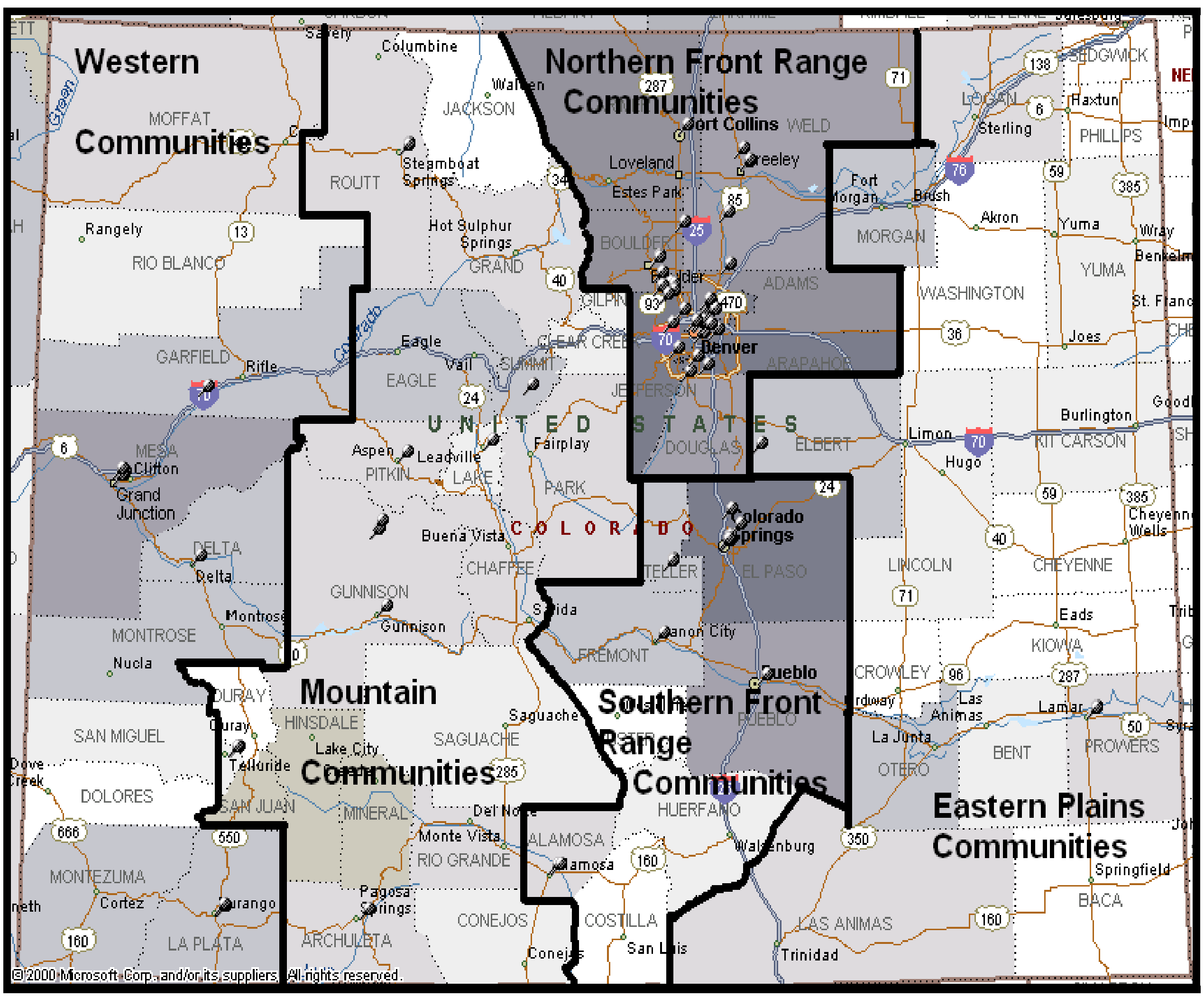
X - Monitors continued in 2004   A – Monitors added in 2004

D – Monitors discontinued in 2004   H – Hourly particulate monitor

County	Site Name	Location	TSP	Pb	PM_{10}	$PM_{2.5}$
Western Communities						
Delta	Delta	560 Dodge St.			X	X
Garfield	Parachute	100 E. 2nd St.			X	
La Plata	Durango	1060 2nd Ave.			X	
		623 E. 5th St.			D	
		56 Davidson Creek Rd.			A	
		1235 Camino del Rio			X	
		1455 S. Camino del Rio			X	
		117 Cutler Dr.			X	
Mesa	Grand Junction	650 South Ave.			X	X
		645 ¼ Pitkin Ave.			A/H	

Figure 1

Monitoring Areas in Colorado



2.0 Criteria Pollutants

The 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 populations in society, usually defined as those with respiratory problems, the very young and the infirm. The concentrations of each standard for the criteria pollutants are discussed in each section and a summary is presented in Table 3.

Table 3 - National Ambient Air Quality Standards[1]

Pollutant	Averaging Time	Concentration
Carbon Monoxide		
Primary	1-hour*	35 ppm
Primary	8-hour*	9 ppm
Ozone		
Primary	8-hour**	0.08 ppm
Secondary	Same as primary	
Nitrogen Dioxide		
Primary	Annual arithmetic mean	0.053 ppm
Secondary	Same as primary	
Sulfur Dioxide		
Primary	Annual arithmetic mean	0.03 ppm
Primary	24-hour*	0.14 ppm
Secondary	3-hour*	0.5 ppm
Particulate (PM_{10})		
Primary	Annual arithmetic mean****	50 $\mu g/m^3$
Primary	24-hour***	150 $\mu g/m^3$
Particulate ($PM_{2.5}$)		
Primary	Annual arithmetic mean****	15 $\mu g/m^3$
Primary	24-hour*****	65 $\mu g/m^3$
Lead		
Primary	Calendar quarter	1.5 $\mu g/m^3$

* This concentration is not to be exceeded more than once per year.

** The 8-hour Ozone standard is set at 0.08 ppm as the 3-year average of the annual 4th maximum 8-hour average concentration.

*** The 24-hour standard is attained when the expected number of exceedances for each calendar year, averaged over three years, is less than or equal to one.

**** The annual arithmetic mean standard is a 3-year average.

***** The 24-hour $PM_{2.5}$ standard is based on the 98th percentile.

2.0.1 Exceedance Summary Table

Table 4 is a summary of the number of exceedances of the ambient air quality standards for Colorado for 2003 and 2004. There were no exceedances of any criteria pollutant at any state operated monitor in 2004. This is only the second time since the APCD began monitoring for criteria pollutants in the early 1970's that no exceedances were recorded at any state operated monitor. The levels of the standards are listed in Table 3.

Table 4 - 2003/2004 Exceedance Summaries

Location	2003			2004**
	PM_{10}	1Hr-O_3	8Hr-O_3	
Highland Reservoir		2	4	
South Boulder Creek			2	
Delta	1*			
Denver Carriage		1	4	
Chatfield Reservoir		2	8	
US Air Force Academy		1		
Crested Butte	1*			
Mt. Crested Butte	1*			
Arvada			3	
Welch			2	
Rocky Flats - N			15	
NREL		1	12	
Fort Collins – Mason			1	
Grand Junction - Powell	1*			
Weld County Tower			2	

* These exceedances were classified as "Natural Events", associated with dust and wildfire smoke of October 30, 2003.

** There were no exceedances of any National Ambient Air Quality Standard in 2004.

2.1 Carbon monoxide

Carbon monoxide is a colorless, odorless and tasteless gas. It is the largest single fraction of pollutants found in urban atmospheres. It is produced primarily during the incomplete combustion of organic fuels used for transportation and heating. Carbon monoxide is also created during refuse and agricultural burning and as a by-product from some industrial processes.[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 given year at any given location. A location will violate the standard with a second exceedance of either standard in a calendar year. The EPA directive requires 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 it from the body. Hemoglobin binds approximately 240 times more readily with carbon monoxide than with oxygen. In the presence of carbon monoxide the distribution of oxygen is reduced throughout the body. Blood laden with carbon monoxide can weaken heart contractions with the result of lowering the volume of blood distributed to the body. It can significantly reduce a healthy person's ability to do manual tasks, such as working, jogging and walking. A life-threatening situation can exist for patients with heart disease when these people are unable to compensate for the oxygen loss by increasing the heart rate.[3]

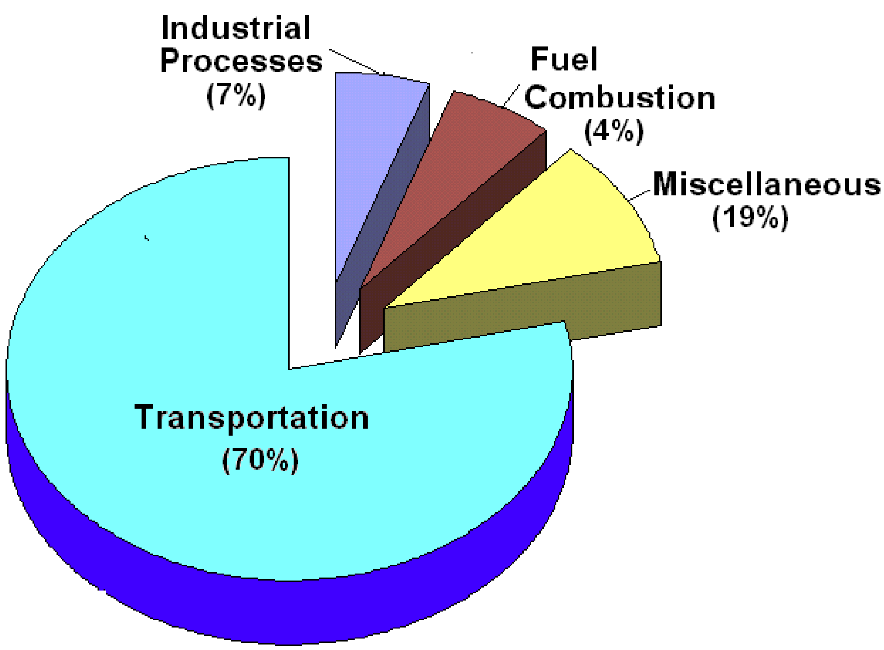
The EPA has concluded that the following groups may be particularly sensitive to carbon monoxide exposures: angina patients, individuals with other types of cardiovascular disease, persons with chronic obstructive pulmonary disease, anemic individuals, fetuses and pregnant women. Concern also exists for healthy children because of increased oxygen requirements that result from their higher metabolic rate.[3]

Carbon monoxide is exhausted from the body at varying rates, depending on physiological and external factors. The general guideline is that 20 to 40 percent is lost from the system after 2 to 3 hours following exposure.[3] The severity of health effects depends on both the concentration and the length of exposure because it takes time to remove it from the blood stream.

2.1.3 Carbon monoxide – Sources

In Denver, the APCD estimates that 86 percent of the carbon monoxide emissions are from automotive sources. An estimated 3 percent of Denver's carbon monoxide emissions are from woodburning stoves and fireplaces. The remainder originates from aircraft, locomotives, construction equipment, power plants and space heating.[4] These numbers are similar to the nationwide emissions shown in Figure 2.[5]

Figure 2 - National Emissions by Source Category in 2003 - Carbon Monoxide



In Denver, the daily concentration peaks are generally just after morning and evening rush hours. The worst problems occur where slow-moving cars congregate, such as in large parking lots or traffic jams. Carbon monoxide can temporarily accumulate to harmful concentrations in calm weather during autumn and winter. The problem is more severe in winter because cold weather makes motor vehicles run less efficiently and woodburning emissions from space heating are increased. In addition, on winter nights, a strong temperature inversion may develop near the ground, trapping pollutants.[4]

Figure 2 shows the nationwide carbon monoxide emissions for 2003. Transportation includes both on and non-road. On-road vehicle sources are the exhaust from cars; trucks and buses while non-road vehicles are trains, planes, boats and construction equipment. Miscellaneous sources are forest fires and other natural sources of carbon monoxide. Fuel combustion sources are woodstoves, gas stoves and space heaters.[5]

2.2 Ozone

Ozone is a highly reactive form of oxygen. At very high concentrations it is a blue, unstable gas with a characteristic pungent odor often associated with arcing electric motors, lightning storms or other electrical discharges.[6] However, at ambient concentrations, ozone is colorless and odorless. Ozone concentrations at remote locations, such as the Western National Air Pollution Background Network, range from 0.02 to 0.04 ppm year-round.[7]

At ground level, ozone is a pollutant. Although chemically identical, ground level ozone should not be confused with the stratospheric ozone layer. The stratospheric ozone layer is found between 12 and 30 miles above the earth's surface and shields the earth from intense, cancer-causing ultraviolet radiation. Concentrations of ozone in this layer are approximately 10 to 12 ppm or more than 100 times the National Ambient Air Quality Standard for ozone. Occasionally, meteorological conditions result in stratospheric ozone being brought to ground level and this can increase concentrations by 0.05 to 0.10 ppm. This stratospheric intrusion has caused concentrations higher than the 0.12 ppm standard.[8]

2.2.1 Ozone – Standards

In July 1997, the U.S. Environmental Protection Agency established a new ozone standard. The reasons for these changes were:

> *". . . to provide protections for children and other at-risk populations against a wide range of ozone induced health effects, including decreased lung function (primarily in children active outdoors), increased respiratory symptoms (particularly in highly sensitive individuals), hospital admissions and emergency room visits for respiratory causes (among children and adults with pre-existing respiratory disease such as asthma), inflammation of the lung and possible long-term damage to the lungs."*[7]

> *"The 1-hour primary standard of 0.12 ppm was replaced by an 8-hour standard at a level of 0.08 ppm with a form based on the 3-year average of the annual 4th-highest daily maximum 8-hour average ozone concentration measured at each monitor within an area."*[7]

The 8-hour averaging time is more directly associated with health effects of concern at lower ozone concentrations than is the former 1-hour averaging time. Therefore, the 8-hour standard was felt to be more appropriate for a human health-based standard than the 1-hour standard.[8]

2.2.2 Ozone – Health Effects

Short-term exposures (one to three hours) to ambient ozone concentrations have been linked to increased hospital admissions and emergency room visits for respiratory-related problems. Repeated exposures to ozone can make people more susceptible to respiratory infection and lung inflammation and can aggravate preexisting respiratory diseases such as asthma. Other health effects attributed to short-term exposures to ozone, generally while individuals are engaged in moderate or heavy exertion, include significant decrease in lung function and increased respiratory symptoms such as chest pain and coughing. Children that are active outdoors during the summer when ozone concentrations are highest are most at risk of experiencing such effects. Other at-risk groups include outdoor workers, individuals with preexisting respiratory disease such as asthma and chronic obstructive lung disease and individuals who are unusually responsive to ozone. Recent studies have attributed these same health effects to prolonged exposures (6 to 8 hours) at relatively low ozone concentrations during periods of moderate exertion. In addition, long-term exposure to ozone presents the possibility of irreversible changes in the lungs that could lead to premature aging of the lungs and/or chronic respiratory illnesses.[8]

The recently completed review of the ozone standard (by the EPA and others) also highlighted concerns with ozone effects on vegetation for which the 1-hour ozone standard did not provide adequate protection. These effects can include reduction in agricultural and commercial forest yields, reduced growth and decreased survivability of tree seedlings, increased tree and plant susceptibility to disease, pests and other environmental stresses and potential long-term effects on forests and ecosystems.[8]

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.[8]

Ozone production is a year-round phenomenon. However, the highest ozone concentrations generally occur during the summer season when the sunlight is more intense and the meteorological conditions are more stagnant. This combination can cause reactive pollutants to remain together in an area for several days. Ozone produced under these summer stagnant conditions remains as a coherent air mass and can be transported many miles from its point of origin.

2.3 Sulfur dioxide

Sulfur dioxide is a colorless gas with a pungent odor. It is detectable by smell at concentrations of about 0.5 to 0.8 ppm.[10] It is highly soluble in water. In the atmosphere, sulfur oxides and nitric oxides are converted to "acid rain"

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.[9]

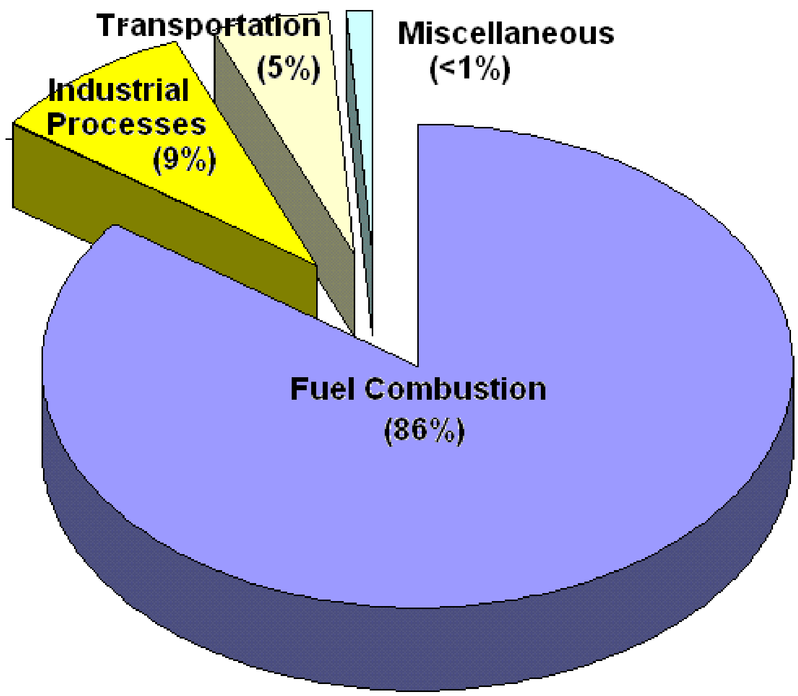
2.3.2 Sulfur dioxide – Health Effects

Sulfur dioxide can be converted in the atmosphere to sulfuric acid aerosols and particulate sulfate compounds, which are corrosive and potentially carcinogenic (cancer-causing). Worldwide elevated sulfur dioxide and particulates have been associated with many air pollution disasters. Deaths in these disasters were due to respiratory failure and occurred predominantly, but not exclusively, in the elderly and infirm. Sulfur dioxide may also play an important role in the aggravation of chronic illnesses such as asthma. The incidence and intensity of asthma attacks increase when people with asthma are exposed to higher concentrations of sulfates.

2.3.3 Sulfur dioxide – Sources

On a worldwide basis, sulfur dioxide is considered a major pollution problem. In the United States, sulfur dioxide is emitted mainly from stationary sources that burn coal and oil. Other sources include refineries and smelters. Significant amounts of sulfur dioxide are also emitted from natural sources such as volcanoes, which rarely contribute to the urban sulfur dioxide problem.[10] Figure 3 shows the distribution of sulfur dioxide emissions nationwide in 2003.

Figure 3 - National Emissions by Source Category in 2003 - Sulfur Dioxide



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 and 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 annual standard for nitrogen dioxide is 0.053 ppm expressed as an annual arithmetic mean (average).[11] Los Angeles is the only U.S. city that has recorded exceedances of the nitrogen dioxide annual standard in the past twelve years.[12]

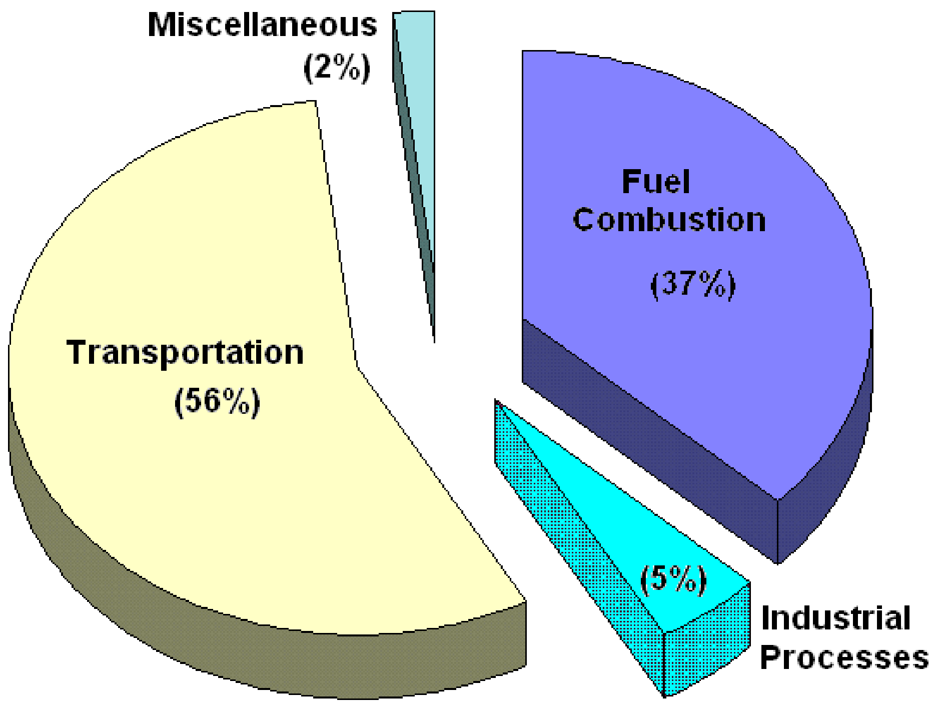
2.4.2 Nitrogen dioxide – Health Effects

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

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.[13] The emissions in Denver can be compared to the national nitrogen dioxide emissions shown in Figure 4.[14]

Figure 4 - National Emissions by Source Category in 2003 - Oxides of Nitrogen



2.5 Particulate Matter – PM_{10}

Particulate matter is the term given to the tiny particles of solid or semi-solid material suspended in the atmosphere. Particulates can range in size from less than 0.1 microns to 50 microns. Particles larger than 50 microns tend to settle out of the air quickly and are not considered to have a health effect. Particulate matter 10 microns in diameter and smaller is considered inhalable and has the greatest health impact.[17]

2.5.1 Particulate Matter – PM_{10} – Standards

In July 1987, EPA promulgated National Ambient Air Quality Standards for particulates with an aerodynamic diameter of 10 microns or less (PM_{10}). This is a size that can be inhaled into the bronchial and alveolar regions of the lungs. The standard has two forms, a 24-hour standard of 150 $\mu g/m^3$ and an annual arithmetic mean standard of 50 $\mu g/m^3$.[15]

1. The 24-hour standard is attained when the expected number of exceedances for each calendar year, averaged over three years, is less than or equal to one. The estimated number of exceedances is computed quarterly using available data and adjusting for missing sample days.
2. The annual arithmetic mean standard is attained when the annual mean, averaged over three years is less than or equal to the level of the standard. Each annual mean is computed from the average of each quarter in the year, with adjustments made for missing sample days.
3. In both cases, a data recovery of 75 percent is needed for each calendar quarter to be considered a valid quarter of data.

The 24-hour standard was modified in by EPA in July 1997, but was subsequently nullified back to this form in May 1999 due to a challenge in the courts.

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."[16]

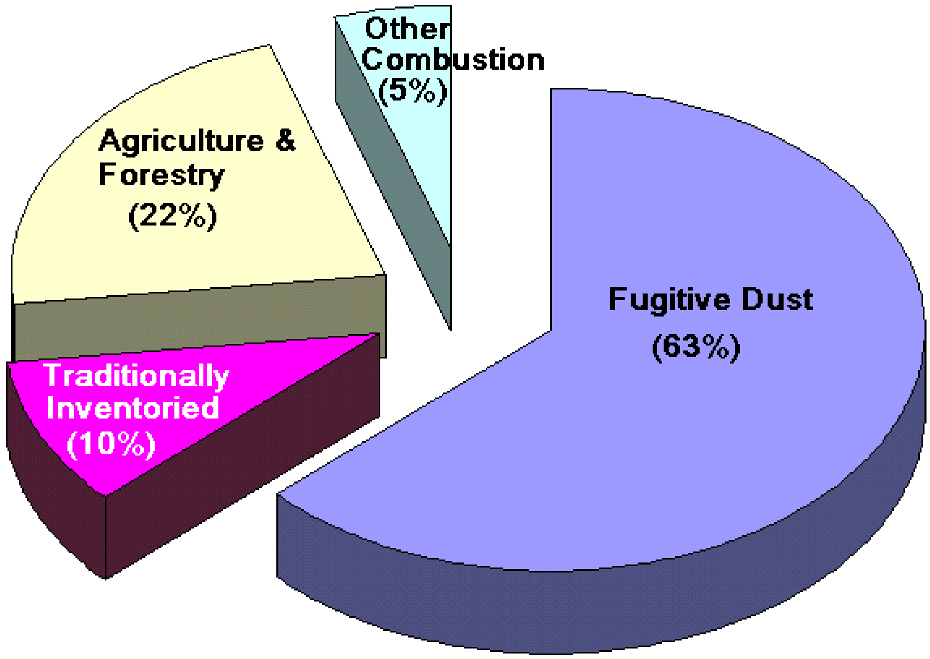
"Fine particulate pollution does not affect the health of exposed persons with equal severity. Certain subgroups of people potentially exposed to air pollutants can be identified as potentially 'at risk' from adverse health effects of air borne pollutants. There is very strong evidence that asthmatics are much more sensitive (i.e., respond with symptoms at relatively low concentrations) to the effects of particulates than the general healthy population. Conversely, little scientific evidence exists that show elderly persons (greater than 65 years old) are particularly sensitive to the effects of particulate matter air pollution"[16]

The welfare effects of particulate exposure may be the most widespread of all the pollutants. Because of the potential for extremely long-range transport of fine particles and chemical reactions that occur, no place on earth has been spared from the particulate pollution generated by urban and rural sources. 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

Most anthropogenic (manmade) particulates are in the 0.1 to 10 micron diameter range. Particles larger than 10 microns are usually due to "fugitive dust". Fugitive dust is wind-blown sand and dirt from roadways, fields and construction sites that contain large amounts of silica (sand-like) materials. Anthropogenic particulates are created during the burning of fuels associated with industrial processes or heating. These particulates include fly ash (from power plants), carbon black (from automobiles and diesel engines) and soot (from fireplaces and woodstoves). The PM_{10} particulates from these sources contain a large percentage of elemental and organic carbon. These types of particles play a role in both visual haze and health issues.[17] Figure 5 shows the distribution of particulate emissions nationwide by source category.[17]

Figure 5 - National Emissions by Source Category in 2003 - PM_{10}



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 SO_2 and NO_X, reacting with ammonia. The main source of SO_2 is combustion of fossil fuels in boilers and the main source of NO_X 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 new fine particle standards, $PM_{2.5}$, to the existing PM_{10} standards. The numbers, 2.5 and 10 refer to the particle size measured in microns. 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 $\mu g/m^3$. However, a lawsuit by the American Trucking Association questioned the EPA's authority to create the new standard. A US District court ruling blocked implementation of the $PM_{2.5}$ standard, but the US Supreme court reversed the lower court and unanimously upheld the legality of the EPA and its creation of the $PM_{2.5}$ standard. The Supreme Court decision was issued on February 27, 2001. 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. The EPA retained the current annual PM_{10} standard of 50 $\mu g/m^3$ and the PM_{10} 24-hour standard of 150 $\mu g/m^3$.

Areas will be considered in compliance with the annual $PM_{2.5}$ standard when the 3-year average of the annual arithmetic mean $PM_{2.5}$ concentrations, from single or multiple communityoriented monitors, is less than or equal to 15 μg/m^3. The 24-hour $PM_{2.5}$ standard is based on the 98th percentile of 24-hour $PM_{2.5}$ concentrations in a year (averaged over 3 years).

