COLORADO

Air Pollution Control Division

Department of Public Health & Environment

Technical Services Program

2024 Air Quality Data Report

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Colorado
Air Quality
Data Report

2024

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Glossary of Terms

AADT	Annual Average Daily Traffic
APCD	Air Pollution Control Division
AQS	Air Quality System (EPA database)
BLM	Bureau of Land Management
CAMP	Continuous Air Monitoring Program
CAQCC	Colorado Air Quality Control Commission
CDOT	Colorado Department of Transportation
CDPHE	Colorado Department of Public Health and Environment
CFR	Code of Federal Regulations
CO	Carbon monoxide
CV	Coefficient of Variation
DQO	Data Quality Objective
EPA	U.S. Environmental Protection Agency
IMPROVE	Interagency Monitoring of Protected Visual Environments
MSA	Metropolitan Statistical Area
NAAQS	National Ambient Air Quality Standards
NO	Nitric oxide
NO_2	Nitrogen dioxide
NO_x	Oxides of nitrogen
NO_y	Total reactive nitrogen
NPS	National Park Service
O_3	Ozone
Pb	Lead
$PM_{2.5}$	Particulate matter with an equivalent diameter less than or equal to 2.5 micrometers
PM_{10}	Particulate matter with an equivalent diameter less than or equal to 10 micrometers
ppb	Parts per billion (one part in 109)
ppm	Parts per million (one part in 106)
PM	Particulate Matter
QA/QC	Quality Assurance/Quality Control
RAQC	Regional Air Quality Council
RAVI	Reasonably Attributable Visibility Impairment
SIP	State Implementation Plan
SLAMS	State or Local Air Monitoring Stations
SO_2	Sulfur dioxide
SPM	Special Purpose Monitor
STN	Speciation Trends Network
TSP	Total Suspended Particulates
µg	Microgram (10^{-6} grams)
USFS	U.S. Forest Service
VOC	Volatile Organic Compound

1. Introduction

The Air Pollution Control Division (APCD) of the Colorado Department of Public Health and Environment (CDPHE) has prepared the 2024 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 historical trends in air quality and includes a detailed examination of the monitoring data collected by APCD in 2024. The Report to the Public discusses the policies and programs designed to improve and protect Colorado's air quality.

1.1. Overview of the Colorado Air Monitoring Network

APCD conducted air quality and meteorological monitoring operations at 45 locations statewide during 2024. Ozone (O_3) and particulate matter (PM) monitors, including those for particulate matter less than 10 µm in diameter (PM_{10}) and particulate matter less than 2.5 µm in diameter ($PM_{2.5}$), are the most abundant and widespread monitors in the network. During 2024, there were PM_{10} monitors at 15 locations, $PM_{2.5}$ monitors at 21 locations, O_3 monitors at 24 locations, carbon monoxide (CO) monitors at five locations, nitrogen dioxide (NO_2) monitors at nine locations, and sulfur dioxide (SO_2) monitors at three locations. APCD also operated 17 meteorological sites statewide for the continuous measurement of wind speed, wind direction, temperature, and other various meteorological parameters. A map of APCD air quality stations is shown in Figure 1.2 and the parameters monitored at each location are given in Table 1.1.

1.1.1. APCD Monitoring History

The State of Colorado has been monitoring air quality statewide since the mid-1960s when high volume and tape particulate samplers, dustfall buckets, and sulfation candles were the state of the art for defining the magnitude and extent of the very visible air pollution problem. Monitoring for gaseous pollutants (CO, SO_2, NO_2, and O_3) began in 1965 when the federal government established the CAMP monitoring station in downtown Denver at the intersection of 21st Street and Broadway, which was the area that was thought at the time to represent the best site for detecting maximum levels of most of the pollutants of concern. Instruments were primitive by comparison with those of today and were frequently out of service. Under provisions of the original Federal Clean Air Act of 1970, the Administrator of the U.S. EPA established National Ambient Air Quality Standards (NAAQS) designed to protect the public's health and welfare. Standards were set for total suspended particulates (TSP), CO, SO_2, NO_2, and O_3. In 1972, the first State Implementation Plan (SIP) was submitted to the EPA. It included an air quality surveillance system in accordance with EPA regulations of August 1971. That plan proposed a monitoring network of 100 monitors (particulate and gaseous) statewide. The system established as a result of that plan and subsequent modifications consisted of 106 monitors. The 1977 Clean Air Act Amendments required States to submit revised SIPs to the EPA by January 1, 1979. The portion of the Colorado SIP pertaining to air monitoring was submitted separately on December 14, 1979, after a comprehensive review, and upon approval by the Colorado Air Quality Control Commission. The 1979 EPA requirements as set forth in 40 CFR 58.20 have resulted in considerable modification to the network. These and subsequent modifications were made to ensure consistency and compliance with Federal monitoring requirements. Station location, probe siting, sampling methodology, quality assurance practices, and data handling procedures are all maintained throughout any changes made to the network.

1.1.2. Description of Monitoring Regions in Colorado

The state has been divided into eight multi-county areas that are generally based on topography and have similar airshed characteristics. These areas are the Central Mountains, Denver Metro/North Front Range, Eastern High Plains, Pikes Peak, San Luis Valley, South Central, Southwestern, and Western Slope regions. Figure 1.1 shows the approximate boundaries of these regions.

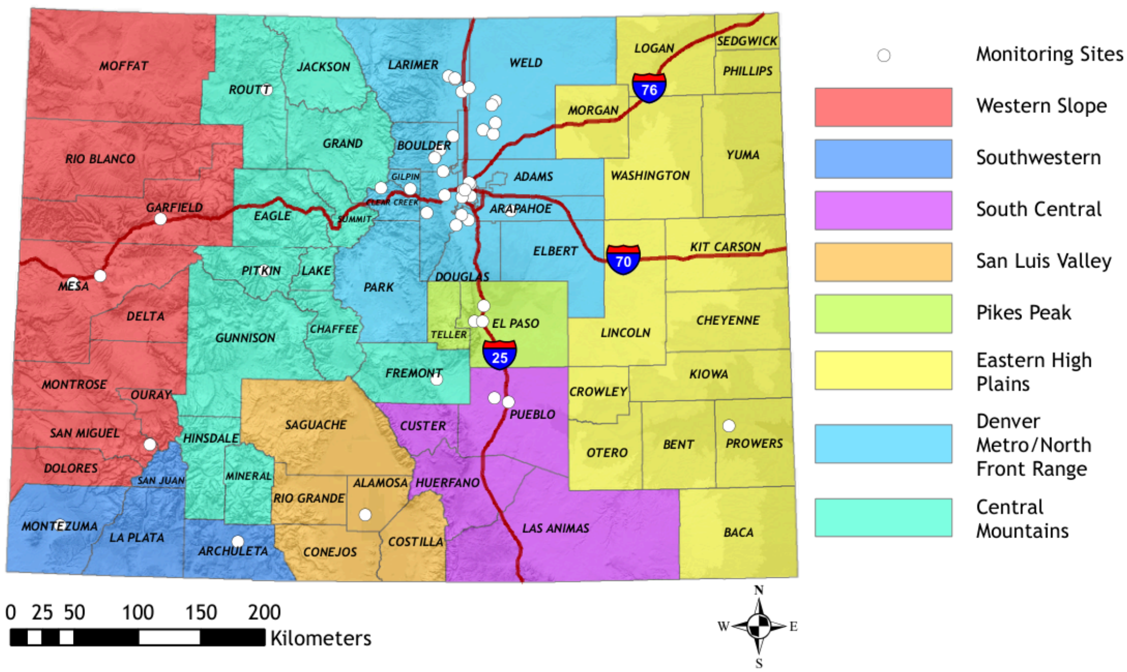

Figure 1.1: Counties and multi-county monitoring regions discussed in this report.

1.1.2.1. Central Mountains Region

The Central Mountains region consists of 12 counties in the central area of the state. The Continental Divide passes through much of this region. Mountains and mountain valleys are the dominant landscape features. Leadville, Steamboat Springs, Cañon City, Salida, Buena Vista, and Aspen represent the larger communities. The population of this region is approximately 245,763, according to the 2020 U.S. Census. Skiing, tourism, ranching, mining, and correctional facilities are the primary industries. The Black Canyon of the Gunnison National Park is located in this region. The primary monitoring concern in this region is centered around particulate pollution from wood burning and road dust. During 2024, there were three particulate monitoring sites operated by APCD in the Central Mountains region. APCD also operates an O_3 monitor at the high-elevation Mines Peak monitoring site. While technically located in Clear Creek County (and therefore in the Denver Metro / North Front Range Region), this site is on the border of Grand County at an elevation of over 12,000 ft., and reports O_3 data representative of the greater Central Mountains Region. Due to difficulties controlling the internal temperature of the

Mines Peak shelter, this site is not considered a regulatory site for O_3. All of this region complies with federal air quality standards.

1.1.2.2. Denver Metro / North Front Range Region

The Denver Metro/North Front Range region includes Adams, Arapahoe, Boulder, Broomfield, Clear Creek, Denver, Douglas, Elbert, Gilpin, Jefferson, Larimer, Park, and Weld counties. This 13 county region comprises the largest population base in the state of Colorado with approximately 4,143,171 people living in the area, according to the 2020 U.S. Census. This region includes Rocky Mountain National Park and several other wilderness areas. Since 2002, the region has complied with all National Ambient Air Quality Standards, except for ozone. The area has been exceeding the EPA's ozone standards since the early 2000s, and in 2007 was formally designated as a “nonattainment” area. This designation was re-affirmed in 2012 when the EPA designated the region as a “marginal” nonattainment area after a more stringent ozone standard was adopted in 2008. In 2015, the EPA reviewed criteria for ozone and related photochemical oxidants and revised the primary and secondary 8 hour ozone standards further downward to a level of 0.070 parts per million (ppm). In June 2018, EPA classified the region as a “marginal" nonattainment area for the 2015 8-hour ozone standard, effective August 3, 2018. The attainment deadline for the 2015 standard was August 3, 2021, based on 2018-2020 ozone season data. In January 2020, EPA classified the region as a “serious" nonattainment area under the 2008 ozone standard. The attainment deadline for the 2008 standard was July 20, 2021, based on 2018-2020 ozone season data. In 2022, EPA classified the region as a “severe” nonattainment area for the 2008 8-hour O_3 standard.

In the past, the Denver-metropolitan area has violated health-based air quality standards for carbon monoxide and fine particles. In response, the Regional Air Quality Council (RAQC), the Colorado Air Quality Control Commission (CAQCC), and APCD developed, adopted, and implemented air quality improvement plans to reduce each of these pollutants. For the rest of the Northern Front Range, Fort Collins, Longmont, and Greeley were nonattainment areas for carbon monoxide in the 1980s and early 1990s, but have met the federal standards since 1995. Air quality improvement plans have been implemented for each of these communities.

During 2024, there were 59 air quality and meteorological monitors at 30 individual sites in the Northern Front Range Region. There were PM_{10} monitors at five locations, $PM_{2.5}$ monitors at 15 locations, O_3 monitors at 18 locations, carbon monoxide (CO) monitors at four locations, nitrogen dioxide (NO_2) monitors at nine locations, and sulfur dioxide (SO_2) monitors at three locations, and 14 meteorological towers. There were also seven air toxics and/or ozone precursor monitoring sites, located at Brighton Fire Station 55, Rocky Flats - N, Missile Site Park (Greeley), Birch Street (Commerce City), Chatfield State Park, and Platteville Middle School. Of the O_3 monitoring sites in the Denver Metro/North Front Range region, 17 recorded exceedances of the 0.070 ppm standard in 2024.

1.1.2.3. Eastern High Plains Region

The Eastern High Plains region encompasses the fifteen counties on the plains of eastern Colorado. The area is semiarid and often windy. The area's population is approximately 134,688, according to the 2020 U.S. Census. Its major population centers have developed around farming, ranching, and trade centers such as Sterling, Fort Morgan, Limon, La Junta, and Lamar. The agricultural base includes both irrigated and dry land farming.

Historically, there have been a number of communities in the Eastern High Plains Region that were monitored for particulates and meteorology but not for any of the gaseous pollutants. In the northeast, along the I-76 corridor, the communities of Sterling, Brush, and Fort Morgan have been monitored. Along the I-70 corridor, only the community of Limon has been monitored for particulates. Along the US-50/Arkansas River corridor, the Division has monitored for particulates in the communities of La Junta and Rocky Ford. These monitoring sites were all discontinued in the late 1970s through early 1990s after a review showed that the concentrations were well below the standards and trending downward. The only sampling site left in operation in this region is a PM monitoring site located in Lamar. The Lamar site recorded a single PM_{10} exceedance in 2023, but recorded no exceedances in 2024.

1.1.2.4. Pikes Peak Region

The Pikes Peak region includes El Paso and Teller counties. The area has a population of approximately 783,027, according to the 2020 U.S. Census. Eastern El Paso County is rural prairie, while the western part of the region is mountainous. The U.S. Government is the largest employer in the area, and major industries include Fort Carson and the U.S. Air Force Academy in Colorado Springs, which are both military installations. Aerospace and technology are also large employers in the area.

One of the O_3 monitors in the region (Manitou Springs) had a 3-year design value in excess of the 0.070 ppm standard in 2024. Manitou Springs recorded a total of 13 O_3 exceedances during 2024, while the other O_3 site in the region (US Air Force Academy) recorded six.

During 2024, there was one CO monitoring site and two O_3 monitoring sites in the Pikes Peak region, as well as one PM_{10} monitoring site and one $PM_{2.5}$ monitoring site. Most of these monitors are located in the populous city of Colorado Springs.

1.1.2.5. San Luis Valley Region

Colorado's San Luis Valley region is located in the south central portion of Colorado and is comprised of a broad alpine valley situated between the Sangre de Cristo Mountains on the northeast and the San Juan Mountains of the Continental Divide to the west. The valley is some 114 km wide and 196 km long, extending south into New Mexico. The average elevation is 2290 meters. Principal towns include Alamosa, Monte Vista, and Del Norte. The population of this area is approximately 46,495, according to the 2020 U.S. Census. Agriculture and tourism are the primary industries. The valley is semiarid and croplands of potatoes, head lettuce, and barley are typically irrigated. The valley is home to Great Sand Dunes National Park.

In 2024, CDPHE operated a single monitoring site in this region, which serves as both a PM_{10} and $PM_{2.5}$ site located in Alamosa. This site began operation on 10/26/2023. All of the area complied with federal air quality standards in 2024.

1.1.2.6. South Central Region

The South Central region is comprised of Pueblo, Huerfano, Las Animas, and Custer counties. Its population is approximately 196,119, according to the 2020 U.S. Census. Population centers include Pueblo, Trinidad, and Walsenburg. The region has rolling semi-arid plains to the east and is mountainous to the west. In 2023, the Pueblo West monitoring site recorded a single O_3 exceedance, while the same site recorded eight O_3 exceedances in 2024. In the past APCD has conducted particulate monitoring in both Walsenburg and Trinidad, but that monitoring was discontinued in 1979 and 1985, respectively, due to low concentrations.

During 2024, there was a single particulate matter monitoring site (both PM_{10} and $PM_{2.5}$) operated in the South Central Region, at a site located in the city of Pueblo. There was also one O_3 monitor and one meteorological tower located in this region during 2024.

1.1.2.7. Southwestern Region

The Southwestern region includes the Four Corners area counties of Montezuma, La Plata, Archuleta, and San Juan. The population of this region is approximately 101,595, according to the 2020 U.S. Census. The landscape includes mountains, plateaus, high valleys, and canyons. Durango and Cortez are the largest towns, while lands of the Southern Ute and Ute Mountain Ute tribes make up large parts of this region. The region is home to Mesa Verde National Park. Tourism and agriculture are the dominant industries, although the oil and gas industry is becoming increasingly important.

During 2024, there was one O_3 monitoring site located in Cortez and one PM_{10} monitoring site located in Pagosa Springs. In 2023, the Pagosa Springs site recorded a single PM_{10} exceedance, but did not record any exceedances in 2024. All of the area currently complies with federal air quality standards.

1.1.2.8. Western Slope Region

The Western Slope region includes nine counties on the far western border of Colorado. A mix of mountains on the east, and mesas, plateaus, valleys, and canyons to the west form the landscape of this region. Grand Junction is the largest urban area, and other cities include Telluride, Montrose, Delta, Rifle, Glenwood Springs, Meeker, Rangely, and Craig. The population of this region is approximately 332,293, according to the 2020 U.S. Census. Primary industries include ranching, agriculture, mining, energy development, and tourism. Dinosaur and Colorado National Monuments are located in this region.

During 2024, there were two O_3 monitoring sites and two meteorological towers operated in the Western Slope Region. There were also two PM_{10} monitoring sites and one $PM_{2.5}$ monitoring site. The Grand Junction Pitkin site also measures air toxics and includes meteorological instrumentation. Both the Rifle Health Department and Palisade Water Treatment O_3 monitoring sites recorded exceedances of the 0.070 ppm standard during 2024.

1.1.3. Monitoring Site Locations and Parameters Monitored

Table 1.1: Summary of parameters monitored at APCD monitoring sites discussed in this report. Detailed site descriptions can be found in Appendix A.

AQS Site Number	Site Name	County	O_3	CO	NO_2	SO_2	PM_{10}	$PM_{2.5}$	Met
08-001-0010	Birch Street	Adams					X	X	
08-001-3001	Welby	Adams	X		X	X	X	X	X
08-003-0001	Alamosa - Adams State (ASC)	Alamosa					X	X	
08-005-0002	Highlands	Arapahoe	X						X
08-005-0005	Arapahoe Community College	Arapahoe						X	
08-005-0006	Aurora East	Arapahoe	X						X
08-007-0001	Pagosa Springs School	Archuleta					X		
08-013-0003	Longmont - Municipal Bldg.	Boulder					X	X	
08-013-0014	Boulder Reservoir	Boulder	X						X
08-013-1001	Boulder - CU - Athens	Boulder					X	X	
08-019-0006	Mines Peak	Clear Creek	X						
08-031-0002	CAMP	Denver	X		X	X		X	
08-031-0013	National Jewish Health (NJH)	Denver						X	
08-031-0026	La Casa	Denver	X	X	X	X	X	X	X
08-031-0027	I-25: Denver	Denver		X	X			X	X
08-031-0028	I-25: Globeville	Denver			X			X	X
08-035-0004	Chatfield State Park	Douglas	X					X	X
08-041-0013	U.S. Air Force Academy (USAFA)	El Paso	X						
08-041-0016	Manitou Springs	El Paso	X						
08-041-0017	Colorado College	El Paso		X			X	X	
08-043-0003	Cañon City - City Hall	Fremont					X		
08-045-0012	Rifle - Health Dept	Garfield	X						
08-047-0003	Black Hawk	Gilpin	X						
08-059-0006	Rocky Flats - N	Jefferson	X		X				X
08-059-0011	NREL	Jefferson	X						
08-059-0014	Evergreen	Jefferson	X						X
08-069-0009	Fort Collins - CSU - Edison	Larimer						X	
08-069-0011	Fort Collins - West	Larimer	X						X
08-069-0015	Fossil Creek	Larimer	X		X				X
08-069-0016	Bethke	Larimer	X		X			X	
08-069-1004	Fort Collins - CSU - Mason	Larimer	X	X					X
08-077-0017	Grand Junction - Powell Bldg.	Mesa					X	X	
08-077-0018	Grand Junction - Pitkin	Mesa							X
08-077-0020	Palisade - Water Treatment	Mesa	X						X
08-083-0006	Cortez - Health Dept.	Montezuma	X						
08-097-0008	Aspen	Pitkin					X	X	
08-099-0002	Lamar Municipal Bldg.	Prowers					X	X	
08-101-0015	Pueblo - Fountain School	Pueblo					X	X	
08-101-0016	Pueblo West	Pueblo	X						X
08-107-0003	Steamboat Springs	Routt					X		
08-113-0004	Telluride	San Miguel					X		
08-123-0006	Greeley - Hospital	Weld						X	
08-123-0008	Platteville - Middle School	Weld						X	
08-123-0009	Greeley - Weld County Tower	Weld	X	X					X
08-123-0015	La Salle	Weld	X		X				

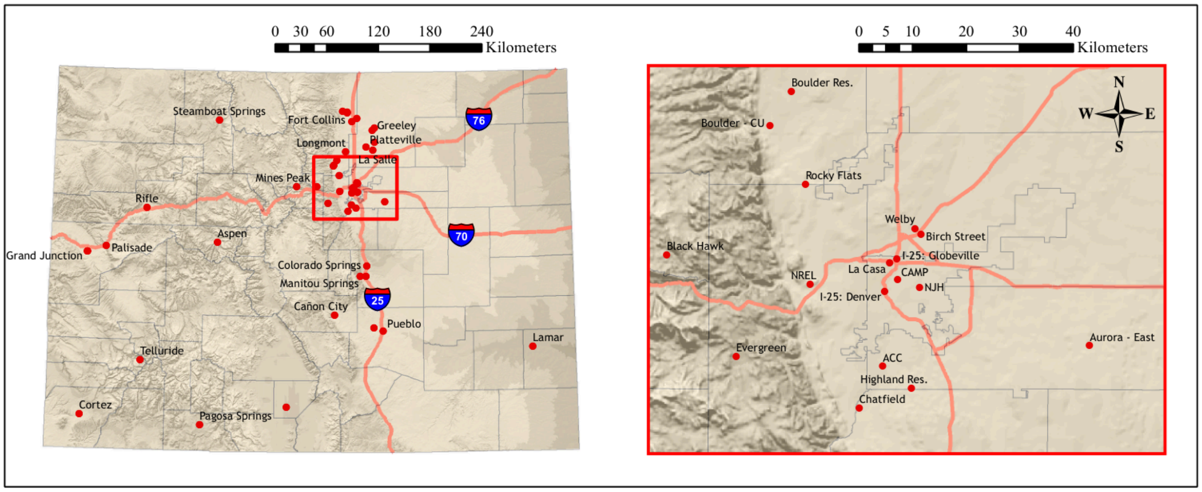

Figure 1.2: Map of Colorado with an inset map of the Denver metropolitan area showing the location of all monitoring sites operated by APCD and listed in Table 1.1. For the purpose of improving the readability of the map, labels for monitoring sites in Fort Collins, Grand Junction, Pueblo, and Colorado Springs have been combined under a single label. Detailed site information, including AQS identification numbers, site descriptions and histories, addresses and coordinates, monitoring start dates, site elevations, site orientation/scale designations, etc., can be found in Appendix A.

2. Criteria Pollutants

Criteria pollutants are those for which the federal government has established National Ambient Air Quality Standards in the Federal Clean Air Act and its amendments. There are six criteria pollutants: carbon monoxide (CO), ozone (O_3), sulfur dioxide (SO_2), nitrogen dioxide (NO_2), lead (Pb), and particulate matter, which is currently split into PM_{10} and $PM_{2.5}$ size fractions. Standards for criteria pollutants are established to protect the most sensitive members of society. These are usually defined as those with heart and/or respiratory problems, the very young, and the elderly. The standards for each of the criteria pollutants are discussed in the following sections. A summary of these levels, as they existed through most of 2024, are presented in Table 2.1. The primary standards are set to protect human health. The secondary standards are set to protect public welfare, and take into consideration such factors as crop damage, architectural damage, damage to ecosystems, and visibility in scenic areas.