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

The health effects of PM2.5 are not just a function of their size, 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.[18]

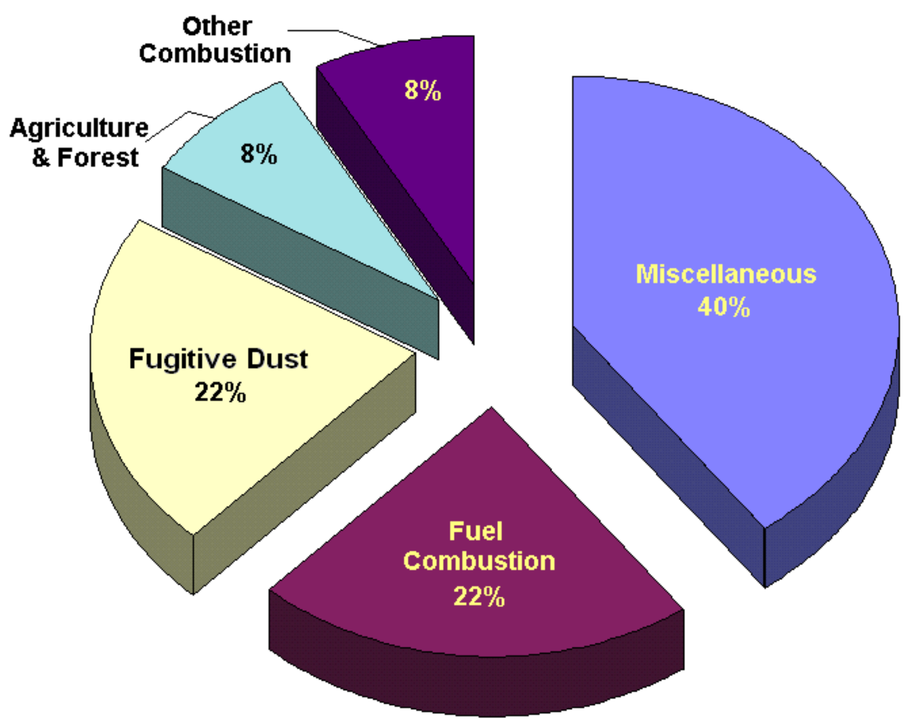
2.6.3 Particulate Matter – $PM_{2.5}$ – Sources

Figure 6 shows the distribution of $PM_{2.5}$ particulates nationwide emissions by source category in 2003.[19]

The primary source of fine particles emitted directly into the air come from crustal materials, ground up rock, carbonaceous material. The carbonaceous material is generated by the incomplete combustion of fossil fuels and other organic compounds.[19] The chart in Figure 6 shows that 60 percent of the national $PM_{2.5}$ emissions come from these types of sources.

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 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.

Figure 6 - National Emissions by Source Category in 2003 - $PM_{2.5}$



2.7 Lead

Since the late 1980s the most significant sources for atmospheric lead are battery plants and nonferrous smelters. With the near elimination of lead as an additive in gasoline the contribution from that source has been reduced significantly.

2.7.1 Lead – Standards

The current federal standard for lead is a calendar quarter (3-month) average concentration not to exceed 1.5 micrograms of lead per cubic meter of air ($\mu g/m^3$). This standard was established to maintain blood lead concentrations below 30 micrograms per deciliter ($\mu g/dL$) due to exposure to atmospheric lead concentrations.[20] In the future, the focus on lead monitoring will shift to ensure that stationary sources do not create violations of the standard in localized areas. Colorado has at least one such source in the Denver area that is the subject of monitoring. The Historical Lead Comparison graphs show data back to 1990. The concentrations recorded at most of the monitoring sites are approaching the limits of detection for ambient lead. The last violation of the lead standard in Colorado was the first quarter of 1980.

2.7.2 Lead – Health Effects

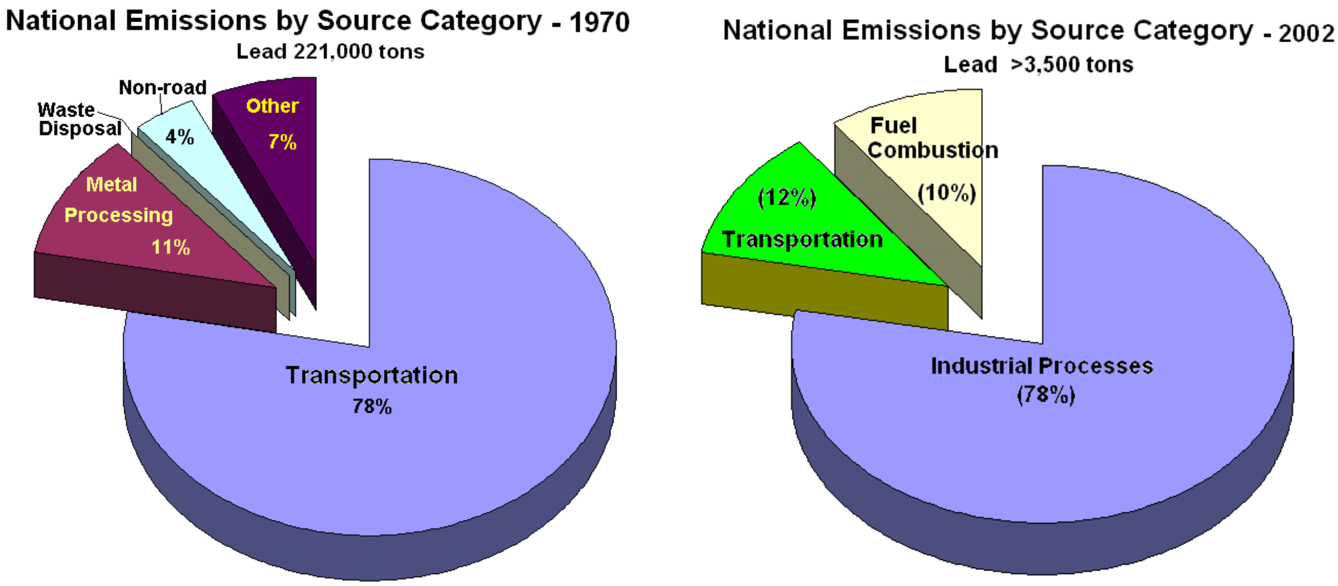
Exposure to lead occurs mainly through inhalation of air and ingestion of lead in food, water, soil, or dust. It accumulates in the blood, bones, and soft tissues and can adversely affect the kidneys, liver, nervous system, and other organs. Excessive exposure to lead may cause neurological impairments 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.[21]

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. The 2002 average air quality concentration for lead is 94 percent lower than in 1983. Emissions of lead decreased 93 percent over the 21-year period 1982–2002. 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. Today, the only violations of the lead NAAQS occur near large industrial sources such as lead smelters and battery manufacturers. Various enforcement and regulatory actions are being actively pursued by EPA and the states for cleaning up these sources.”[21]

Figure 7 shows not only the decline in lead emissions but also the change in the distribution of lead sources in the past 32 years. There have been changes in the categories but the affect of reducing lead in gasoline has been dramatic a decline from approximately 172,000 tons to less than 420 tons per year. The other categories have shown similar declines. Metal processing accounted for only 11 percent of the emissions in 1970 or more than 24,000 tons, that is almost seven times the total inventory for 2002.

Figure 7 - Comparison of National Lead Emissions for 1970 and 2002



3.0 Non-Criteria Pollutants

Non-criteria pollutants are those pollutants for which there are not current national ambient air quality standards. These include but are not limited to visibility, total suspended particulates, nitric oxide and air toxics. Meteorological measurements of wind speed, wind direction, temperature and humidity are also included within 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[22] 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.[23] 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. The worth of visibility is difficult to measure; yet good visibility is something that people undeniably value. Impaired visibility can affect the enjoyment of a recreational visit to a scenic mountain area. Similarly, people prefer to have clear views from their homes and offices. These concerns are often 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.

There is increasing information that shows a correlation between ambient concentrations of particulate matter and respiratory illnesses. Some researchers believe this link may be 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 2.6.1for 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's “Brown Cloud” persists and other major population centers in Colorado are concerned about the potential for worsening visibility. Monitoring performed in and near national parks, monuments, and wilderness areas shows pollution-related visibility impairment occurring in these areas in Colorado. The type of impairment most often impacting Colorado's important scenic mountain views is known as regional haze. It is characterized by having many sources and interstate or even regional-scale transport between source areas and areas of impact.

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 and a transmitter located on the roof of a downtown building. 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 visibility is affected by rain, snow or high relative humidity are termed “excluded” (as shown in Figures 20 and 22) 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 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 Maroon Bells/Snowmass Wilderness. 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" tab on the left side of the screen at the Air Pollution Control Division's web site http://apcd.state.co.us/psi/main.html. There is a great deal of other information available from this site in addition to the image at 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 8 are show the visibility on the "Best" and "Worst" days in 2004. The "Best " visibility day was August 28, 2004. The "Worst" visibility day was July 21, 2004.

Figure 8 - Best and Worst Visibility Days for 2004

These two pictures are sections of the larger images made by the video web camera at visibility monitor located at 1901 13th Ave. in Denver. These images are centered on the Federal Building at 20th Ave. and Stout St. The entire image is available from the APCD web site and is refreshed every 10 minutes. The difference in these two pictures is the brightness and detail that can be seen in the image on the left as compared to the image on the right.

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 the precursor, or involved in the reaction, of nitrogen dioxide, nitric acid, nitrates and ozone, all of which have demonstrated adverse health effects.[24] 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 St. 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.

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. The reason that TSP samplers are still in operation is to measure particulate sulfates, lead and other metals such as cadmium, arsenic and zinc. While there are still monitors that exceed the old standards, as can be seen by comparing the current data to the historical maximums, the concentrations have declined dramatically.

3.4 Meteorology

The Air Pollution Control Division takes a limited set of meteorological measurements at eighteen locations around the state. These measurements include wind speed, wind direction, temperature, standard deviation of horizontal wind direction and some monitoring of relative humidity. Relative humidity measurements are also taken in conjunction with the two visibility monitors and the $PM_{2.5}$ particulate monitors. The humidity data are not summarized in this report since they are used primarily to validate the visibility and particulate measurements taken at the specific locations. In addition, 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. The instruments are on ten-meter towers and the data are stored as hourly averages.

This year's report has included a graphical representation of annual wind speed and direction data known as a wind rose. These wind roses 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 yourself 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 24, 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.[25]

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. The data from this study will be presented in a separate report.

4.0 Statewide Summaries For Criteria Pollutants

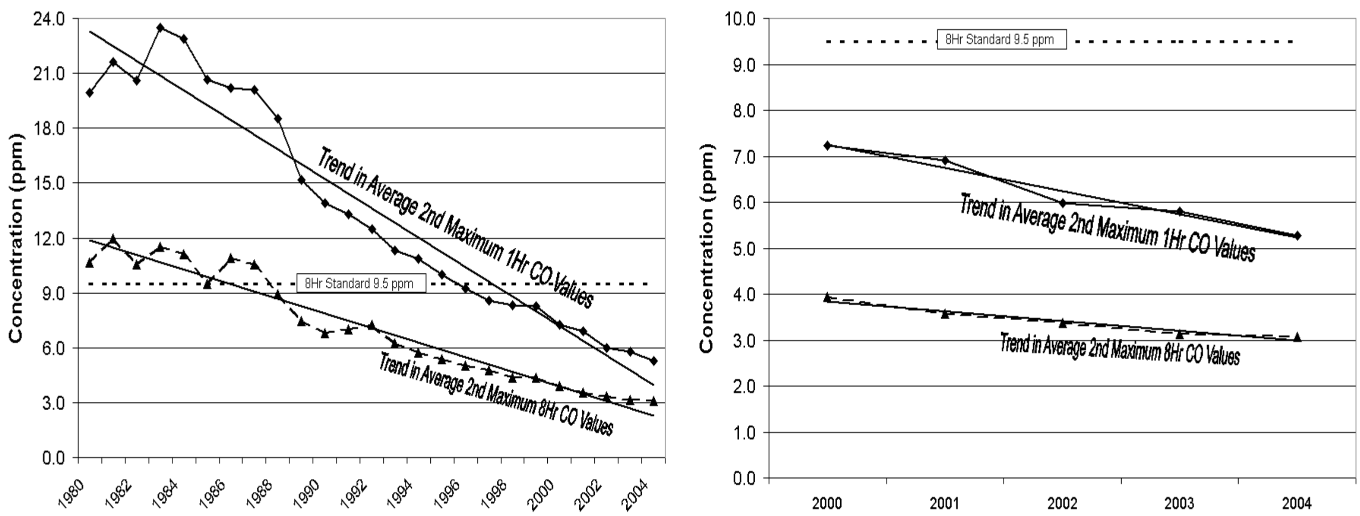
4.1 Carbon monoxide

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 in the state that exceeded the level of the 8-hour standard of 9.5 ppm. 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. In the past ten years none of the state-operated monitors have recorded a violation of the 8-hour standard. In 2004 the highest statewide 2nd maximum 8-hour concentration was a 4.1 ppm recorded at the Denver CAMP station, which is less than one half of the 8-hour standard.

Figure 9, shows the trend of the second maximum 1-hour and 8-hour statewide averages for carbon monoxide for the periods from 1980 to 2004 and from 2000 to 2004. Two important points to note are:

1. Throughout the 1980s 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. The data form the last 5-year period show that although the decline in both 1-hour and 8-hour carbon monoxide levels is not as steep they are still declining and that the statewide 8-hr average has remained less than one half of the level of the standard.

Figure 9 - Statewide Ambient Trends – Carbon Monoxide



The trend in the 1-hour average carbon monoxide concentrations statewide has fallen even more drastically than the 8-hour concentrations. The maximum concentration ever recorded at any of the state-operated monitors was a 79.0 ppm recorded at the Denver CAMP monitor in 1968. Exceedances of both the 1-hour and 8-hour standard were common in the late 1960s and early 1970s. In 2004, the maximum 1-hour concentration was recorded was 8.7 ppm at the Denver CAMP monitor. In comparison, in 1966, there were 367 exceedance periods of the 8-hour standard compared to only one exceedance in the past six years. The 1-hour annual maximum concentrations have declined from more than twice the standard in the late 1960s to less than one half of the standard in 2004. Table 5 presents the historical maximum values.

Table 5 - Historical Maximum 1-Hr and 8-Hr Carbon Monoxide Concentrations[26]

1-Hour ppm	Location	Date	Number of Annual Exceedances Periods	8-Hour ppm	Location	Date	Number of Annual Exceedances Periods
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

4.2 Ozone

Figure 10, 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 slightly upward. However, in the past ten years the trend in 1-hour and 8-hour concentrations is clearly upward. There is a great deal of year-to-year variation but as shown in the 1995 – 2004 graph the trend in 1-hour values has changed. The elevated concentrations recorded in 1998 and 2003 were the result of hot dry summers.

Figure 10 - Statewide Ambient Trends – Ozone

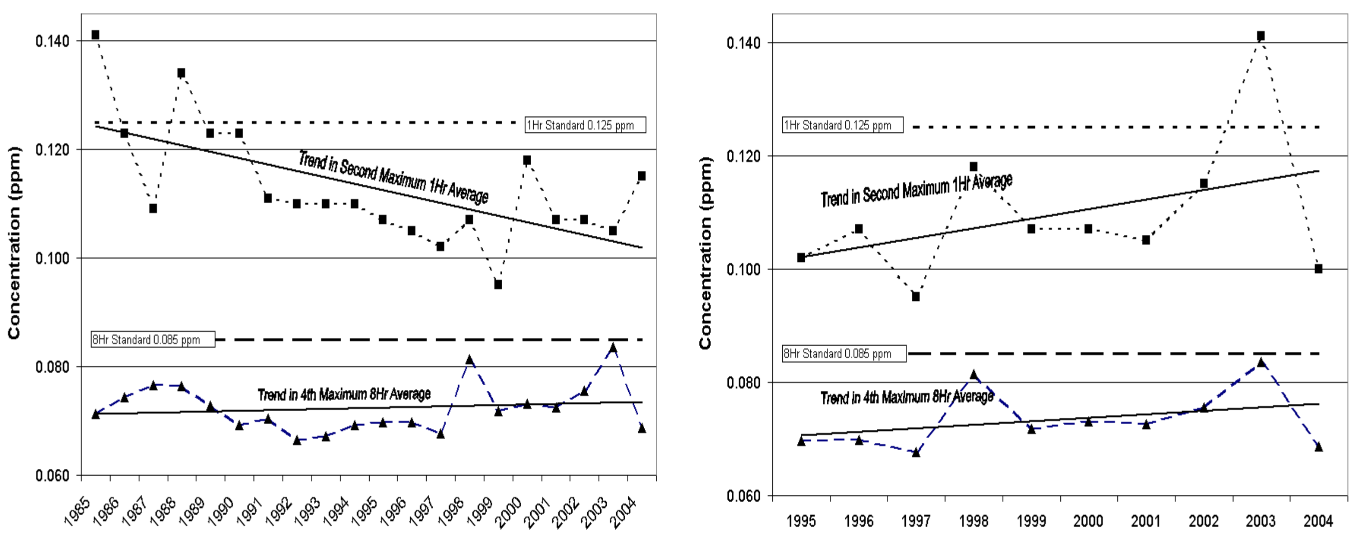


Table 6 lists the five highest 1-hour ozone concentrations recorded in Colorado. Ozone monitoring began in 1972 at the Denver CAMP station and eight exceedances of the standard were recorded that year. However, data before 1975 are not included because quality assurance and maintenance records are no longer available. In addition, a review of the ozone data before 1975 shows several values that are questionable because of time of day, time of year and inconsistencies with other monitors in the area.

Table 6 - Historical Maximum 1-Hour Ozone Concentrations[27]

1-Hour ppm	Monitor	Date
0.223	Welby	March 3, 1978
0.197	Arvada	July 28, 1975
0.186	Children's Asthmatic Research Institute and Hospital, 21st Ave. & Julian St.	September 17, 1976
0.184	Arvada	June 30, 1976
0.182	Welby	August 5, 1975

4.3 Sulfur Dioxide

The concentrations of sulfur dioxide in Colorado have never been a major health concern since we do not have the types of 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 0.003 ppm in 2004.

Figure 19 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 7 - Historical Maximum Annual Average Sulfur Dioxide Concentrations[28]

Annual Average ppm	Monitor	Date
0.018	Denver CAMP	1979
0.013	Denver CAMP	1980
0.013	Denver CAMP	1981
0.013	Denver CAMP	1983
0.012	Denver CAMP	1978

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, for the past ten years the annual average has been nearly flat.

Figure 18 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 consumption associated with the increases in population in the Denver-metro area.

Table 8 - Historical Maximum Annual Average Nitrogen Dioxide Concentrations[29]

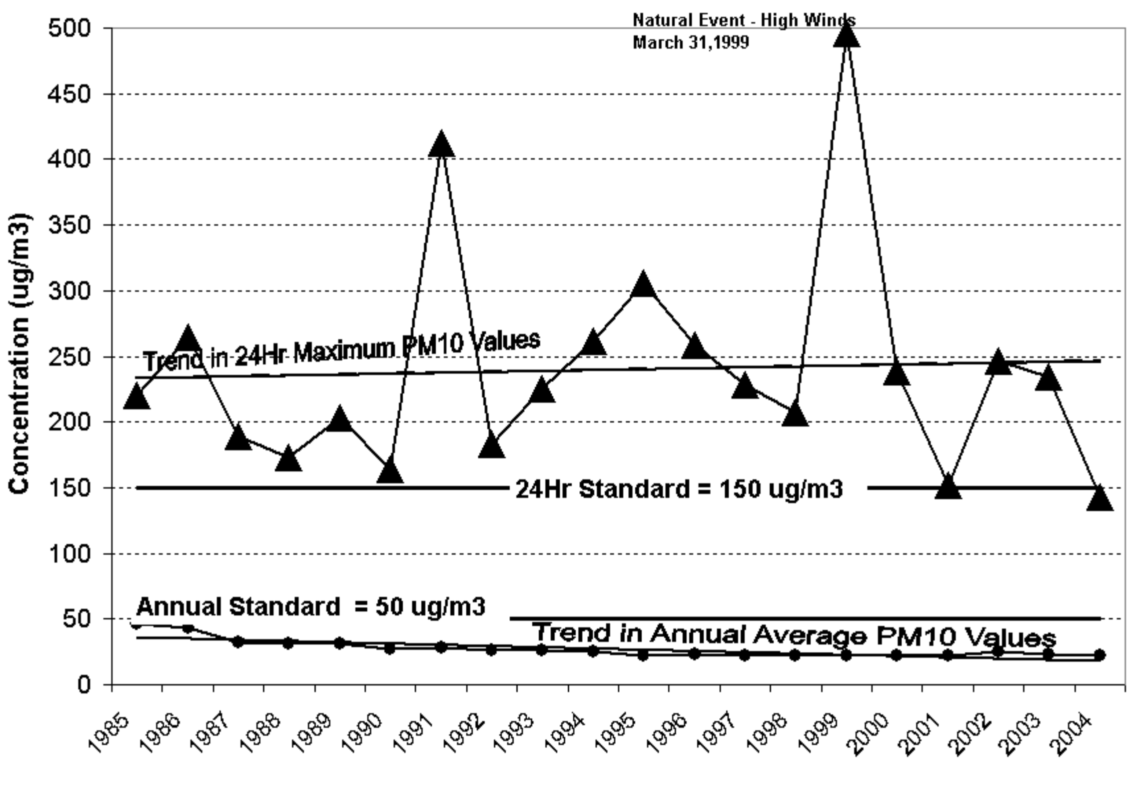
Annual Average ppm	Monitor	Date
0.052	Denver CAMP	1975
0.052	Denver CAMP	1976
0.052	Denver CAMP	1979
0.052	Denver CAMP	1973
0.051	Denver CAMP	1977

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 the following graph the there is a great deal more variation in the 24-hour maximum values than in the annual averages.

Figure 11 - Statewide Ambient Trends – PM_{10}



The data contained Figure 11, in the Statewide Trends graph, and the data in Table 9, 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 this exclusion a value (or values) has to be associated with a regional natural 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, not because they are without any health risk but because they are natural and are not controllable or predictable.

Table 9 - Historical Maximum 24-Hour PM_{10} Concentrations[30]

24-Hour Maximum μg/m³	Monitor	Date
412	Alamosa	April10, 1991
306	Cripple Creek	December 27, 1995
262	Pagosa Springs	December 29, 1994
236	Aspen	February 22, 1991
235	Cripple Creek	February 11, 1997

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 and Elbert County in 1999. Additional sites were established nearly every month until full implementation of the base network was achieved in April of 2000. 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 are seven special purpose-monitoring 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.

Only one site in Colorado has exceeded the level of the new 24-hour standard and no sites have exceeded the level of the new annual standard. The Denver CAMP site exceeded the 24-hour level of the standard twice in 2001. The exceedances occurred on Thursday, February 15, 2001 (68.4 $\mu g/m^3$) and Saturday, February 17, 2001 (68.0 $\mu g/m^3$).

4.7 Lead

In Colorado the last violation of the federal 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, to the point where now all monitors are regularly at or near the minimum detectable limits of analysis. 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.

Table 10 - Historical Maximum Quarterly Lead Concentrations[31]

Quarterly Maximum μg/m³	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

5.0 National Comparisons For Criteria Pollutants

5.1 Carbon monoxide

According to the Environmental Protection Agency's emissions trends report: "Between 1993 and 2002, ambient CO concentrations decreased 42 percent. Total CO emissions decreased 21 percent (excluding wildfires and prescribed burning) for the same period. This improvement in air quality occurred despite a 23-percent increase in vehicle miles traveled during the 10-year period."[32]

Table 11 - 2004 National Ranking of Carbon Monoxide Monitors by 8-Hr Concentrations[33]

Nationwide (451 monitors)					Colorado (14 Monitors)				
National Rank	City/Area	Max ppm	2nd Max ppm	# >9.5 ppm	Nat'l Rank	City/Area	Max ppm	2nd Max ppm	# >9.5 ppm
1	Pittsboro, IN	28.0	27.3	82	33	Greeley	4.8	3.7	0.0
2	Weirton, WV	16.5	12.0	2	41	Denver CAMP	4.4	4.1	0.0
3	Calexico, CA	10.3	8.3	1	89	Auraria	3.7	3.6	0.0
4	Birmingham, AL	8.3	8.2	0	91	Carriage	3.7	3.4	0.0
5	Anchorage, AK	8.1	7.9	0	92	Longmont	3.7	3.2	0.0

5.2 Ozone

Over the past 30 years, EPA, in conjunction with state and local agencies, has instituted various programs to reduce NOx and VOC emissions that contribute to ozone formation. These emission reductions occurred at the same time the nation's economy, energy consumption, and population were growing. For example, between 1970 and 2003, gross domestic product increased approximately 176%; VMT, 155%; energy consumption, 45%; and population, 39%, whereas emissions of NOx and VOCs decreased approximately 25% and 54%, respectively. The ratio of NOx and VOC emissions to population has also dropped since 1970.[34]

Table 12 - 2004 National Ranking of Ozone Monitors by 1-Hr Concentrations in ppm[34]

Nationwide (1,195 Monitors)					Colorado (14 Monitors)				
National Rank	City/Area	Max ppm	2nd ppm	Viol Days	National Rank	City/Area	Max ppm	2nd ppm	Viol Days
1	Houston, TX	0.192	0.127	2.0	383	Ft Collins	0.100	0.086	0.0
2	Seabrook, TX	0.176	0.134	3.0	602	NREL	0.093	0.087	0.0
3	Crestline, CA	0.163	0.139	9.1	603	Highlands Res.	0.093	0.085	0.0
4	Redlands, CA	0.160	0.148	12.1	647	Lookout Mnt	0.092	0.089	0.0
5	Santa Clarita, CA	0.158	0.142	13.5	650	Chatfield Res.	0.091	0.088	0.0

This year, both the 1-hour and the 8-hour ozone national rankings have been included. The fourth maximum value is included in the 8-hour table because that the value that is compared to the standard. The ozone standard is set at 0.08 ppm as the 3-year average of the annual 4th maximum 8-hour average concentration.