In 2015, based on an EPA review of O_3 health effects studies, EPA revised the level of both the primary and secondary standards. EPA revised the primary and secondary ozone standard levels to 0.070 parts per million (ppm), and retained their forms (fourth-highest daily maximum, averaged across three consecutive years) and averaging times (eight hours). The final rulemaking was effective on October 26th 2015. In 2024, EPA also revised both the $PM_{2.5}$ primary standard and the SO_2 secondary standard. These changes are discussed in the following sections for the respective pollutants.

Due to low measured concentrations over the last decade, the APCD has not operated lead monitors in recent years. Historic trends data are available in data reports from previous years.[1]

2.1. Summary of Exceedances

Table 2.2 is a summary of those APCD sites that have recorded exceedances of the ambient air quality standards in the last two years, with the number of days of measured exceedances listed. An exceedance of a NAAQS is defined in 40 CFR 50.1 as “one occurrence of a measured or modeled concentration that exceeds the specified concentration level of such standard for the averaging period specified by the standard.” A violation of the NAAQS consists of one or more exceedances of a NAAQS. The precise number of exceedances necessary to cause a violation depend on the form of the standard and other factors, including data quality, defined in federal rules such as 40 CFR 50. Exceedances that have been flagged by the Division as exceptional events are shown in parentheses in Table 2.2. See subsubsection 2.2.5.4 for an explanation of exceptional events.

[1] https://www.colorado.gov/airquality/tech_doc_repository.aspx

Table 2.1: National Ambient Air Quality Standards (NAAQS) for criteria pollutants.

Pollutant	Primary / Secondary	Averaging Time	Level	Form
Carbon Monoxide (CO)	Primary	8-hr	9 ppm	Not to be exceeded more than once per year
		1-hr	35 ppm	
Nitrogen Dioxide (NO_2)	Primary	1-hr	100 ppb	98th percentile of 1-hour daily maximum concentrations, averaged over three years
	Primary and Secondary	Annual	53 ppb	Annual mean
Sulfur Dioxide (SO_2)	Primary	1-hr	75 ppb	99th percentile of 1-hour daily maximum concentrations, averaged over three years
	Secondary	3-hr	500 ppb	Not to be exceeded more than once per year
Ozone (O_3)	Primary and Secondary	8-hr	0.070 ppm	Annual fourth-highest daily maximum 8-hr concentration, averaged over three years
PM_{10}	Primary and Secondary	24-hr	150 $\mu g\ m^{-3}$	Not to be exceeded more than once per year on average over three years
$PM_{2.5}$	Primary	Annual	12 $\mu g\ m^{-3}$	Annual mean, averaged over three years
	Secondary	Annual	15 $\mu g\ m^{-3}$	Annual mean, averaged over three years
	Primary and Secondary	24-hr	35 $\mu g\ m^{-3}$	98th percentile, averaged over three years

Table 2.2: Exceedance summary table for APCD monitoring sites showing the number of days in exceedance for O_3, PM_{10}, and $PM_{2.5}$ in 2023 and 2024. Data in the table may include exceptional events. Exceptional events are periods of high pollutant concentrations that cannot reasonably be prevented using typical air pollution control strategies

AQS Site Number	Site Name	2023			2024		
		O_3	PM_{10}	$PM_{2.5}$	O_3	PM_{10}	$PM_{2.5}$
08-001-3001	Welby	2			22		
08-005-0002	Highlands	8			6		
08-005-0006	Aurora East	4			16		
08-007-0001	Pagosa Springs School		1				
08-013-0014	Boulder Reservoir	4			10		
08-031-0002	CAMP	3			16		
08-031-0026	La Casa	3			28		
08-035-0004	Chatfield State Park	13			24		
08-041-0013	U.S. Air Force Academy (USAFA)				6		
08-041-0016	Manitou Springs				13		
08-045-0012	Rifle - Health Dept				1		
08-047-0003	Black Hawk	4			12		
08-059-0006	Rocky Flats - N	10			25		
08-059-0011	NREL	11			26		
08-059-0014	Evergreen	8			21		
08-069-0011	Fort Collins - West	5			18		
08-069-0015	Fossil Creek				18		
08-069-0016	Bethke				12		
08-069-1004	Fort Collins - Mason	1			16		
08-077-0020	Palisade - Water Treatment				3		
08-099-0002	Lamar Municipal Bldg.		1				
08-101-0016	Pueblo West	1			8		
08-123-0009	Greeley - Weld County Tower	1			18		
08-123-0015	La Salle				15		

2.2. General Statistics for Criteria Pollutants

In this section, historical trends in ambient pollutant concentrations are illustrated using NAAQS standard values measured throughout Colorado in each year. This comparison is for reference only as the NAAQS apply only over the averaging periods shown in Table 2.1 (typically a three-year period). Subsequent sections of this report include an evaluation of the concentrations of each pollutant in a manner directly comparable to the NAAQS.

2.2.1. Carbon Monoxide

CO is a colorless and odorless gas formed when carbon compounds in fuel undergo incomplete combustion. The majority of CO emissions to ambient air originate from mobile sources (i.e., transportation), particularly in urban areas, where as much as 85% of all CO emissions may come from automobile exhaust. CO can cause harmful health effects by reducing oxygen delivery to the body's organs and tissues. High concentrations of CO generally occur in areas with heavy traffic congestion. In Colorado, peak CO concentrations typically occur during the colder months of the year when CO automotive emissions are highest and nighttime temperature inversions are more frequent.[2] The National Emissions Inventory[3] estimates that 31% of CO emissions are from highway vehicle sources. They also estimate that off-highway transportation sources, including all off-road mobile sources that use gasoline, diesel, and other fuels, contribute an additional 22% of emissions, making transportation approximately 53% of the total CO emissions nationwide. Figure 2.1 illustrates the trend of national CO emissions from 1970 through 2023.

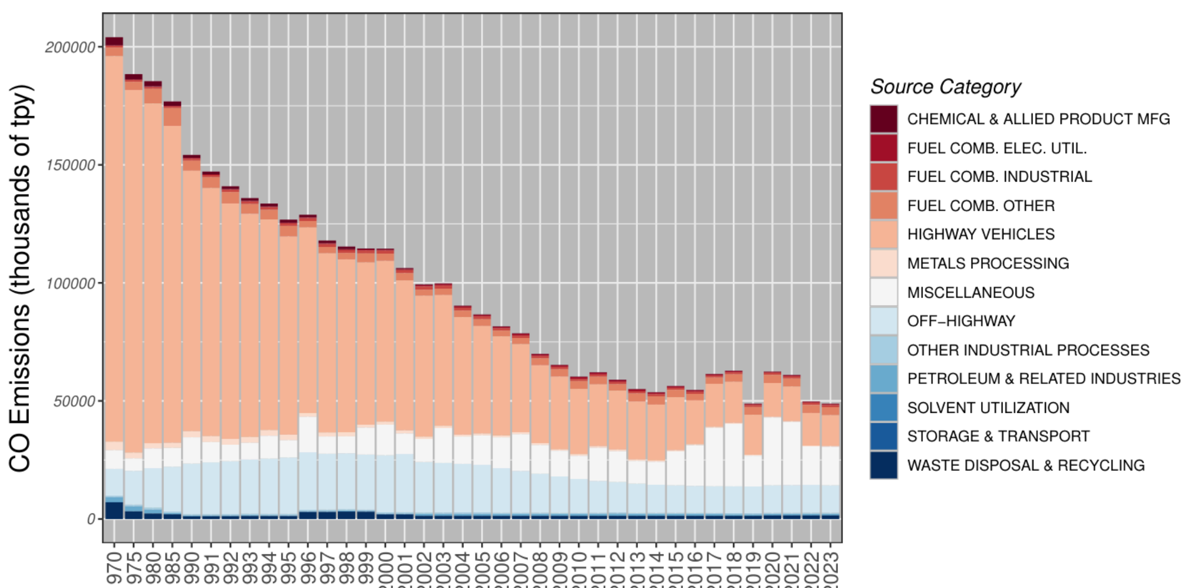

Figure 2.1: Trends in national carbon monoxide emissions from 1970 to 2023. Data was sourced from the 2020 National Emissions Inventory.

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[2] Reddy, P. J., Barbarick, D. E., & Osterburg, R. D. (1995). Development of a statistical model for forecasting episodes of visibility degradation in the Denver metropolitan area. Journal of Applied Meteorology, 34(3), 616-625

[3] https://www.epa.gov/air-emissions-inventories/

2.2.1.1. Standards

The EPA first set air quality standards for CO in 1971. For protection of both public health and welfare, EPA set an eight-hour primary standard at 9 parts per million (ppm) and a one-hour primary standard at 35 ppm. In a review of the standards completed in 1985, the EPA revoked the secondary standards (for public welfare) due to a lack of evidence of adverse effects on public welfare at or near ambient concentrations. The last review of the CO NAAQS was completed in 2011 and the EPA chose not to revise the standards at that time.

The one-hour and eight-hour NAAQS standards are not to be exceeded more than once in a year at the same location. A site will violate the standard with a second exceedance of either the one-hour or eight-hour standard in the same calendar year. An EPA directive states that the comparison with the CO standards will be made in integers. Fractions of 0.5 or greater are rounded up; therefore, actual concentrations of 9.5 ppm and 35.5 ppm or greater are necessary to exceed the eight-hour and one-hour standards, respectively.

The five CO monitors currently operated by APCD are associated with both State Maintenance Plan requirements and federal regulatory requirements. Recently, the EPA has revised the minimum requirements for CO monitoring by requiring CO monitors to be sited near roads in certain urban areas. EPA has also specified that monitors required in metropolitan areas of 2.5 million or more persons are to be operational by January 1, 2015, and that monitors required in Core Based Statistical Areas of one million or more persons are required to be operational by January 1, 2017. Monitors have been installed at a near-roadway NO_2 site (I-25 Denver) to satisfy these requirements.

2.2.1.2. Health Effects

CO 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, forming carboxyhemoglobin. Normally, hemoglobin carries oxygen from the lungs to the cells. The oxygen attached to the hemoglobin is exchanged for the carbon dioxide generated by the cell’s metabolism. The carbon dioxide is then carried back to the lungs where it is exhaled from the body. Hemoglobin binds approximately 240 times more readily with CO than with oxygen. How quickly the carboxyhemoglobin builds up is a factor of the concentration of the gas being inhaled and the duration of the exposure. Compounding the effects of the exposure is the long half-life (approximately 5 hours) of carboxyhemoglobin in the blood. Half-life is a measure of how quickly levels return to normal. This means that for a given exposure level, it will take about 5 hours for the level of carboxyhemoglobin in the blood to drop to half its current level after the exposure is terminated.

The health effects of CO vary with concentration. At low concentrations, effects include fatigue in healthy people and chest pain in people with heart disease. At moderate concentrations, angina, impaired vision, and reduced brain function may result. At higher concentrations, effects include impaired vision and coordination, headaches, dizziness, confusion, and nausea. It can cause flu-like symptoms that clear up after leaving the polluted area. CO is fatal at very high concentrations. The EPA has concluded that the following groups may be particularly sensitive to CO 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.

2.2.1.3. Statewide Summaries

CO concentrations have dropped dramatically since the early 1970s. This change is evident in both the concentrations measured and the number of monitors that have exceeded the level of the eight-hour standard. In 1975, 9 of 11 (81%) state-operated monitors exceeded the eight-hour standard. In 1980, 13 of 17 (77%) state-operated monitors exceeded the eight-hour standard. Since 1996, no state-operated monitors have recorded a violation of the eight-hour standard. In 2024, the highest statewide second maximum eight-hour concentration was 2.7 ppm as recorded at the I-25 monitoring station. Historical trends in CO NAAQS values for the CAMP and Welby stations are shown in Figure 2.2 and Figure 2.3 for illustration purposes.

Figure 2.4 shows the trend in maximum one-hour CO values recorded statewide between 1965 and 2024. The highest one-hour concentration ever recorded at any of the state-operated monitors was 79.0 ppm, which was recorded at the Denver CAMP monitor in 1968. In 2024 the highest one-hour concentration was 3.7 ppm, a value recorded at the I-25 monitoring station. The one-hour annual maximum concentrations have declined from more than twice the standard in the late 1960s to about one quarter of the standard today. Table 2.3 presents the historical maximum values recorded in Colorado.

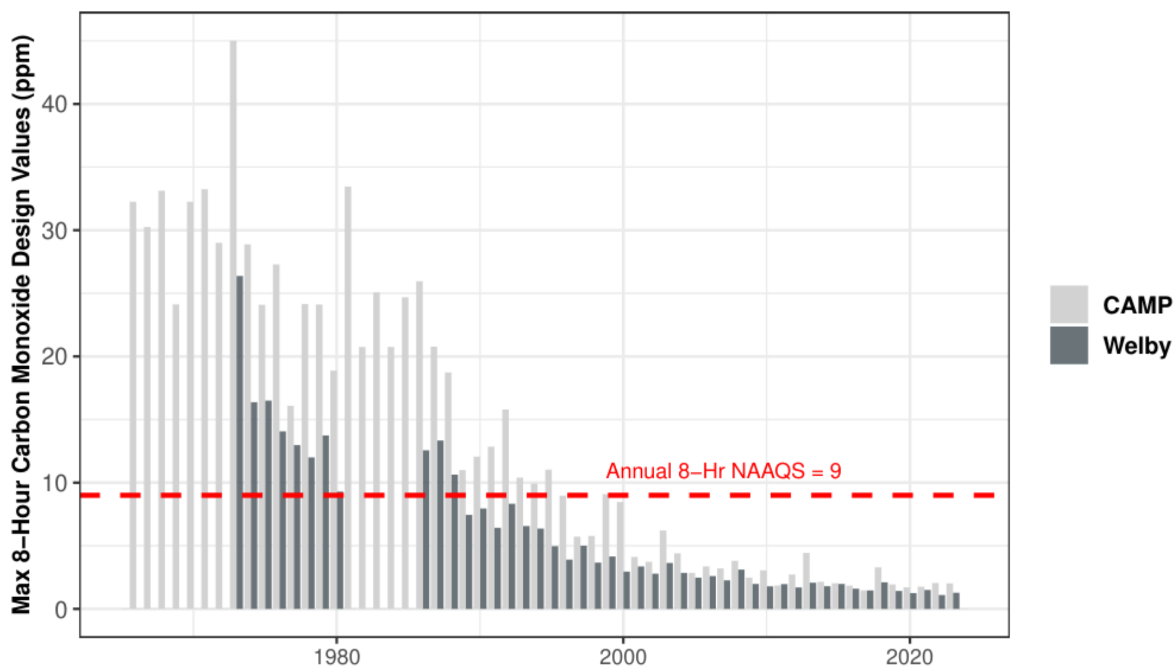

Figure 2.2: Historical record of maximum eight-hour carbon monoxide values at the CAMP and Welby stations.

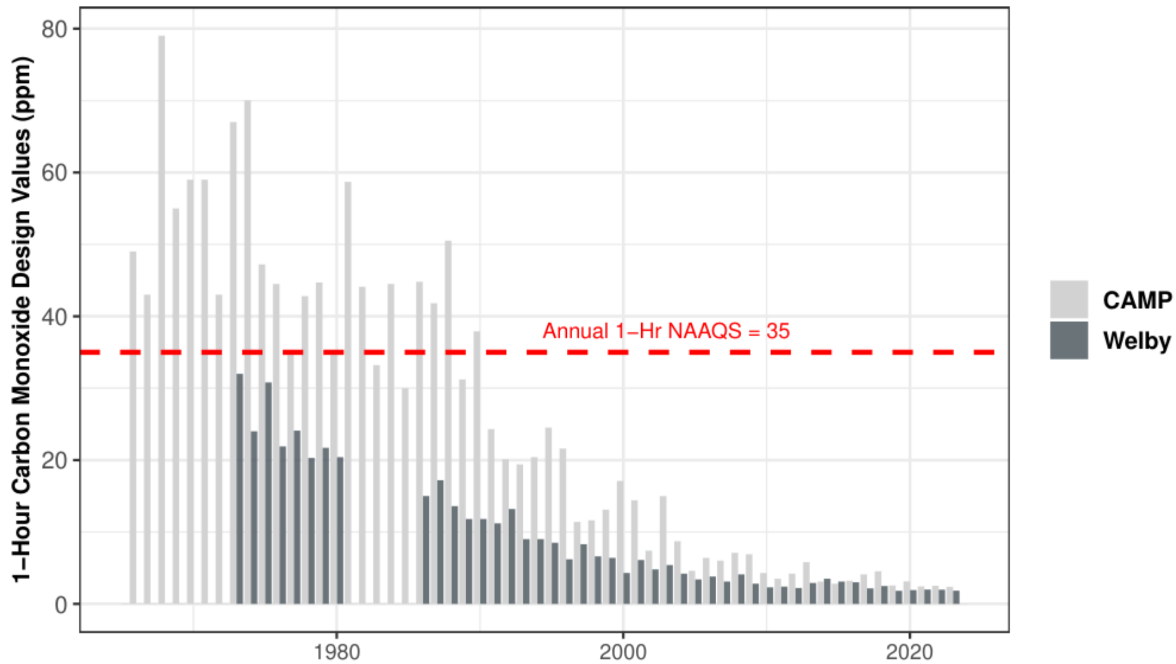

Figure 2.3: Historical record of maximum one-hour carbon monoxide values at the CAMP and Welby stations.

Table 2.3: Historical maximum one-hour CO concentrations in Colorado

Site	Max 1-Hour CO (ppm)	Year
CAMP	79.0	1968
CAMP	70.0	1974
CAMP	67.0	1973
Denver	64.9	1979
CAMP	59.0	1970
2024 Maximum		
I-25 Denver	3.7	2024

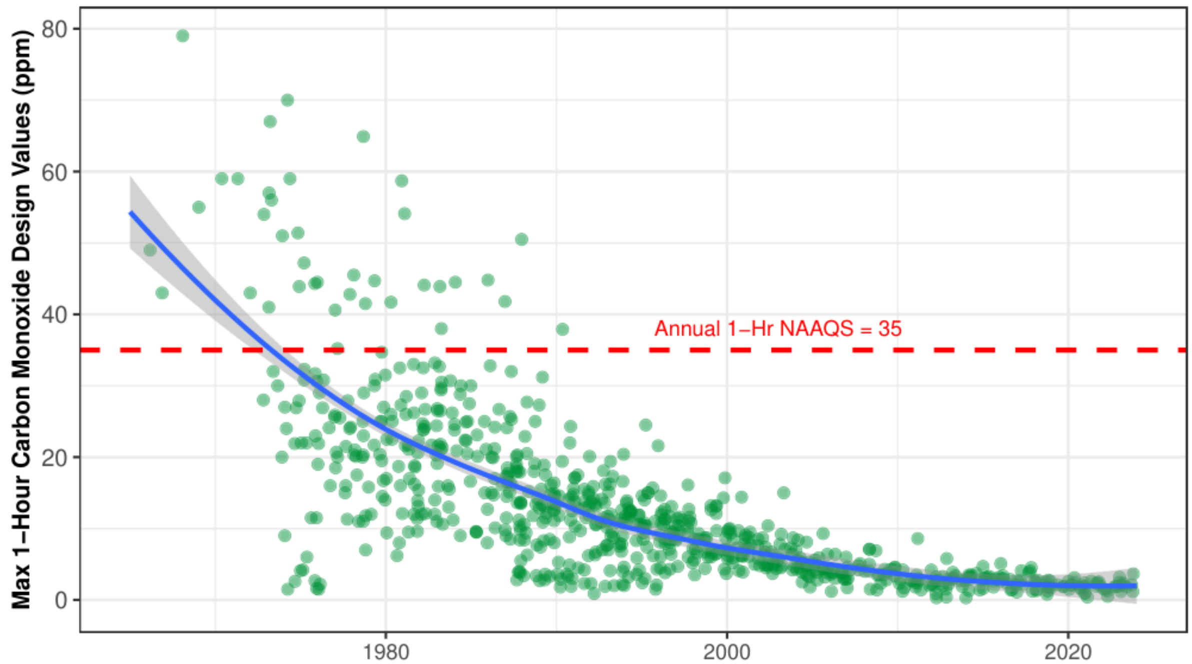

Figure 2.4: Statewide historical record of maximum one-hour carbon monoxide values. The mean trend obtained using a generalized additive model is shown as a blue line.

2.2.2. Sulfur Dioxide

Sulfur dioxide (SO_2) is one of a group of highly reactive gasses known as “oxides of sulfur,” or sulfur oxides (SO_x). The largest sources of SO_2 emissions are from fossil fuel combustion at power plants (73%) and other industrial facilities (20%), as shown in Figure 2.5. Smaller sources of SO_2 emissions include industrial processes such as extracting metal from ore, and the burning of high sulfur containing fuels by locomotives, large ships, and non-road equipment. SO_2 is linked with a number of adverse effects on the respiratory system.[4] Furthermore, SO_2 dissolves in water and is oxidized to form sulfuric acid, which is a major contributor to acid rain, as well as fine sulfate particles in the $PM_{2.5}$ fraction, which degrade visibility and represent a human health hazard.

[4] Ware, J. H., Ferris Jr, B. G., Dockery, D. W., Spengler, J. D., Stram, D. O., & Speizer, F. E. (1986). Effects of ambient sulfur oxides and suspended particles on respiratory health of preadolescent children. The American Review of Respiratory Disease, 133(5), 834-842

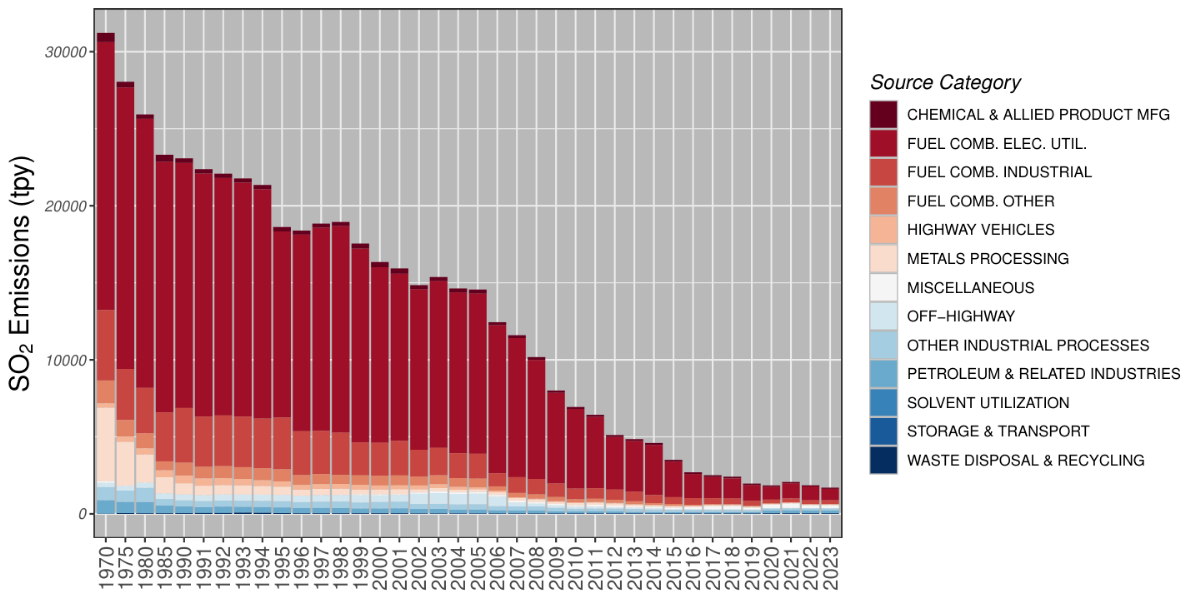

Figure 2.5: Trends in national sulfur dioxide emissions from 1970 to 2023. Data was sourced from the 2020 National Emissions Inventory.

2.2.2.1. Standards

The EPA first promulgated standards for SO_2 in 1971, setting a 24-hour primary standard at 140 ppb and an annual average standard at 30 ppb (to protect health). A three-hour average secondary standard at 500 ppb was also adopted to protect the public welfare. In 1996, the EPA reviewed the SO_2 NAAQS and chose not to revise the standards. However, in 2010, the EPA revised the primary SO_2 NAAQS by establishing a new one-hour standard at a level of 75 parts per billion (ppb). The two existing primary standards were revoked because they were deemed inadequate to provide additional public health protection given a one-hour standard at 75 ppb. On December 10, 2024, the Environmental Protection Agency revised an air quality standard to better protect public welfare against adverse effects caused by criteria air pollutants – including ecological effects such as damage to aquatic and terrestrial ecosystems. This action revises the secondary NAAQS for SO_2 from a 500 ppb three-hour-average, not to be exceeded more than one per year, to a 10 ppb three-year-average of the annual mean concentration.

APCD has monitored SO_2 at eight locations in Colorado in the past. Three SO_2 monitoring sites were operated in 2024. No area of the country has been found to be out of compliance with the current SO_2 standards. There were two exceedances of the one-hour standard at a site in Colorado Springs during the 2014-2015 period; however, there were no exceedances recorded at any site in 2024.

2.2.2.2. Health Effects

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

2.2.2.3. Statewide Summaries

The concentrations of sulfur dioxide in Colorado have never been a major health concern as there are few industries that burn large amounts of coal in the state. Additionally, western coal that is mined or imported into Colorado is naturally low in sulfur. The concern in Colorado with sulfur dioxide has been associated with acid deposition and its effects on mountain lakes and streams, as well as the formation of fine aerosols. Ambient SO_2 levels have decreased significantly in the past forty years, with one-hour SO_2 annual 99th percentile values at the CAMP station having declined from greater than 200 ppb in the late 1960s and early 1970s to 4.9 ppb in 2024, as shown in Figure 2.6. Figure 2.7 shows the declining trend in sulfur dioxide readings over the last several decades, with relatively low concentrations of sulfur dioxide recorded at APCD monitors. This same trend is evident, although not as pronounced, in the three-hour and 24-hour averages. Table 2.4 presents the historical maximum one-hour concentrations recorded in Colorado.

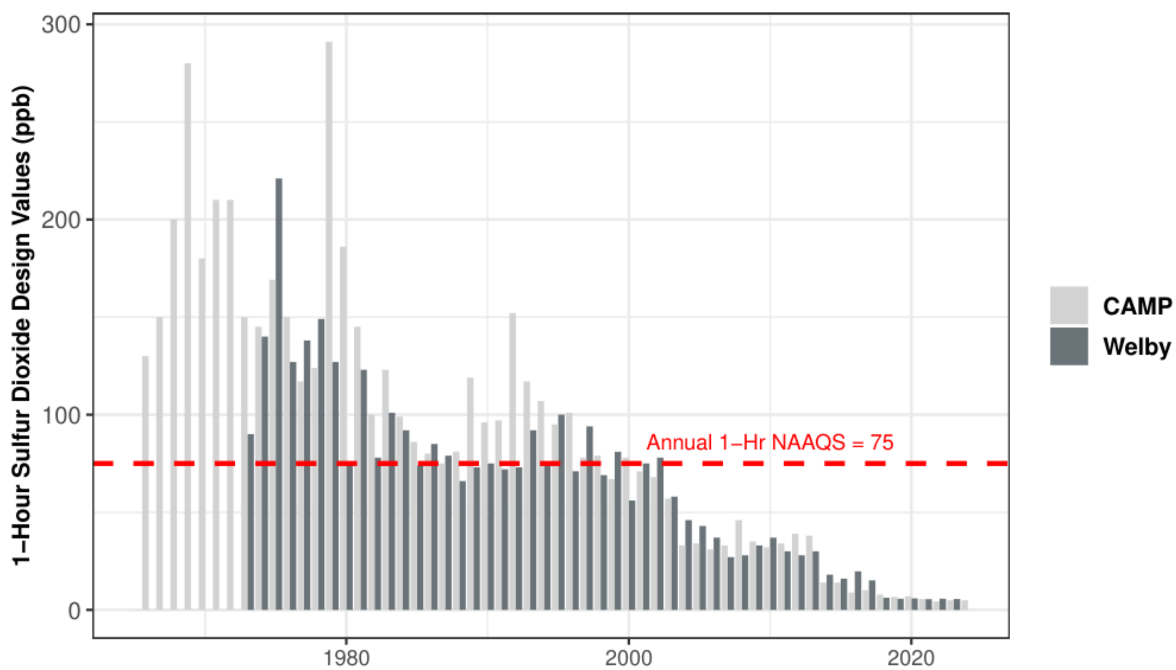

Figure 2.6: Historical record of one-hour sulfur dioxide annual 99th percentile values at the CAMP and Welby stations.

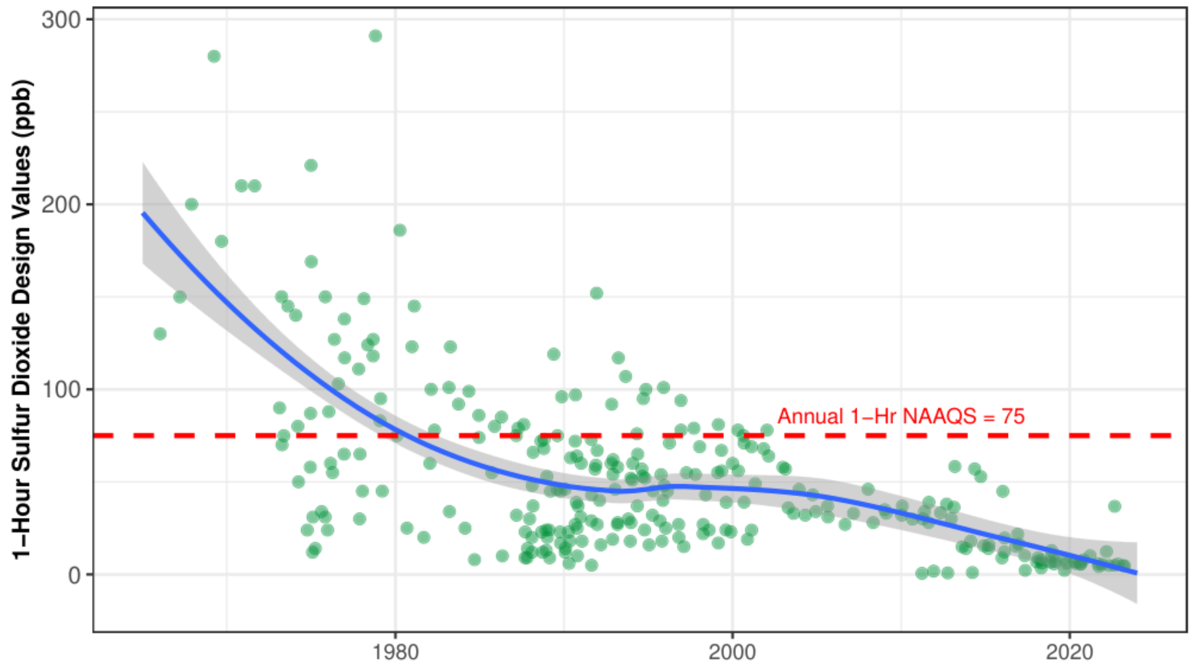

Figure 2.7: Statewide historical record of one-hour sulfur dioxide annual 99th percentile values. The mean trend obtained using a generalized additive model is shown as a blue line.

Table 2.4: Historical maximum one-hour SO_2 concentrations in Colorado

Site	Max 1-Hour SO_2 (ppb)	Year
Rio Blanco	733	1976
Denver	550	1974
CAMP	490	1969
CAMP	360	1965
Denver	328	1976
2024 Maximum		
La Casa	6.8	2024

2.2.3. Ozone

Ozone (O_3) is an atmospheric oxidant composed of three oxygen atoms. It is not usually emitted directly into the air, but at ground-level is formed via photochemical reactions among NO_x and volatile organic compounds (VOCs) in the presence of sunlight. Emissions from industrial facilities and electric utilities, motor vehicle exhaust, gasoline vapors, and chemical solvents are some of the major sources of NO_x and VOCs (see Figure 2.8 and Figure 2.10). Breathing ozone can trigger a variety of health problems, particularly for children, the elderly, and people of all ages who have lung diseases such as asthma.[5] Urban areas generally experience the highest ozone concentrations, but even rural areas may be subject to increased ozone levels because air masses can carry ozone and its precursors hundreds of miles away from their original source regions.

[5] Kampa, M., & Castanas, E. (2008). Human health effects of air pollution. Environmental pollution, 151(2), 362-367

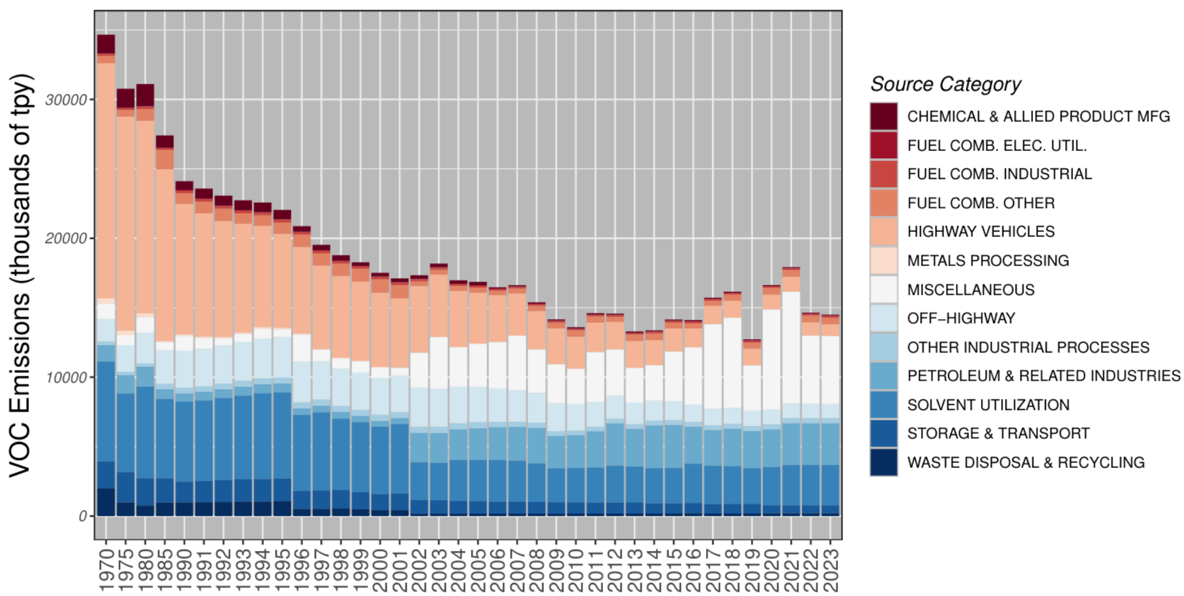

Figure 2.8: Trends in national VOC emissions from 1970 to 2023. Data was sourced from the 2020 National Emissions Inventory.

Sunlight and warm weather facilitate the ozone formation process and can lead to high concentrations. Ozone is therefore considered to be primarily a summertime pollutant and typically reaches maximum concentrations when hot summer days provide the conditions for the precursor chemicals to react and form ozone. However, ozone can also be a wintertime pollutant in some areas. For example, snow-covered oil and gas-producing basins in the western U.S. can be subject to wintertime ozone concentrations well in excess of current air quality standards. High ozone concentrations in winter are thought to occur when stable atmospheric conditions allow for a build-up of precursor chemicals, and the reflectivity of the snow cover increases the rate of UV-driven reactions during the day. Ozone and its precursors are then effectively trapped under the inversion. The Upper Green River Basin in Wyoming has been studied to model such effects.[6]

2.2.3.1. Standards

In 1971, the EPA promulgated the first NAAQS for photochemical oxidants, setting a one-hour primary standard at 80 pbb (O_3 is one of a number of chemicals that are common atmospheric oxidants). The level of the primary standard was then revised in 1979 from 80 ppb to 120 ppb and the chemical designation of the standard was changed from “photochemical oxidants” to “ozone.” In 1993, the EPA reviewed the O_3 NAAQS and chose not to revise the standards. However, in 1997, the EPA promulgated a new level of the NAAQS for O_3 of 80 ppb as an annual fourth-highest daily maximum eight-hour concentration, averaged over three years. The O_3 NAAQS was then revised again in 2008 when the EPA set an eight-hour standard of 75 ppb. On November 26, 2014, the EPA again proposed lowering the O_3 NAAQS standard from 75 ppb to a level between 65 ppb and 70 ppb. In November 2015, the EPA set the standard at 70 ppb as an annual fourth-highest daily maximum eight-hour concentration, averaged over

[6] Carter,W. P., & Seinfeld, J. H. (2012). Winter ozone formation and VOC incremental reactivities in the Upper Green River Basin of Wyoming. Atmospheric Environment, 50, 255-266

three years. To ensure compliance with the 2008 and 2015 O_3 standards, the EPA has extended the O_3 monitoring requirements for Colorado by 5 months, essentially redefining Colorado's ozone season as January through December. In 2024, 15 of 24 O_3 sites operated by APCD had three-year NAAQS values in excess of the current eight-hour O_3 standard of 70 ppb (five additional sites had one-year design values in excess of 70 ppb, but do not possess the necessary three years of valid regulatory monitoring data).

2.2.3.2. Health Effects

Exposure to ozone has been linked to a number of health effects, including significant decreases in lung function, inflammation of the airways, and increased respiratory symptoms, such as cough and pain when taking a deep breath.[7] Exposure can also aggravate lung diseases such as asthma, leading to increased medication use and increased hospital admissions and emergency room visits. Active children are the group at highest risk from ozone exposure because they often spend a large part of the summer playing outdoors. Children are also more likely to have asthma, which may be aggravated by ozone exposure. Other at-risk groups include adults who are active outdoors (e.g., some outdoor workers) and individuals with lung diseases such as asthma and chronic obstructive pulmonary disease. In addition, long-term exposure to moderate levels of ozone may cause permanent changes in lung structure, leading to premature aging of the lungs and worsening of chronic lung disease.

Ozone also affects vegetation and ecosystems, leading to reductions in agricultural crop and commercial forest yields, reduced growth and survivability of tree seedlings, and increased plant susceptibility to disease, pests, and other environmental stresses (e.g., harsh weather).[8] In long-lived species, these effects may become evident only after several years or even decades and may result in long-term effects on forest ecosystems. Ground level ozone injury to trees and plants can lead to a decrease in the natural beauty of our national parks and recreation areas.

2.2.3.3. Statewide Summaries

Statewide O_3 design values from 1972 to present are shown in Figure 2.9, compared to the current EPA 8-hour NAAQS standard for O_3 (70 ppb). In 2024, a high number of O_3 exceedances were recorded throughout the State of Colorado (Table 2.2).

Ozone monitoring began in 1972 at the Denver CAMP station, and eight exceedances of the then-applicable one-hour standard were recorded that year. Table 2.5 lists the five highest eight-hour concentrations recorded in Colorado. Note that all five maximum historical values were recorded within the first three years of ozone monitoring.

[7] Lippmann, M. (1989). Health effects of ozone: a critical review. Journal of the Air Pollution Control Association, 39(5), 672-695.
[8] Ashmore, M. R. (2005). Assessing the future global impacts of ozone on vegetation. Plant, Cell & Environment, 28(8), 949-964.

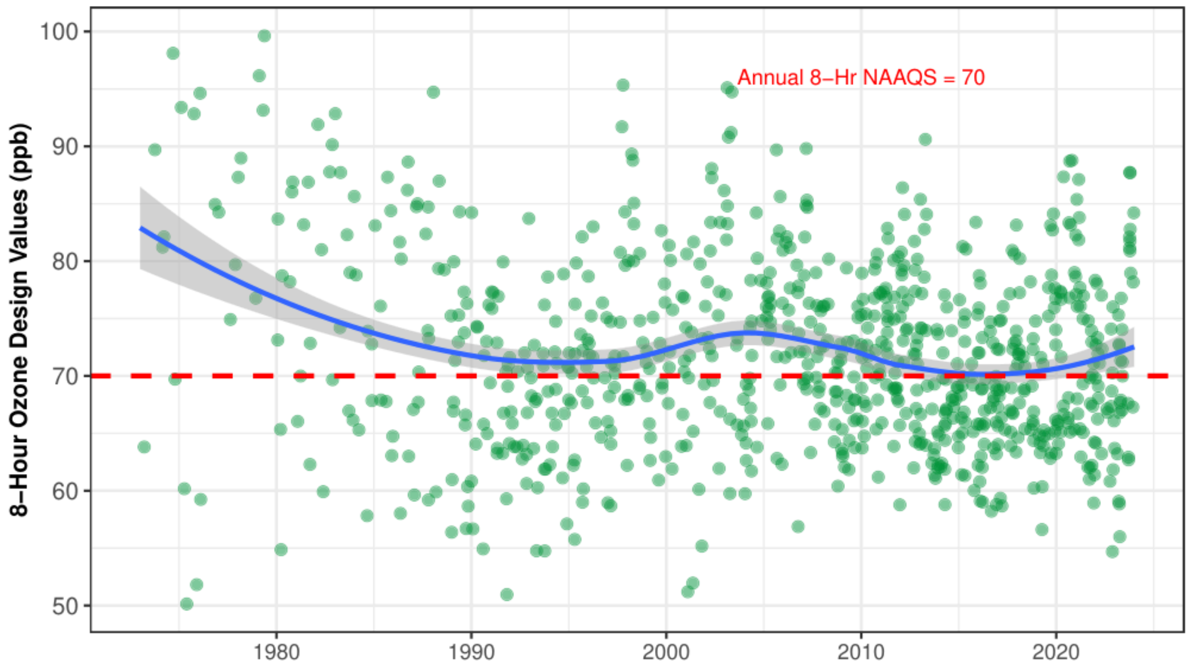

Figure 2.9: Statewide historical record of eight-hour ozone NAAQS values. The mean trend obtained using a generalized additive model is shown as a blue line.

Table 2.5: Historical maximum eight-hour O_3 concentrations in Colorado

Site	Max 8-Hour O_3 (ppb)	Year
CAMP	310	1972
CAMP	264	1973
Arvada	198	1973
Denver	194	1973
Welby	156	1974
2024 Maximum		
Rocky Flats - N	95	2024

2.2.4. Nitrogen Dioxide

NO_2 is one of a group of highly reactive gasses known as "oxides of nitrogen," or nitrogen oxides (NO_x). Other NO_x species include nitric oxide (NO), nitrous acid (HNO_2), and nitric acid (HNO_3). The EPA's National Ambient Air Quality Standard uses NO_2 as the indicator for the larger group of nitrogen oxides. NO_2 forms quickly from emissions from motor vehicles, power plants, and off-road equipment, with on and off-road vehicles accounting for over 50% of emissions nationally. In addition to contributing to the formation of ground-level ozone and fine particle pollution, NO_2 is linked with a number of adverse effects on the respiratory system.[9]

[9] Weinmayr, G., Romeo, E., De Sario, M., Weiland, S. K., & Forastiere, F. (2010). Short-term effects of PM_{10} and NO_2 on respiratory health among children with asthma or asthma-like symptoms: a systematic review and meta-analysis. Environmental Health Perspectives, 118(4), 449-57

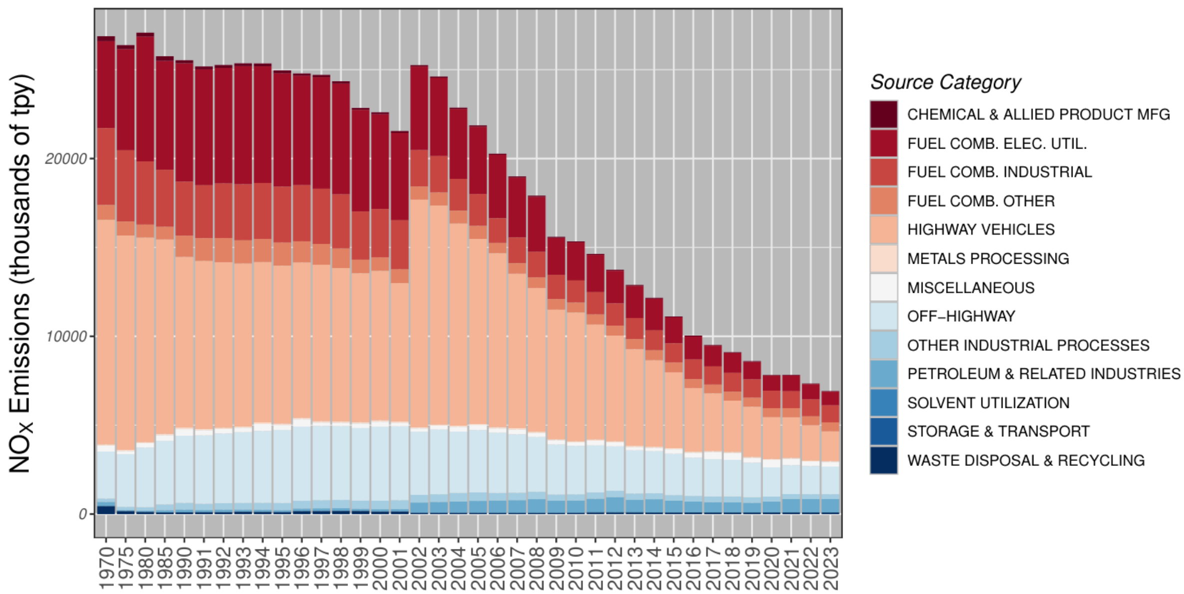

Figure 2.10: Trends in national NOx emissions from 1970 to 2023. Data was sourced from the 2020 National Emissions Inventory.

2.2.4.1. Standards

The EPA first set standards for NO_2 in 1971, setting both a primary standard (to protect health) and a secondary standard (to protect the public welfare) at 0.053 parts per million (53 ppb), averaged annually. The Agency has reviewed the standards twice since that time, but chose not to revise the annual standards at the conclusion of each review. In January 2010, the EPA established an additional primary standard at 100 ppb, averaged over one hour. Together the primary standards protect public health, including the health of sensitive populations; i.e., people with asthma, children, and the elderly.

The EPA has established requirements for an NO_2 monitoring network that will include monitors at locations where maximum NO_2 concentrations are expected to occur, including within 50 meters of major roadways, as well as monitors sited to measure area-wide NO_2 concentrations that occur more broadly across communities. Per these requirements, at least one monitor must be located near a major road in any urban area with a population greater than or equal to 1,000,000 people. A second monitor is required near another major road in areas with either: (1) population greater than or equal to 2.5 million people, or (2) one or more road segments with an annual average daily traffic (AADT) count greater than or equal to 250,000 vehicles. Near-roadway monitoring is conducted at the I-25 Denver (installed in 2013) and I-25 Globeville (installed in 2015) sites. In addition to the near roadway monitoring, there must be one monitoring station in each metropolitan area with a population of 1 million or more persons to monitor a location of expected highest NO_2 concentrations representing the neighborhood or larger spatial scales. The CAMP site satisfies this requirement. Additionally, the Welby monitoring location serves as an EPA Regional Administrated NO_2 site targeted at the characterization of NO_2 exposure for susceptible and vulnerable populations.