Table 13 - 2004 National Ranking of Ozone Monitors by 8-Hr Concentrations in ppm[35]

Nationwide (1,195 Monitors)					Colorado (13 Monitors)				
National Rank	City/Area	Max ppm	4th Max	Viol Days	National Rank	City/Area	Max ppm	4th Max	Viol Days
1	Crestline, CA	0.145	0.122	66	547	Golden	0.081	0.078	0.0
2	Redlands, CA	0.135	0.119	56	711	Chatfield Res.	0.077	0.075	0.0
3	Santa Clarita, CA	0.133	0.107	52	771	NREL	0.076	0.074	0.0
4	San Bernardino, CA	0.129	0.112	39	772	Rocky Flats	0.076	0.073	0.0
5	Arvin, CA	0.126	0.112	103	773	Highland Res.	0.076	0.072	0.0

5.3 Sulfur Dioxide

"Nationally, average SO_2 ambient concentrations have decreased 54 percent from 1983 to 2002 and 39 percent over the more recent 10-year period 1993 to 2002. SO_2 emissions decreased 33 percent from 1983 to 2002 and 31 percent from 1993 to 2002. Reductions in SO_2 concentrations and emissions since 1990 are due, in large part, to controls implemented under EPA's Acid Rain Program beginning in 1995."[36]

Table 14 - 2004 National Ranking of SO_2 Monitors by 24-Hr Concentrations in ppm[37]

Nationwide (545 Monitors)					Colorado (3 Monitors)				
National Rank	**City/Area**	**Max ppm**	**2nd ppm**	**#>0.14 ppm**	**Nat'l Rank**	**City/Area**	**Max ppm**	**2nd ppm**	**#>0.14 ppm**
1	Tahlequah, OK	0.279	0.276	4	305	Denver CAMP	0.016	0.011	0.0
2	Hawaii Volcanoes, HI	0.143	0.137	0	407	Welby	0.010	0.009	0.0
3	Warren Co, PA	0.120	0.061	0	484	S. Adams	0.006	0.005	0.0
4	Morgantown, WV	0.110	0.044	0					
5	Steubenville, OH	0.102	0.098	0					

5.4 Nitrogen Dioxide

"Since 1983, monitored levels of NO_2 have decreased 21 percent. These downward trends in national NO_2 levels are reflected in all regions of the country. Nationally, average NO_2 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 NO_2 now meet that standard. Over the past 20 years, national emissions of NOx have declined by almost 15 percent. The reduction in emissions for NOx presented here differs from the increase in NOx emissions reported in previous editions of this report. In particular, this report's higher estimate of NOx emissions in the 1980s and early 1990s reflects an improved understanding of emissions from real-world driving. While overall NOx 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 NOx 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 NOx emissions from nonroad diesel engines."[38]

Table 15 - 2004 National Ranking of NO_2 Monitors by 1-Hr Concentrations in ppm[39]

Nationwide (437 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	Miami, FL	0.417	0.316	0.013	26	Denver CAMP	0.115	0.101	0.027
2	Sublette Co, WY	0.267	0.161	0.011	33	Welby	0.111	0.106	0.022
3	Jacksonville, FL	0.201	0.196	0.014					
4	Norwood, OH	0.160	0.089	0.018					
5	Los Angeles, CA	0.157	0.156	0.034					

5.5 Particulates

"The highest concentrations were recorded in Inyo and Mono counties, California; El Paso County, Texas; and Dona Ana County, New Mexico. The highest annual averages occurred in southern California and Pittsburgh. High levels are also seen in many urban areas in the Southeast, Northeast, and Industrial Midwest. See www.epa.gov/airtrends/pm.html for county-level maps of PM."[40]

"$PM_{2.5}$ concentrations can reach unhealthy levels even in areas that meet the annual standard. In 2003, there were 277 counties with at least 1 unhealthy day based on $PM_{2.5}$ AQI values. Nearly two-thirds of those counties had annual averages below the level of the standard. Most metropolitan areas had fewer unhealthy $PM_{2.5}$ days in 2003 compared to the average from the previous 3 years, which reflects the improvements observed in 2003."[40]

Table 16 - 2004 National Ranking of PM_{10} Monitors by 24-Hr Maximum Concentrations in $\mu g/m^3$ [40]

Nationwide (1,179 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	Olancha, CA	4,913	3,847	78	85	Alamosa City	143	113	23.9
2	Keeler, CA	3,322	813	40	116	Mt Crested Butte	129	99	24.6
3	Mono Lake, CA	987	913	63	142	Alamosa ASC	116	89	21.2
4	Campbell, WY	625	436	33	173	Welby	104	95	29.5
5	Harrison Court, AK	605	97	29	183	Commerce City	102	98	34.6

Table 17 - 2004 National Ranking of $PM_{2.5}$ Monitors by 24-Hr Maximum Concentrations in $\mu g/m^3$ [41]

Nationwide (1,162 Monitors)					Colorado (22 Monitors)				
National Rank	City/Area	1st Max	2nd Max	Annual Mean	National Rank	City/Area	1st Max	2nd Max	Annual Mean
1	Fairbanks, AK	506	469	51.2	129	Commerce City	48.8	39.4	11.08
2	Theodore. AL	188	87	14.6	287	Grand Junction	42.1	32.7	12.44
3	Billings, MT	151	21	8.2	364	Denver CAMP	40.4	40.2	9.36
4	Logan, UT	133	128	15.2	813	Greeley	31.2	28.0	8.34
5	Riverside, CA	94	67	20.8	821	Delta	31.2	27.2	7.81

5.6 Lead

The statistic used to track ambient lead air quality is the maximum quarterly mean concentration for each year. From 1981 to1990, a total of 228 ambient lead monitors nationwide met the trends completeness criteria; a total of 130 ambient lead monitors met the trends data completeness criteria for the 10-year period 1991 to 2000. Point source-oriented monitoring data were omitted from all ambient trends analysis presented in this section to avoid masking the underlying urban trends.

"Because of the phaseout of leaded gasoline, lead emissions and concentrations decreased sharply during the 1980s and early 1990s. The 2002 average air quality concentration for lead is 94 percent lower than in 1983. Emissions of lead decreased 93 percent over the 21-year period 1982 to 2002. 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. Today, the only violations of the lead NAAQS occur near large industrial sources such as lead smelters and battery manufacturers. Various enforcement and regulatory actions are being actively pursued by EPA and the states for cleaning up these sources."[42]

Table 18 - 2004 National Ranking of Lead Monitors by 24-Hr Maximum Concentration in $\mu g/m^3$ [43]

Nationwide (194 Monitors)					Colorado (6 Monitors)				
National Rank	City/Area	24-hr Max	Max Qtr	Qtrs in Viol	National Rank	City/Area	24-hr Max	Max Qtr	Qtrs in Viol
1	Herculaneum, MO	14.37	1.48	0	38	Globeville	0.50	0.14	0
2	Muncie, IN	11.76	11.53	2	74	Commerce City	0.12	0.04	0
3	Tampa, FL	3.50	1.26	0	90	Denver, CAMP	0.07	0.02	0
4	Iron Co, MO	3.47	0.79	0	99	Leadville	0.05	0.02	0
5	Williams Co, TN	3.22	0.30	0	106	Denver Gates	0.05	0.01	0

6.0 Monitoring Results by Area in Colorado

6.1 Eastern Plains Communities

The Eastern Plains Communities are those east of the urbanized I-25 corridor. Historically there have been a number of communities that were monitored for particulates. 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. In the southeast, the US-50/Arkansas River corridor, only Lamar is currently monitored for particulates. The communities of La Junta and Rocky Ford have been monitored in the past, but like the other communities that have been monitored on the Eastern Plains, the monitoring was discontinued when the concentrations were shown to be below the standard.

Two of the Lamar sites, the 415 Camino de Santa Fe and 3445 W. Road HH, were operated as short term special projects for 2004. The sites operated from March 22, 2004 through September 2004. These monitors were set to monitor dust emissions from nearby feedlots and were discontinued at the end of the study. As shown in Table 19, the levels at the two sites were not only below the PM_{10} standard of 150 µg/m^3 but below both long-term monitors as well.

Table 19 - Eastern Plains Monitors In Operation For 2004
X - Monitors continued in 2004   A – Monitors added in 2004
D – Monitors discontinued in 2004   H – Hourly particulate monitor

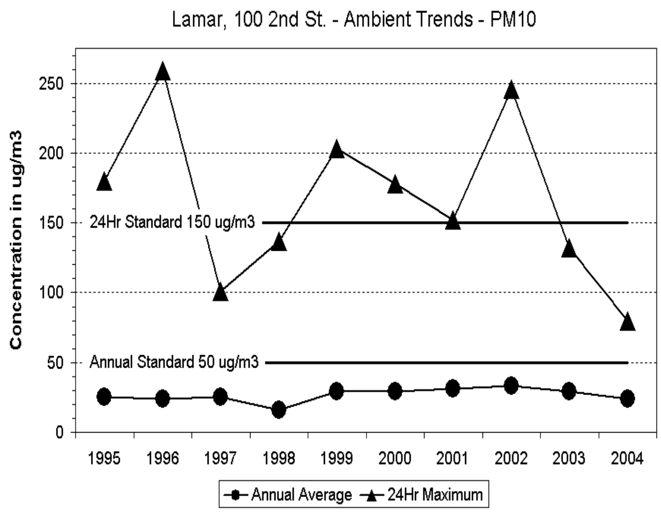
Site Name	Location	PM_{10}	$PM_{2.5}$
Elbert			
Elbert	Wright-Ingraham Inst		X
Prowers			
Lamar	100 2nd St.	X	
	104 Parmenter St.	X	
	415 Camino de Santa Fe	A/D	
	3445 W. Road HH	A/D	

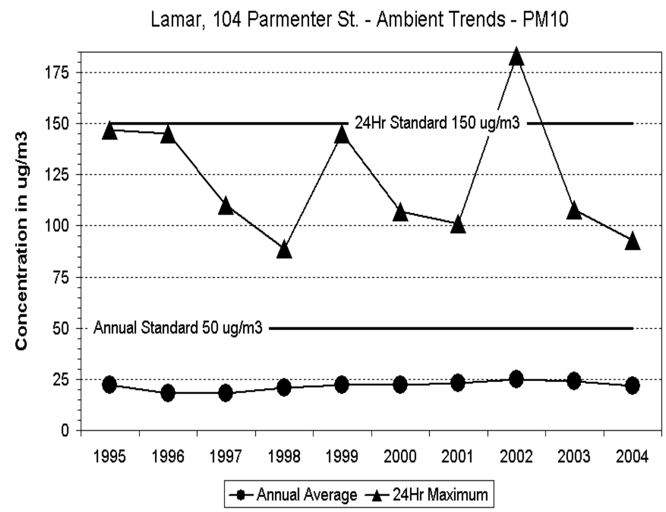
Table 20 - Eastern Plains Particulate Values For 2004

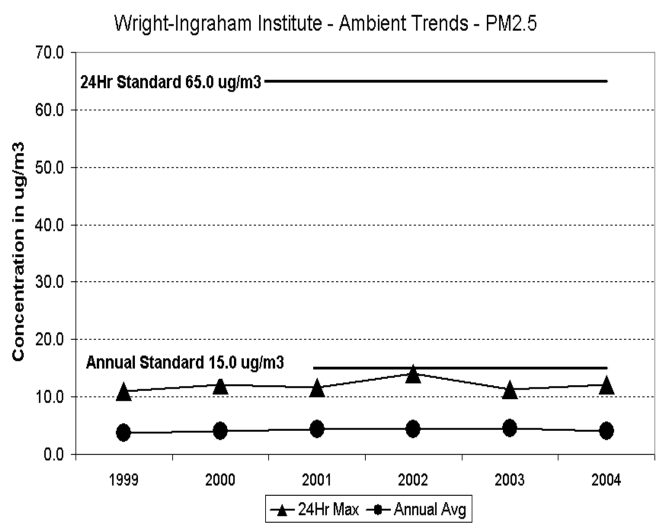
Location	PM_{10} (µg/m^3)		$PM_{2.5}$ (µg/m^3)	
	Annual Average	24-hour Maximum	Annual Average	24-hour Maximum
Elbert				
Wright-Ingraham Inst			4.07	12.2
Prowers				
100 2nd St.	23.8	80		
104 Parmenter St.	21.9	93		
415 Camino de Santa Fe	(23.2)	63		
3445 W. Road HH	(20.2)	69		

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

Figure 12 - Eastern Plains Particulate Graphs







6.2 Northern Front Range Communities

The Northern Front Range Communities 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 21 - Northern Front Range Particulate Monitors In Operation For 2004
X - Monitors continued in 2004 A – Monitors added in 2004
D – Monitors discontinued in 2004 H – Hourly particulate monitor

Site Name	Location	TSP	Pb	PM_{10}	$PM_{2.5}$
Adams					
Brighton	22 S. 4th Ave.			X	
Commerce City	7101 Birch St.	X	X	X	X/H
Globeville	5400 Washington St.	X	X		
Welby	78th Ave. & Steele St.			X/H	
Arapahoe					
Arapahoe Community Coll.	6190 S. Santa Fe Dr.				X
Boulder					
Boulder	2440 Pearl St.			X	X
	2102 Athens St.				A/H
Longmont	3rd Ave. & Kimbark St.			X	X
Denver					
Denver CAMP	2105 Broadway	X	X	X/H	X/H
Denver Gates	1050 S. Broadway	X	X	X	
Denver - NJH	14th Ave. & Albion St.				H
Denver Visitor Center	225 W. Colfax Ave.			X	
Lowry	8100 Lowry Blvd.			X	
Swansea Elementary School	4650 Columbine St.				A
Douglas					
Chatfield Reservoir	11500 Roxborough Pk Rd				A/H
Larimer					
Fort Collins	251 Edison St.			X	X
Weld					
Greeley	1516 Hospital Rd.			X	X/H
Platteville	1004 Main St.				X

Table 22 - Northern Front Range Particulate Values For 2004

Site Name	PM_{10} (µg/m^3)		$PM_{2.5}$ (µg/m^3)	
	Annual Average	24-hour Maximum	Annual Average	24-hour Maximum
Adams				
Brighton	27.6	102		
Commerce City	34.6	102	9.92	36.5
(Continuous Monitor)			8.78	32.6
Welby	29.5	104		
(Continuous Monitor)	28.0	76		
Arapahoe				
Arapahoe Community Coll.			7.63	21.0
Boulder				
Boulder, 2440 Pearl St.	(19.1)	51	(6.72)	19.7
Boulder, 2102 Athens St.			(6.96)	23.2
Longmont	(21.6)	75	8.55	27.8
Denver				
Denver CAMP	29.1	53	9.36	40.4
(Continuous Monitor)	24.5	73	10.63	44.4
Denver Gates	(28.1)	84		
Denver - NJH			5.92	23.7
Denver Visitor Center	26.1	98		
Lowry	19.7	43		
Swansea Elementary School			(14.60)	23.4
Douglas				
Chatfield Reservoir			(3.95)	10.8
Larimer				
Fort Collins	19.9	70	7.67	23.4
Weld				
Greeley	23.7	92	8.34	31.2
(Continuous Monitor)			(6.09)	19.3
Platteville			8.26	18.5

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

Figure 13 - Northern Front Range PM_{10} Particulate Graphs

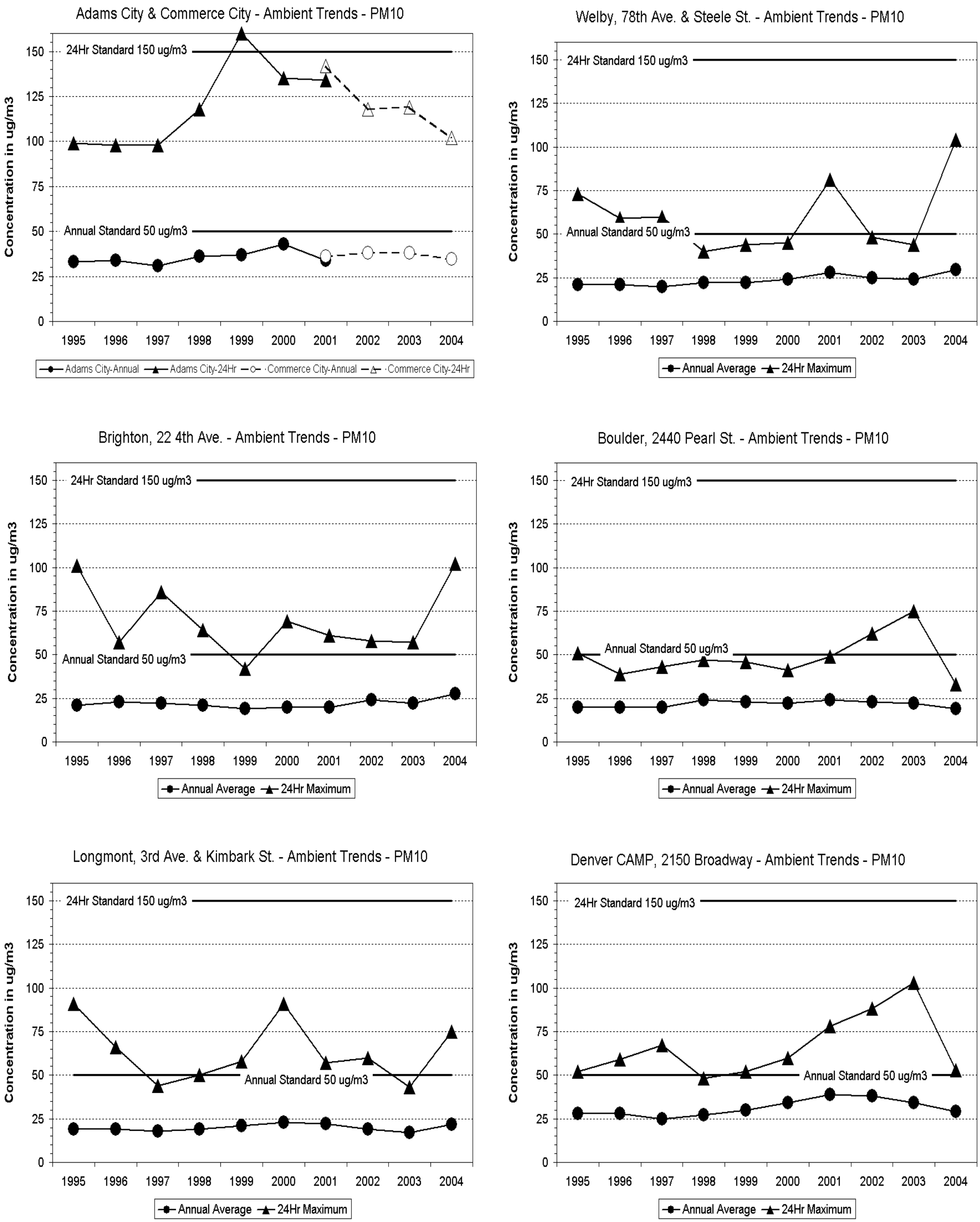
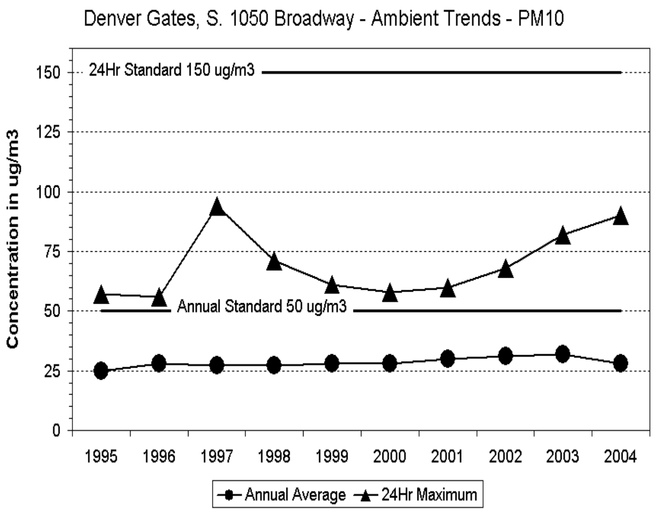
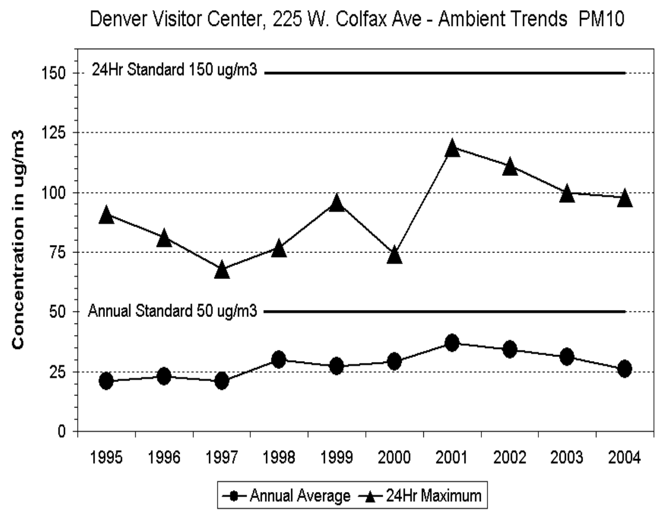
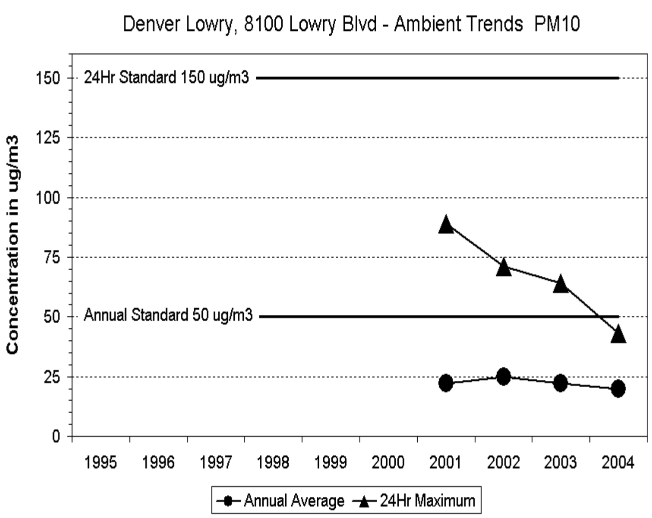
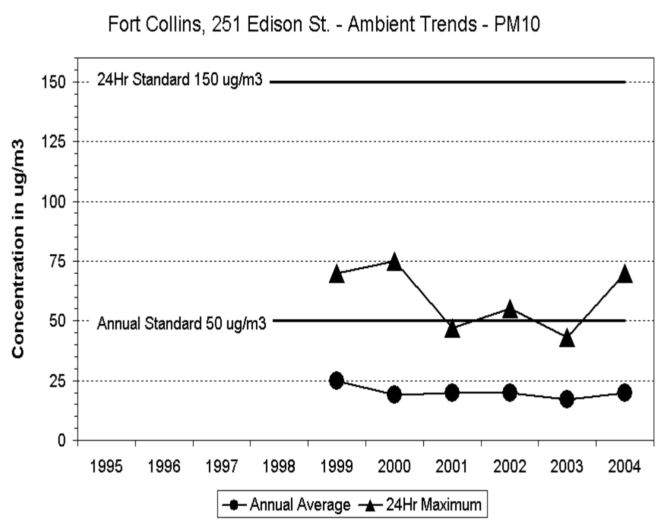


Figure 13 - Northern Front Range PM_{10} Particulate Graphs (continued)









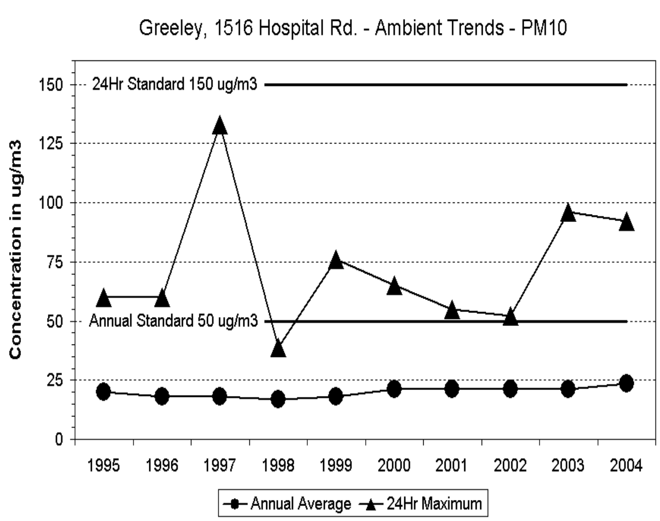
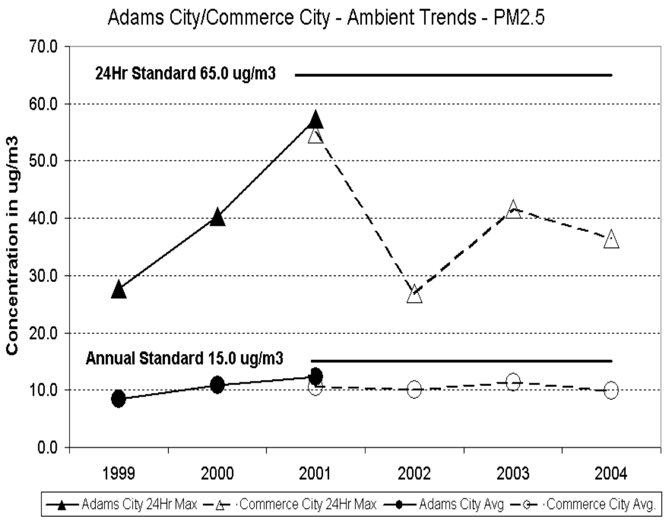
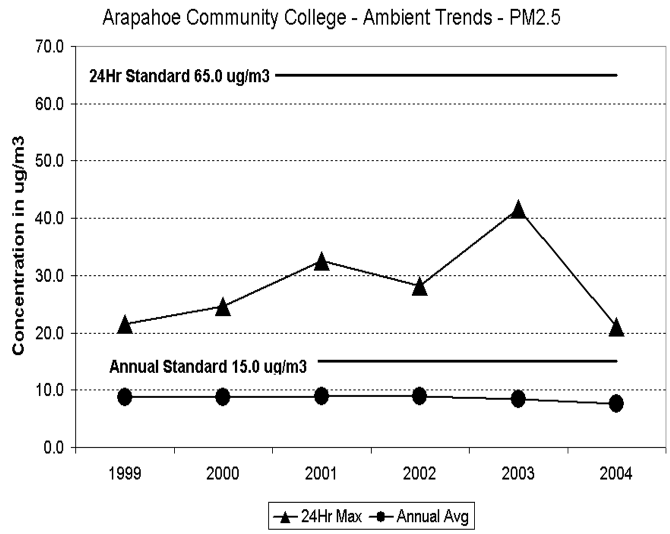
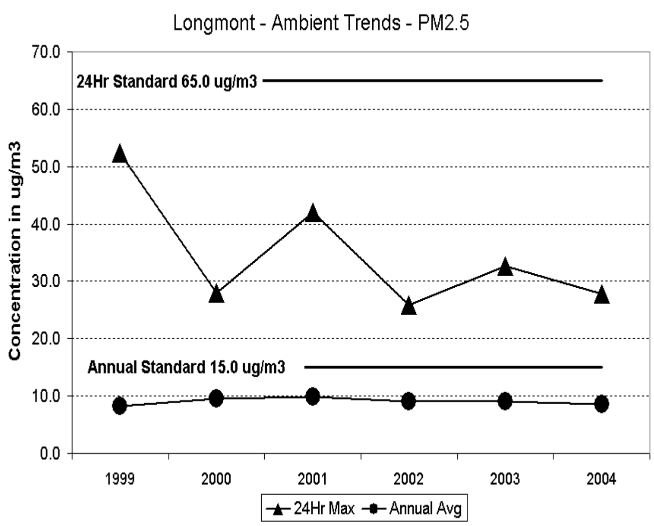
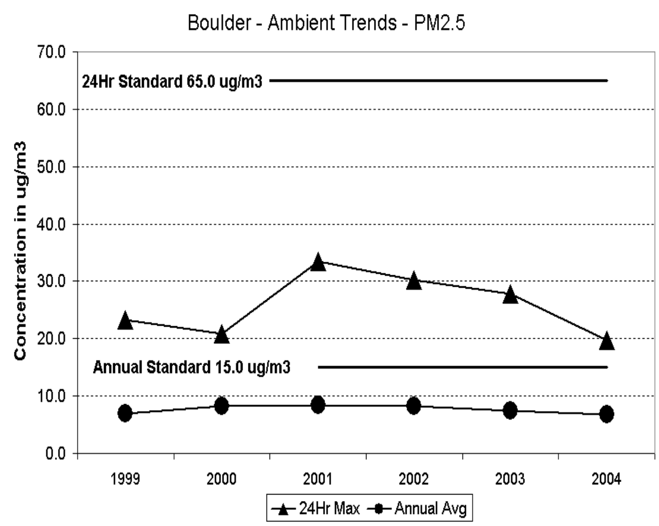


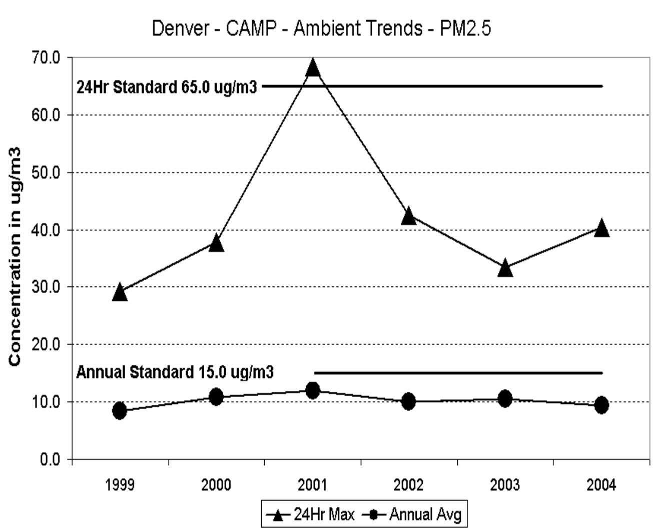
Figure 14 - Northern Front Range $PM_{2.5}$ Particulate Graphs