2.2.4.2. Health Effects

Elevated concentrations of nitrogen dioxide cause respiratory distress, degradation of vegetation, clothing, visibility, and increased acid deposition. Nitrogen dioxide also causes concern with the formation of fine aerosols. Nitrate aerosols, which result from NO and NO_2 combining with water vapor in the air, have been consistently linked to Denver's visibility problems.[10]

2.2.4.3. Statewide Summaries

Colorado exceeded the annual mean NO_2 standard of 53 ppb in 1977 at the Denver CAMP monitor, but concentrations have shown a gradual decline since this time. Figure 2.11 and Figure 2.12 show that levels have declined minimally but remained below the NAAQS at both the Welby and CAMP monitors over the past ten years in terms of both the annual mean and one-hour NAAQS values. The statewide historical trend is summarized in Figure 2.13. Table 2.6 presents the historical maximum one-hour NO_2 values recorded in Colorado.

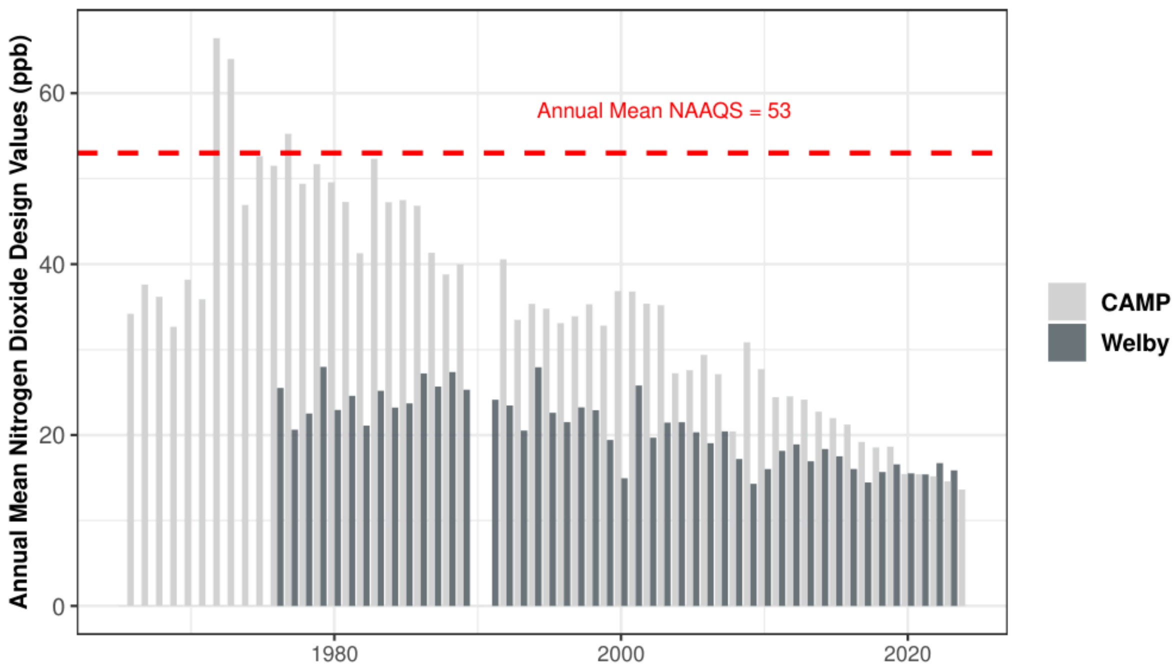

Figure 2.11: Historical record of annual mean nitrogen dioxide NAAQS values at the CAMP and Welby stations.

[10] Sloane, C. S., Watson, J., Chow, J., Pritchett, L., & Richards, L. W. (1991). Size-segregated fine particle measurements by chemical species and their impact on visibility impairment in Denver. Atmospheric Environment. Part A. General Topics, 25(5), 1013-1024.

Table 2.6: Historical maximum one-hour NO_2 concentrations in Colorado

Site	Max 1-Hour NO_2 (ppb)	Year
Denver	639	1983
CAMP	620	1973
CAMP	462	1989
CAMP	448	1983
CAMP	420	1974
2024 Maximum		
I-25 Globeville	67	2024

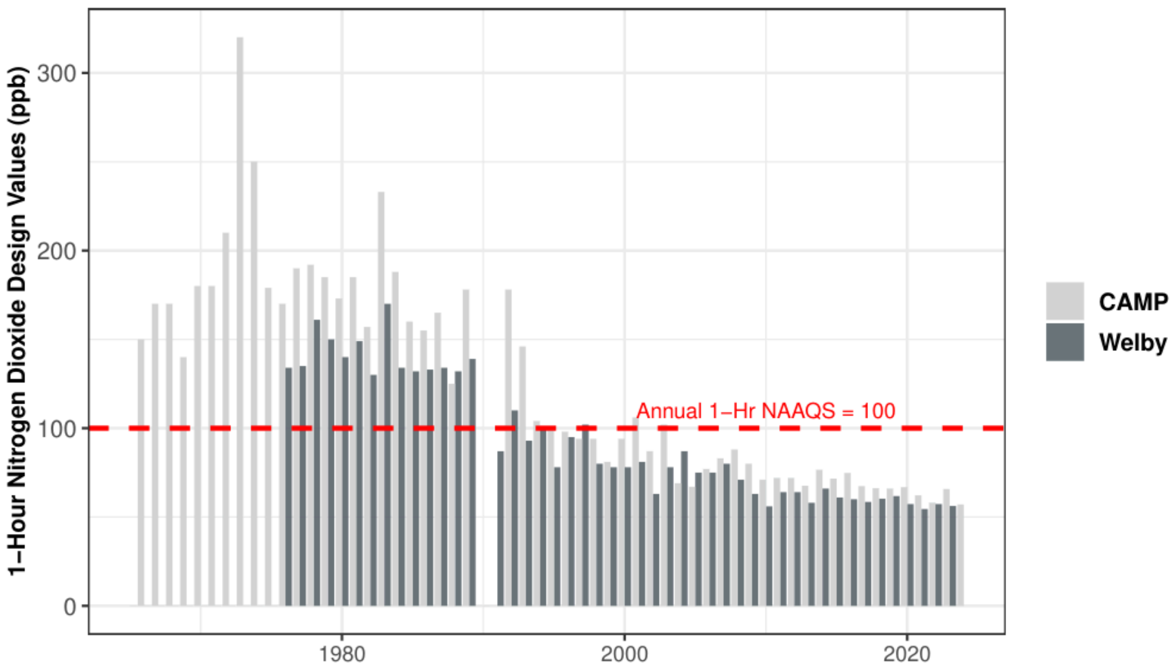

Figure 2.12: Historical record of one-hour nitrogen dioxide NAAQS values at the CAMP and Welby stations.

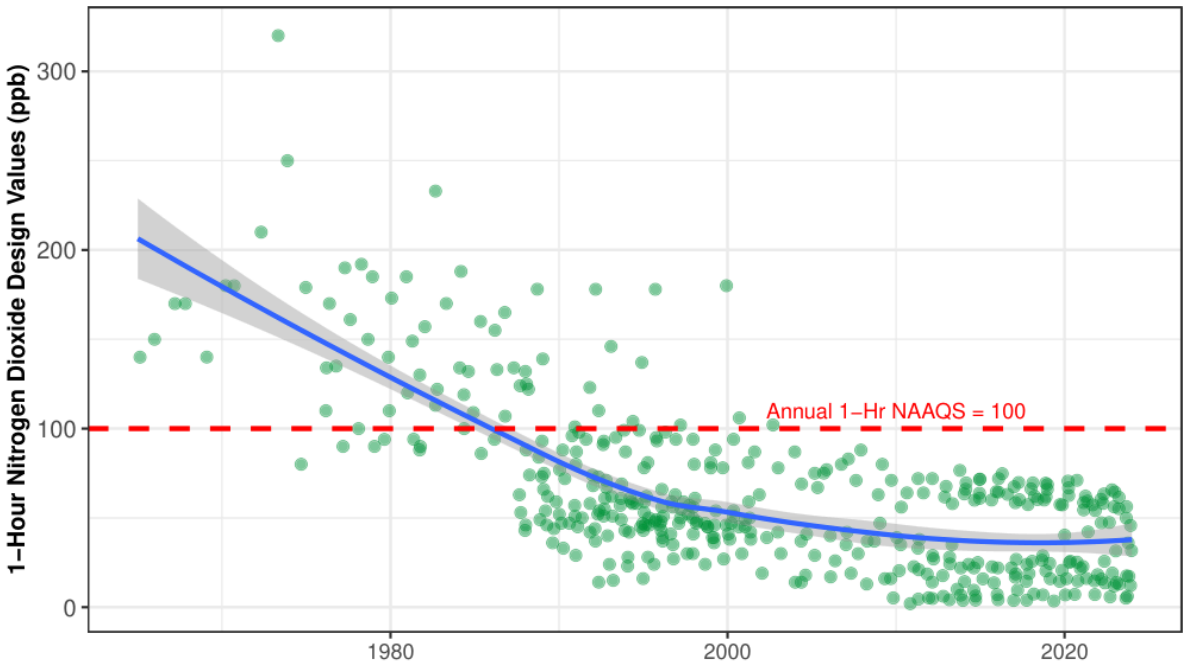

Figure 2.13: Statewide historical record of one-hour nitrogen dioxide NAAQS values. The mean trend obtained using a generalized additive model is shown as a blue line.

2.2.5. Particulate Matter

Atmospheric particulate matter (PM) consists of microscopic solid or liquid particles suspended in the air. PM can be made up of a number of different components, including acidic aerosols (e.g., nitrates and sulfates), organic carbon, metals, soil or dust particles, and allergens (such as fragments of pollen or mold spores). Some of these particles are carcinogenic and others have health effects due to their size, morphology, or composition.

2.2.5.1. Health Effects

Particle size is the factor most directly linked to the health impacts of atmospheric PM. Particles of less than 10 micrometers (µm) in aerodynamic diameter (PM_{10}) are inhalable and thus pose a health threat. Particles less than 2.5 µm aerodynamic diameter ($PM_{2.5}$) can penetrate deeply into the alveoli in the lungs, while the smallest particles, such as those less than 0.1 µm in aerodynamic diameter (ultrafine particles), can penetrate all the way into the bloodstream. Exposure to such particles can affect the lungs, the heart, and the cardiovascular system. Particles with diameters between 2.5 µm and 10 µm ($PM_{10\text{-}2.5}$) represent less of a health concern, although they can irritate the eyes, nose, and throat, and cause serious harm due to inflammation in the airways of people with respiratory diseases such as asthma, chronic obstructive pulmonary disease, and pneumonia. Note that PM_{10} encompasses all particles smaller than 10 µm, including the $PM_{2.5}$ and ultrafine fractions.

The welfare effects of particulate exposure may be the most widespread of all the pollutants. No place on earth has been spared from the particulate pollution generated by urban and rural sources. This is due to the potential for extremely long-range transport of fine particles and chemical reactions that occur from gases in the atmosphere to create secondary particulate matter in the form of microscopic liquid droplets. 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.

2.2.5.2. Emissions and Sources

The majority of PM_{10} pollution comes from miscellaneous sources, which are mainly fugitive dust sources rather than stack emissions or combustion sources. Fugitive emissions are those not caught by a capture system and are often due to equipment leaks, earth moving equipment vehicles, and windblown disturbances. $PM_{2.5}$, on the other hand, is typically formed in the atmosphere via gas to particle conversion and consists primarily of nitrates, sulfates, and organic carbon (black carbon from combustion can be an important primary source of particles in the $PM_{2.5}$ size fraction). The historical trend in national PM emissions from 1990 to 2023 is shown in Figure 2.14 and Figure 2.15 for illustration purposes.

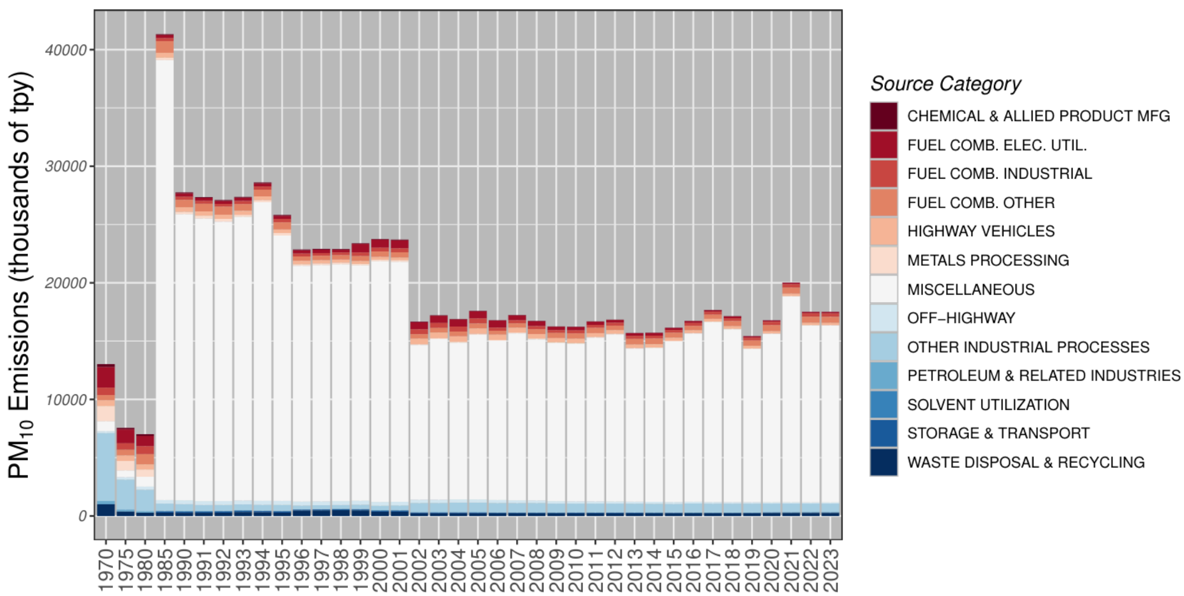

Figure 2.14: Trends in national PM_{10} emissions from 1970 to 2023. Data was sourced from the 2020 National Emissions Inventory.

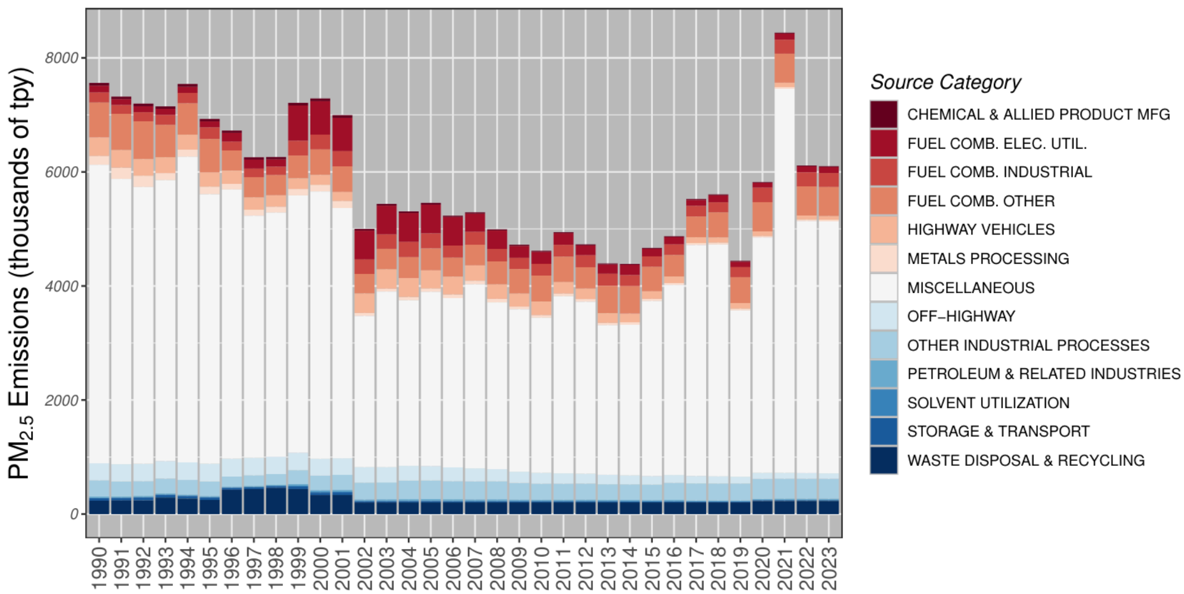

Figure 2.15: Trends in national $PM_{2.5}$ emissions from 1990 to 2023. Data was sourced from the 2020 National Emissions Inventory.

2.2.5.3. Standards

EPA first established standards for PM in 1971. The reference method specified for determining attainment of the original standards was the high-volume sampler, which collects PM up to a nominal size of 25 to 45 μm (referred to as total suspended particulates or TSP). The primary standards, as measured by the indicator TSP, were 260 μm m^{-3} (as a 24-hour average) not to be exceeded more than once per year, and 75 μm m^{-3} (as an annual geometric mean). In October 1979, the EPA announced the first periodic review of the air quality criteria and NAAQS for PM, and significant revisions to the original standards were promulgated in 1987. In that decision, the EPA changed the indicator for particles from TSP to PM_{10}. EPA also revised the level and form of the primary standards. The EPA promulgated significant revisions to the NAAQS again in 1997. In that decision, the EPA revised the PM NAAQS in several respects. While it was determined that the PM NAAQS should continue to focus on particles less than or equal to 10 μm in diameter (i.e., PM_{10}), the EPA also decided that the fine and coarse fractions of PM_{10} should be considered separately. The Agency's decision to modify the standards was based on evidence that serious health effects were associated with short- and long-term exposure to fine particles in areas that met the existing PM_{10} standards. The EPA added new standards, using $PM_{2.5}$ as the indicator for fine particles and using PM_{10} as the indicator for the $PM_{10-2.5}$ fraction. The EPA established two new $PM_{2.5}$ standards: an annual standard of 15 μm m^{-3}, based on the 3-year average of annual arithmetic mean $PM_{2.5}$ concentrations from single or multiple community-oriented monitors, and a 24-hour standard of 65 μm m^{-3}, based on the 3-year average of the 98th percentile of 24-hour $PM_{2.5}$ concentrations at each population-oriented monitor within an area. These standards were modified again in 2006 and 2012. The current NAAQS for PM_{10} is a primary 24-hour standard of 150 μm m^{-3} not to be exceeded more than once per year on average over three years. There were three NAAQS in effect for $PM_{2.5}$ during most of 2024: (1) a primary annual standard of 12 μm m^{-3}, based on the 3-year average of annual arithmetic mean $PM_{2.5}$ concentrations, (2) a secondary annual standard of 15 μm m^{-3}, based on the 3-year average of annual arithmetic mean $PM_{2.5}$ concentrations, and (3) and a 24-hour standard of 35 μm m^{-3}, based on the 3-year average of the 98th percentile of 24-hour $PM_{2.5}$ concentrations. On February 7, 2024, EPA strengthened the NAAQS for PM2.5, lowering the level of the primary (health-based) annual PM2.5 standard from 12 μm m^{-3} to 9.0 μm m^{-3} to provide increased public health protection, consistent with the available health science.

2.2.5.4. A Brief Explanation of Exceptional Events

Often, air pollution episodes originate from natural sources that are not preventable and cannot be reasonably controlled. These include events like volcanic eruptions, large regional dust storms, and wildfires. If an exceedance of the NAAQS (PM_{10} concentrations greater than 150 μm m^{-3} in attainment areas and greater than 98 μm m^{-3} in PM_{10} non-attainment areas) can be shown to have resulted from a natural event and can be documented with scientific evidence, the event can be excluded from NAAQS calculations. For example, 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, Alamosa, Crested Butte, Durango, Grand Junction, Pagosa Springs, and Pueblo. These events are not included in NAAQS determinations, not because they are without any health risk but because they are naturally occurring events that cannot be reasonably prevented or controlled. The EPA may concur on events that APCD flags and documents as exceptional events in the EPA's AQS database. The Exceptional Events Rule was revised in 2016, with an effective date of September 30, 2016. The EPA has been much more restrictive on concurring natural events since the revision. Concentrations between 98 and 155 μm m^{-3} that are located in State Implementation Plan maintenance areas are also allowed by the Exceptional Events Rule to be flagged and documented as exceptional events. More details can be found at: https://www.epa.gov/air-quality-analysis/treatment-air-quality-monitoring-data-influenced-exceptional-events.

2.2.5.5. Statewide Summaries

PM_{10} - PM_{10} data have been collected in Colorado since 1985. The samplers were subsequently modified to conform to the requirements of a new standard when it was established in July of 1987. Therefore, annual trends are only valid back to July 1987. Since 1988, at least one Colorado monitor has exceeded the level of the 24-hour PM_{10} standard (150 μm m^{-3}) every year except for 2004.

In cases other than exceptional events and more so than for other pollutants, PM_{10} pollution is a localized phenomenon and concentrations can vary considerably in Colorado on both spatial and temporal scales. Therefore, local averages and maximum concentrations of PM_{10} are more meaningful than averages covering large regions or the entire state. However, statewide values have been summarized in a box plot in Figure 2.16 for illustration purposes. The box plot shows the median PM_{10} NAAQS value statewide for each year as a horizontal black bar, as well as the first quartile (Q1, box bottom), the third quartile (Q3, box top), and the minimum and maximum values, which are represented by vertical black tick marks. For each year, outliers are considered to be those points with values greater than Q3 + 1.5*(Q3 - Q1) or less than Q1 - 1.5*(Q3 - Q1), and are represented by black points.

PM_{10} exceedances in Colorado are mainly due to large regional dust storms that usually begin in desert areas to the south and west of the state. These are natural or exceptional events for which the Division is currently analyzing the scientific data and may be documented as high wind/blown dust exceptional events. The data shown in Figure 2.16 include those concentrations that are the result of exceptional events (see subsubsection 2.2.5.4). There have been several of these events documented in Colorado since PM_{10} monitoring began in 1987, including the maximum 24-hour PM_{10} concentration of 1220 μm m^{-3}

recorded in Lamar in 2013 and the 635 μm m^{-3} value recorded in Alamosa in 2011. Table 2.7 presents the historical maximum 24-hour PM_{10} concentrations recorded in Colorado.