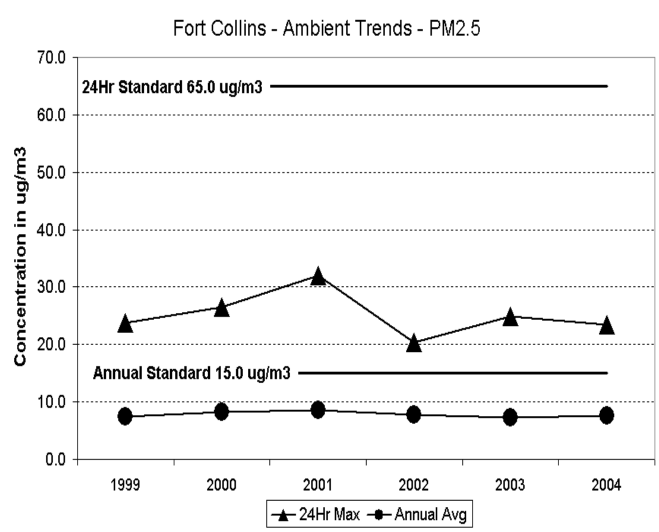


Figure 14 - Northern Front Range $PM_{2.5}$ Particulate Graphs (continued)

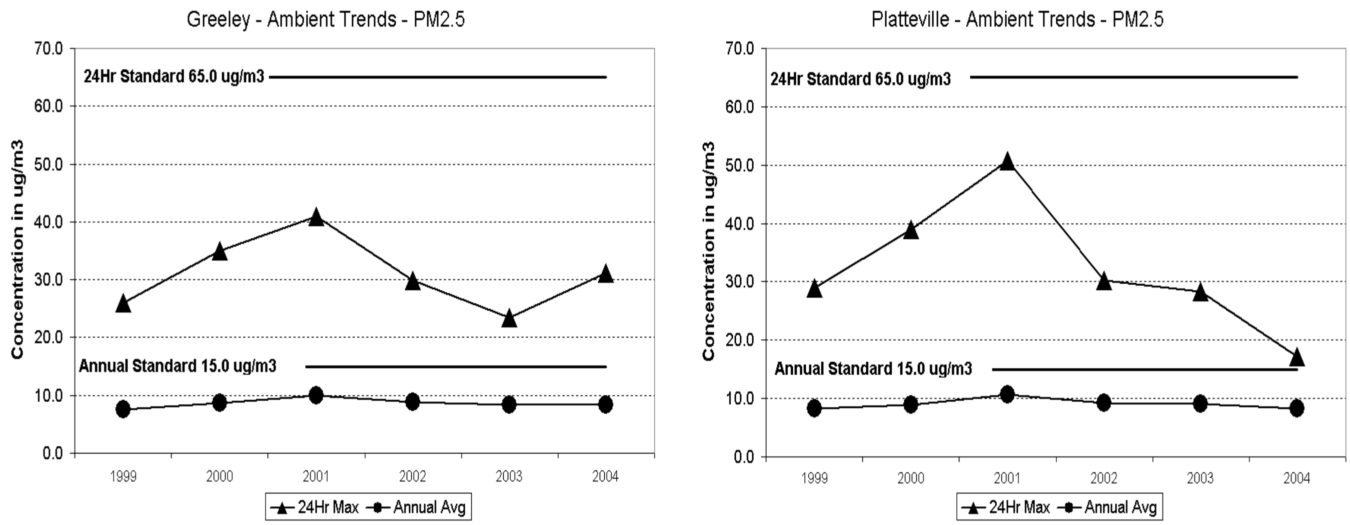


Table 23 - Northern Front Range TSP and Lead Values For 2004

Site Name	Location	TSP (µg/m³)		Lead (µg/m³)	
		Annual Geometric Mean	24-hour Maximum	Maximum Quarter	24-hour Maximum
Adams					
Adams	Commerce City	75.0	162	0.04	0.12
	Globeville	85.5	211	0.14	0.50
Denver					
Denver	Denver CAMP	70.3	134	0.02	0.07
	Denver Gates	67.4	156	0.01	0.05

Figure 15 - Northern Front Range Lead Graphs

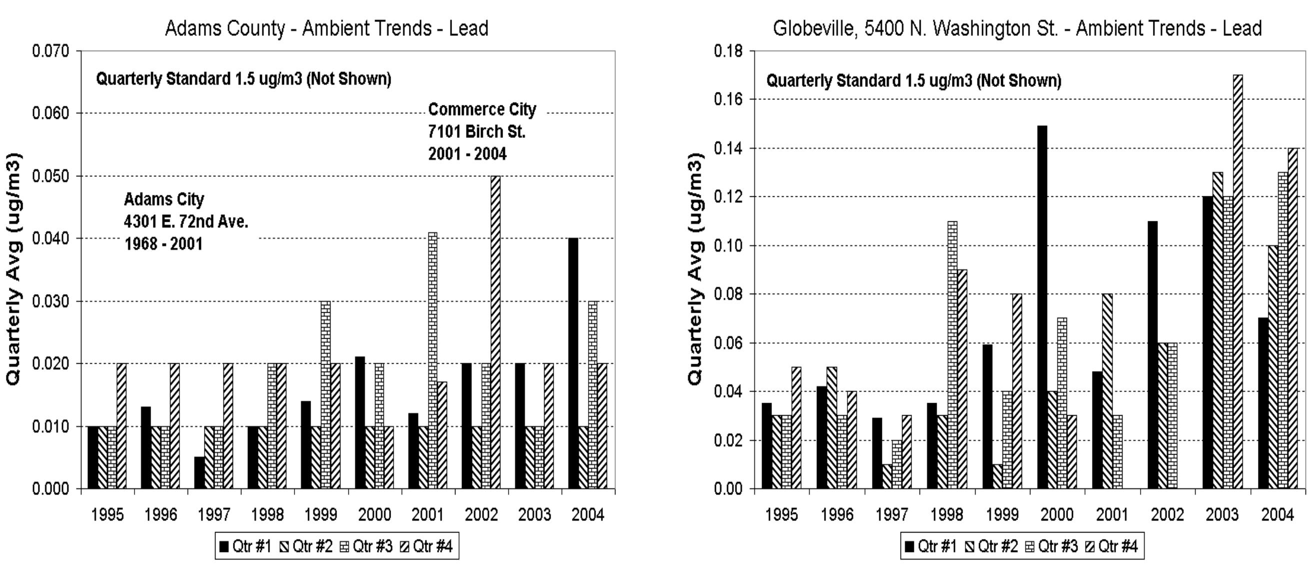
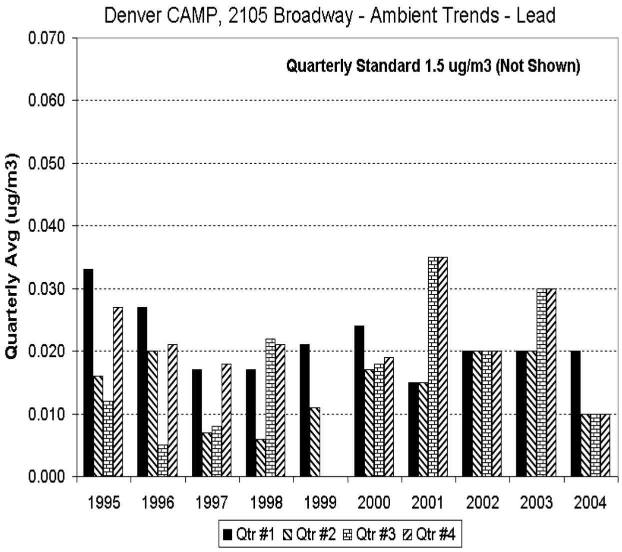


Figure 15 - Northern Front Range Lead Graphs (continued)



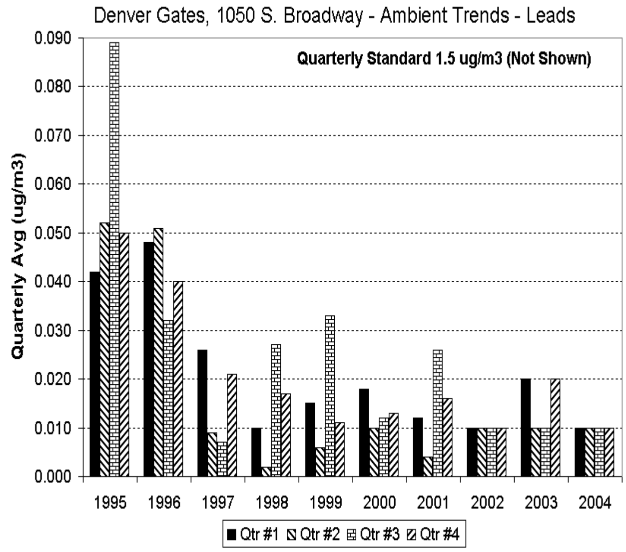


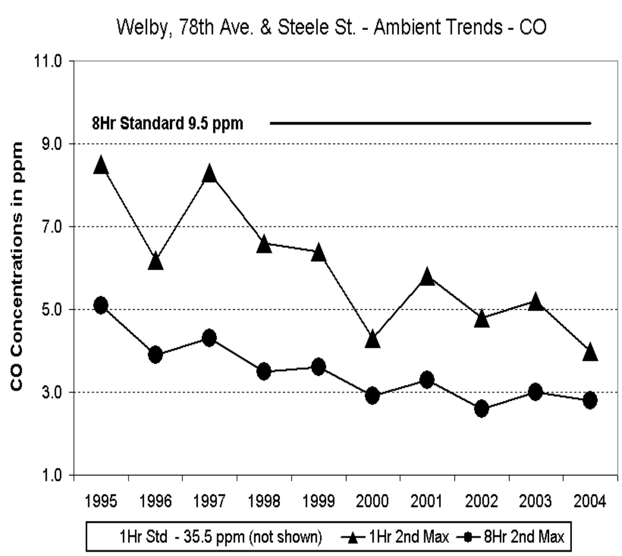
Table 24 - Northern Front Range Continuous Monitors In Operation For 2004
X - Monitors continued in 2004   A – Monitors added in 2004
D – Monitors discontinued in 2004   H – Hourly particulate monitor

Site Name	Location	CO	SO_2	NO_X	O_3	Met
Adams						
Commerce City	7101 Birch St.					X
South Adams	5580 Niagara St.		D			
Welby	78th Ave. & Steele St.	X	X	X	X	X
Arapahoe						
Highland Res.	8100 S. University Blvd.				X	X
Boulder						
Boulder	2150 28th St.	X				
	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	23rd Ave. & Julian St.	X			X	X
Denver NJH	14th Ave. & Albion St.	X				
Firehouse #6	1300 Blake St.	X				
Douglas						
Chatfield Reservoir	Roxborough Park Rd.				D	
	11500 N. Roxborough Park Rd.				A	A
Jefferson						
Arvada	W. 57th Ave. & Garrison	X			X	X
Lookout Mtn.	636 Lookout Mtn. Rd.				A/D	
NREL	2054 Quaker St.				X	
Rocky Flats - N	16600 W. Hwy. 128				X	X
Rocky Flats - NE	11501 Indiana St.					X
Rocky Flats - S	9901 Indiana St.					X
Rocky Flats - SE	18000 W. Hwy. 72					X
Rocky Flats - W	11190 N. Hwy. 93					X
Welch	12400 W. Hwy. 285				X	X
Larimer						
Fort Collins	708 S. Mason St.	X			X	X
	4407 S. College Ave.	X				
Weld						
Greeley	905 10th Ave.	X				
	3101 35th Ave.				X	

Table 25 - Northern Front Range Carbon Monoxide Values For 2004

Site Name	Location	CO 1-hour Avg. (ppm)		CO 8-hour Avg. (ppm)	
		Max	2nd Max	Max	2nd Max
Adams					
Welby	78th Ave. & Steele St.	4.2	4.0	2.9	2.8
Boulder					
Boulder	2150 28th St.	4.7	4.5	2.9	2.5
Longmont	440 Main St.	5.3	4.3	3.7	3.2
Denver					
Denver CAMP	2105 Broadway	8.7	8.7	4.4	4.1
Denver Carriage	23rd Ave. & Julian St.	5.3	4.9	3.7	3.4
Denver NJH	14th Ave. & Albion St.	7.3	6.8	3.6	3.4
Firehouse #6	1300 Blake St.	5.9	5.8	3.7	3.6
Jefferson					
Arvada	W. 57th Ave. & Garrison St.	4.3	3.7	2.7	2.6
Larimer					
Fort Collins	708 S. Mason St.	5.6	5.3	3.3	3.1
	4407 S. College Ave.	4.5	4.3	3.1	3.0
Weld					
Greeley	905 10th Ave.	7.0	6.4	4.8	3.7

Figure 16 - Northern Front Range Carbon Monoxide Graphs



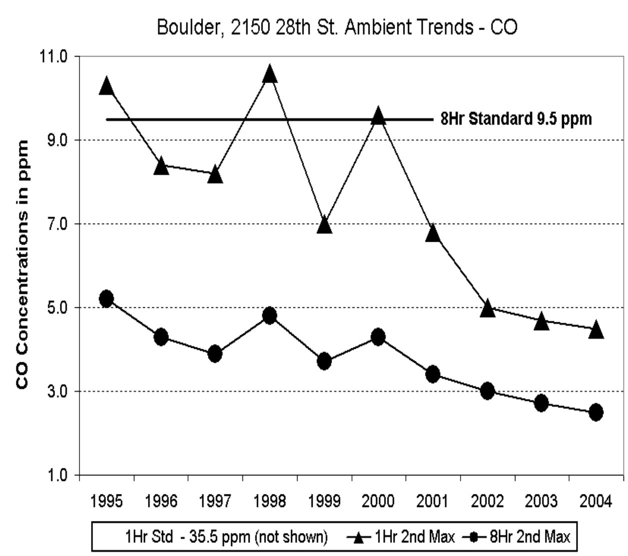
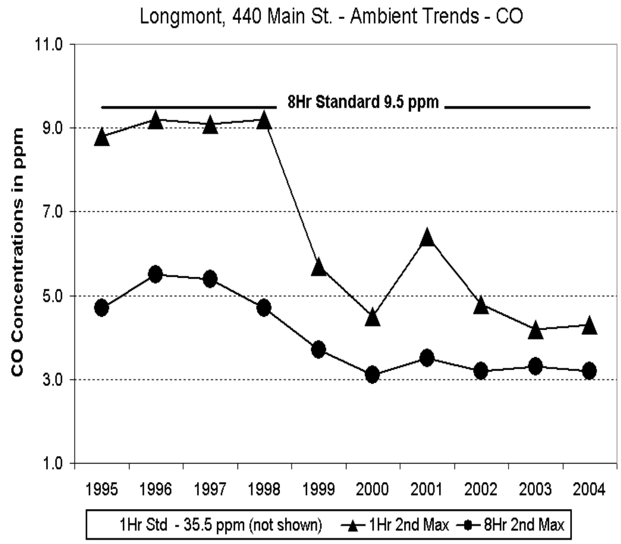
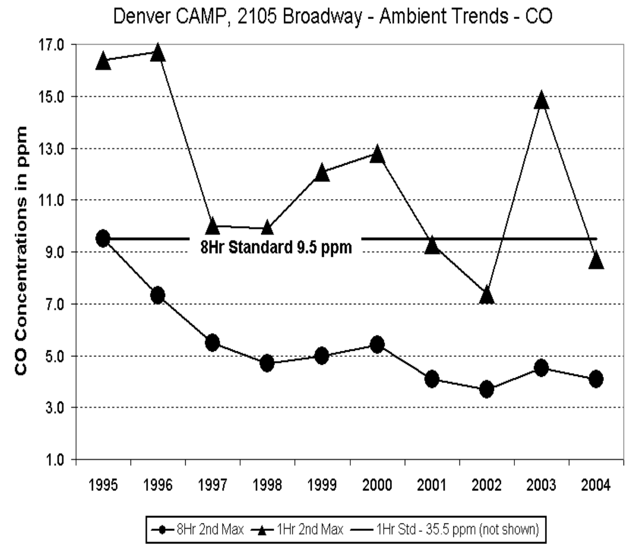
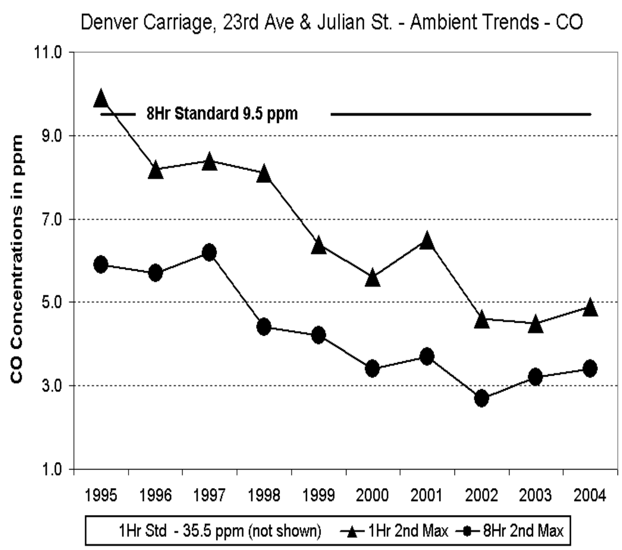
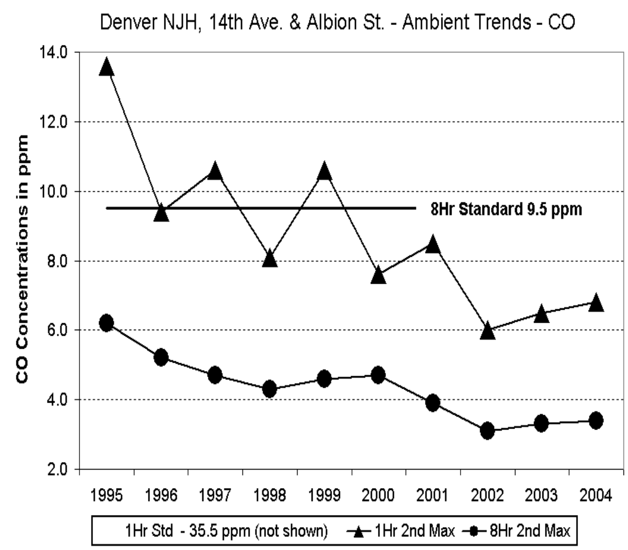


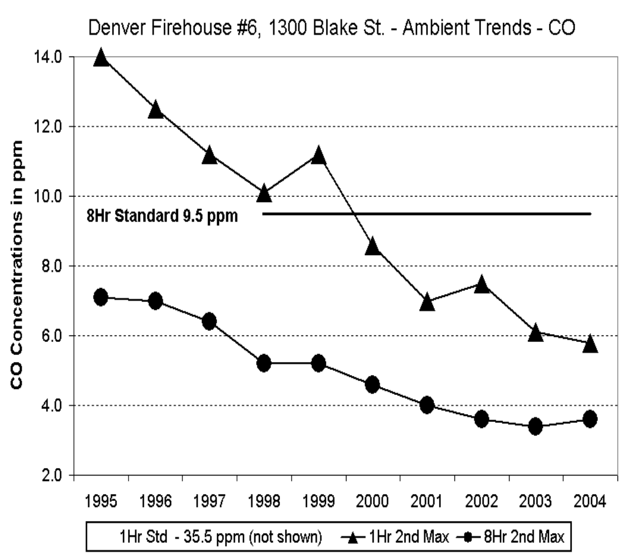
Figure 16 - Northern Front Range Carbon Monoxide Graphs (continued)











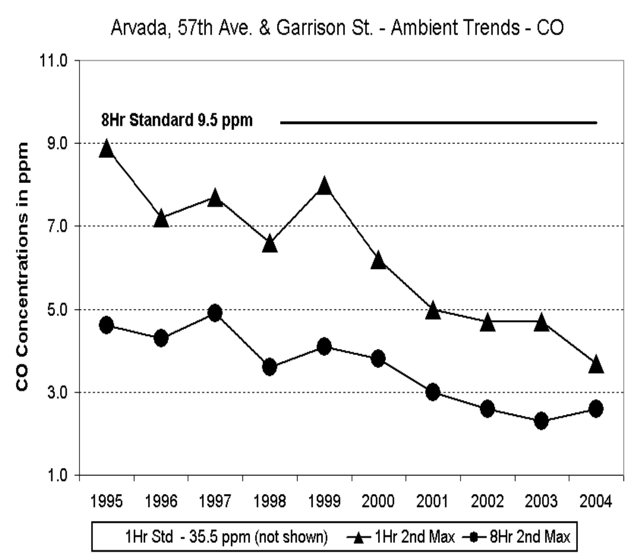
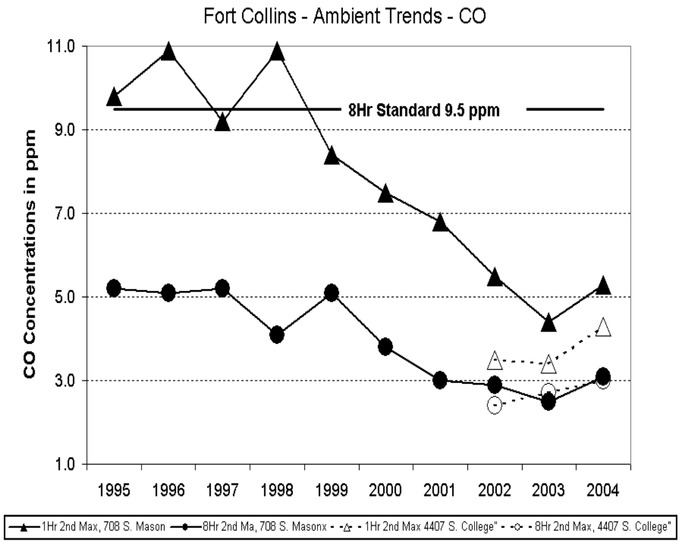


Figure 16 - Northern Front Range Carbon Monoxide Graphs (continued)



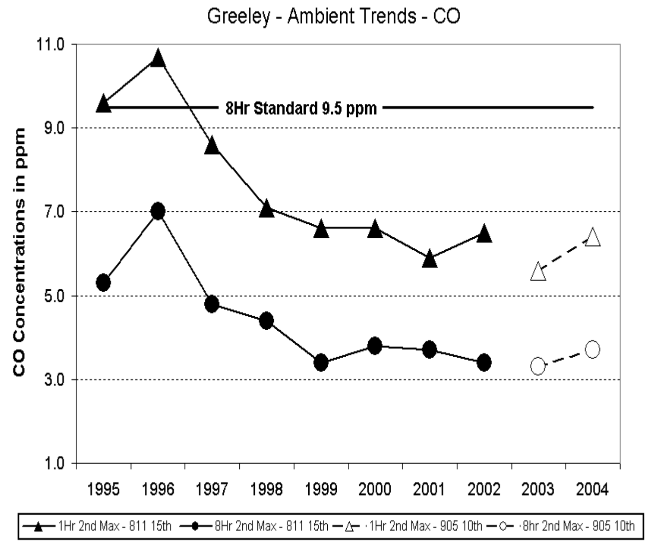


Table 26 - Northern Front Range Ozone Values For 2004

Site Name	**Location**	**Ozone 1-hour Avg. (ppm)**		**Ozone 8-hour Avg. (ppm)**	
		Maximum	**2nd Maximum**	**Maximum**	**4th Maximum**
Adams					
Welby	78th Ave. & Steele St.	0.078	0.075	0.070	0.066
Arapahoe					
Highland Res.	8100 S. University	0.093	0.085	0.076	0.072
Boulder					
Boulder	1405½ S. Foothills Hwy	0.080	0.079	0.069	0.068
Denver					
Carriage	23rd Ave. & Julian St.	0.087	0.080	0.067	0.066
Douglas					
Chatfield Res.	Roxborough Park Rd.	0.069	0.068	0.065	0.059
	11500 Roxborough Park Rd.	0.091	0.088	0.077	0.075
Jefferson					
Arvada	W. 57th Ave. & Garrison St.	0.086	0.081	0.071	0.065
Lookout Mnt	636 Lookout Mnt Rd.	0.092	0.089	0.081	0.078
NREL	2054 Quaker St.	0.093	0.087	0.076	0.074
Rocky Flats	16600 W. Hwy 128	0.086	0.083	0.076	0.073
Welch	12400 W. Hwy 285	0.076	0.074	0.065	0.062
Larimer					
Fort Collins	708 S. Mason St.	0.100	0.086	0.071	0.064
Weld					
Greeley	3101 35th Ave.	0.083	0.082	0.071	0.069