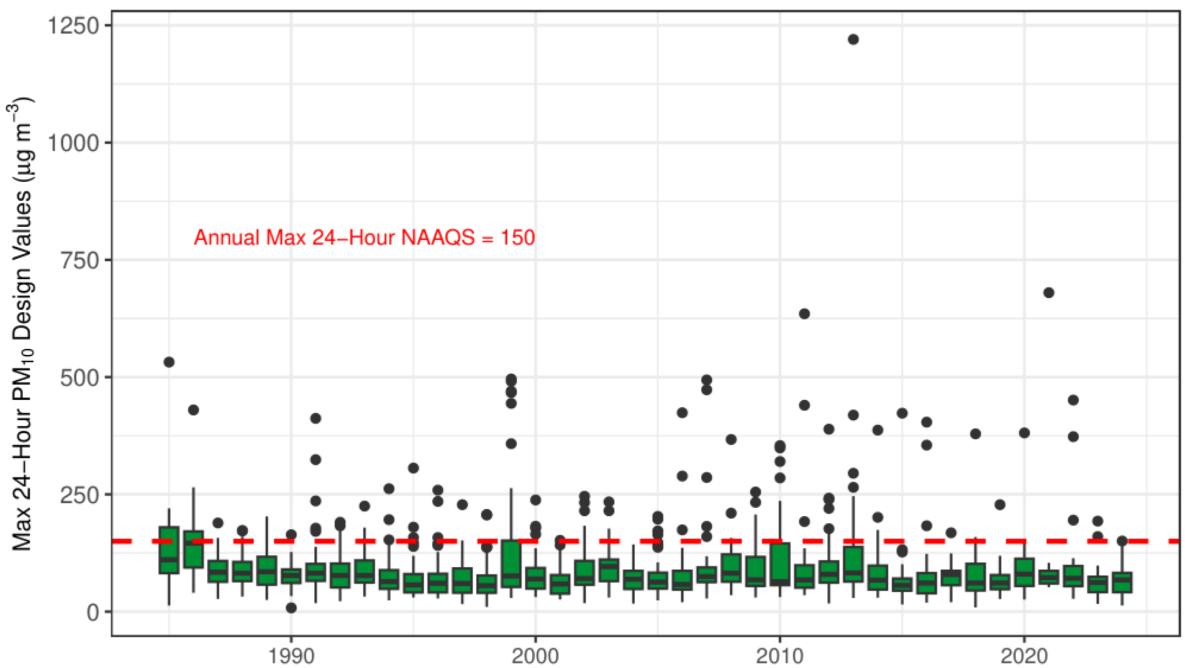

Figure 2.16: Statewide historical record of annual 24-hour PM_{10} values. The box plot shows the median PM_{10} NAAQS value statewide for each year, as well as the interquartile range (box) of values observed at monitoring sites throughout the state and the minimum and maximum values. Outliers are indicated by black points.

Table 2.7: Historical maximum 24-hour PM_{10} concentrations in Colorado

Site	Max 24-Hour PM_{10} (μg m^{-3})	Year
Lamar	1,220	2013
Alamosa	635	2011
Denver	532	1985
Alamosa	494	2007
Montrose	491	1999
2024 Maximum		
Alamosa	150	2024

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

Figure 2.17 and Figure 2.18 show the historical trends in annual mean and 24-hour maximum $PM_{2.5}$ NAAQS values, respectively. Since the 35 μm m^{-3} standard is based on a three-year average of the 98th percentile, the 24-hour standard has not been violated at any site, nor has the three-year average annual standard of 12 μm m^{-3}. Table 2.8 presents the historical maximum 24-hour $PM_{2.5}$ concentrations recorded in Colorado.

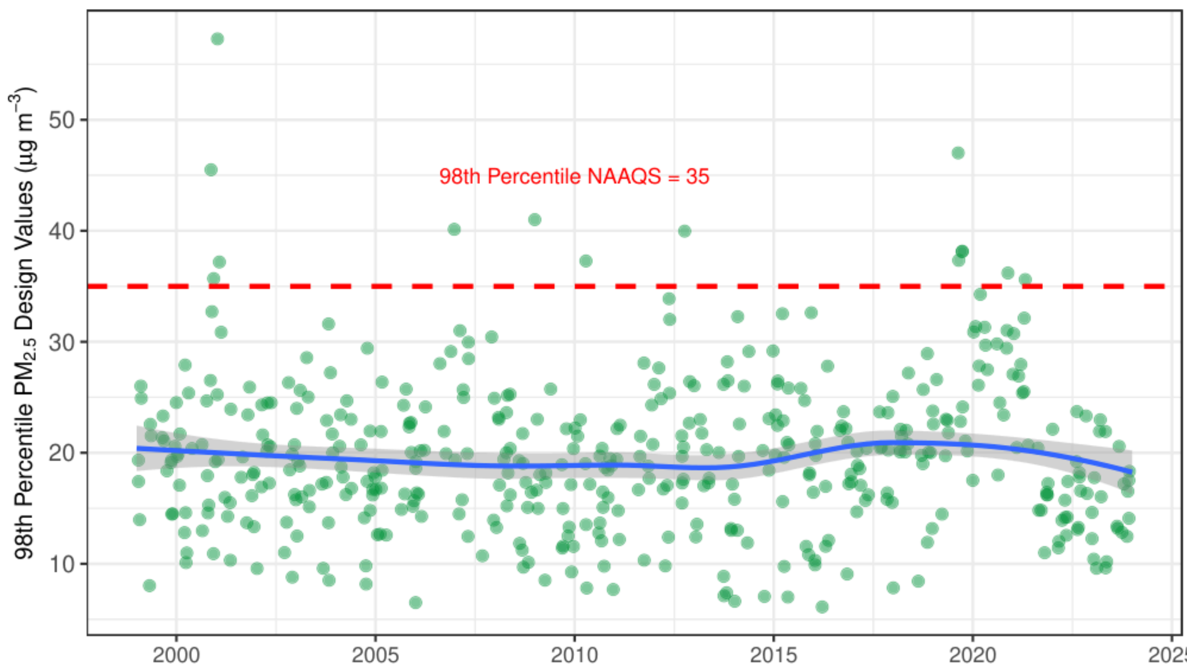

Figure 2.17: Statewide historical record of 24-hour $PM_{2.5}$ 98th percentile values. The mean trend obtained using a generalized additive model is shown as a blue line.

Table 2.8: Historical maximum 24-hour $PM_{2.5}$ concentrations in Colorado. Data includes potential exceptional events.

Site	Max 24-Hour $PM_{2.5}$ (μg m^{-3})	Year
Arapahoe Community College (ACC)	140	1999
Longmont - Municipal Bldg.	98.2	2023
National Jewish Health (NJH)	95.6	2023
Chatfield State Park	92.7	2023
La Casa	92.2	2023
2024 Maximum		
Longmont - Municipal Bldg.	44.5	2024

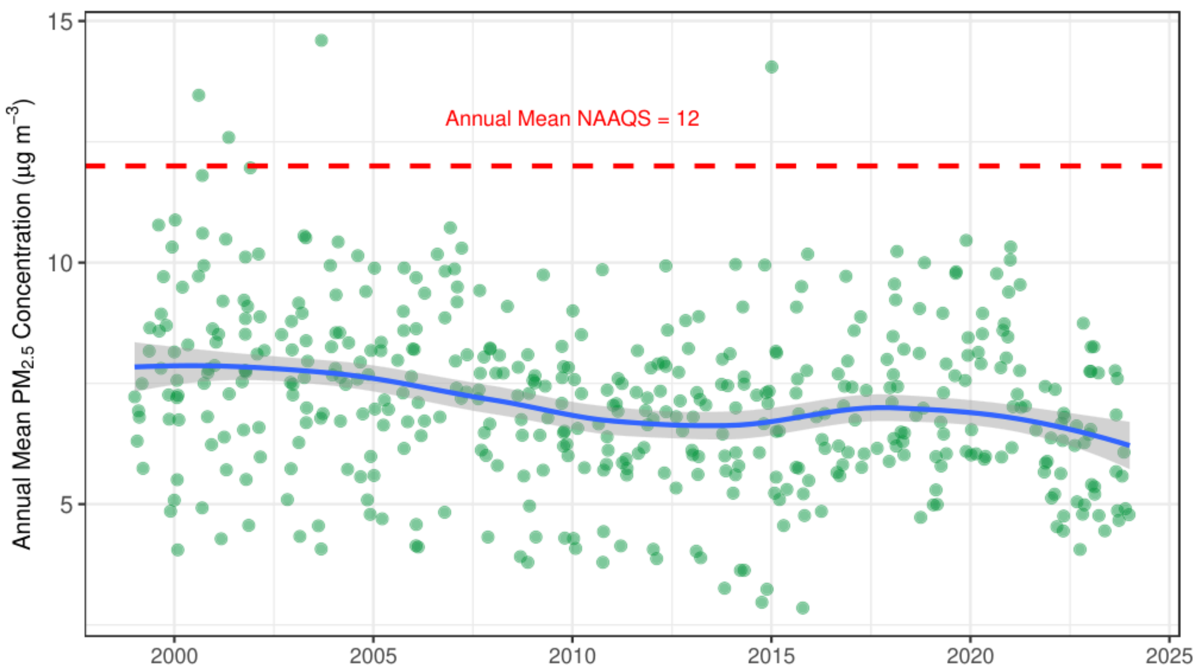

Figure 2.18: Statewide historical record of annual mean $PM_{2.5}$ values. The mean trend obtained using a generalized additive model is shown as a blue line.

3. Non-Criteria Pollutants

Non-criteria pollutants are those pollutants for which there are no current national ambient air quality standards. These include but are not limited to visibility, certain oxides of nitrogen species, total suspended particulates, some continuous particulate monitoring, and air toxics. Meteorological measurements of wind speed, wind direction, temperature, and humidity are also included in this group, as is chemical speciation of $PM_{2.5}$.

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 we experience it.

3.1.1. Standards

The Colorado Air Quality Control Commission established a visibility standard in 1990 for the Denver Metropolitan "AIR Program" area. The standard, an atmospheric extinction of 0.076 per inverse 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% of the light is extinguished in each kilometer of air, and the standard is violated when the four-hour average extinction exceeds 7.6%. The standard applies from 8 A.M. to 4 P.M. each day, during those hours when the relative humidity is less than 70%. 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 wood burning 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 (Clean Air Act as amended in 1977, Section 169a 1977) 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 man-made air pollution." The implementation of Section 169a has led to federal requirements to protect visual air quality in large national parks and wilderness areas (Visibility Protection for Federal Class 1 Areas n.d.). Twelve of these Class I areas are located in Colorado. Federal and state law prohibits visibility impairment in national parks and wildernesses due to large stationary sources of air pollution.

3.1.2. Impacts on Public Welfare

Visual air quality is an element of public welfare. Specifically, it is an important aesthetic, natural, and economic resource of the State of Colorado. EPA, the US Forest Service, and the US National Park

Service have conducted studies that show that good visibility is something that people undeniably value. They have also shown that impaired visibility affects the enjoyment of a recreational visit to a scenic mountain area. While the value of visibility is difficult to measure, APCD believes that people prefer to have clear views from their homes and offices. These concerns are reflected in residential property values and office rents. Any loss in visual air quality may contribute to corresponding losses in tourism and usually make an area less attractive to residents, potential newcomers, and industry. Researchers have found this link strongest with concentrations of fine particles, which are the main contributor to visibility impairment. In July 1997, the EPA developed a NAAQS for $PM_{2.5}$ (more details are in subsubsection 2.2.5.3). Any control strategies to lower ambient concentrations of fine particulate matter for health reasons will also improve visibility.

3.1.3. Sources

The cause of visibility impairment in Colorado is most often fine particles in the 0.1 to 2.5 μm size range. Light passing from a vista to an observer is either scattered away from the sight path or absorbed by the atmospheric fine particulates. 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 wood burning, 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 theWest contains low humidity and minimal levels of visibility-degrading pollution. Nevertheless, visibility problems occur periodically throughout the state. Wood burning haze is a concern in several mountain communities each winter and Denver has its “Brown Cloud” pollution episodes.[11] Even national parks, monuments, and wilderness areas experience pollution related visibility impairment on occasion due to regional haze, interstate traffic or even regional or global-scale transport of visibility-degrading pollution.[12] 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 acceptable and improve visibility where it is degraded.

3.1.4. Class I Areas in Colorado

Phase 1 of the visibility program, also known as Reasonably Attributable Visibility Impairment (RAVI), addresses impacts in Class I areas by establishing a process to evaluate source specific visibility impacts, or plume blight, from individual sources or small groups of sources. Figure 3.1 illustrates these areas in Colorado.

[11] Neff, W. D. (1997). The Denver Brown Cloud studies from the perspective of model assessment needs and the role of meteorology. Journal of the Air & Waste Management Association, 47(3), 269-285
[12] Kavouras, I. G., Etyemezian, V., DuBois, D. W., Xu, J., & Pitchford, M. (2009). Source reconciliation of atmospheric dust causing visibility impairment in Class I areas of the western United States. Journal of Geophysical Research: Atmospheres (1984-2012), 114(D2)

Section 169B was added to the Clean Air Act Amendments of 1990 to address Regional Haze. Since Regional Haze and visibility problems do not respect state and tribal boundaries, the amendments authorized EPA to establish visibility transport regions as a way to combat regional haze.

Phase 2 of the visibility program addresses Regional Haze. This form of visibility impairment focuses on overall decreases in visual range, clarity, color, and ability to discern texture and details in Class I areas. The responsible air pollutants can be generated in the local vicinity or carried by the wind often many hundreds or even thousands of miles from where they originated.

APCD developed a Regional Haze State Implementation Plan (SIP) in 2010 illustrating how Colorado intends to meet the requirements of EPA's Regional rules for the period ending in 2018 (the first planning period in the rule), while also establishing enforceable controls that will help address the long term national visibility goals targeted to be achieved by the year 2064.

Colorado's Regional Haze SIP was approved by the Colorado Air Quality Control Commission on January 7, 2011. This plan will lead to less haze and improved visibility in some of Colorado's most treasured and scenic areas, including Rocky Mountain National Park, Mesa Verde, Maroon Bells, and the Great Sand Dunes.[13]

[13] https://oitco.hylandcloud.com/POP/DocPop/DocPop.aspx?docid=3262052

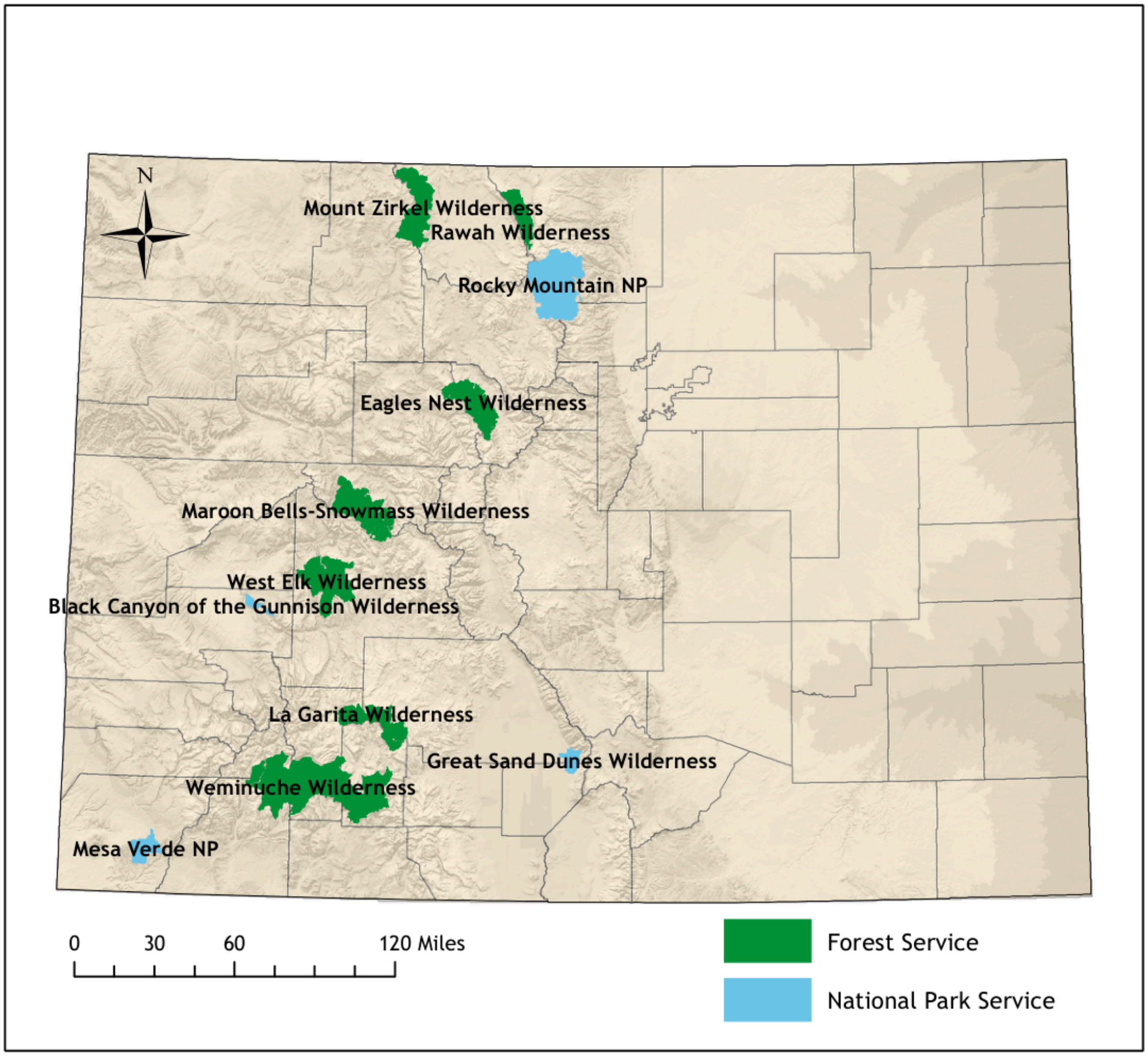

Figure 3.1: Class I areas in Colorado shown in green and blue. Blue indicates a National Park or Preserve, and green indicates a federally-protected wilderness area.

3.1.5. Monitoring

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

A visibility site was installed in Denver in late 1990 using a long-path transmissometer. Visibility in the downtown area is monitored using a receiver located near Cheesman Park at 1901 E. 13th Avenue and a transmitter located on the roof of the Federal Building at 1929 Stout Street (Figure 3.2). This instrument directly measures light extinction, which is proportional to the ability of atmospheric particles and gases to attenuate image-forming light as it travels from an object to an observer. The visibility standard is stated in units of atmospheric extinction. Days when the visibility is affected by rain, snow, or relative humidity above 70% are termed "excluded" and are not counted as violations of the visibility standard.

Elsewhere in Colorado, several agencies of the federal government, in cooperation with regional and nationwide state air pollution organizations, also monitor visibility in a number of national parks and wilderness Class I areas, either individually or jointly through the Interagency Monitoring of Protected Visual Environments (IMPROVE) program. The goals of the monitoring programs are to establish background visibility levels, identify trends of deterioration or improvement, 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 IMPROVE monitoring sites in Rocky Mountain National Park, Mesa Verde National Park, Weminuche Wilderness, Mount Zirkel Wilderness, Great Sand Dunes National Monument, White River National Forest, and San Juan National Forest. These data are not contained in this report, but are available at https://vista.cira.colostate.edu/improve/.

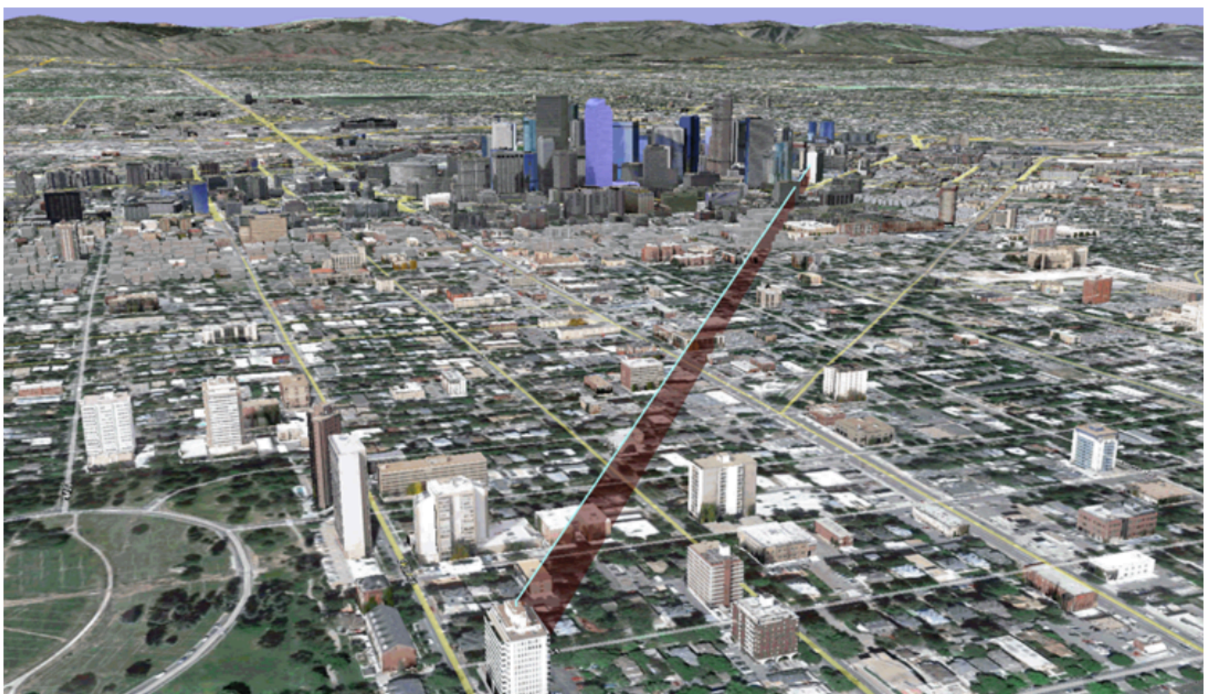

Figure 3.2: Denver transmissometer path (for illustration purposes only).

3.1.6. Denver Camera

APCD operates a web-based camera that can be viewed on the Live Image of Denver icon on the bottom left side of the screen at the APCD web site https://www.colorado.gov/airquality. There is a great deal of other information available from this site in addition to the image from the visibility camera, including the Front Range Air Quality Forecast, Air Quality Advisory, Monitoring Reports, this report, and the Open Burning Forecast.

The images in Figure 3.3 show the visibility on one of the worst and one of the best days for the year, 07/22/24 and 05/08/24, respectively.

Figure 3.3: Denver Camera images of the worst (left) and best (right) visibility days in Denver during 2024.

These two pictures are images made by the web camera at the visibility monitor located at 1901 E. 13th Avenue in Denver, and are centered on the Federal Building at 1929 Stout Street (see Figure 3.2, the camera follows the transmissometer path). The difference in these two pictures is not just the brightness but the detail that can be seen between the two images. On the worst day, contrast between buildings is lower, and the Front Range is obscured. On the best day, however, buildings can be clearly resolved, and the Front Range is visible.

3.2. Nitric Oxide

Nitric oxide (NO) 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, NO is a precursor to nitrogen dioxide, nitric acid, particulate nitrates, and ozone, all of which have demonstrated adverse health effects. There are no federal or state standards for nitric oxide. Nitric oxide was measured simultaneously with NO_2 at the Welby, CAMP, La Casa, I-25 Globeville, I-25 Denver, Rocky Flats - N, Fossil Creek, Bethke, and La Salle sites. Table 3.1 shows the maximum and average NO concentrations measured in Colorado in 2024. Without national standards with which to compare these numbers, they are presented here for informational purposes only, and are considered by APCD to be consistent with recent historical nitric oxide concentrations.

Table 3.1: Summary of average and maximum one-hour nitric oxide values measured at APCD monitoring sites in 2024.