Figure 17 - Northern Front Range Ozone Graphs

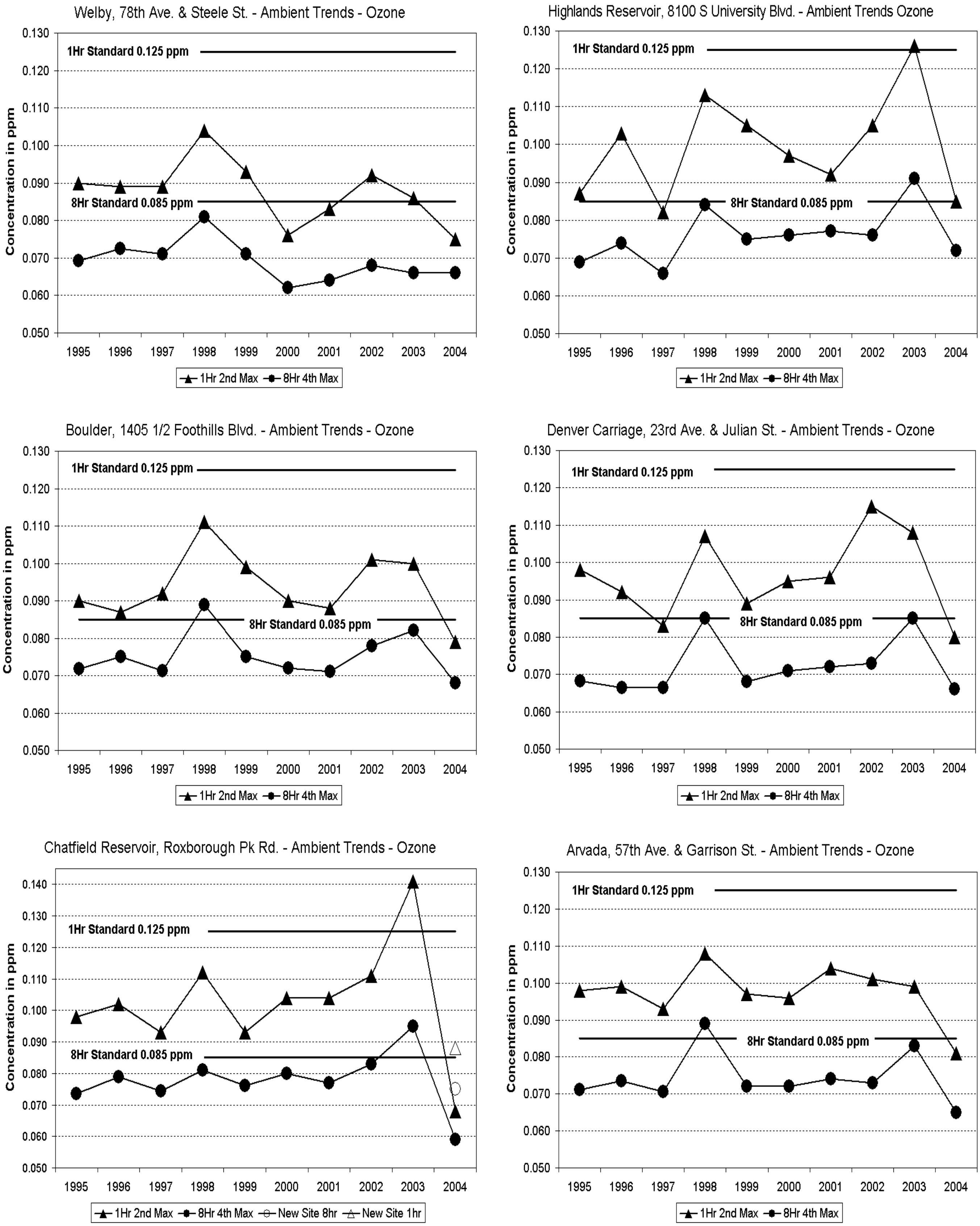
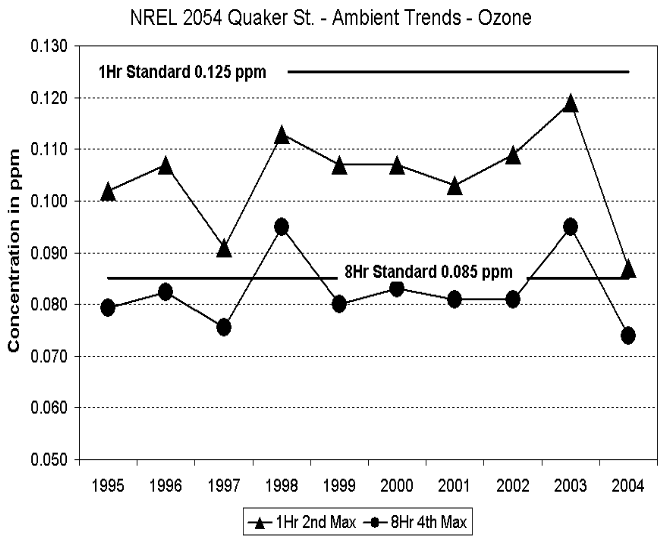
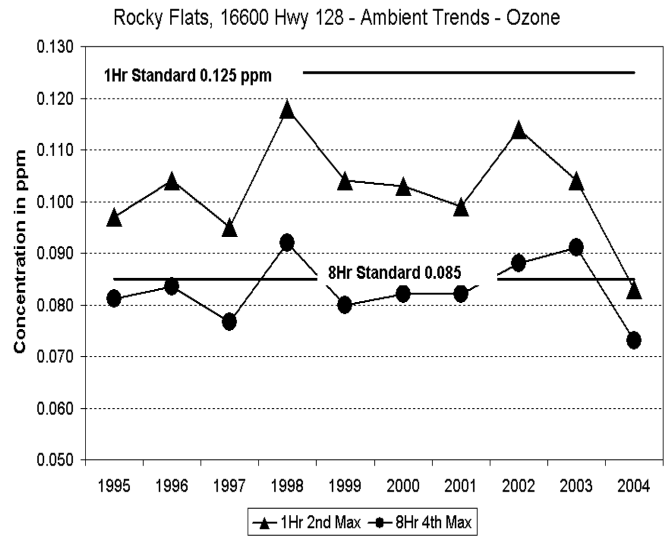
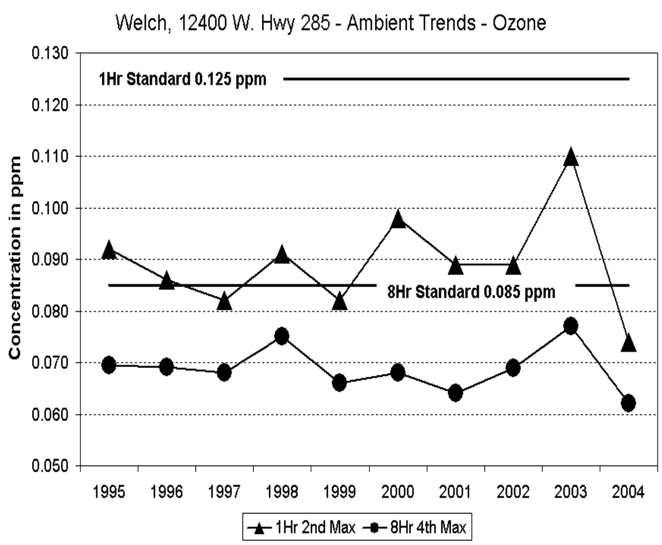
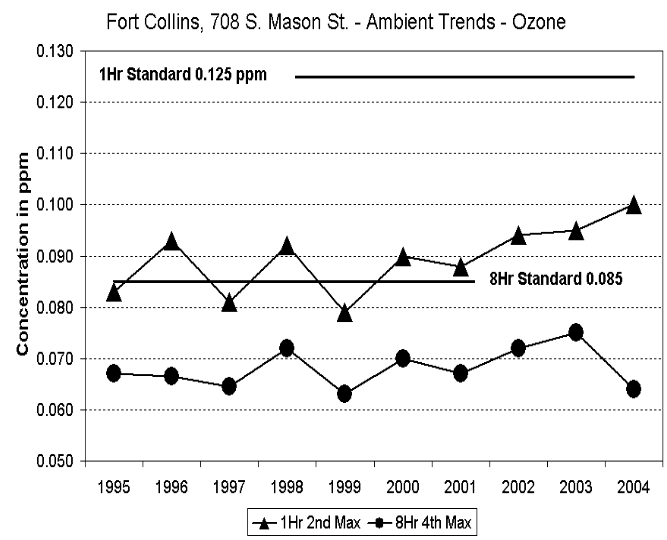


Figure 17 - Northern Front Range Ozone Graphs (continued)









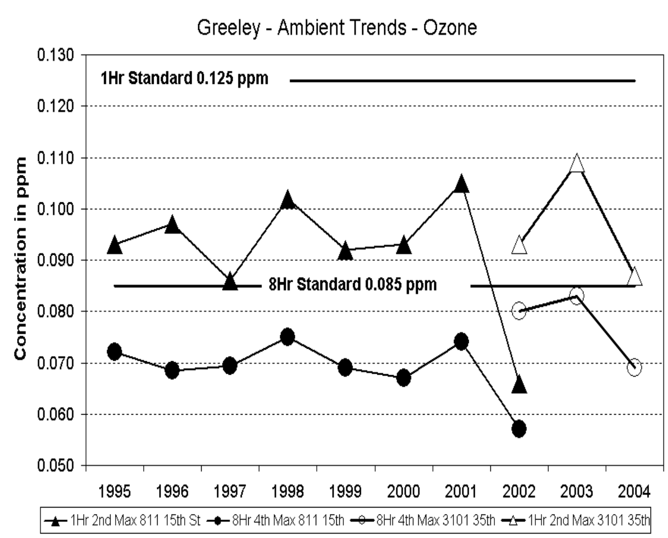


Table 27 - Northern Front Range Oxides of Nitrogen and Sulfur Dioxide Values For 2004

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						
South Adams	5580 Niagara St.			0.013	0.005	0.0021
Welby	78th Ave. & Steele St.	0.0217	0.0355	0.029	0.009	0.0024
Denver						
Denver CAMP	2105 Broadway	0.0272	0.0450	0.030	0.011	0.0026

() Indicates less than 75% data for the year.

Figure 18 - Northern Front Range Nitrogen Dioxide Graphs

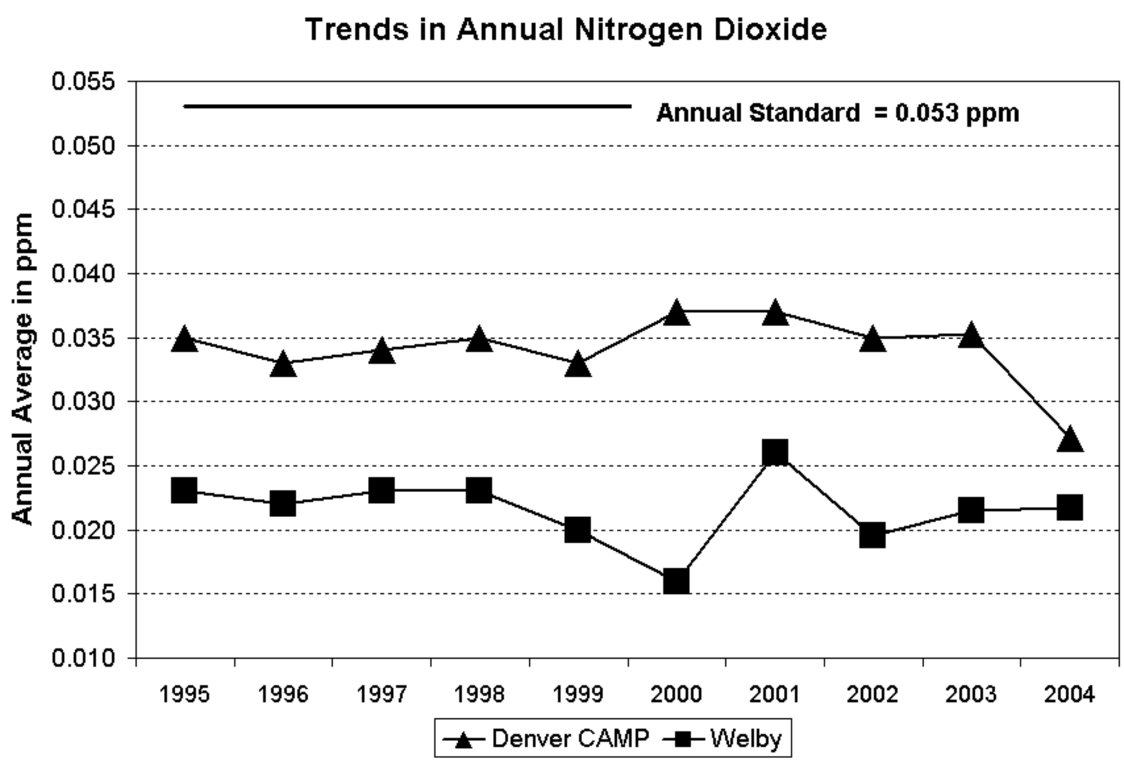


Figure 19 - Northern Front Range Sulfur Dioxide Graphs

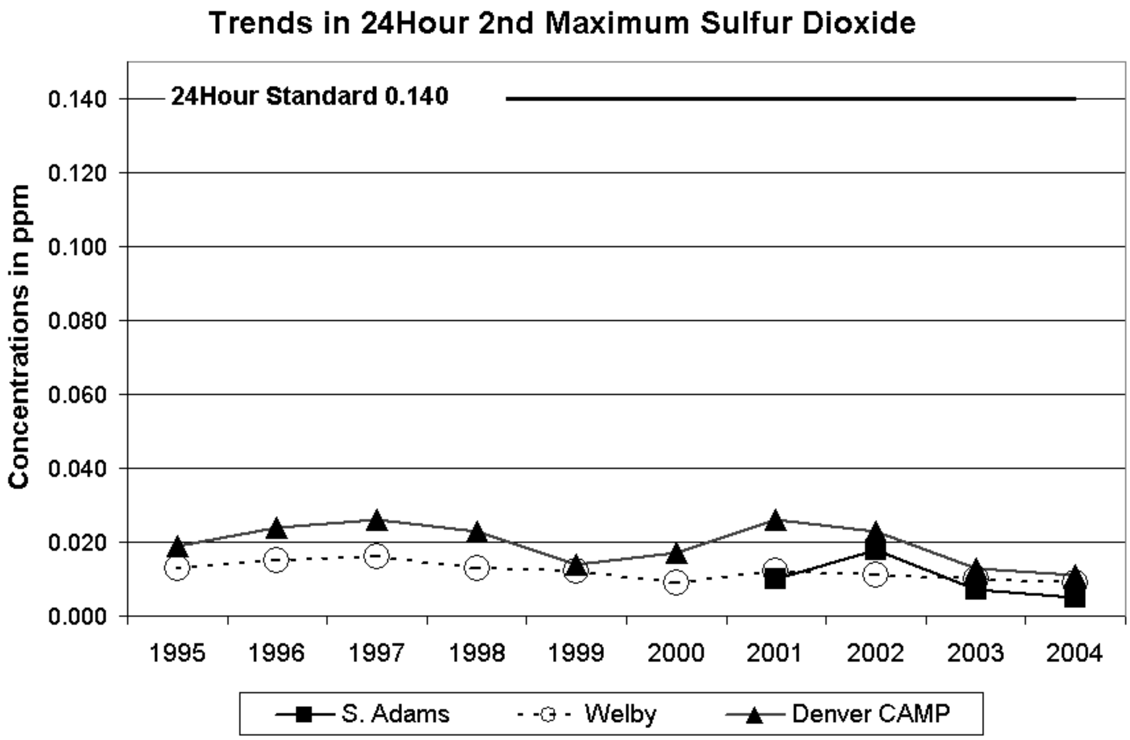


Table 28 - Denver Visibility Standard Exceedance Days
(Transmissometer Data)
January 2004 – December 2004

Month	Days	EX POOR	POOR	FAIR	GOOD	Missing	(>70% RH)
January	31	2	6	7	10	3	3
February	29	4	5	10	6	0	4
March	31	1	10	13	6	0	1
April	30	2	9	7	5	0	7
May	31	2	3	14	11	0	1
June	30	2	12	7	3	0	6
July	31	3	9	13	3	1	2
August	31	4	12	6	8	0	1
September	30	0	14	11	3	0	2
October	31	3	6	8	11	0	3
November	30	2	11	7	4	0	6
December	31	2	11	9	9	0	0
TOTALS	**366**	**27**	**108**	**112**	**79**	**4**	**36**

Figure 20 - Denver Visibility Data (January 2004 to December 2004)

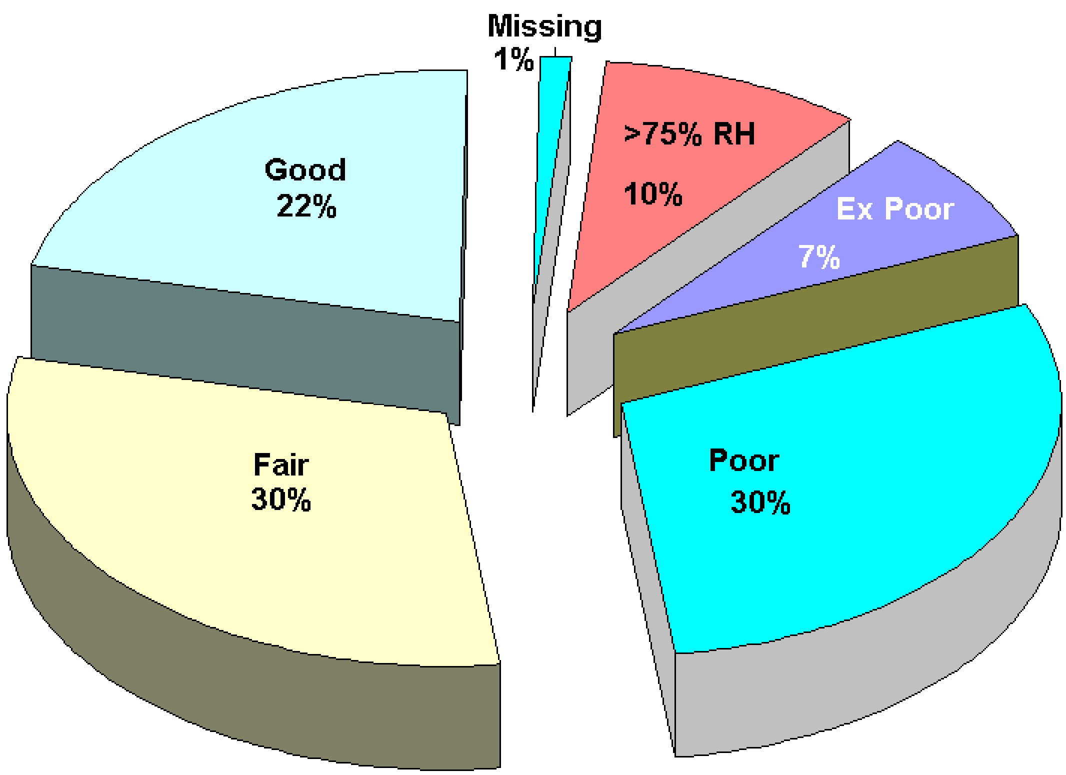


Table 28 and Figure 20 show that 4 days or 1 percent of the data for 2004 were listed as missing. In 2003 177 days were listed as missing. This dramatic change has been due to improvements in the bulb calibrations and fewer instrument problems. In short 2004 was as abnormally free of instrument problems as 2003 was plagued with them.

Figure 21 - Denver Visibility Comparison (1995 to 2004)

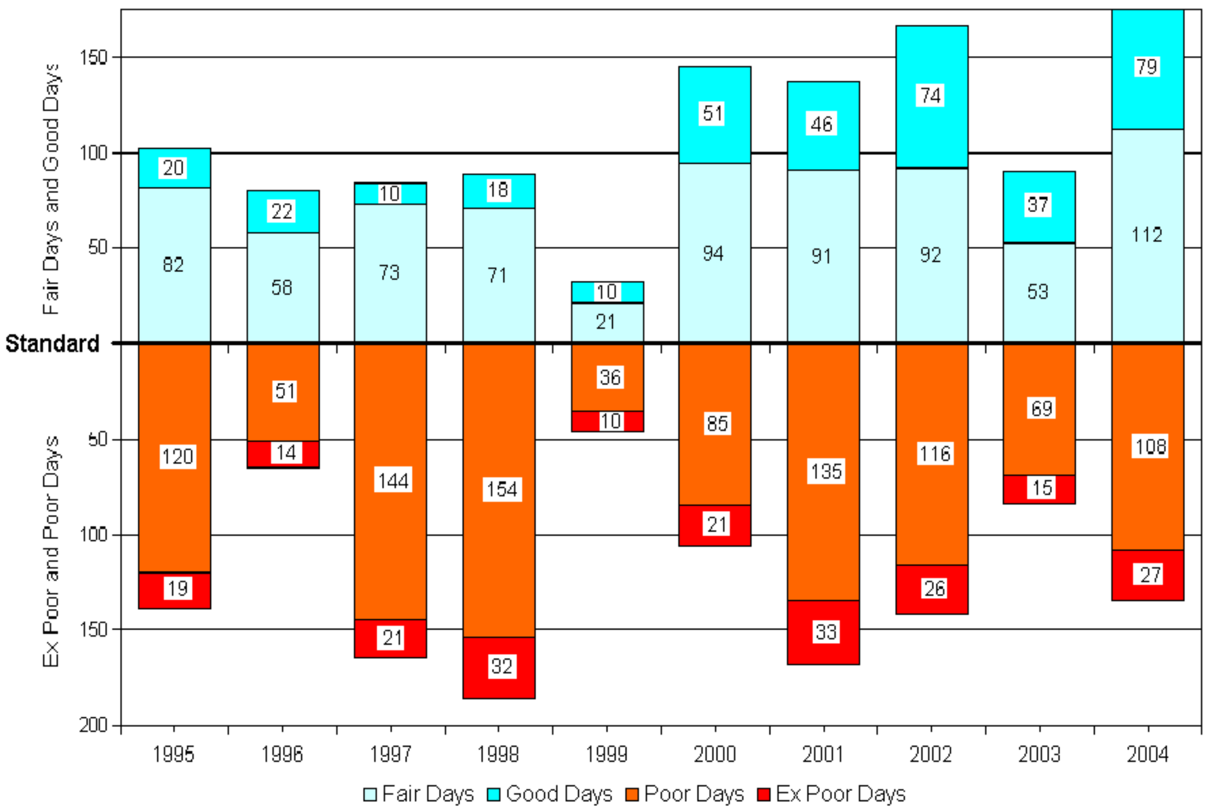


Figure 21 shows the general increase in “Good” and “Fair” days over the past ten years. “Good” and “Fair” days are those where the visibility is better than the standard. “Poor” and “Extra Poor” days are those that are equal to or below the standard. Visibility monitoring began in late 1990. The dip in monitored days in 1996, 1999 and 2003 were caused by problems with the analyzer. With the exception of these years data recovery has been high. Data loss prior to 2000 was primarily due to the one to two months lost each summer for recalibration and testing by the manufacturer. Since 2000 the APCD has been provided with a replacement machine during the summer calibration period.

Table 29 - Fort Collins Visibility Standard Exceedance Days
(Transmissometer Data)
January 2004 – December 2004

Month	Days	EX POOR	POOR	FAIR	GOOD	Missing	(>70% RH)
January	31	0	1	10	10	6	4
February	29	0	5	4	12	7	1
March	31	0	4	9	15	2	1
April	30	0	3	6	8	12	1
May	31	0	2	9	11	9	0
June	30	0	3	7	2	18	0
July	31	0	4	9	12	6	0
August	31	0	12	9	6	4	0
September	30	0	4	18	2	6	0
October	31	0	1	12	4	13	1
November	30	0	7	5	2	9	7
December	31	0	5	5	7	14	0
TOTALS	**366**	**0**	**51**	**103**	**91**	**106**	**15**

Figure 22 - Fort Collins Visibility Data (January 2004 to December 2004)

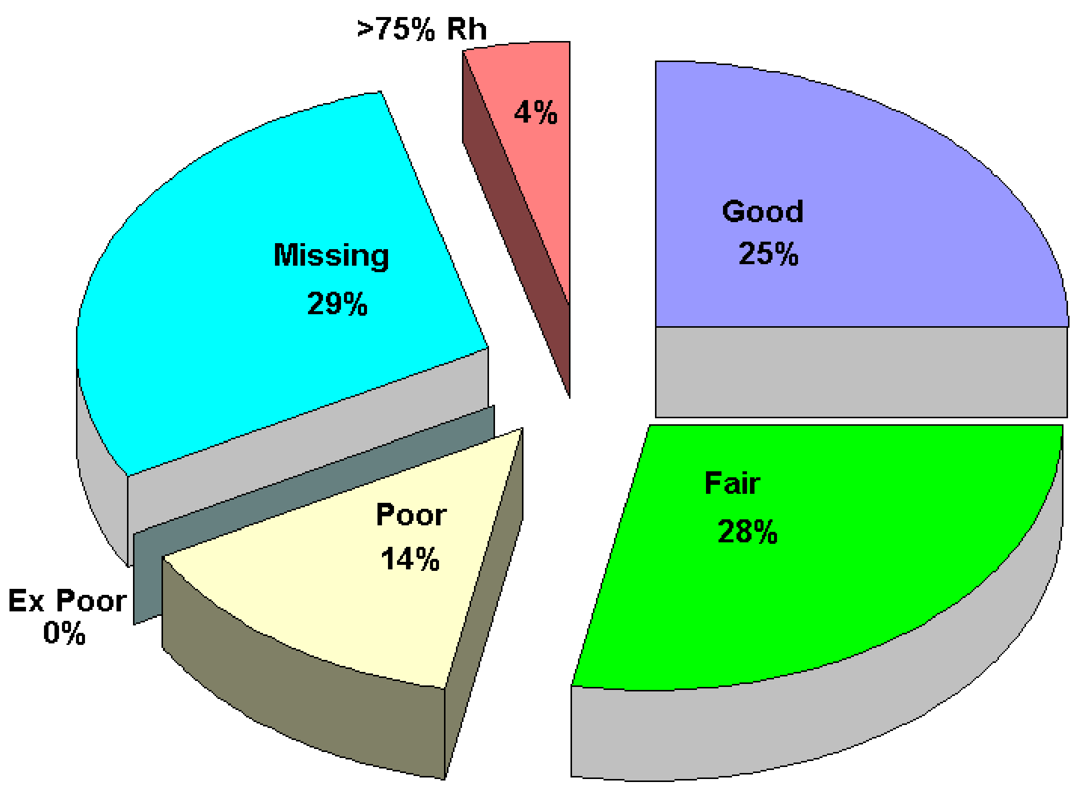


Figure 23 - Fort Collins Visibility Data (1995 to 2004)

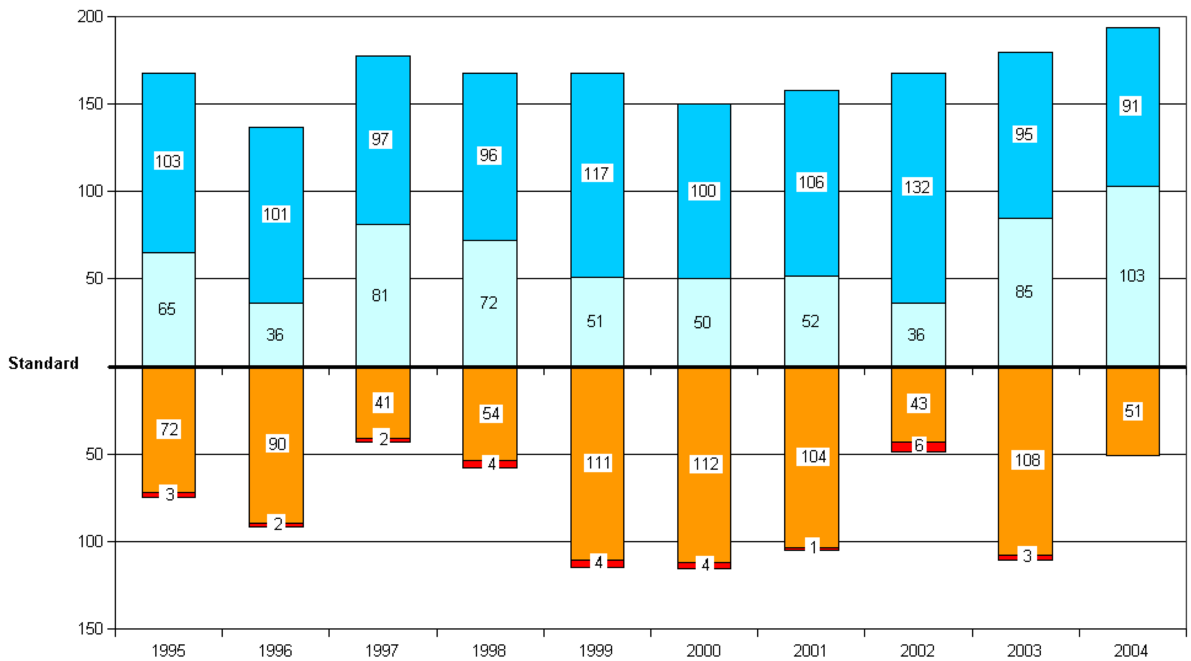
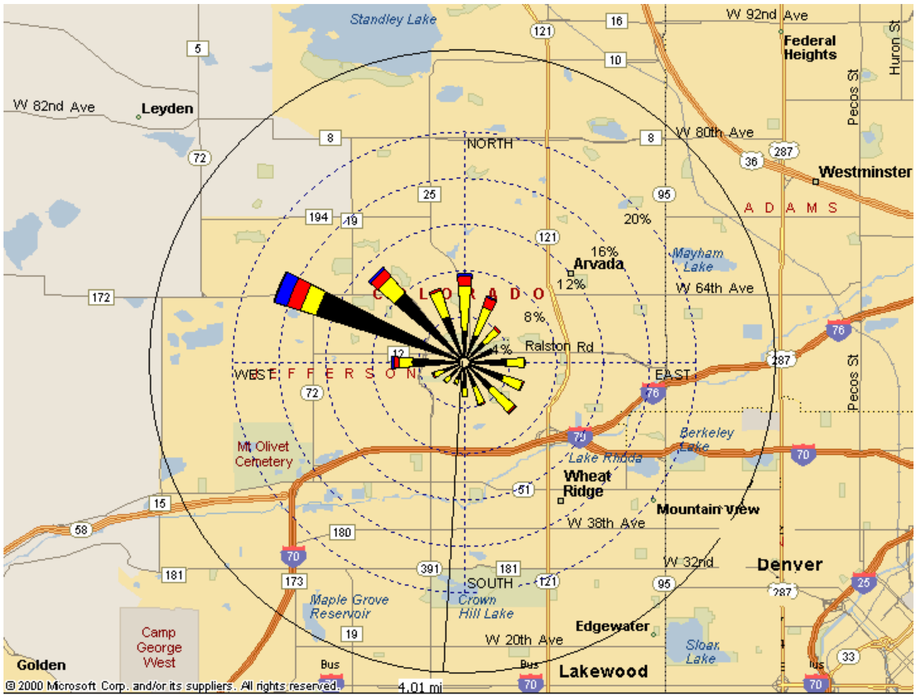


Figure 23 shows that for the past ten years Fort Collins has averaged 164 days per year where the visibility was either "Fair" or "Good" and only 85 days where the visibility was either "Poor" or "Ex Poor". The missing days are lost due to either high relative humidity (greater than 70 percent) or machine maintenance.

Figure 24 - Northern Front Range Wind Roses

Arvada, 57th Ave. & Garrison St.



Auraria, Parking Lot R

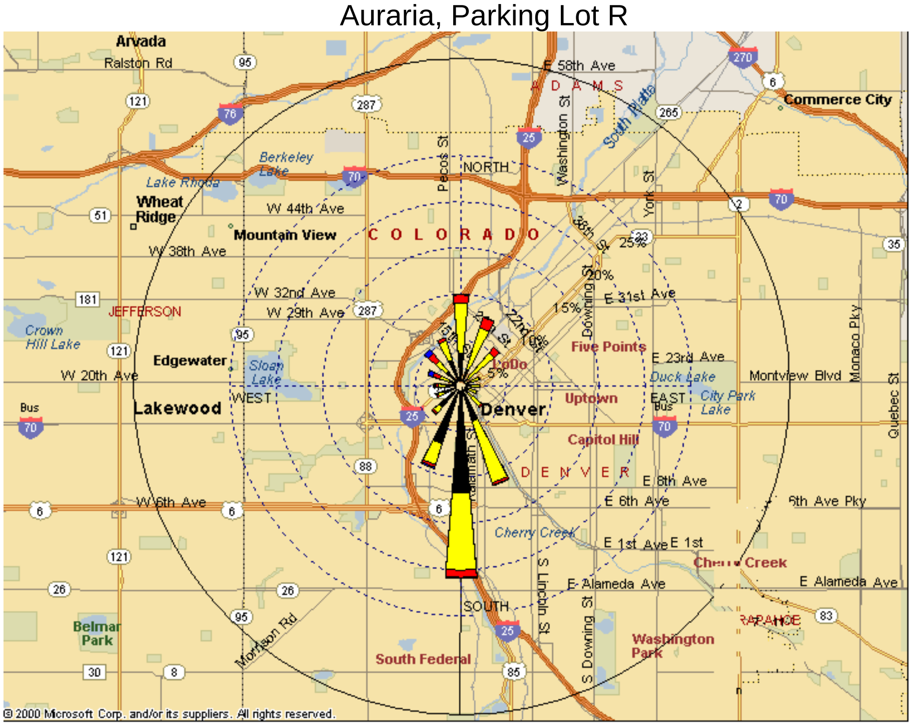
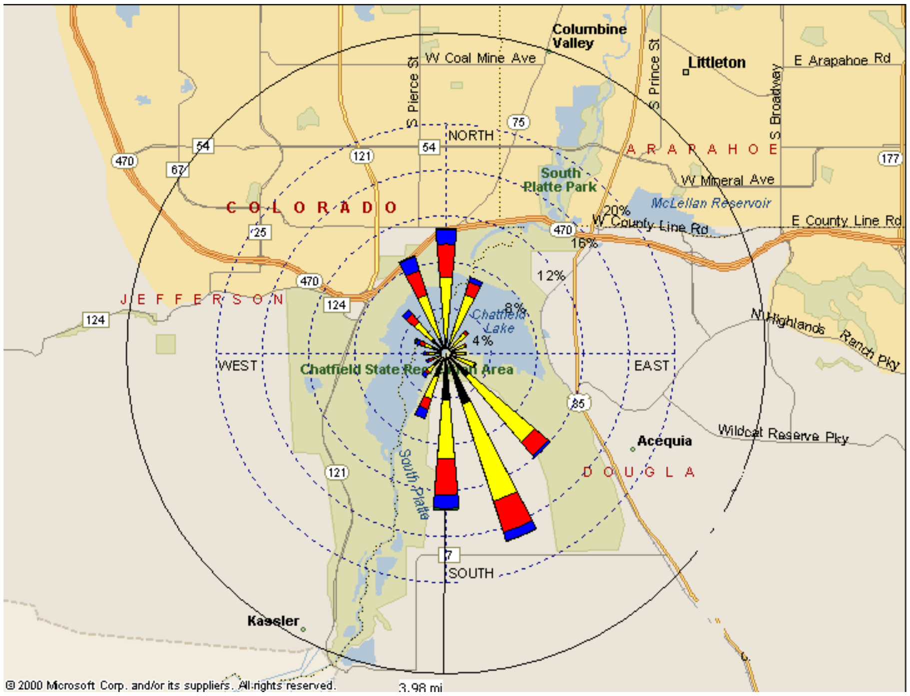


Figure 24 - Northern Front Range Wind Roses (continued)

Chatfield Reservoir



Commerce City, 7101 Birch St.

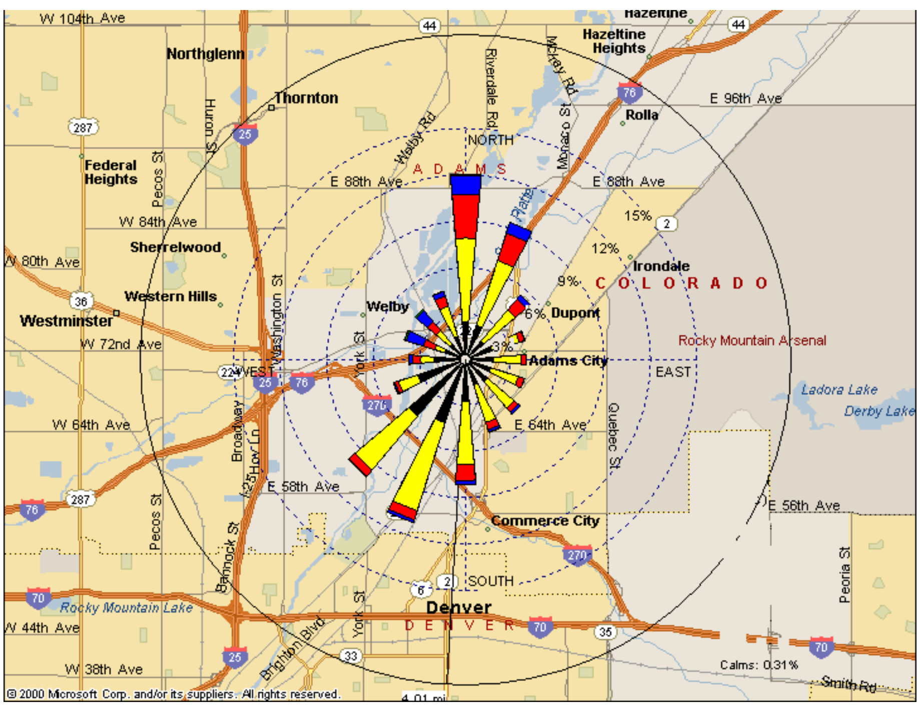
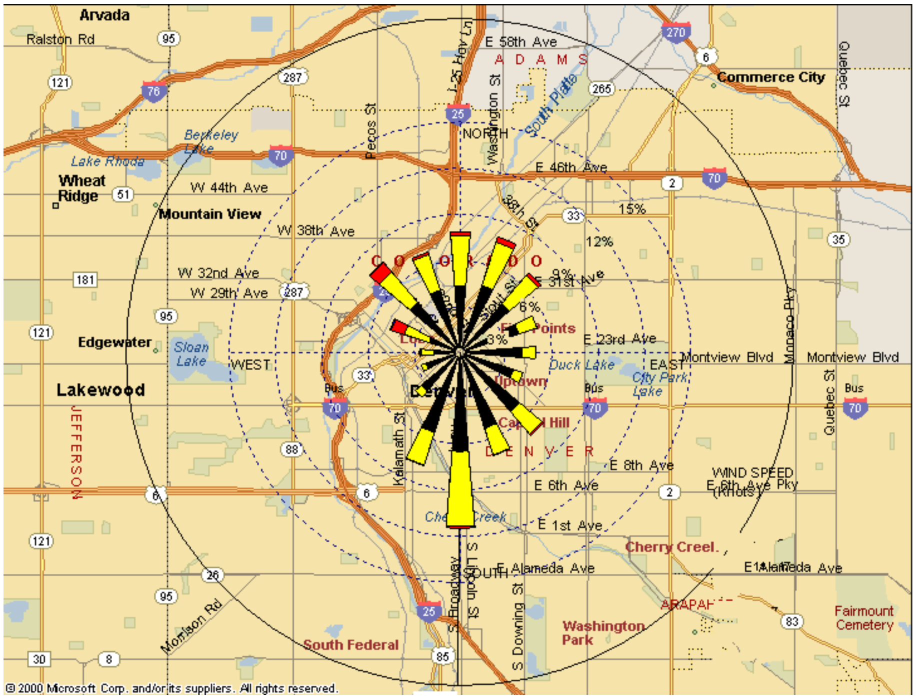


Figure 24 - Northern Front Range Wind Roses (continued)

Denver CAMP, 2105 Broadway



Denver Carriage, 23rd Ave. and Julian St.

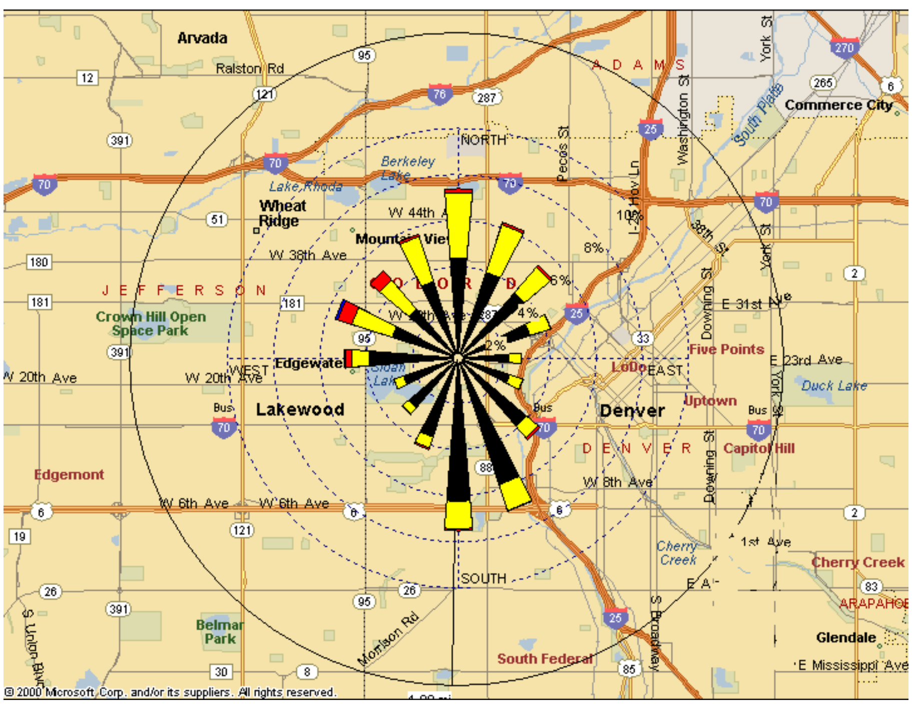
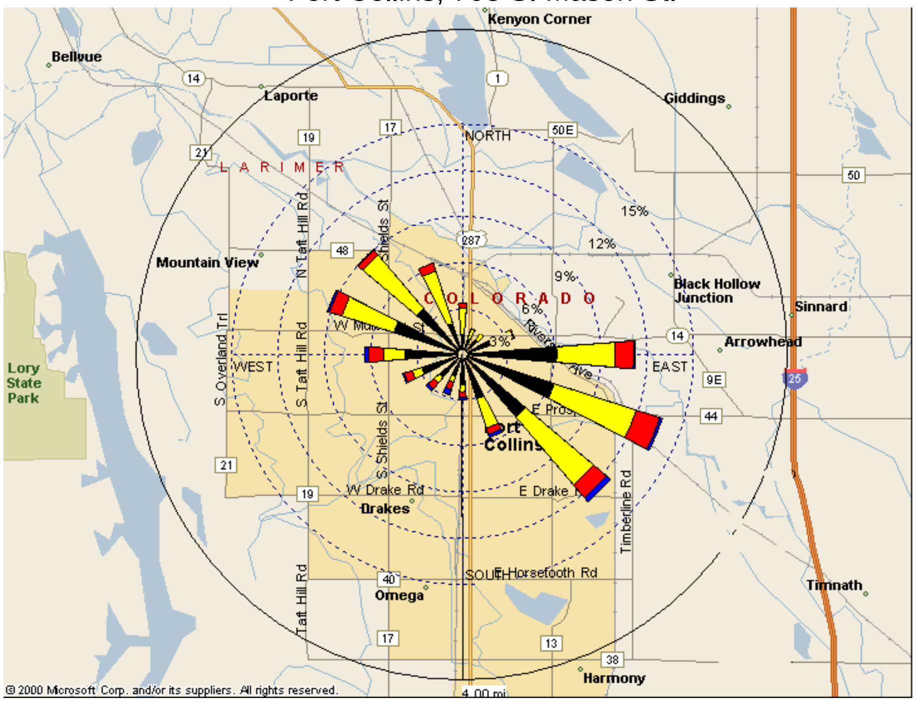


Figure 24 - Northern Front Range Wind Roses (continued)

Fort Collins, 708 S. Mason St.



Highland Reservoir, 8100 S. University Blvd.

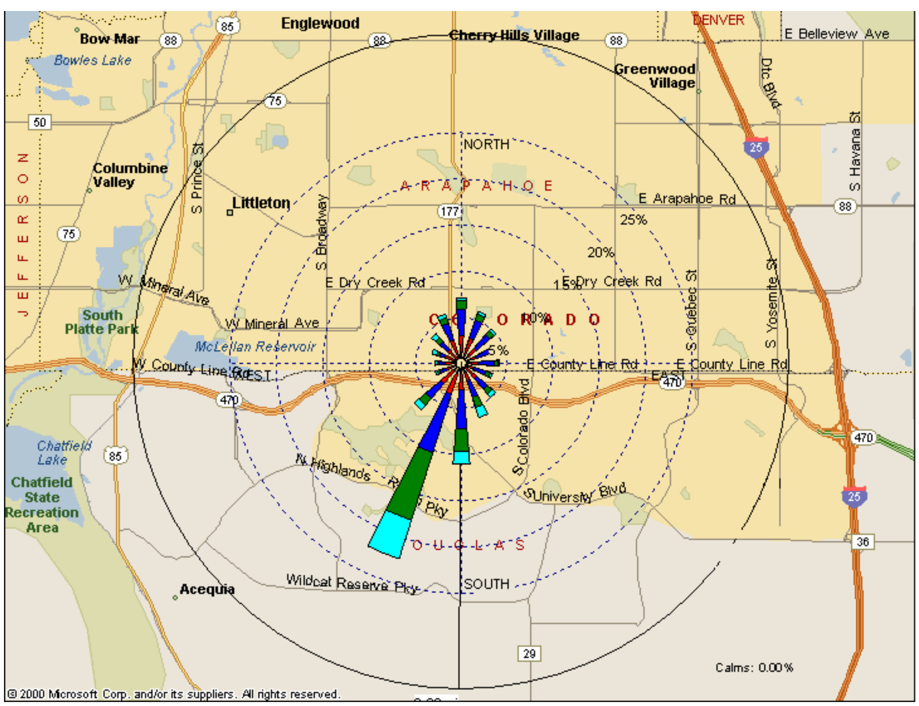
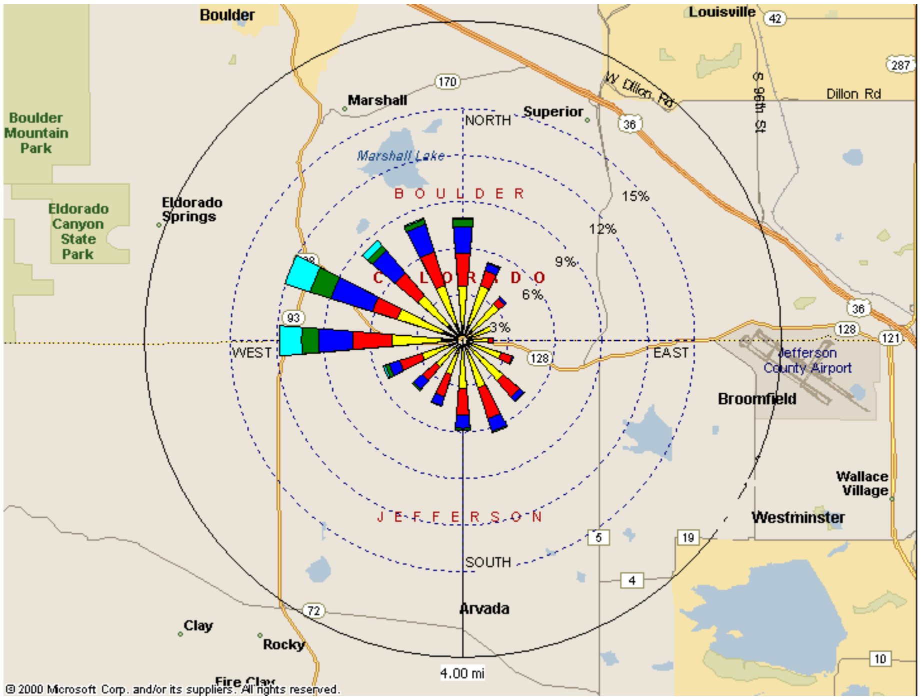


Figure 24 - Northern Front Range Wind Roses (continued)

Rocky Flats-N, 16600 W. Hwy. 128



Rocky Flats-NE, 11501 Indiana St

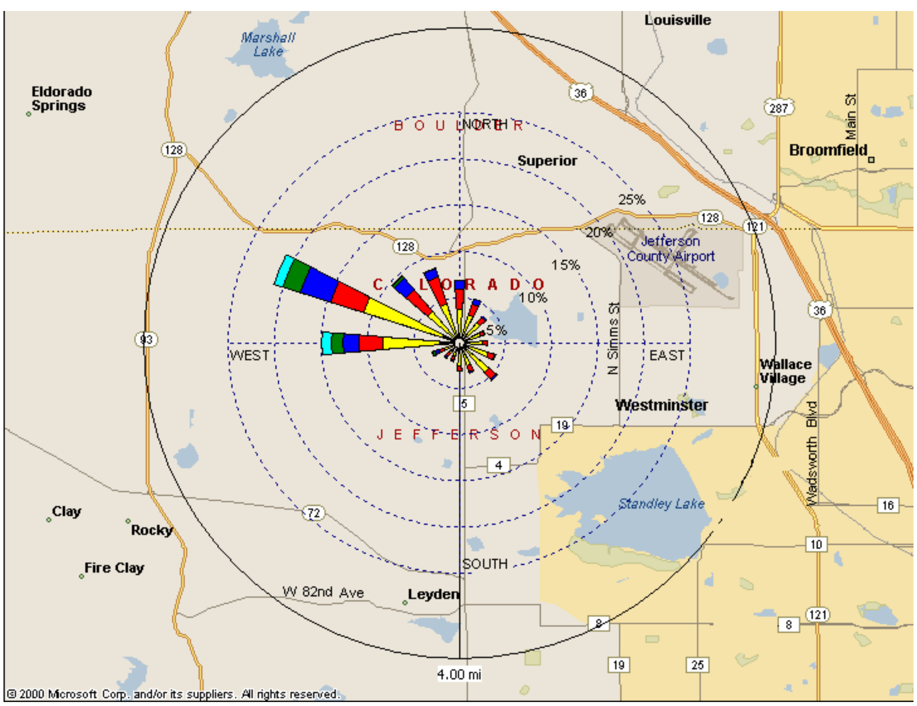
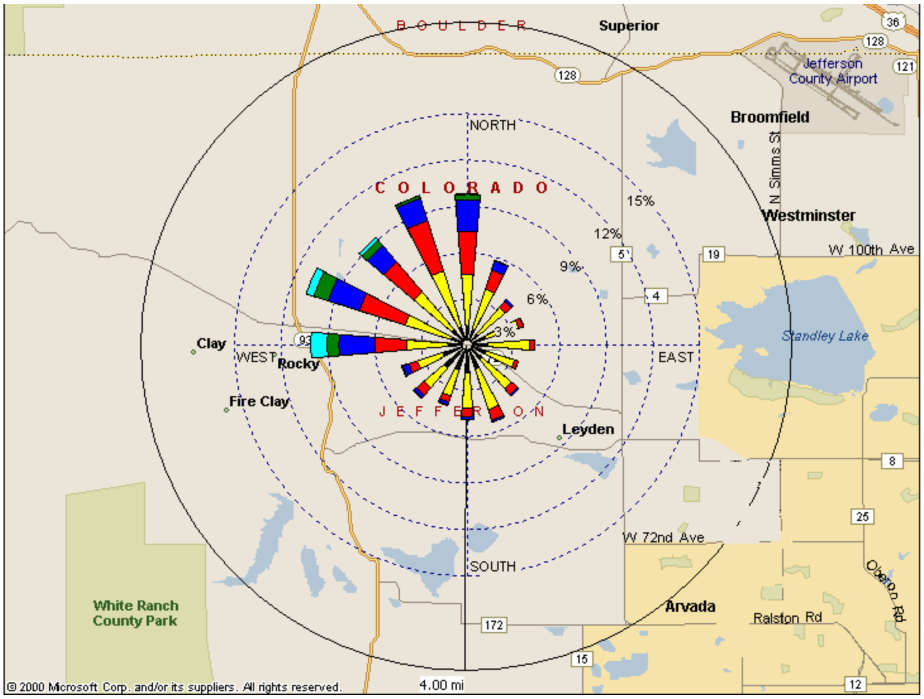


Figure 24 - Northern Front Range Wind Roses (continued)
Rocky Flats-S, 18000 W. Hwy 72



Rocky Flats-SE, 9901 Indiana St.

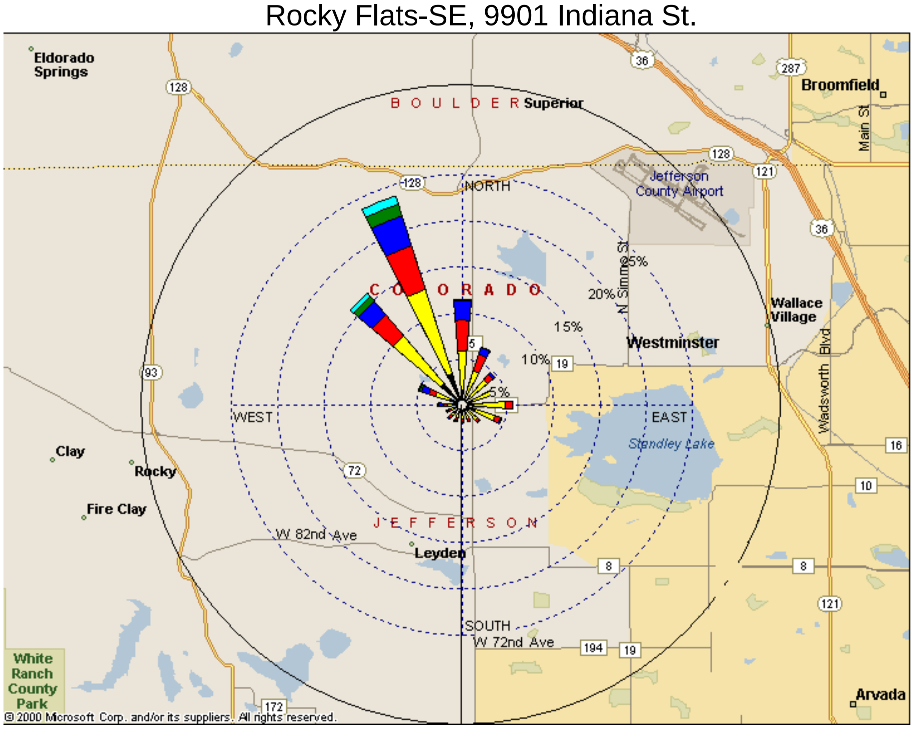
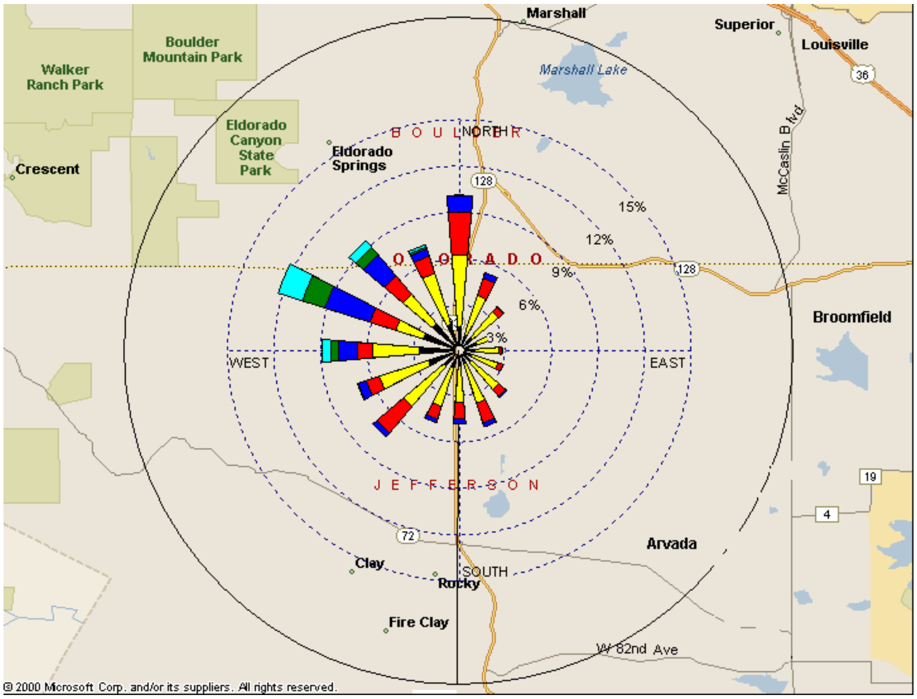


Figure 24 - Northern Front Range Wind Roses (continued)
Rocky Flats – W, 11190 N. Hwy 93



Welby, 78th Ave. & Steele St.