Site Name	County	NO (ppb)	
		Annual Average	Maximum Value
Welby	Adams	9.8	227
CAMP	Denver	6.1	248
La Casa	Denver	6.5	200
I-25: Denver	Denver	20.1	242
I-25: Globeville	Denver	26.9	309
Rocky Flats - N	Jefferson	0.2	14
Fossil Creek	Larimer	3.3	45
Bethke	Larimer	1.8	46
La Salle	Weld	1.1	104

3.3. 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 air toxics 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 like cars, trucks, and construction equipment, and stationary sources like factories, refineries, and power plants, as well as indoor sources (some building materials and cleaning solvents). Some air toxics are also released from natural sources such as volcanic eruptions and forest fires.[14]

People exposed to air toxics at sufficient concentrations may experience various health effects including cancer and damage to the immune system, as well as neurological, reproductive (including reduced fertility), developmental, respiratory, and other health problems. In addition to exposure from breathing air toxics, risks are also 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.

In 2024, the APCD monitored air toxics at eight monitoring sites located in Greeley, La Salle, Platteville, Brighton, Commerce City, Rocky Flats, Chatfield State Park, and Grand Junction. Since 2004, APCD has monitored air toxics in Grand Junction as part of EPA's National Air Toxics Trend Stations project. This network grew to include La Salle and Birch Street sites in 2024. Monitoring for ozone precursors, which are a subset of air toxics, began at CAMP and Platteville Middle School in December of 2011 and was added to Brighton, Missile Site Park (Greeley), Chatfield State Park, and Rocky Flats sites between 2020 and 2024. Ozone precursor monitoring at the CAMP site was discontinued in late 2023. The data from the Grand Junction study and the Ozone Precursor study are available in separate reports, available at: https://cdphe.colorado.gov/public-information/air-monitoring-data-and-technical-reports.

3.4. Meteorology

APCD takes a limited set of meteorological measurements at 17 locations around the state. These measurements include wind speed, wind direction, temperature, standard deviation of horizontal wind direction, and select monitoring of relative humidity and solar radiation. Relative humidity measurements are also taken in conjunction with the two visibility monitors. The humidity data are not summarized in this report since they are used primarily to validate the visibility measurements taken at the specific locations. The wind speed, wind direction, and temperature measurements are collected primarily for air quality forecasting and air quality modeling. These instruments are installed on ten-meter towers and the data are collected as hourly averages and sent along with other air quality data to be stored on the EPA's Air Quality System (AQS) database. The wind speed and wind direction data are shown as wind roses at the end of each monitoring area in subsection 4.2.7.

[14] https://www.epa.gov/haps/hazardous-air-pollutants-sources-and-exposure

The wind roses displayed in this report (see subsection 4.2.7) 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 divided into 12 cardinal directions (ESE, for example). The wind speed is divided into six ranges: 0-2 ms^{-1}, 2-4 ms^{-1}, 4-6 ms^{-1}, 6-8 ms^{-1}, 8-10 ms^{-1}, and greater than 10 ms^{-1}. 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 the percentage of time the wind is blowing from that direction.

3.5. Chemical Speciation of $PM_{2.5}$

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

Colorado began chemical speciation monitoring at the Commerce City site in February 2001. Four other chemical speciation sites were established in 2001 in Colorado Springs, Durango, Grand Junction, and Platteville. The Durango site was closed in September 2003. The Colorado Springs site was closed in December 2006. These sites were eliminated when concentrations were found to trend low and when funding was reduced for the project. The Grand Junction site was closed in December 2009 and moved to DMAS NCore where it began sampling in January of 2010 to comply with the requirement from EPA to monitor $PM_{2.5}$ speciation at NCore sites. The DMAS NCore site was shut down due to redevelopment of the property and moved to the La Casa NCore monitoring site at 4545 Navajo Street in late 2012. APCD is currently monitoring for $PM_{2.5}$ speciation at the La Casa, Platteville and Commerce City monitoring sites.

If $PM_{2.5}$ pollution is to be controlled, it is important to know the composition of $PM_{2.5}$ particles so that the appropriate sources can be targeted for reductions (see subsubsection 2.2.5.2 above for more information on $PM_{2.5}$ sources). Therefore, chemical speciation monitoring is conducted for 47 elemental metals, five ionic species, and elemental and organic carbon. Selected filters can also be analyzed for semi-volatile organics and microscopic analyses. The results of these samples can be obtained from APCD upon request. Some of these chemical species and compounds can cause serious health effects, premature death, visibility degradation, and regional haze. The chemical speciation data for $PM_{2.5}$ is used in many ways, such as to determine which general source categories are likely responsible for the $PM_{2.5}$ pollution at a given monitoring site on a given day, and how much pollution comes from each source category. There are two broad categories of $PM_{2.5}$ - primary and secondary particles. Primary $PM_{2.5}$ particles include those emitted directly to the air. Primary particles include carbonaceous particles from incomplete combustion in internal combustion engines, wood burning appliances, waste burning, and crushed geologic materials. Secondary $PM_{2.5}$ is formed from gases that combine in the atmosphere through chemical processes and form liquid aerosol droplets. Ammonium nitrates and ammonium sulfates are generally the two largest types of secondary $PM_{2.5}$ in Colorado.

4. Spatial Variability of Air Quality

In this section, concentration data covering the last fifteen years are summarized for each air quality monitor in the APCD network, which are grouped below by monitoring region and pollutant. The plots in this section show annual means and one-hour, eight-hour, or 24-hour values in the form of the NAAQS standards. The values recorded at individual sites are compared to statewide averages, which are shown in light blue in all plots. Please refer to subsection 1.1.2 for a brief description of the monitoring regions discussed below.

4.1. Central Mountains Region

Monitoring data from the central mountains monitoring region are shown in tables 4.1-4.2 and figure 4.1 below.

4.1.1. Particulate Matter

PM data for the Central Mountain Region is shown below. The data shown may include exceptional events. See subsubsection 2.2.5.4 for a description of exceptional events.

Table 4.1: Summary of PM_{10} values recorded at monitoring stations in the Central Mountains region during 2024.

			PM_{10} (µg m^{-3})		
Site Name	County	POC	Annual Mean	24-Hr Max	3-Year Exceedances
Cañon City	Fremont	3	17.1	72	0
Aspen	Pitkin	3	17.4	81	0
Steamboat Springs	Routt	4	15.6	59	0

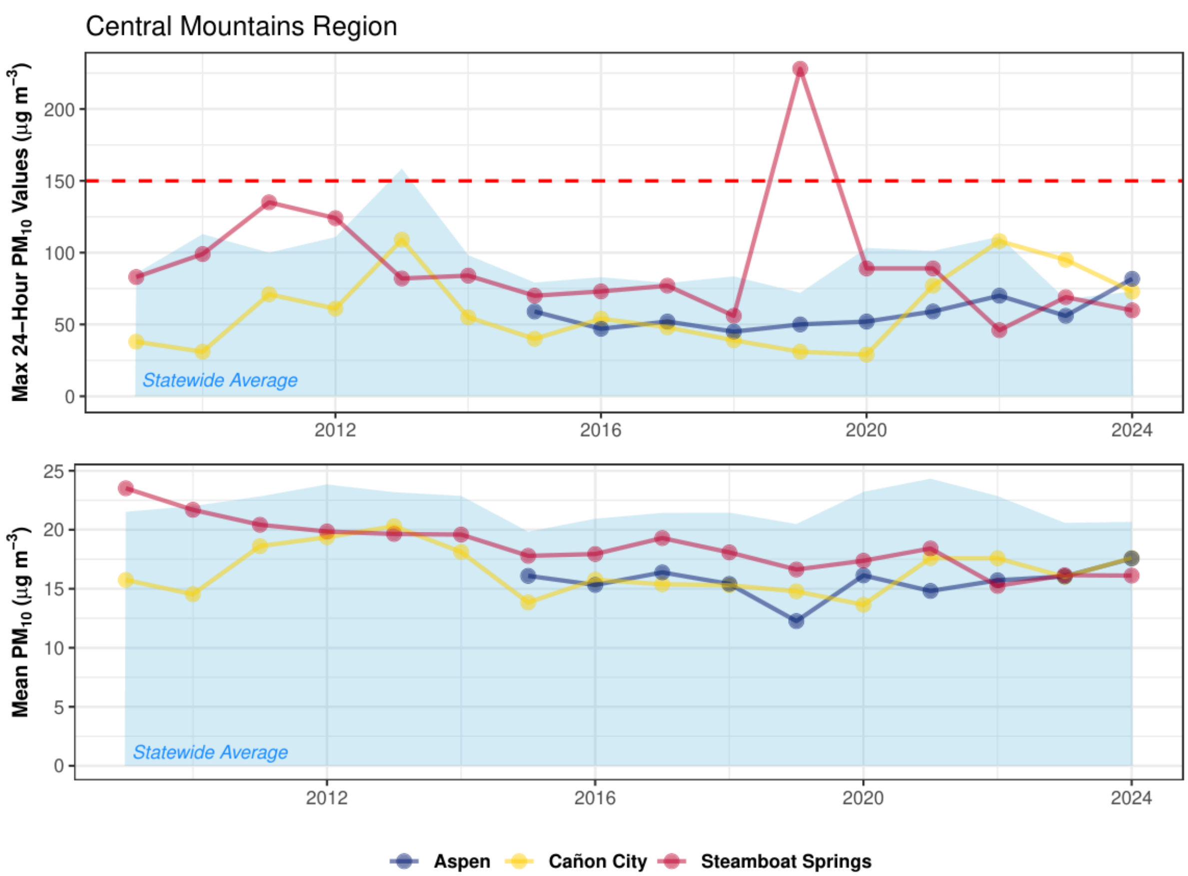

Figure 4.1: Fifteen-year trend in maximum 24-hour PM_{10} values (top) and annual mean concentrations (bottom) for monitoring sites in the Central Mountains region. The 24-hour NAAQS (150 mg m^{-3}) is shown as a dashed red line.

Table 4.2: Summary of $PM_{2.5}$ values recorded at monitoring stations in the Central Mountains region during 2024. The Aspen $PM_{2.5}$ monitor is less than three years old, and did not have three years of regulatory monitoring data at the time of this report. Therefore the design value listed for this site is not directly comparable to the 3-year NAAQS standard for $PM_{2.5}$.

			$PM_{2.5}$ (µg m^{-3})		
Site Name	County	POC	Annual Mean	98^{th} Percentile	3-Year Avg. of 98^{th} percentile
Aspen	Pitkin	3	4.2	13	13

4.2. Denver Metro / North Front Range Region

Monitoring data from the Denver Metro / North Front Range monitoring region are shown in tables 4.3-4.8 and figures 4.2-4.30 below.

4.2.1. Particulate Matter

There were no violations of the PM_{10} or $PM_{2.5}$ NAAQS in the Denver Metro/Northern Front Range counties in 2024. The Boulder - CU and CAMP monitors do not meet requirements for three consecutive years of operation; therefore, while the 2023 PM values are reported, the data from these sites cannot be compared to the NAAQS in terms of a three-year average. The $PM_{2.5}$ plots below show the 98th percentile of the data collected during each year rather than the three-year average.

Table 4.3: Summary of PM_{10} values recorded at monitoring stations in the Denver Metro/Northern Front Range region during 2024. The Boulder CU PM_{10} monitor is new, and did not have three years of regulatory monitoring data at the time of this report. Therefore the design value listed for this site is not directly comparable to the 3-year NAAQS standard for PM_{10}. CAMP and Bouder CC monitoring data are not shown, as PM_{10} monitoring at the sites was decommissioned in 2024.

			PM_{10} (µg m^{-3})		
Site Name	County	POC	Annual Mean	24-Hr Max	3-Year Exceedances
Birch Street	Adams	3	35.7	142	0
Welby	Adams	3	33.6	139	0
Longmont Municipal Bldg	Boulder	4	23.9	92	0
Boulder - CU - Athens	Boulder	3	17.5	72	0
La Casa	Denver	1	21.7	65	0

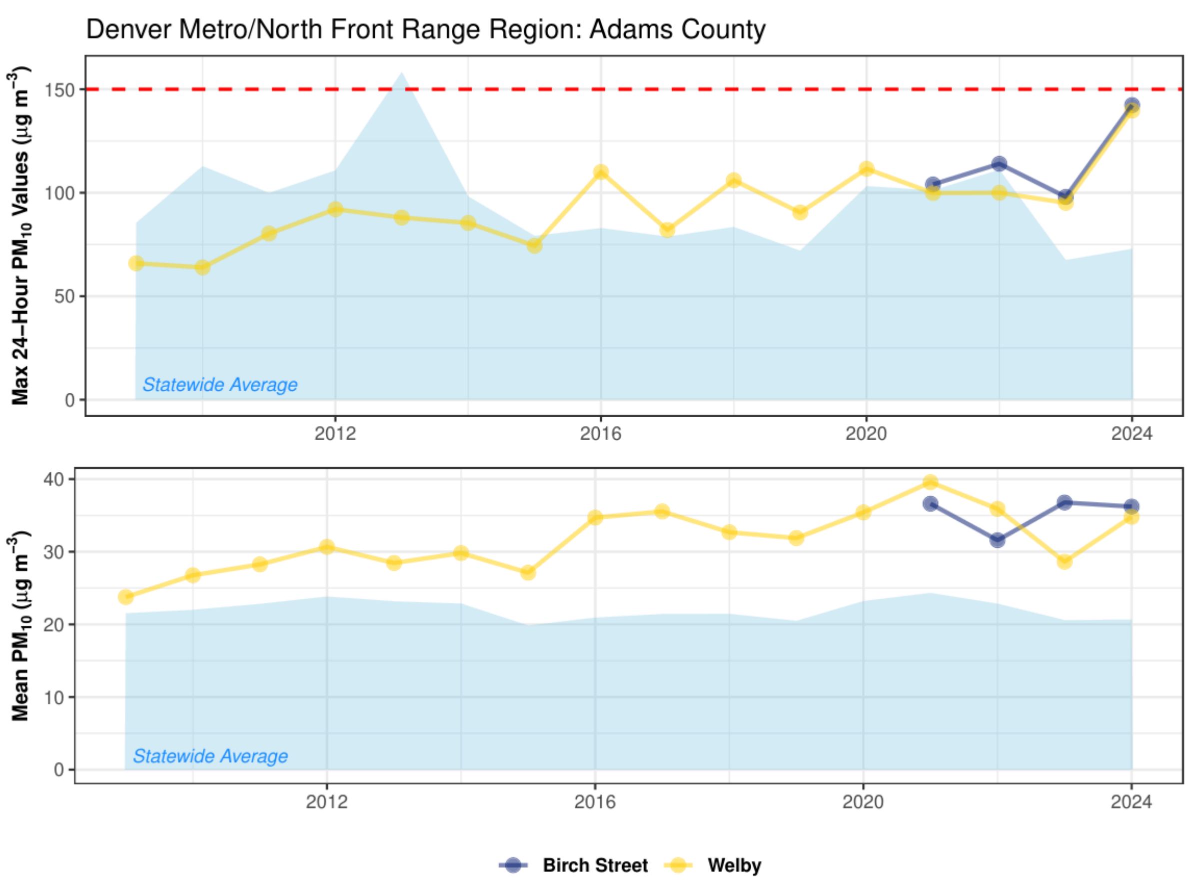

Figure 4.2: Fifteen-year trend in maximum 24-hour PM_{10} values (top) and annual mean concentrations (bottom) for monitoring sites in Adams County. The 24-hour NAAQS (150 mg m^{-3}) is shown as a dashed red line.

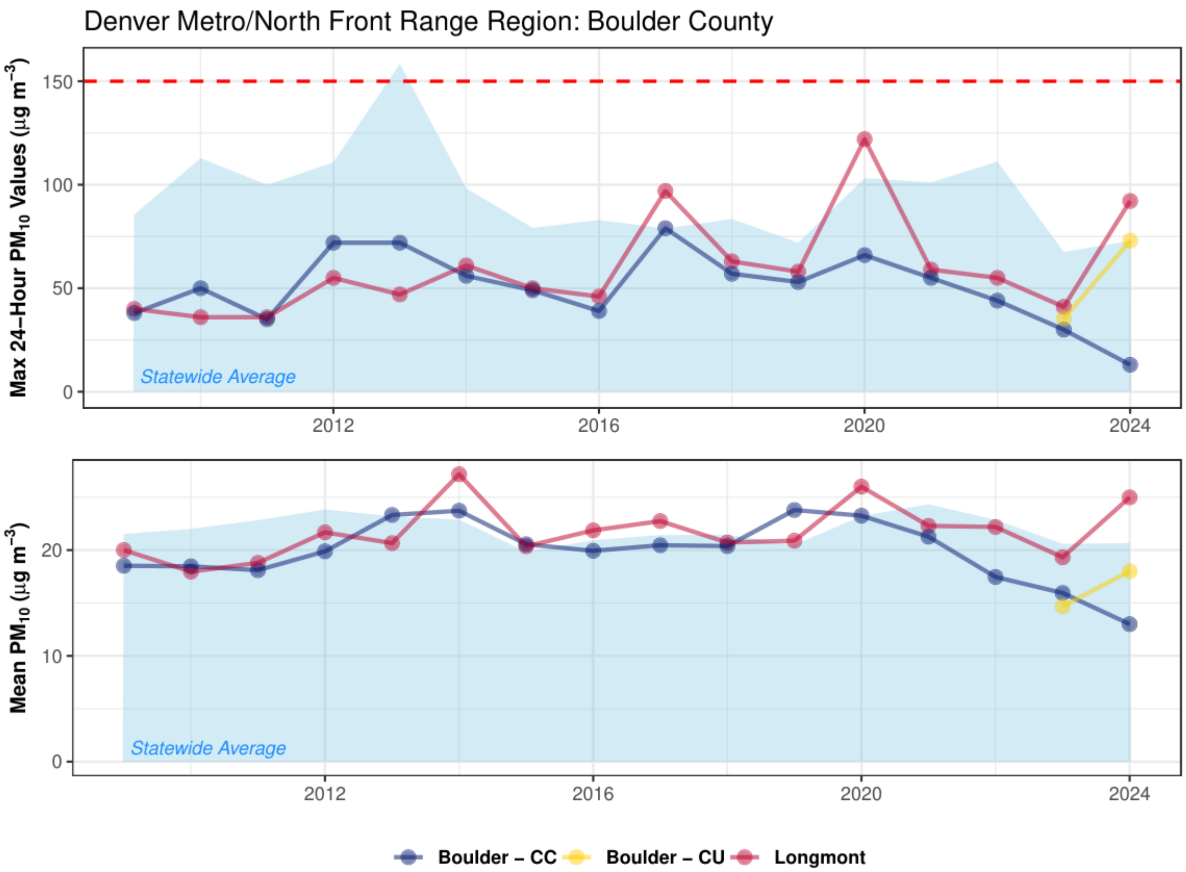

Figure 4.3: Fifteen-year trend in maximum 24-hour PM_{10} values (top) and annual mean concentrations (bottom) for monitoring sites in Boulder County. The 24-hour NAAQS (150 mg m^{-3}) is shown as a dashed red line.

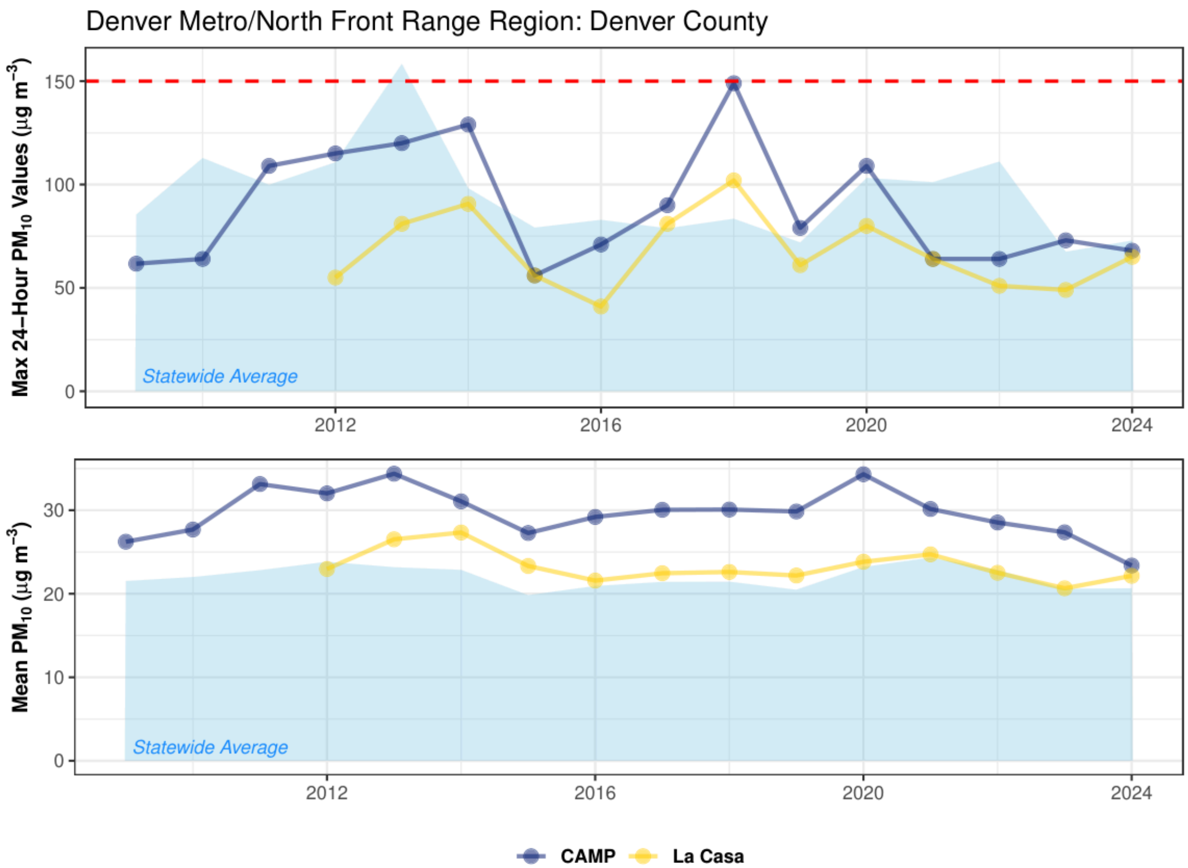

Figure 4.4: Fifteen-year trend in maximum 24-hour PM_{10} values (top) and annual mean concentrations (bottom) for monitoring sites in Denver County. The 24-hour NAAQS (150 mg m^{-3}) is shown as a dashed red line.

Table 4.4: Summary of $PM_{2.5}$ values recorded at monitoring stations in the Denver Metro/Northern Front Range region during 2024. The Welby and Boulder CU $PM_{2.5}$ monitors are less than three years old, and did not have three years of regulatory monitoring data at the time of this report. The Bethke monitoring site is also less than three years old, and did not have three years of regulatory monitoring data at the time of this report. Therefore the design values listed for these sites are not directly comparable to the 3-year NAAQS standard for $PM_{2.5}$.

			$PM_{2.5}$ ($\mu g\ m^{-3}$)		
Site Name	County	POC	Annual Mean	98^{th} Percentile	3-Year Avg. of 98^{th} percentile
Birch Street	Adams	3	7.1	21.5	21
Welby	Adams	3	7.0	21.6	22
Arapahoe Community College	Arapahoe	3	5.3	17.5	15
Longmont Municipal Bldg	Boulder	4	7.0	23.5	19
Boulder - CU - Athens	Boulder	3	4.8	17.2	15
CAMP	Denver	1	6.1	17.3	18
National Jewish Health	Denver	3	6.0	18.5	16
La Casa	Denver	3	5.6	18.3	17
I-25	Denver	3	7.8	21.2	18
Globeville	Denver	3	7.6	19.2	20
Chatfield State Park	Douglas	3	4.5	16.8	14
Fort Collins - CSU - Edison	Larimer	3	6.4	20.5	19
Bethke	Larimer	3	4.9	13.4	13
Greeley - Hospital	Weld	3	6.8	20.6	22
Platteville - Middle School	Weld	3	7.7	24.8	22

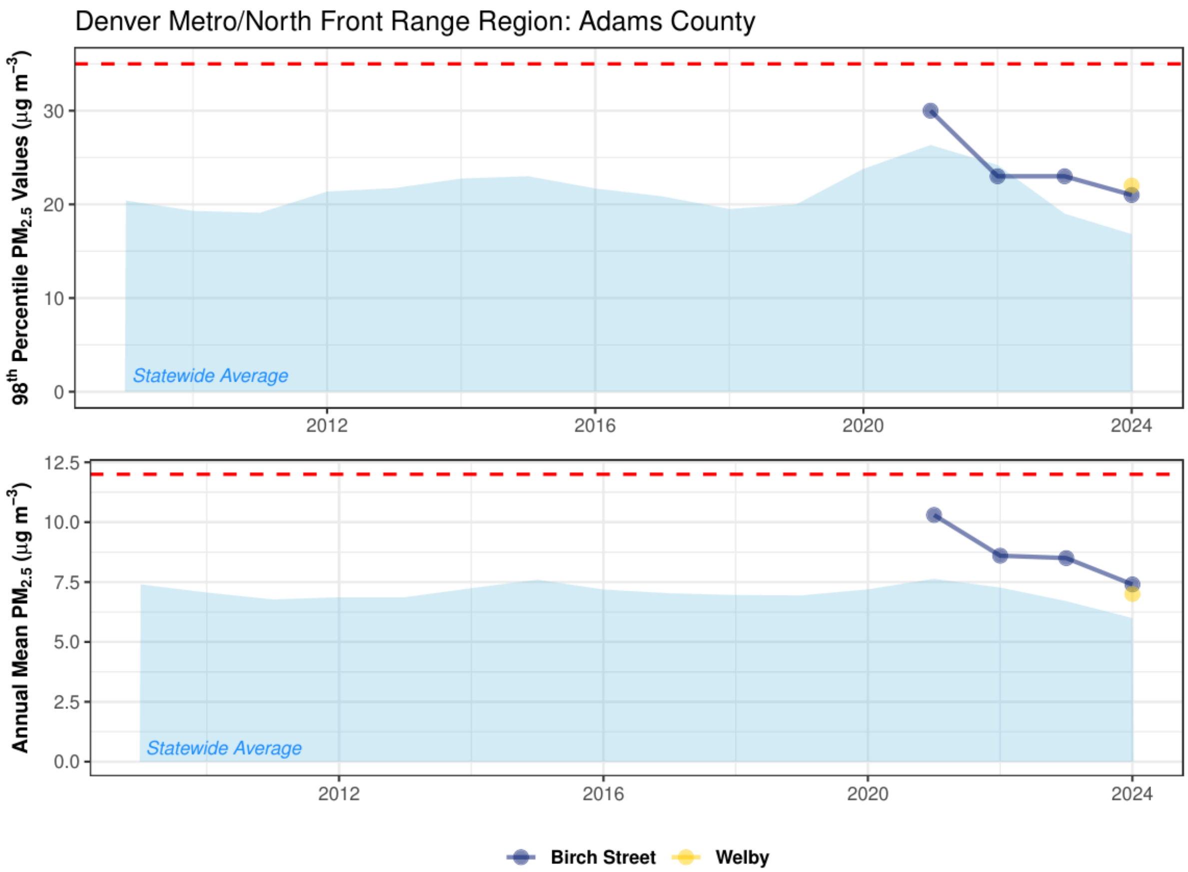

Figure 4.5: Fifteen-year trend in 24-hour $PM_{2.5}$ annual 98th percentile values (top) and annual mean concentrations (bottom) for monitoring sites in Adams County. The 24-hour and annual mean NAAQS (35 mg m^{-3} and 12 mg m^{-3}, respectively) are shown as dashed red lines.

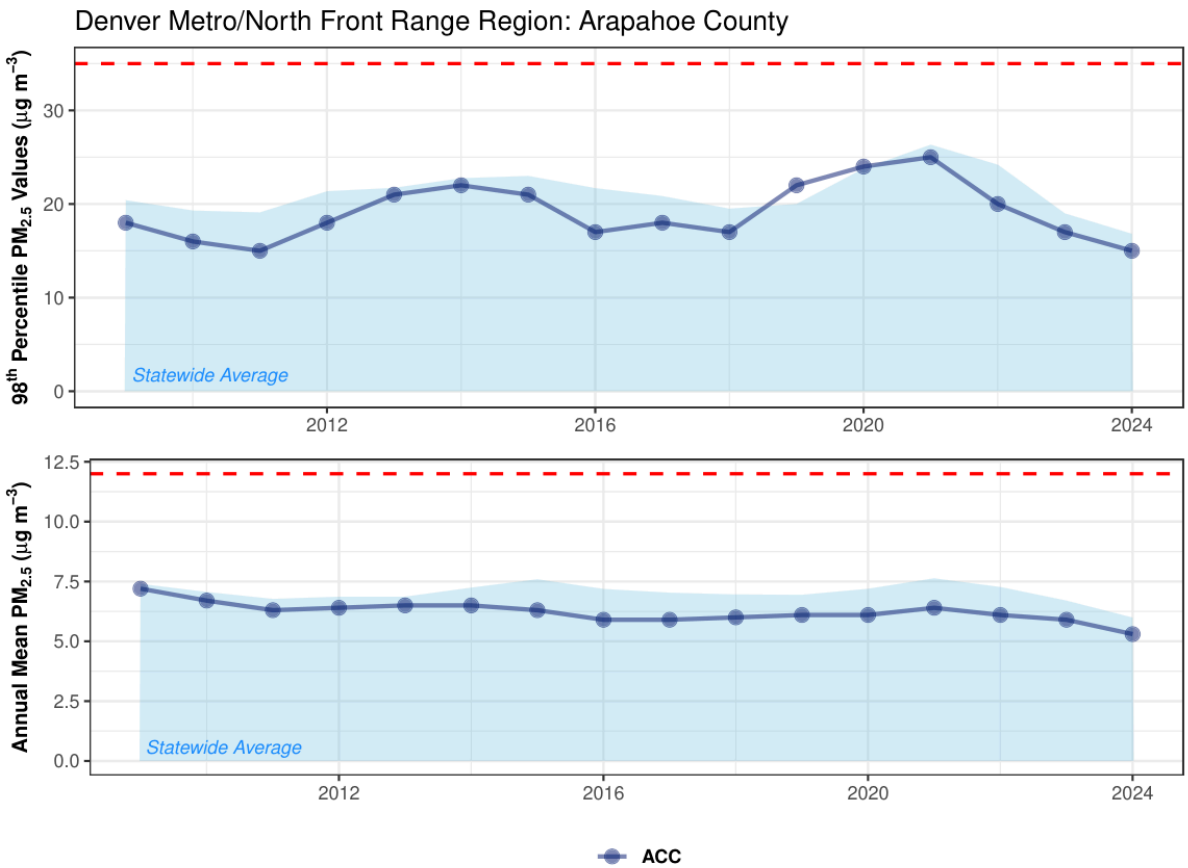

Figure 4.6: Fifteen-year trend in 24-hour $PM_{2.5}$ annual 98th percentile values (top) and annual mean concentrations (bottom) for monitoring sites in Arapahoe County. The 24-hour and annual mean NAAQS (35 mg m^{-3} and 12 mg m^{-3}, respectively) are shown as dashed red lines.

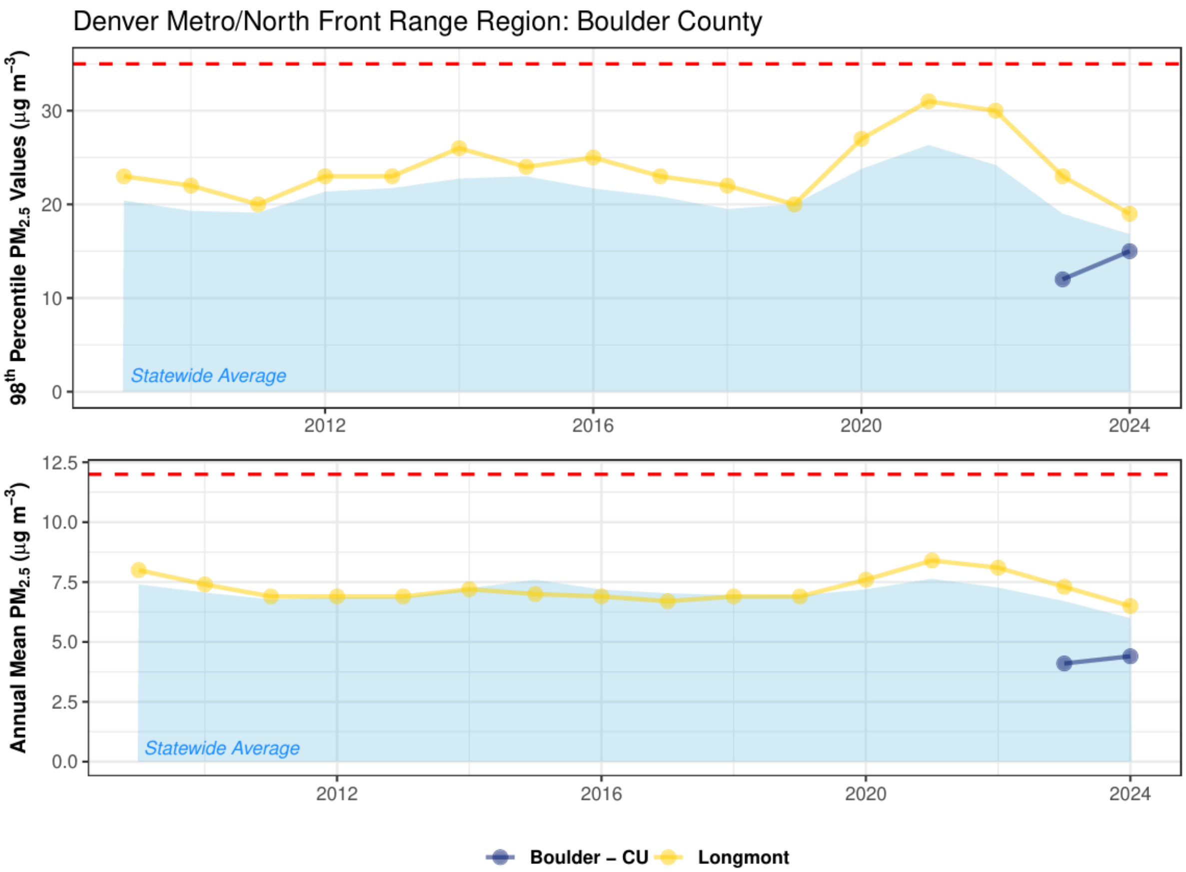

Figure 4.7: Fifteen-year trend in 24-hour $PM_{2.5}$ annual 98th percentile values (top) and annual mean concentrations (bottom) for monitoring sites in Boulder County. The 24-hour and annual mean NAAQS (35 mg m^{-3} and 12 mg m^{-3}, respectively) are shown as dashed red lines.

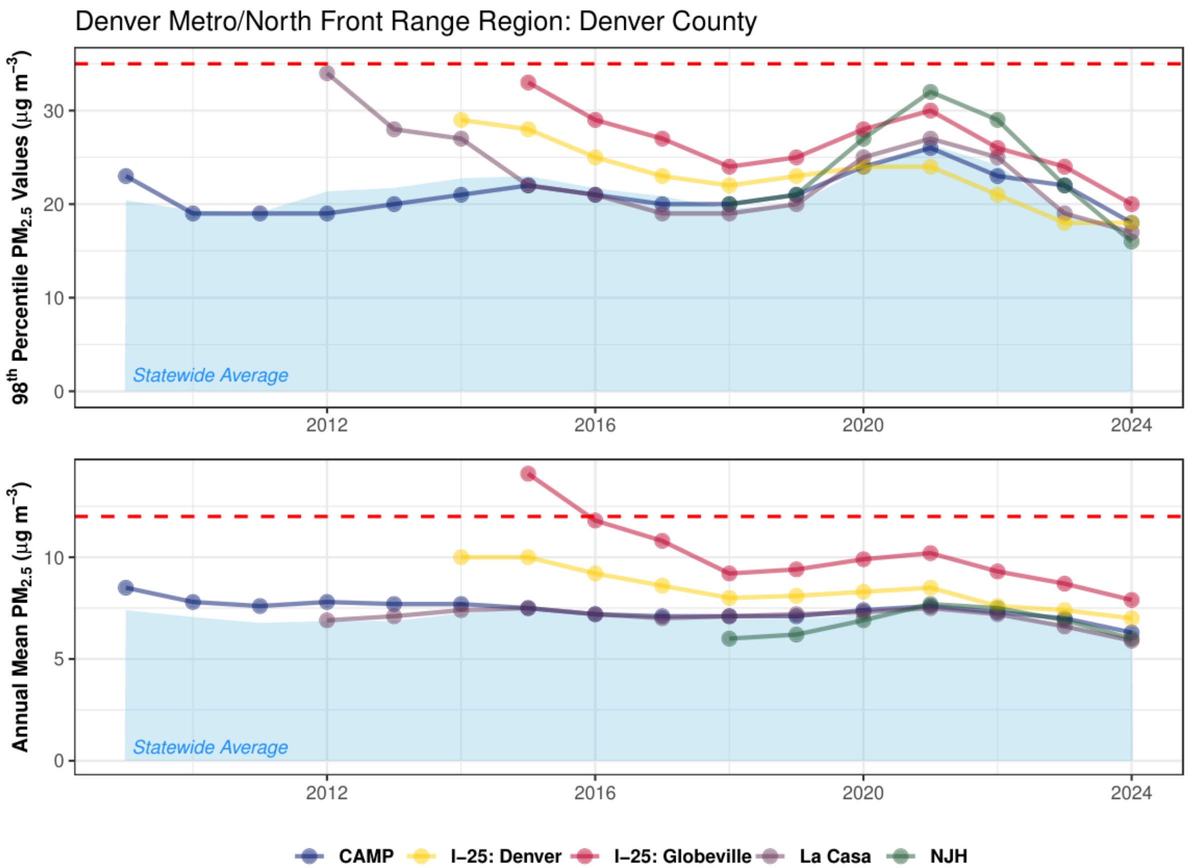

Figure 4.8: Fifteen-year trend in 24-hour $PM_{2.5}$ annual 98th percentile values (top) and annual mean concentrations (bottom) for monitoring sites in Denver County. The 24-hour and annual mean NAAQS (35 mg m^{-3} and 12 mg m^{-3}, respectively) are shown as dashed red lines.

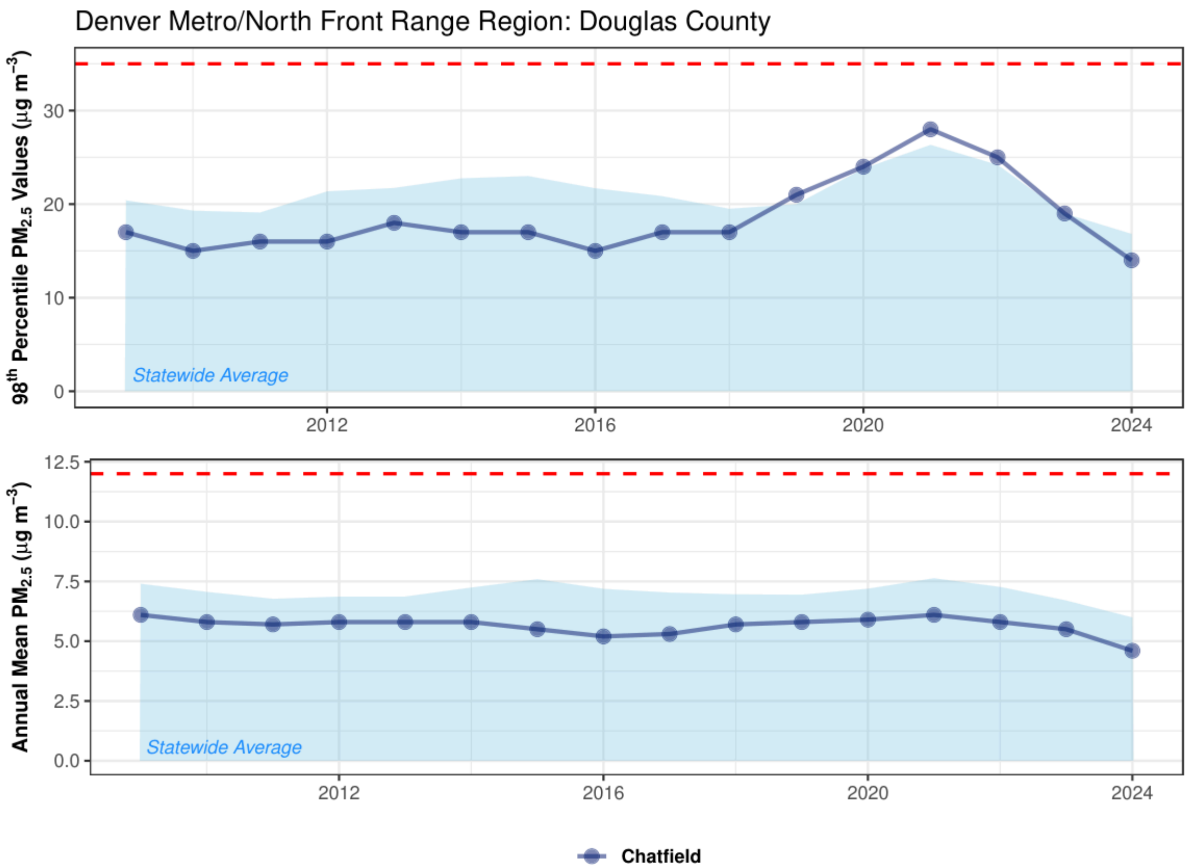

Figure 4.9: Fifteen-year trend in 24-hour $PM_{2.5}$ annual 98th percentile values (top) and annual mean concentrations (bottom) for monitoring sites in Douglas County. The 24-hour and annual mean NAAQS (35 mg m^{-3} and 12 mg m^{-3}, respectively) are shown as dashed red lines.

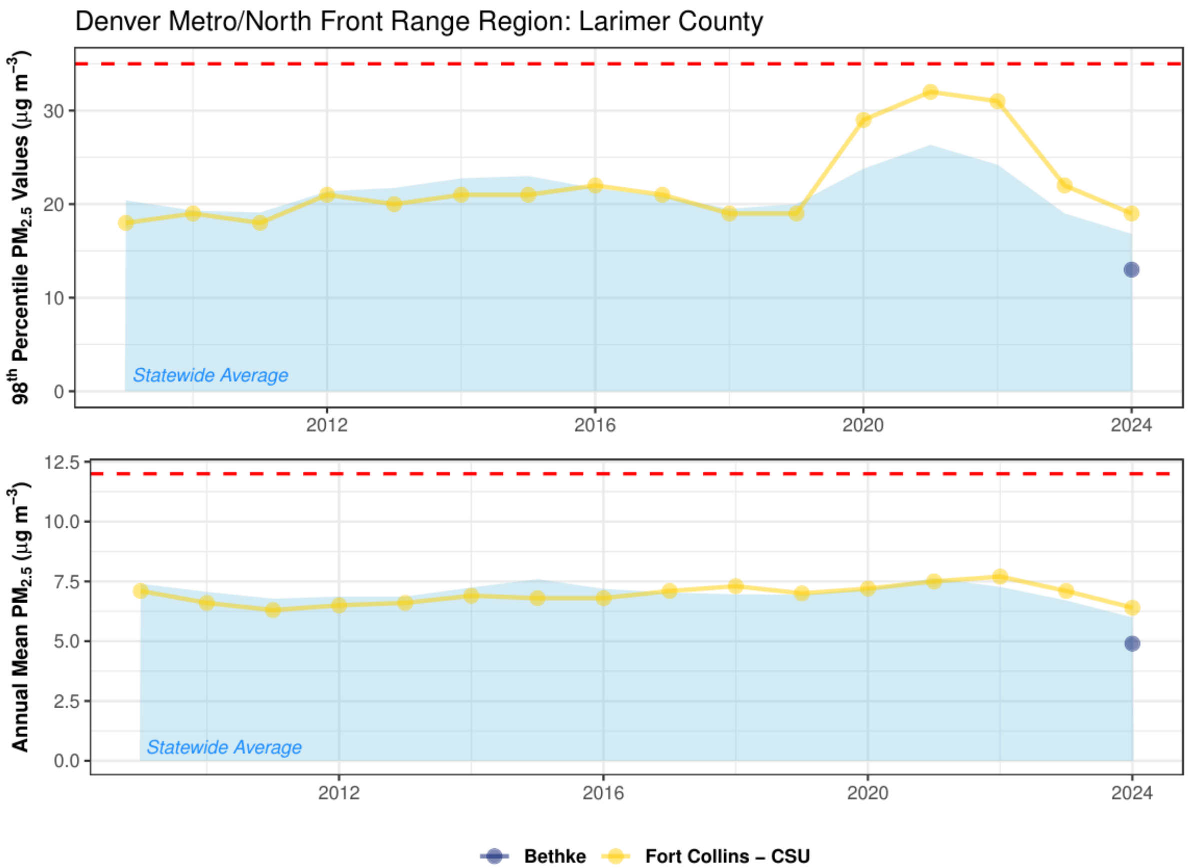

Figure 4.10: Fifteen-year trend in 24-hour $PM_{2.5}$ annual 98th percentile values (top) and annual mean concentrations (bottom) for monitoring sites in Larimer County. The 24-hour and annual mean NAAQS (35 mg m^{-3} and 12 mg m^{-3}, respectively) are shown as dashed red lines.