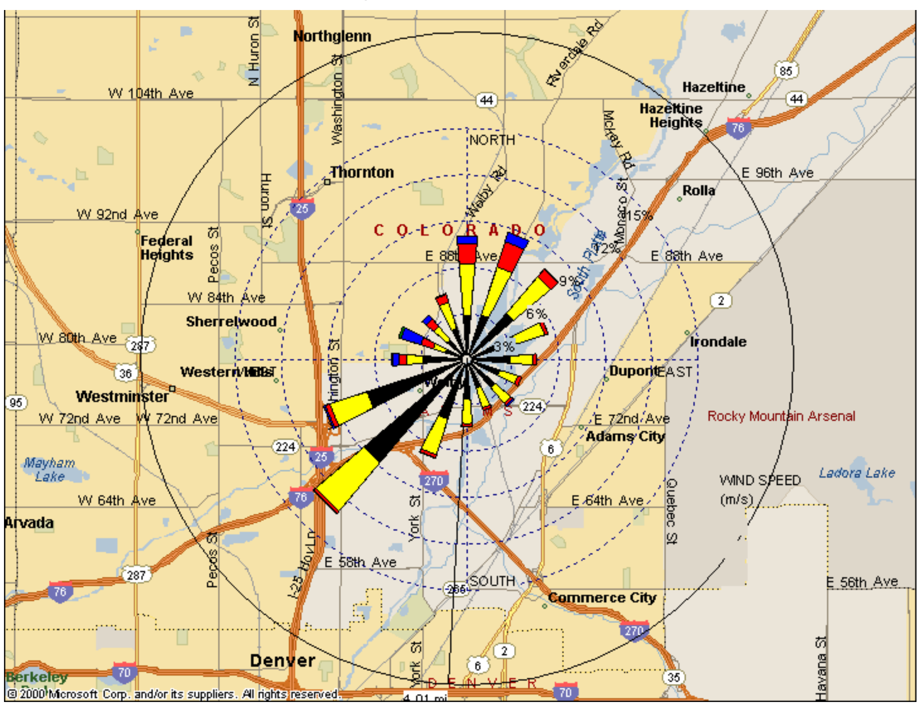
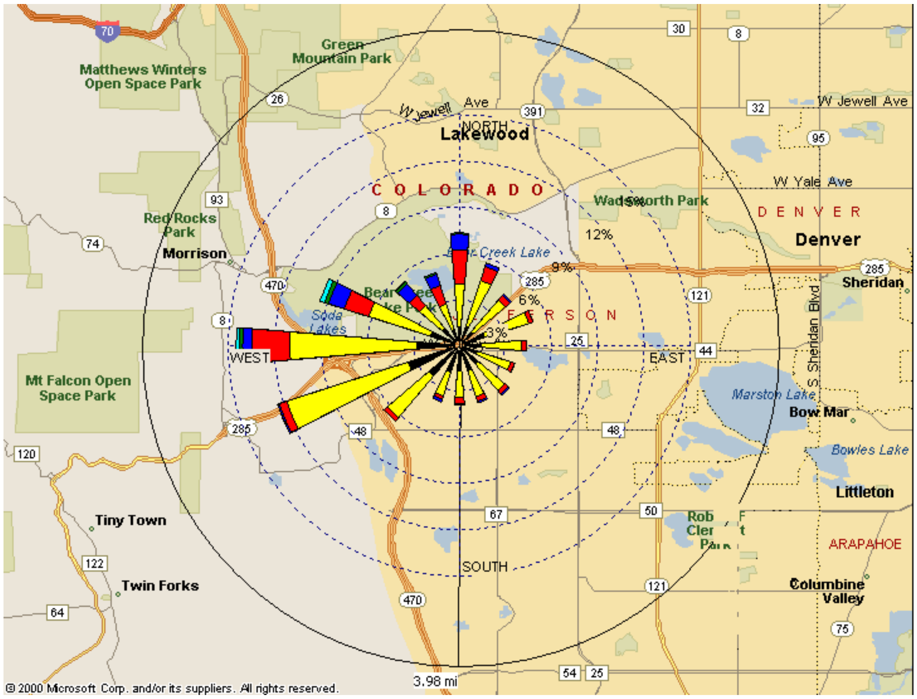


Figure 24 - Northern Front Range Wind Roses (continued)
Welch, 12400 W. Hwy. 285



6.3 Southern Front Range Communities

The Southern Front Range Communities 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, Cripple Creek, 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 Communities. 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 APCD has conducted particulate monitoring in both Walsenburg and Trinidad but that monitoring was discontinued in 1979 and 1985 respectively.

Table 30 - Southern Front Range Monitors In Operation For 2004

X - Monitors continued in 2004 A – Monitors added in 2004

D – Monitors discontinued in 2004 H – Hourly particulate monitor

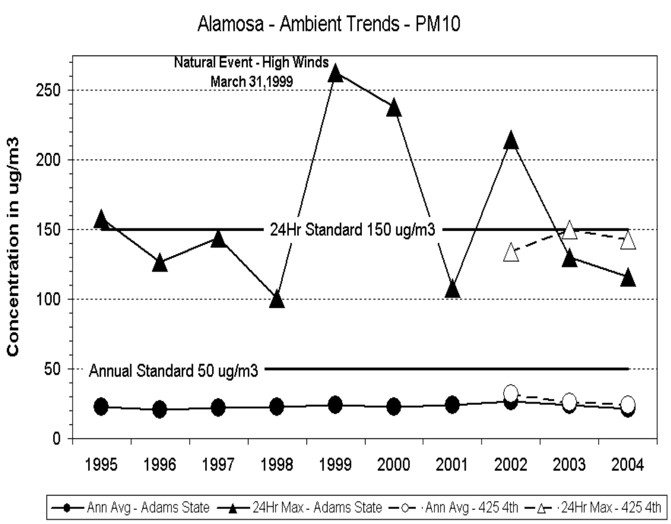
Site Name	Location	CO	O_3	TSP	Pb	PM_{10}	$PM_{2.5}$	Met
Alamosa								
Alamosa	359 Poncha Ave.					X		
	425 4th St.					X		
El Paso								
Colorado Springs	I-25 & Uintah St.	X						
	3730 Meadowlands					X	X	
	101 W. Costilla St.			X	X	X	X	
	USAF Rd. 640		X					
	690 W. Hwy. 24	X						
Manitou Springs	101 Banks Pl.		A					
Fremont								
Cañon City	7th Ave. & Macon St.					D		
	128 Main St.					A		
Pueblo								
Pueblo	211 D St.					X	X	
Teller								
Cripple Creek	209 Bennett Ave.					X		
	Warren Ave. & 2nd St							X

Table 31 - Southern Front Range Maximum Particulate Values For 2004

Site Name	Location	PM_{10} ($\mu g/m^3$)		$PM_{2.5}$ ($\mu g/m^3$)	
		Annual Average	24-Hr Maximum	Annual Average	24-Hr Maximum
Alamosa					
Alamosa	359 Poncha Ave.	21.2	116		
	425 4th St.	23.9	143		
El Paso					
Colorado Springs	3730 Meadowlands	22.8	82	6.87	22.3
	101 W. Costilla St.	21.2	38	8.56	21.0
Fremont					
Cañon City	7th Ave. & Macon St.	(13.9)	32		
	128 Main St	(10.3)	17		
Pueblo					
Pueblo	211 D St.	22.9	68	6.78	20.0
Teller					
Cripple Creek	209 Bennett Ave.	20.0	97		

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

Figure 25 - Southern Front Range PM_{10} Particulate Graphs



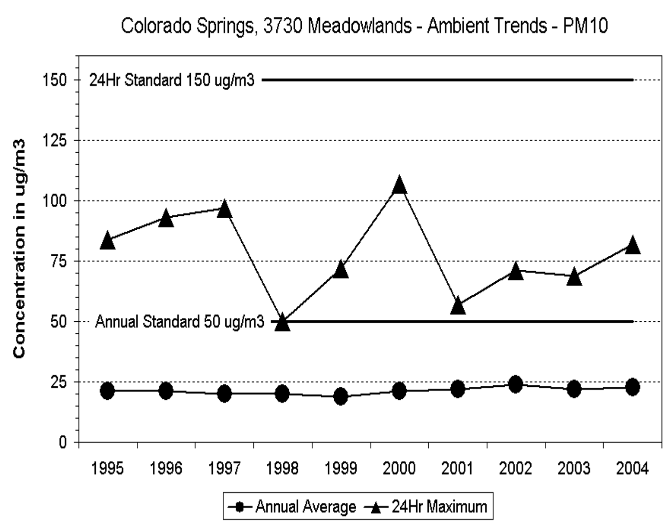


Figure 26 - Southern Front Range PM_{10} Particulate Graphs

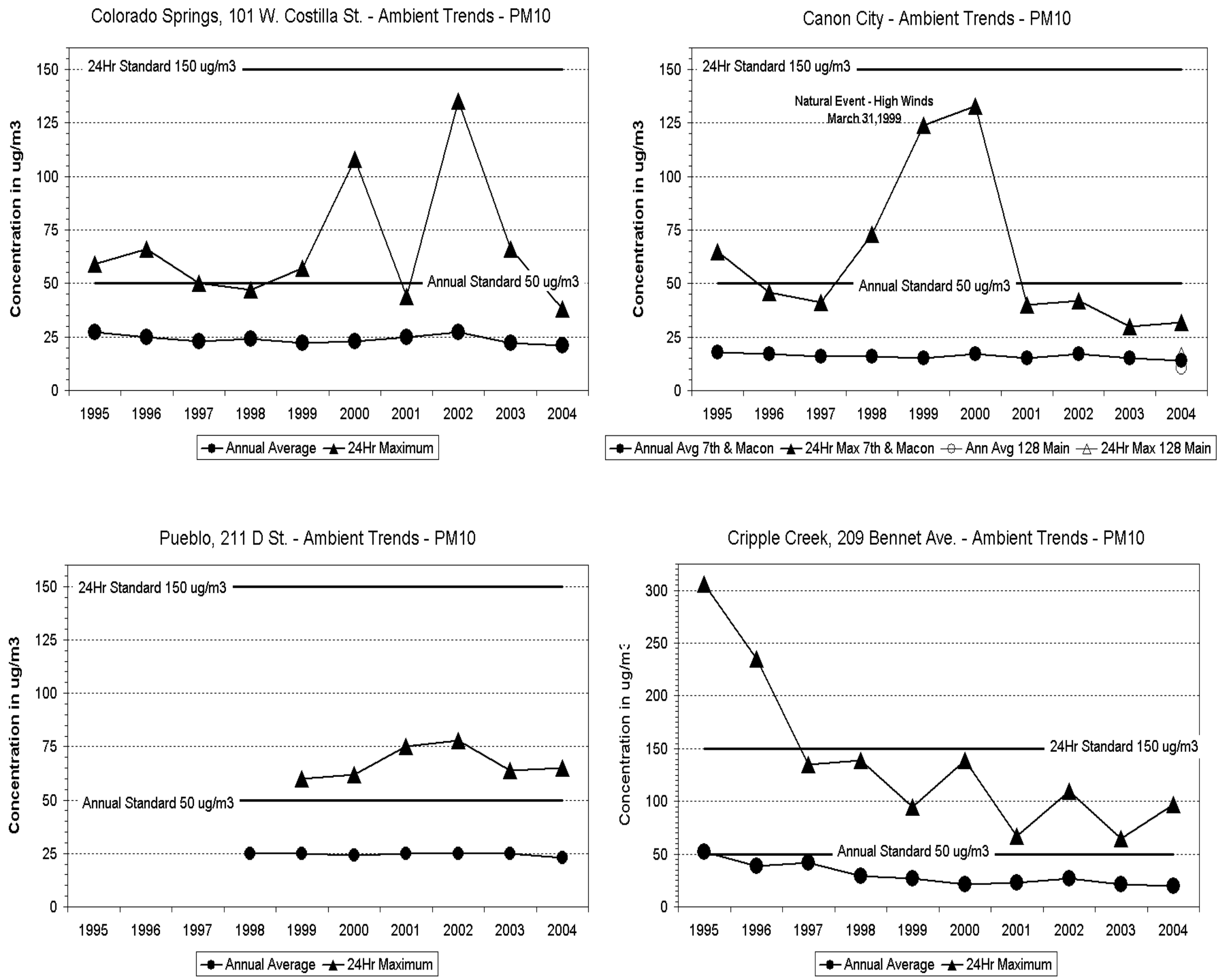


Figure 27 - Southern Front Range $PM_{2.5}$ Particulate Graphs

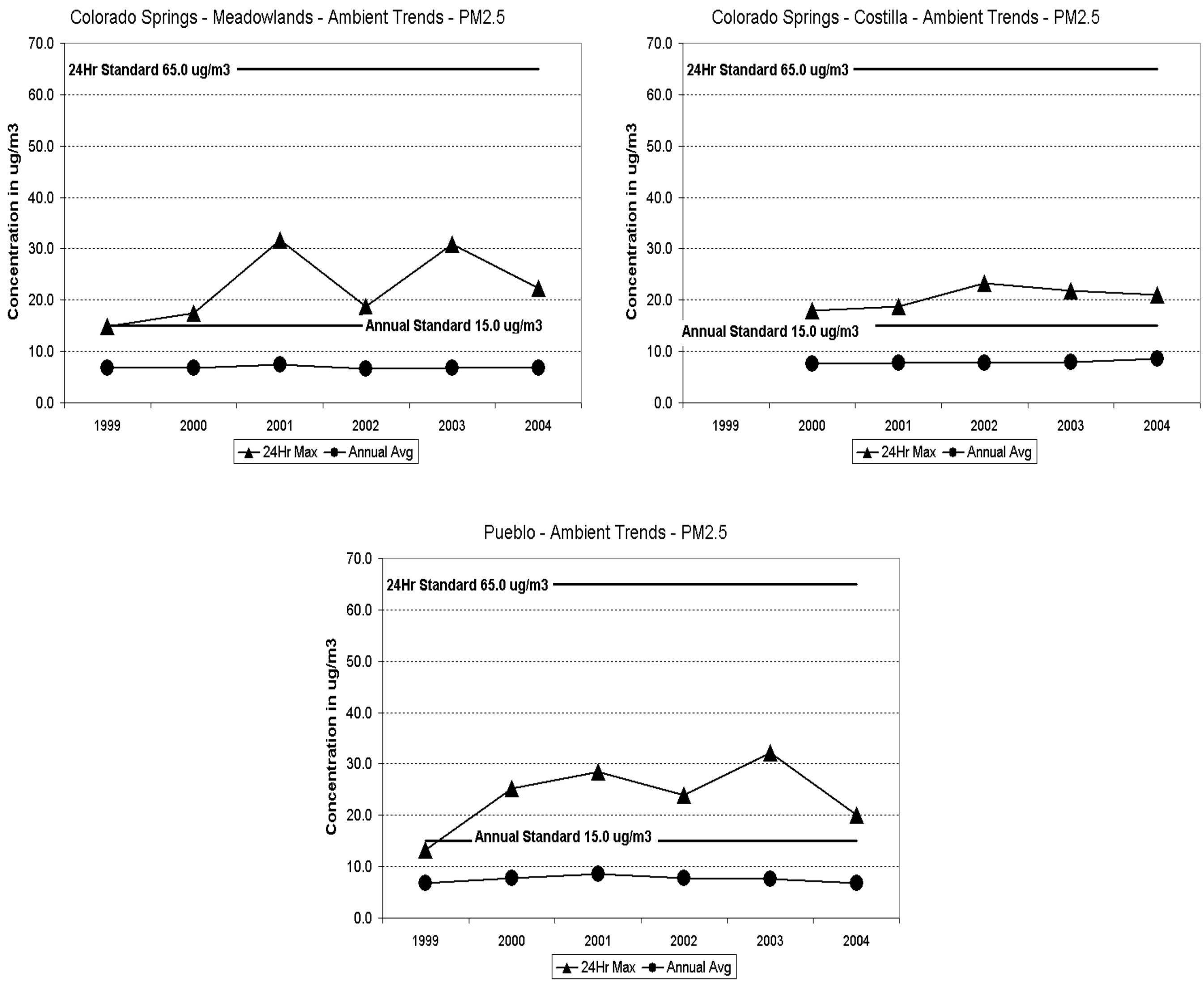


Table 32 - Southern Front Range TSP and Lead Values For 2004

Site Name	Location	TSP (µg/m³)		Lead (µg/m³)	
		Annual Geometric Mean	24-Hr Maximum	Maximum Quarter	24-Hr Maximum
El Paso					
Colorado Springs	101 W. Costilla St.	52.9	95	0.01	0.01

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

Figure 28 - Southern Front Range Lead Graph

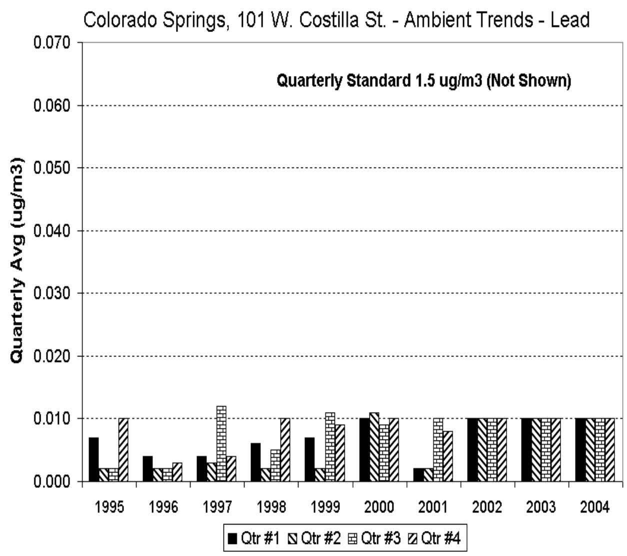
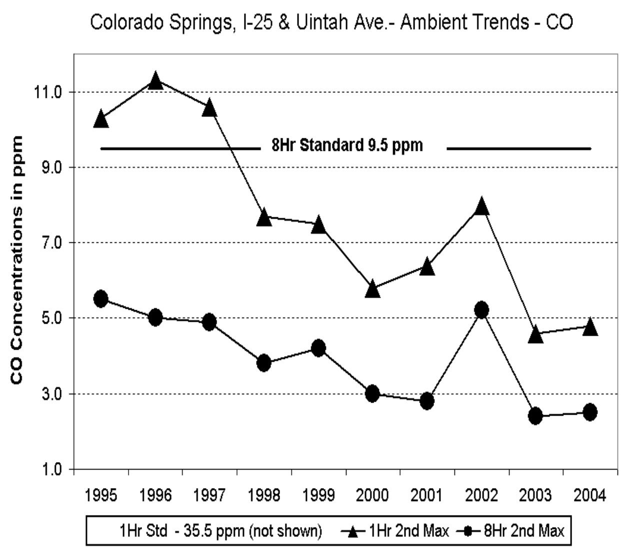


Table 33 - Southern Front Range Carbon Monoxide Values For 2004

Site Name	Location	CO 1-hour Avg. (ppm)		CO 8-hour Avg. (ppm)	
		Maximum	2nd Maximum	Maximum	2nd Maximum
El Paso					
Colorado Springs	I-25 & Uintah	6.4	4.8	2.7	2.5
	690 Hwy. 24	8.4	6.5	3.3	3.1

Figure 29 - Southern Front Range Carbon Monoxide Graphs



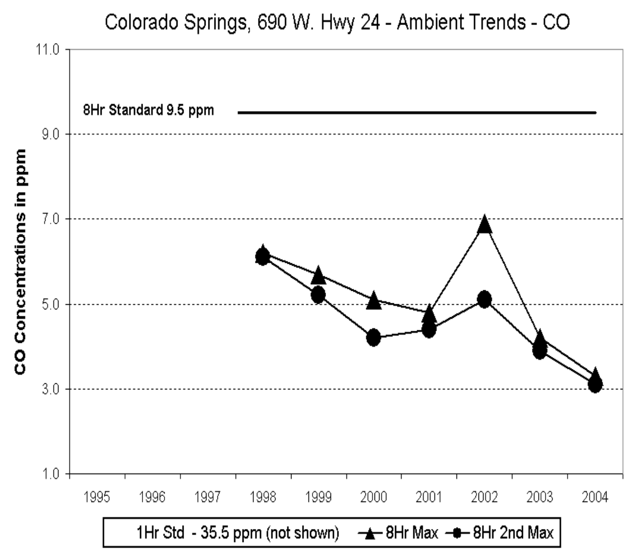


Table 34 - Southern Front Range Ozone Values For 2004

Site Name	Location	Ozone 1-hour Avg. (ppm)		Ozone 8-hour Avg. (ppm)	
		Maximum	2nd Maximum	Maximum	4th Maximum
El Paso					
Colorado Springs	USAFA Rd. 640	0.081	0.079	0.72	0.70
Manitou Springs	101 Banks Pl.	0.081	0.081	0.69	0.66

Figure 30 - Southern Front Range Ozone Graph

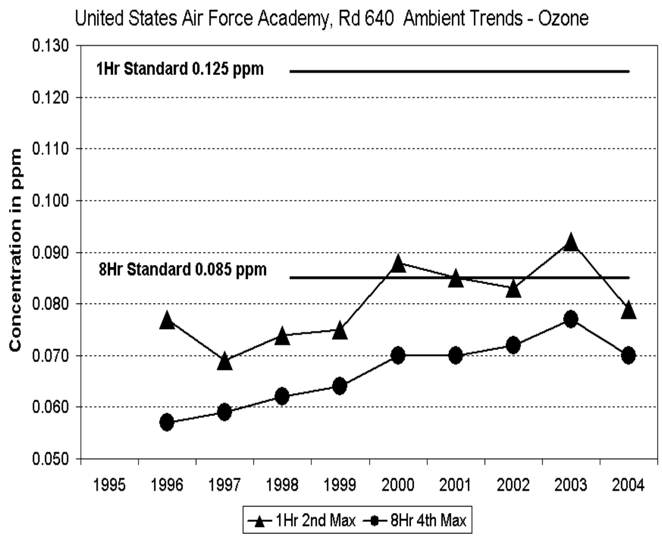
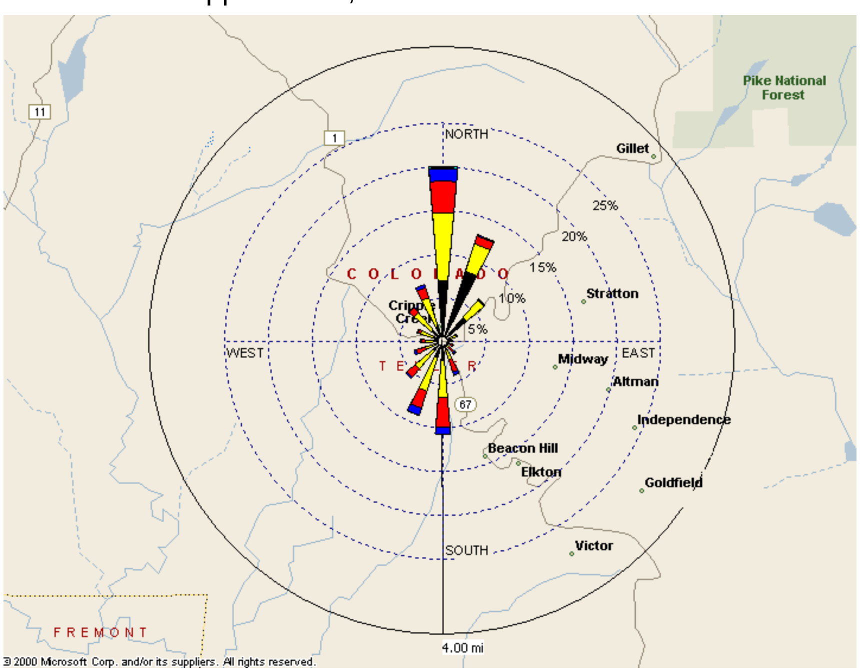


Figure 31 - Southern Front Range Wind Rose
Cripple Creek, Warren Ave. & 2nd St.



6.4 Mountain Communities

The Mountain Communities 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 Silverthorne and Breckenridge in the I-70 corridor, Aspen, Leadville, Crested Butte, Mt. Crested Butte and Gunnison in the central mountains to Telluride in the southwest.

Table 35 - Mountain Communities Monitors In Operation For 2004
X - Monitors continued in 2004 A – Monitors added in 2004
D – Monitors discontinued in 2004 H – Hourly particulate monitor

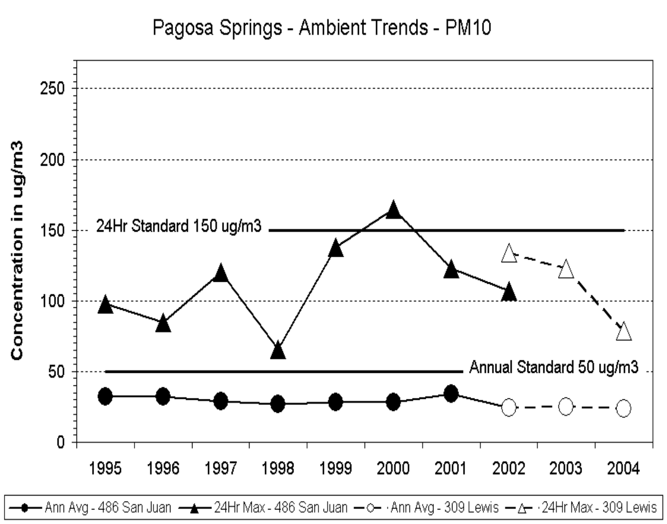
Site Name	Location	TSP	Pb	PM_{10}	$PM_{2.5}$	Met
Archuleta						
Pagosa Springs	309 Lewis St.			X	X	
Gunnison						
Crested Butte	Colo. 135 & Whiterock			X		
Mt. Crested Butte	9 Emmons Loop			X	X	
Gunnison	211 Wisconsin Ave.			X		
Lake						
Leadville	510 Harrison St.	X	X			
Pitkin						
Aspen	120 Mill St.			X/H		
Routt						
Steamboat Springs	136 6th St.			X	X	
	137 10th St.					X
San Miguel						
Telluride	333 W. Colorado Ave.			X	X	
Summit						
Breckenridge	County Justice Center			X		

Table 36 - Mountain Communities Particulate Values For 2004

Site Name	Location	PM_{10} ($\mu g/m^3$)		$PM_{2.5}$ ($\mu g/m^3$)	
		Annual Average	24-Hr Maximum	Annual Average	24-Hr Maximum
Archuleta					
Pagosa Springs	309 Lewis St.	23.4	79	5.72	14.5
Gunnison					
Crested Butte	Colo. 135 & Whiterock	24.6	83		
Mt. Crested Butte	9 Emmons Loop	24.6	129	5.53	23.0
Gunnison	211 Wisconsin Ave.	15.5	61		
Pitkin					
Aspen	120 Mill St.	(17.9)	65		
	(Continuous sampler)	17.2	48		
Routt					
Steamboat Springs	136 6th St.	22.5	94	(7.48)	27.8
San Miguel					
Telluride	333 W. Colorado Ave.	17.6	72	(4.55)	10.3
Summit					
Breckenridge	County Justice Center	(16.7)	82		

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

Figure 32 - Mountain Communities PM_{10} Particulate Graphs



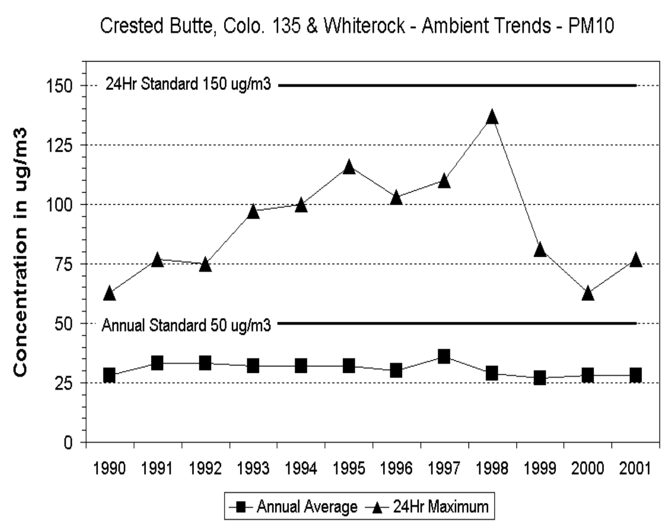
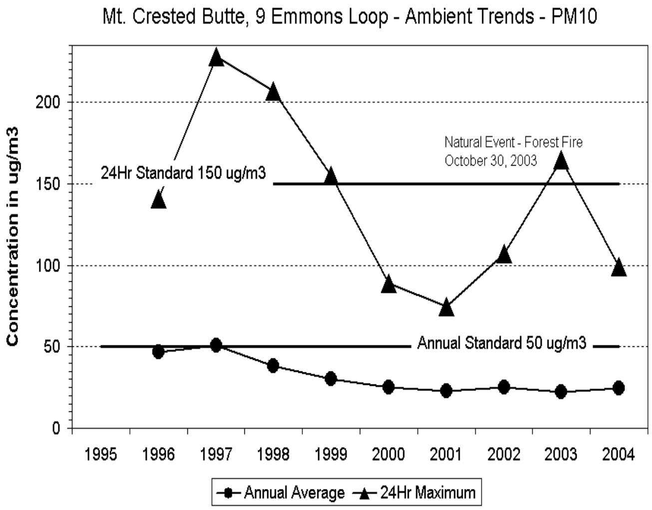
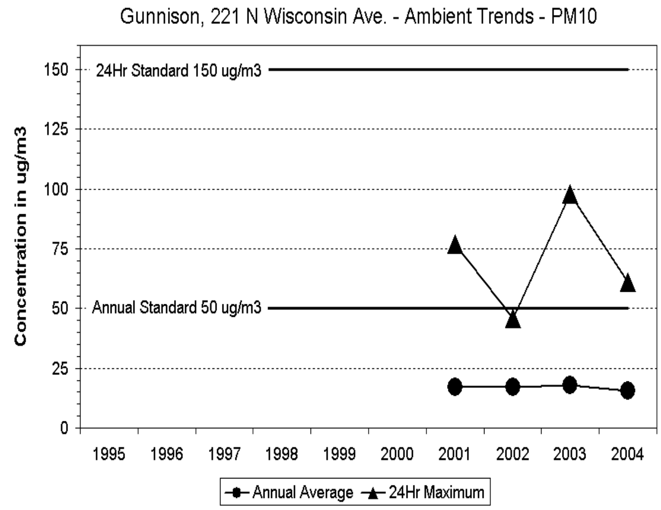
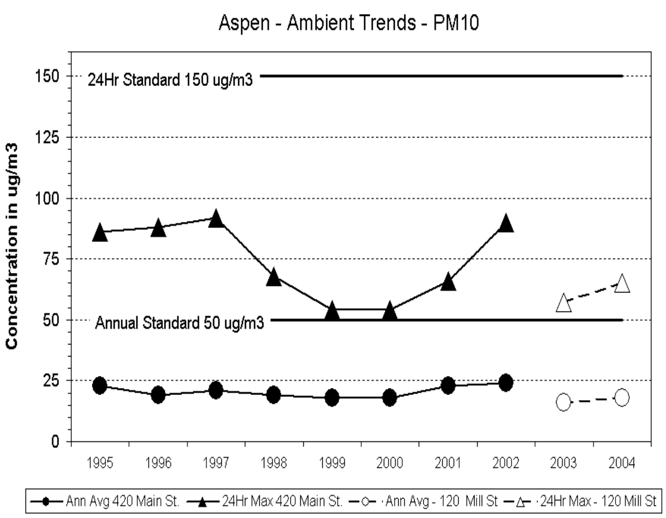
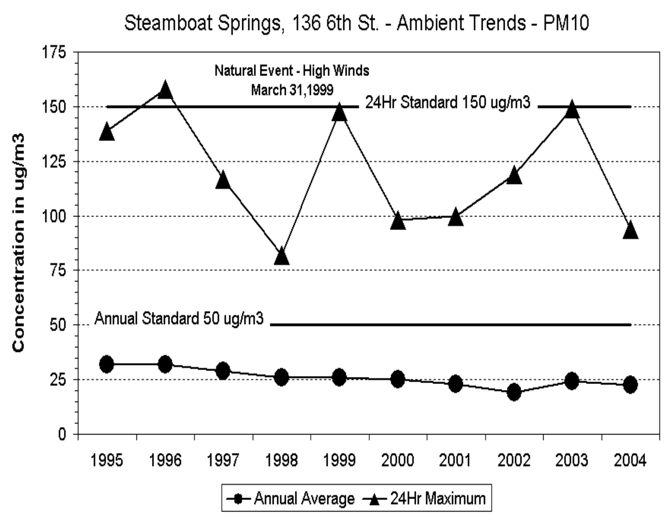


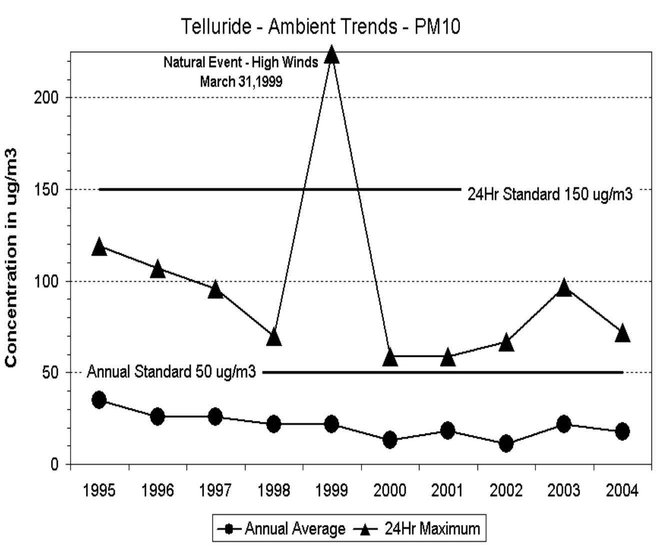
Figure 32 - Mountain Communities PM_{10} Particulate Graphs (continued)











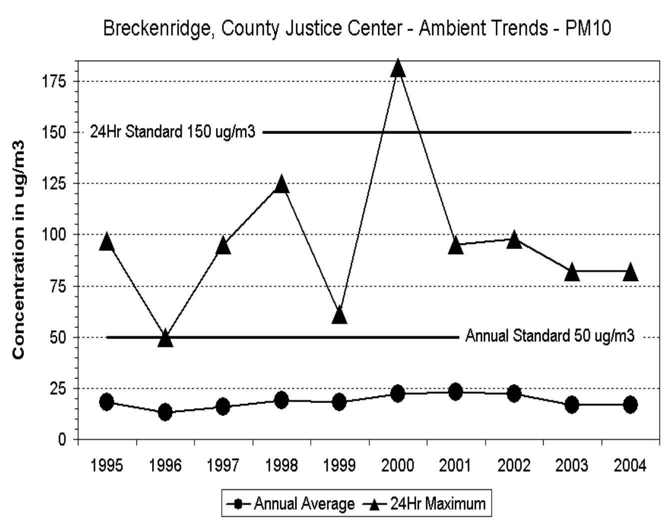


Figure 33 - Mountain Communities $PM_{2.5}$ Particulate Graphs

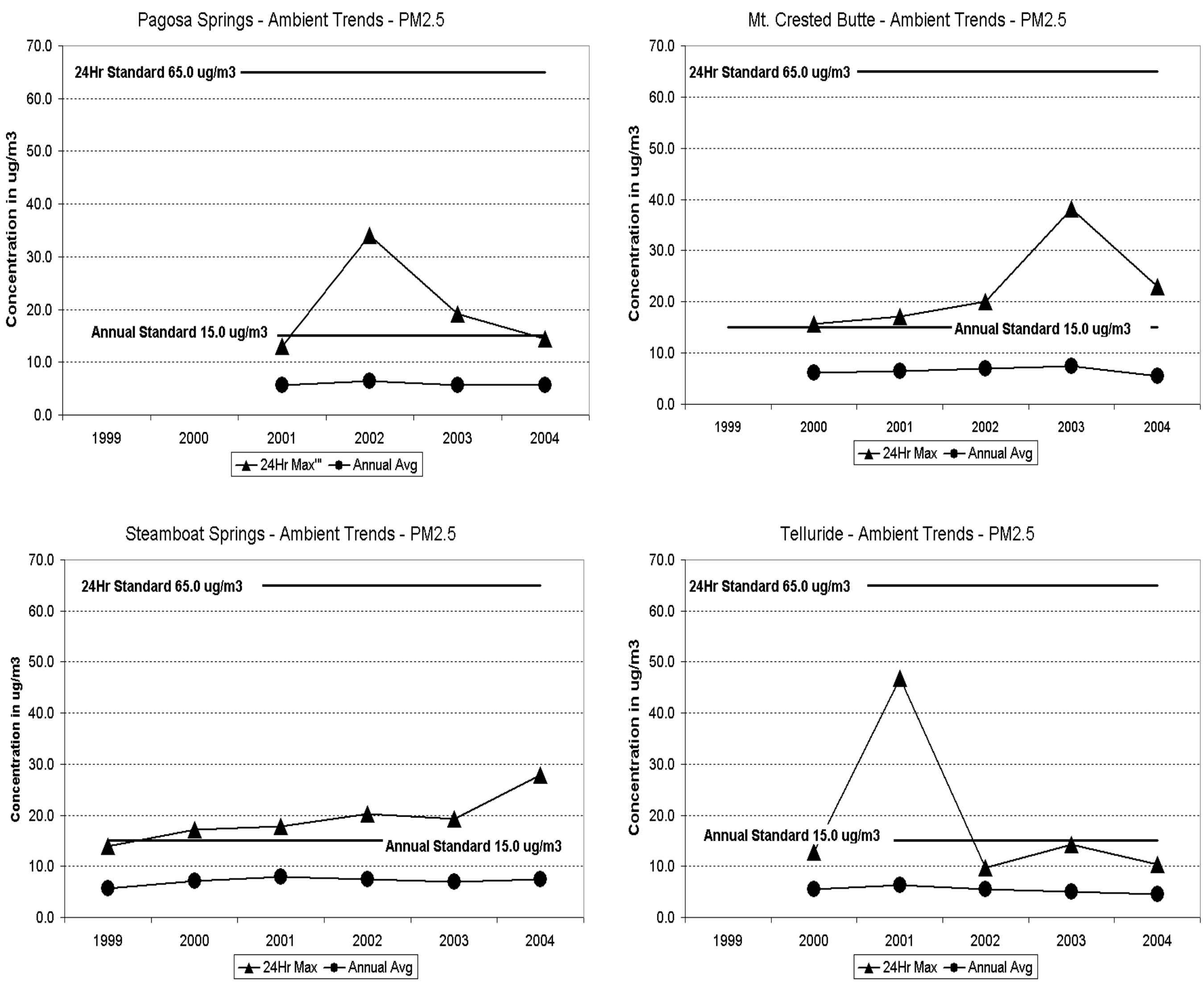


Table 37 - Mountain Communities TSP and Lead Concentrations For 2004

Site Name	Location	TSP (µg/m³)		Lead (µg/m³)	
		24-Hr Maximum	Annual Geometric Mean	Maximum Quarter	24-Hr Maximum
Lake					
Leadville	510 Harrison St.	70	30.9	0.02	0.05

Figure 34 - Mountain Communities Lead Graphs

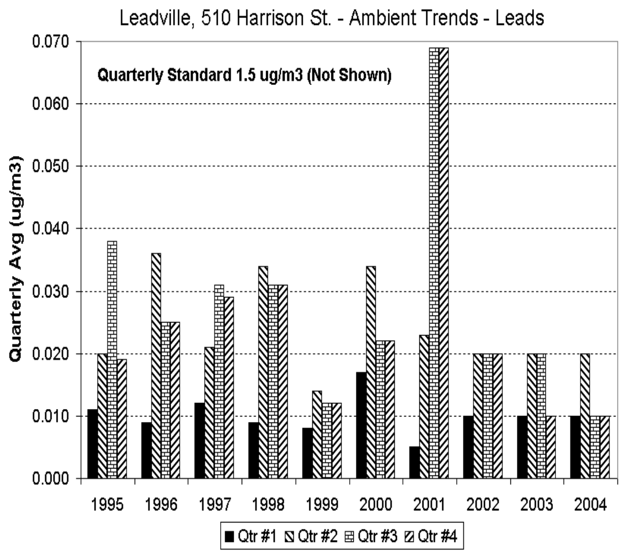
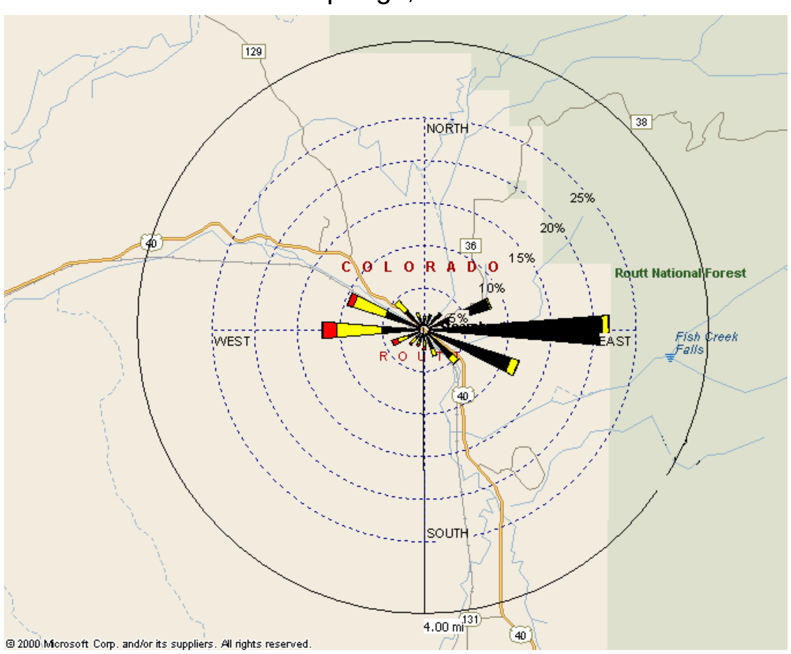


Figure 35 - Mountain Communities Wind Roses

Steamboat Springs, 137 10th St.



6.5 Western Communities

The Western Communities 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 and Pagosa Springs.

Table 38 - Western Communities Monitors In Operation For 2004
X - Monitors continued in 2004 A – Monitors added in 2004
D – Monitors discontinued in 2004 H – Hourly particulate monitor

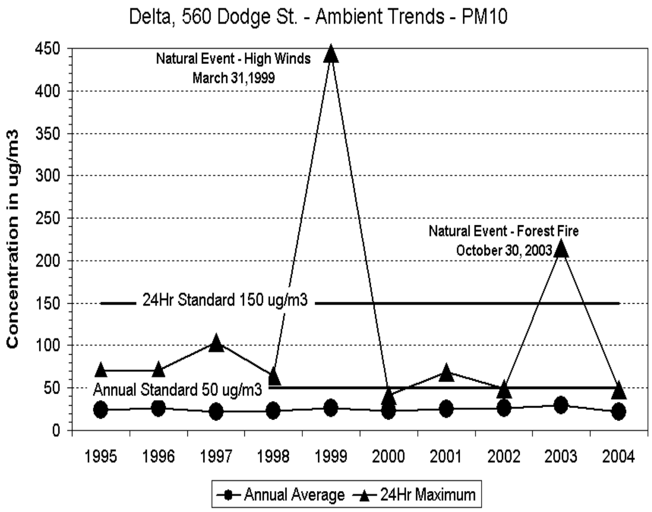
Site Name	Location	CO	PM_{10}	$PM_{2.5}$	Met
Delta					
Delta	560 Dodge St.		X	X	
Garfield					
Parachute	100 E. 2nd Ave.		X		
La Plata					
Durango	1060 2nd Ave.		X		
	623 E. 5th St.		D		
	56 Davidson Creek Rd.		A		
	1235 Camino Del Rio		X		
	1455 S. Camino del Rio		X		
	117 Cutler Dr.		X		
Mesa					
Grand Junction	650 South Ave.		X	X	
	645 ¼ Pitkin Ave.	A	A/H		A

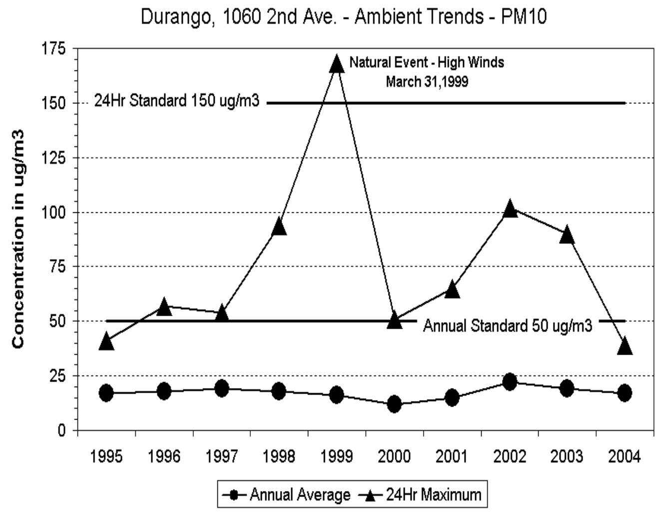
Table 39 - Western Communities Particulate Values For 2004

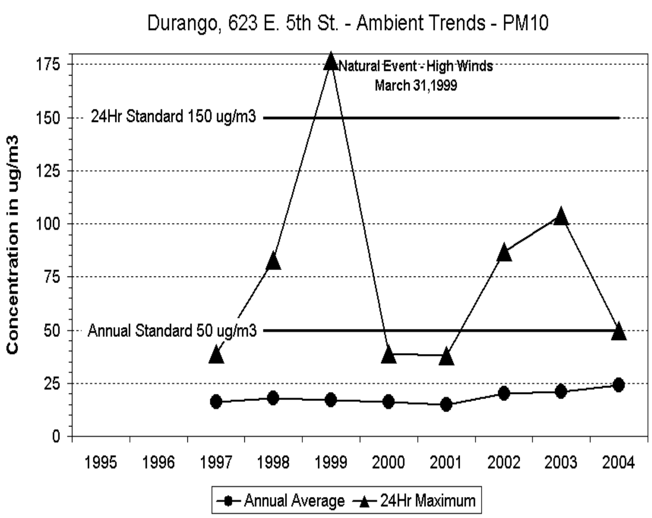
Site Name	Location	PM_{10} (μg/m³)		$PM_{2.5}$ (μg/m³)	
		Annual Average	24-Hr Maximum	Annual Average	24-Hr Maximum
Delta					
Delta	560 Dodge St.	22.1	48	7.81	31.2
Garfield					
Parachute	100 E. 2nd Ave.	(22.1)	61		
La Plata					
Durango	1060 2nd Ave.	16.9	40		
	623 E. 5th St.	(24.0)	50		
	56 Davidson Creek Rd.	(18.2)	39		
	1235 Camino Del Rio	20.1	46		
	1455 S. Camino del Rio	19.3	51		
	117 Cutler Dr.	(15.0)	39		
Mesa					
Grand Junction	650 South Ave.	29.0	102	10.42	36.3
(Continuous Monitor)	645 ¼ Pitkin Ave.	(29.6)	78		

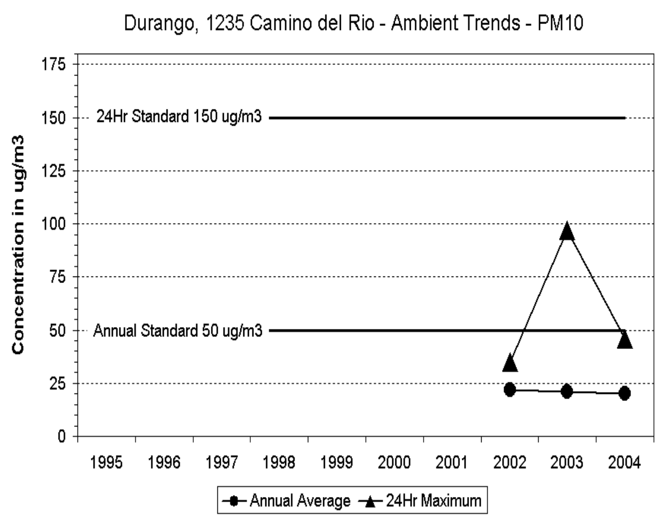
() Indicates less than 75% data for one or more quarters.

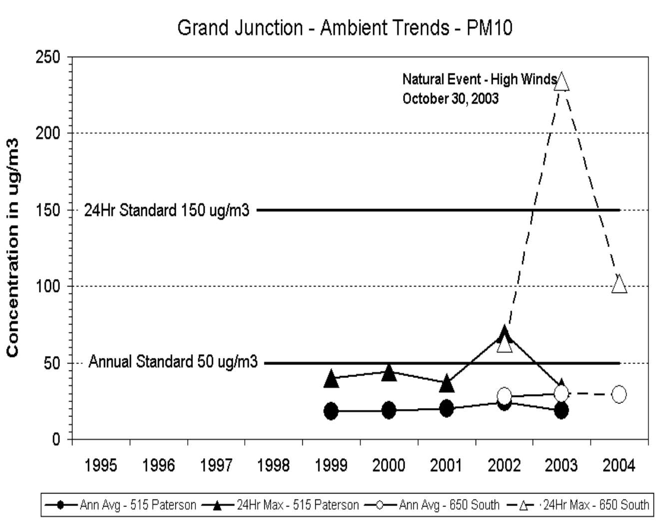
Figure 36 - Western Communities PM_{10} Particulate Graphs











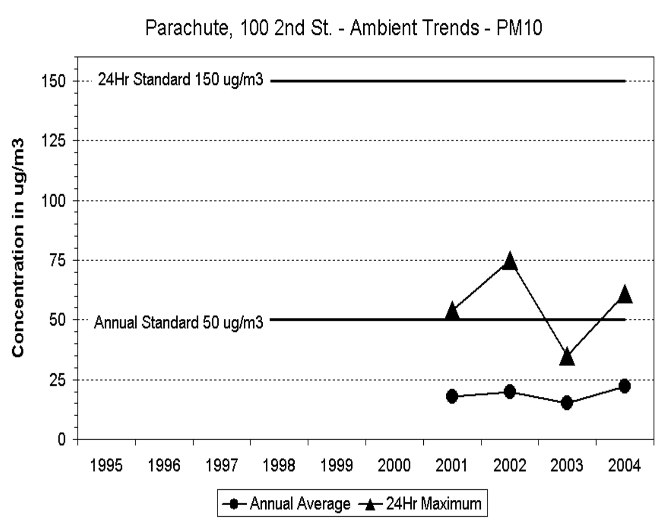


Figure 37 - Western Communities $PM_{2.5}$ Particulate Graph

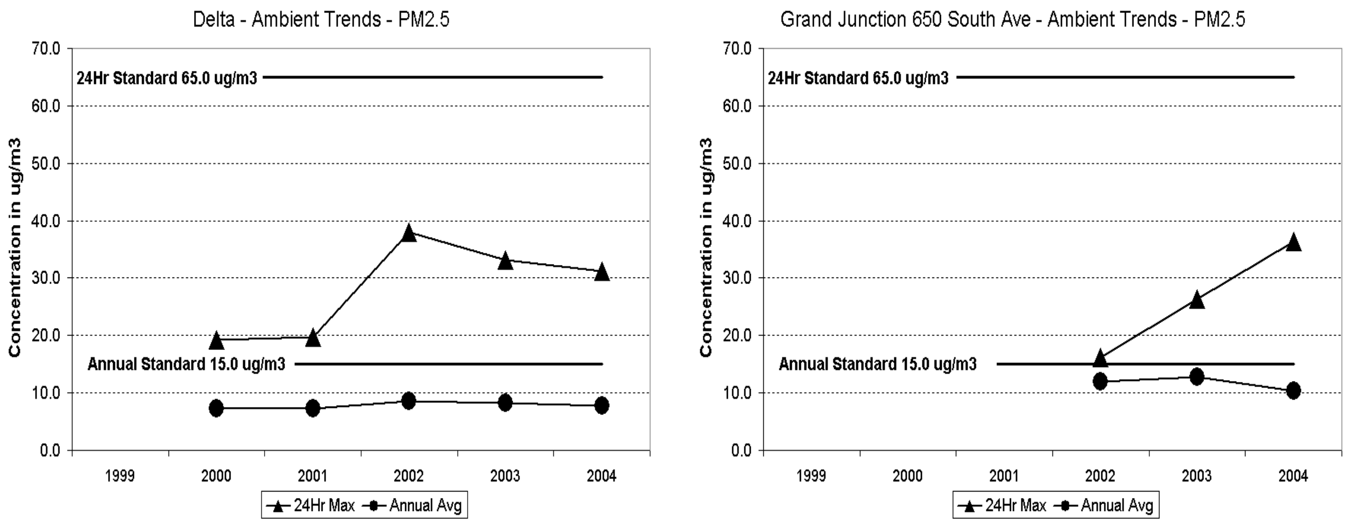


Table 40 - Western Communities Carbon Monoxide Values For 2004

Site Name	Location	CO 1-hour Avg. (ppm)		CO 8-hour Avg. (ppm)	
		Maximum	2nd Maximum	Maximum	2nd Maximum
Mesa					
Grand Junction	645 ¼ Pitkin Ave.	3.9	3.7	2.1	2.1

Figure 38 - Western Communities Carbon Monoxide

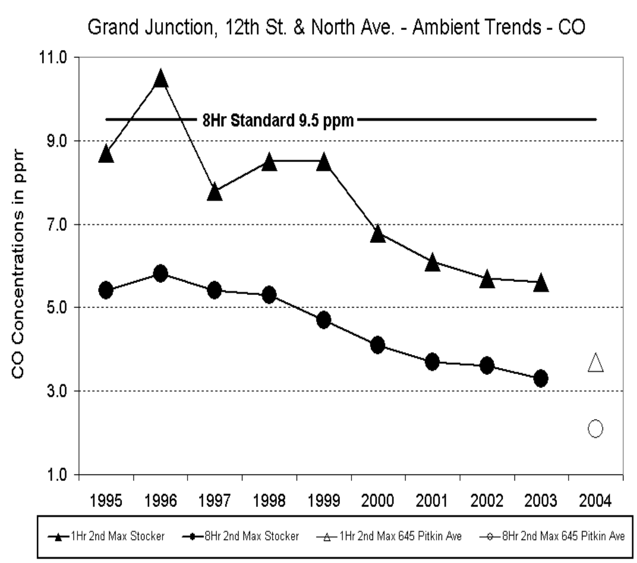
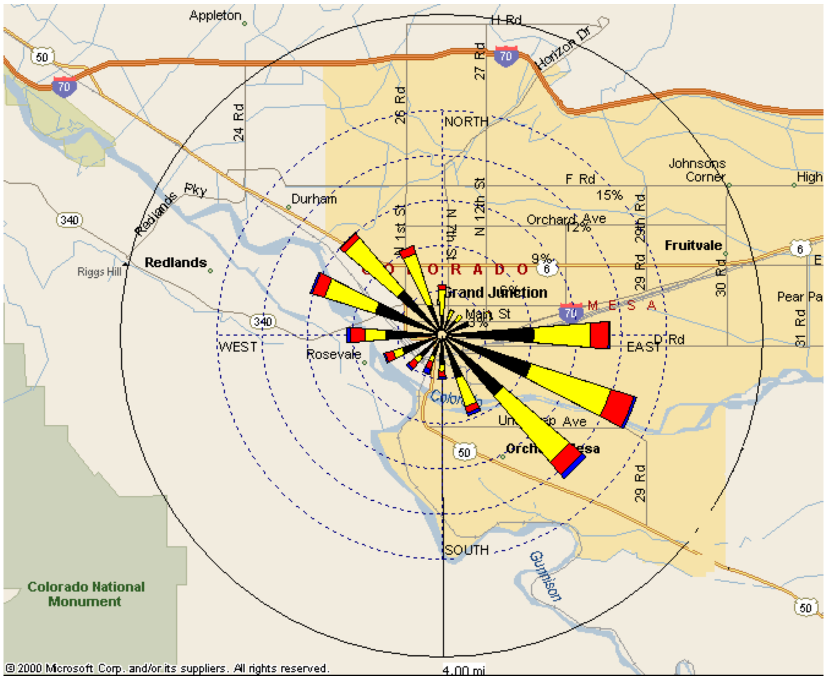


Figure 39 - Western Communities Wind Roses
Grand Junction, 645 ¼ Pitkin Ave.



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