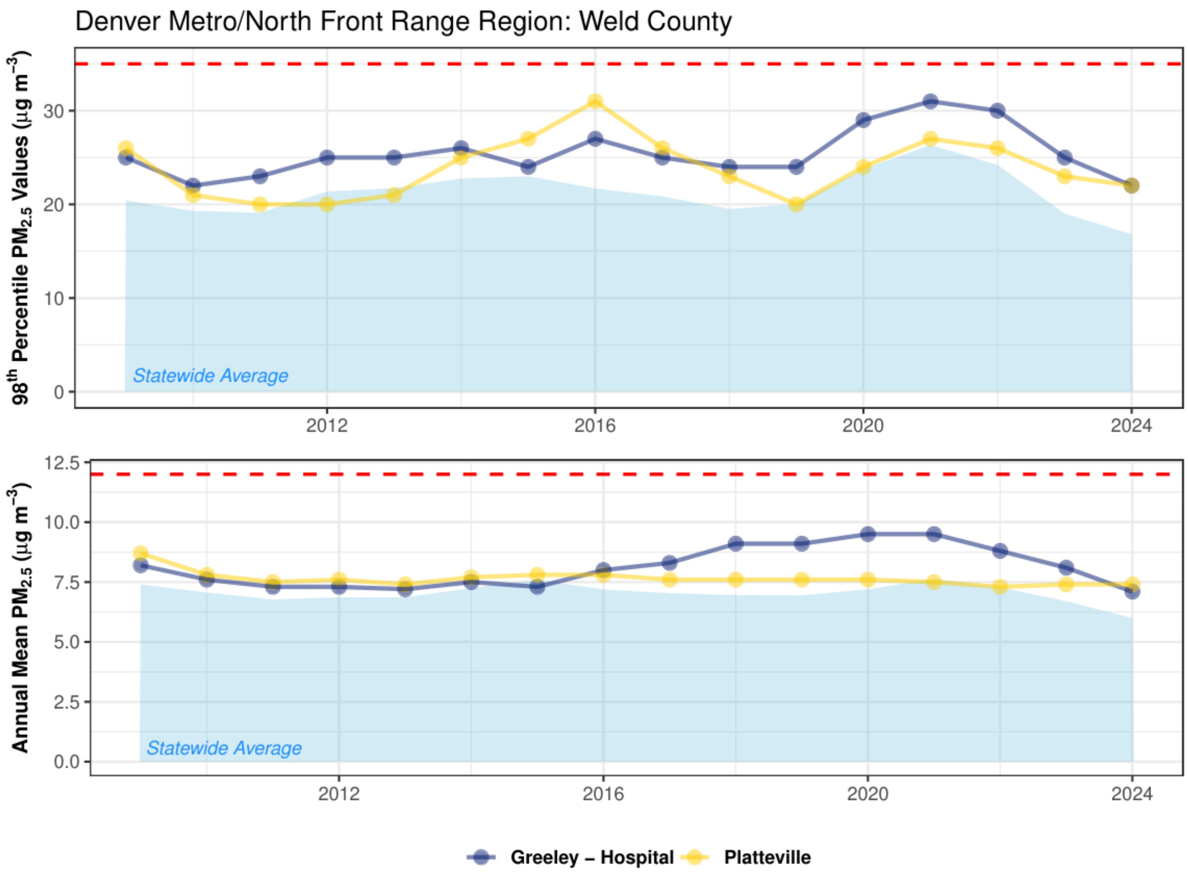

Figure 4.11: Fifteen-year trend in 24-hour $PM_{2.5}$ annual 98th percentile values (top) and annual mean concentrations (bottom) for monitoring sites in Weld County. The 24-hour and annual mean NAAQS (35 mg m^{-3} and 12 mg m^{-3}, respectively) are shown as dashed red lines.

4.2.2. Carbon Monoxide

Table 4.5: Summary of CO values recorded at monitoring stations in the Denver Metro / Northern Front Range region during 2024.

			CO 1-Hour Avg. (ppm)		CO 8-Hour Avg. (ppm)	
Site Name	County	POC	1st Max Value	2nd Max Value	1st Max Value	2nd Max Value
La Casa	Denver	1	2.1	2.0	1.9	1.3
I-25	Denver	1	3.7	2.9	2.7	2.1
Fort Collins - CSU - Mason	Larimer	1	2.0	1.8	1.2	1.0
Greeley - Weld County Tower	Weld	1	1.5	1.2	1.1	0.8

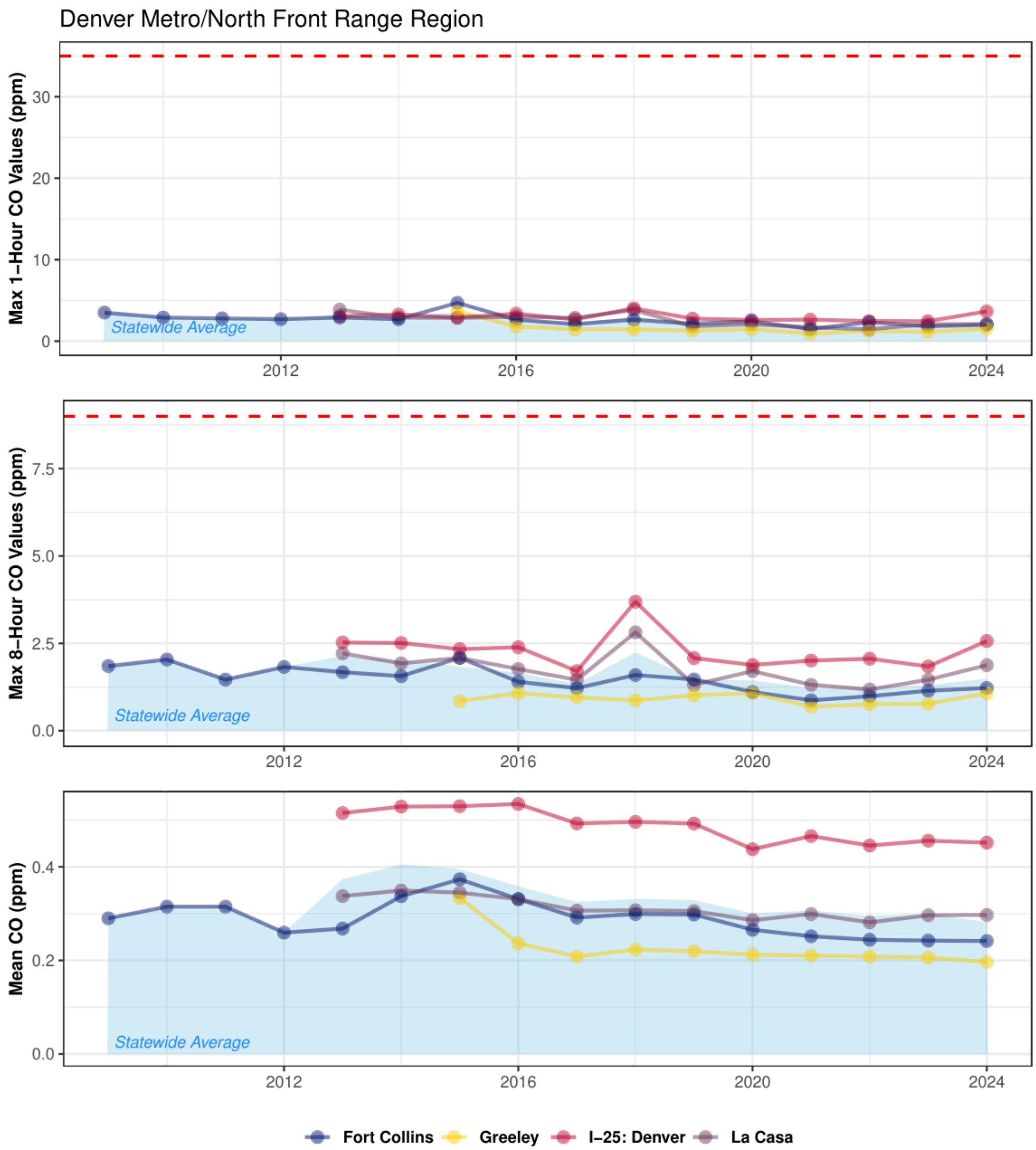

Figure 4.12: Fifteen-year trend in annual maximum one-hour (top) and eight-hour (center) CO values and annual mean eight-hour CO concentrations (bottom) for monitoring sites in the Denver Metro/Northern Front Range region. The one-hour and eight-hour NAAQS (35 ppm and 9 ppm, respectively) are shown as dashed red lines.

4.2.3. Ozone

Table 4.6: Summary of O_3 values recorded at monitoring stations in the Denver Metro / Northern Front Range region during 2024. The Fossil Creek, Bethke, and La Salle sites are less than three years old, and did not have three years of regulatory monitoring data at the time of this report. Therefore the design values listed for these sites are not directly comparable to the 3-year NAAQS standard for ozone. The Mines Peak monitoring site is exempt from NAAQS monitoring due to its unique site characteristics, and therefore does not have a reported design value.

			Ozone 8-Hour Avg. (ppm)		
Site Name	County	POC	1st Max Value	4th Max Value	3-Year Avg. of 4th Max (8-Hr)
Welby	Adams	2	0.090	0.083	0.076
Highlands	Arapahoe	1	0.083	0.073	0.073
Aurora East	Arapahoe	1	0.090	0.081	0.074
Boulder Reservoir	Boulder	1	0.087	0.084	0.075
Mines Peak	Clear Creek	1	0.081	0.077	NA
CAMP	Denver	6	0.088	0.079	0.073
La Casa	Denver	1	0.094	0.084	0.075
Chatfield State Park	Douglas	1	0.092	0.088	0.080
Black Hawk	Gilpin	1	0.085	0.079	0.074
Rocky Flats - N.	Jefferson	1	0.095	0.088	0.081
NREL	Jefferson	1	0.093	0.086	0.079
Evergreen	Jefferson	1	0.092	0.085	0.077
Fort Collins - West	Larimer	1	0.090	0.083	0.075
Fossil Creek	Larimer	1	0.089	0.084	0.084
Bethke	Larimer	1	0.086	0.078	0.078
Fort Collins - CSU - Mason	Larimer	1	0.088	0.082	0.073
Greeley - Weld County Tower	Weld	1	0.090	0.081	0.073
La Salle Tower	Weld	1	0.091	0.079	0.079

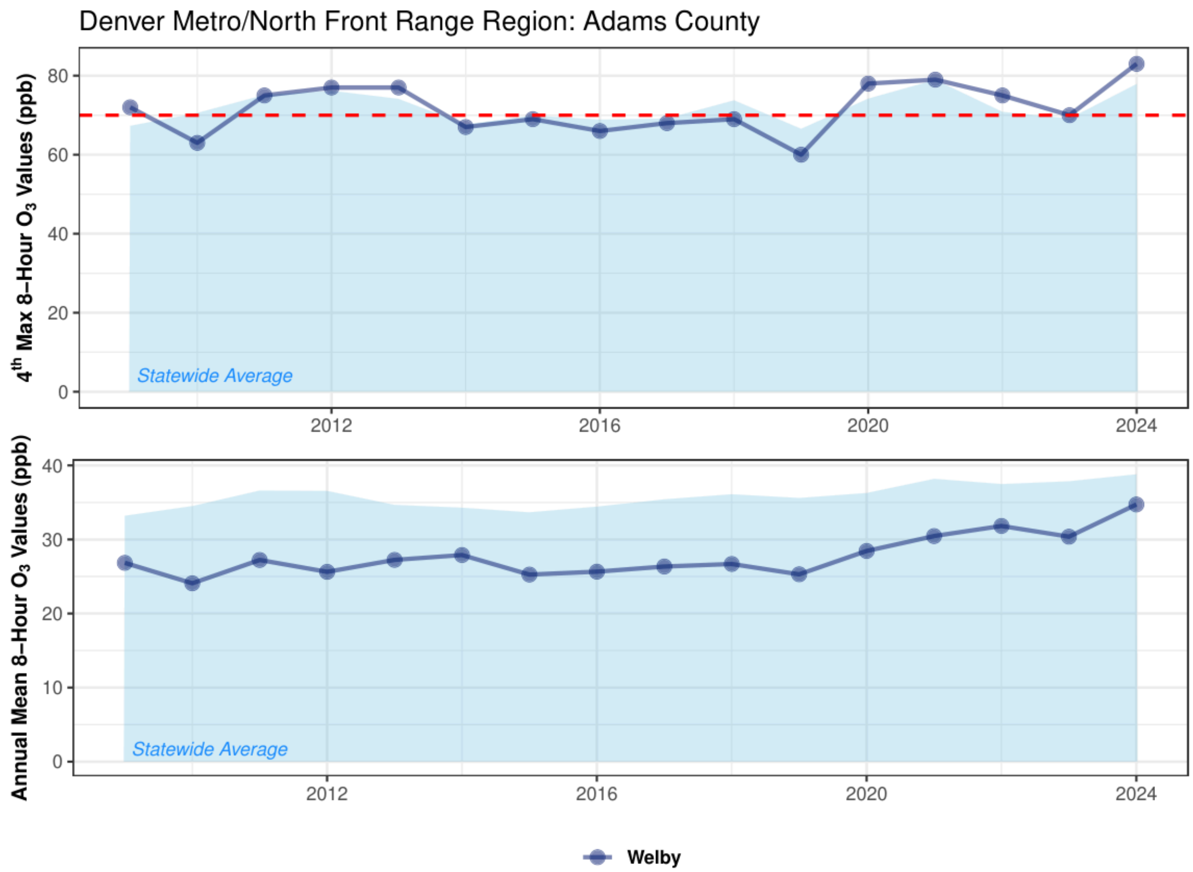

Figure 4.13: Fifteen-year trend in ozone eight-hour NAAQS value (top) and annual mean 8-hour concentration (bottom) for monitoring sites in Adams County. The 8-hour NAAQS (70 ppb) is shown as a dashed red line.

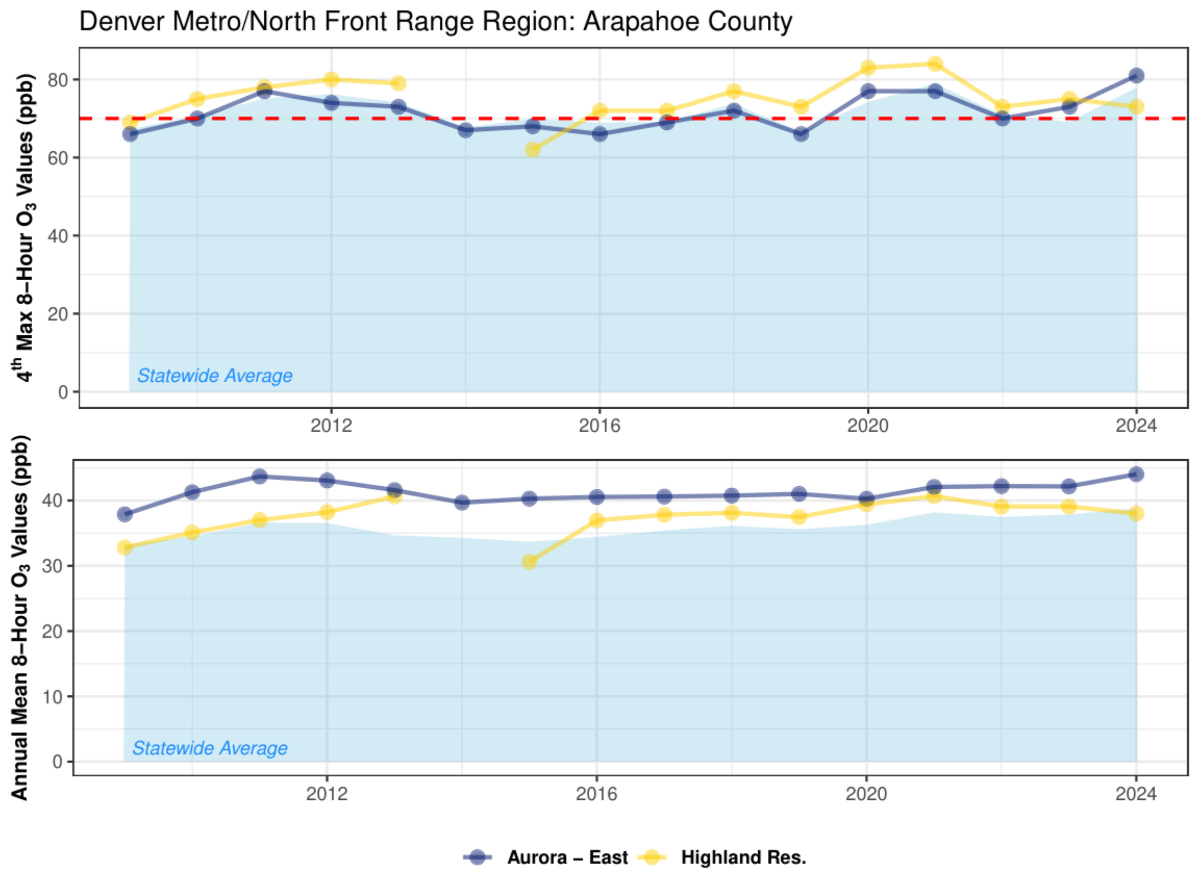

Figure 4.14: Fifteen-year trend in ozone eight-hour NAAQS values (top) and annual mean eight-hour concentrations bottom) for monitoring sites in Arapahoe County. The 8-hour NAAQS (70 ppb) is shown as a dashed red line.

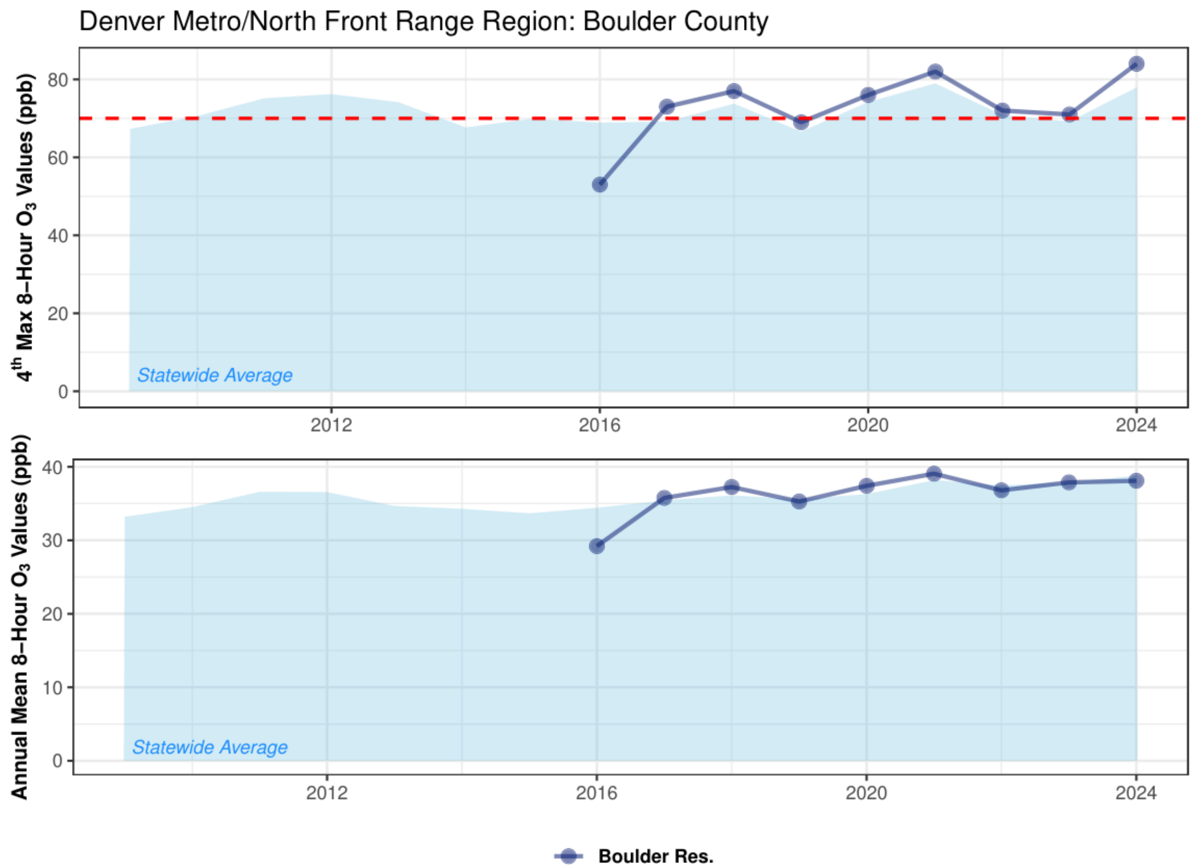

Figure 4.15: Fifteen-year trend in ozone eight-hour NAAQS values (top) and annual mean eight-hour concentrations (bottom) for monitoring sites in Boulder County. The eight-hour NAAQS (70 ppb) is shown as a dashed red line.

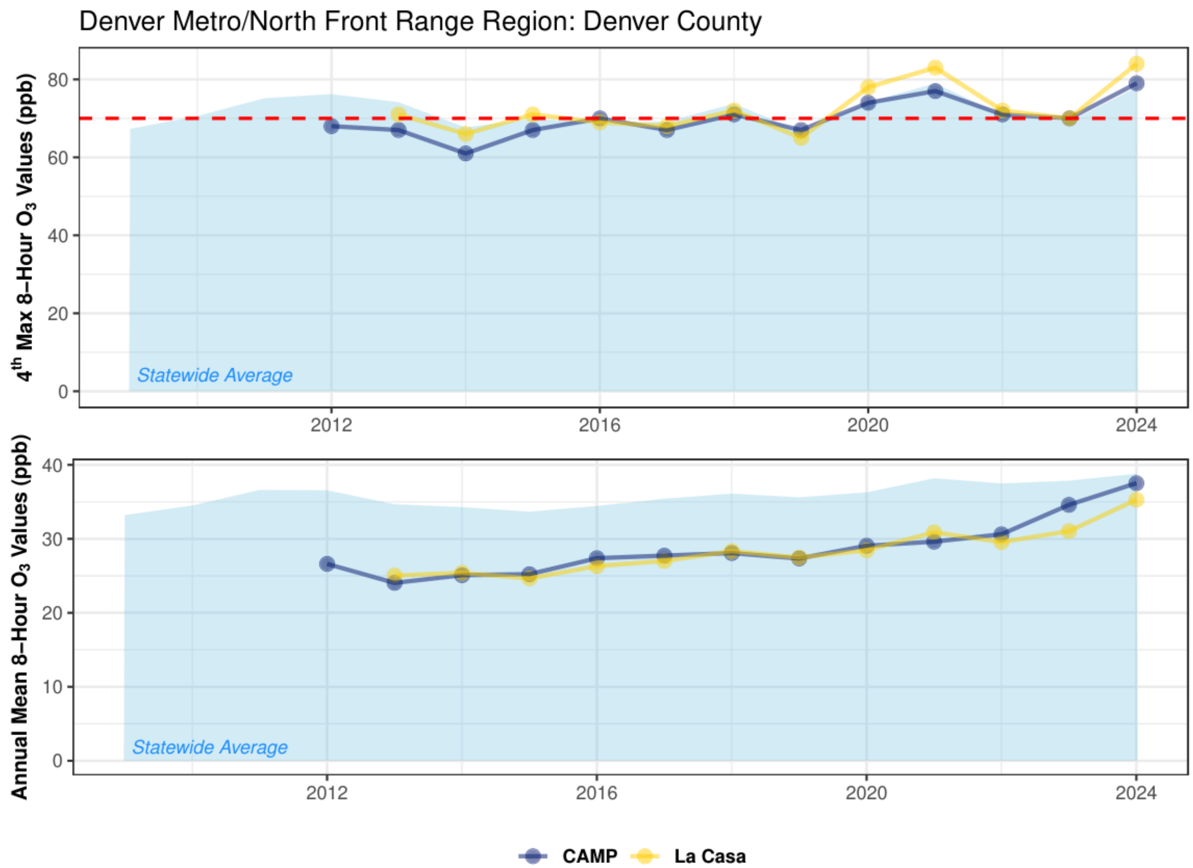

Figure 4.16: Fifteen-year trend in ozone eight-hour NAAQS values (top) and annual mean eight-hour concentrations (bottom) for monitoring sites in Denver County. The eight-hour NAAQS (70 ppb) is shown as a dashed red line.

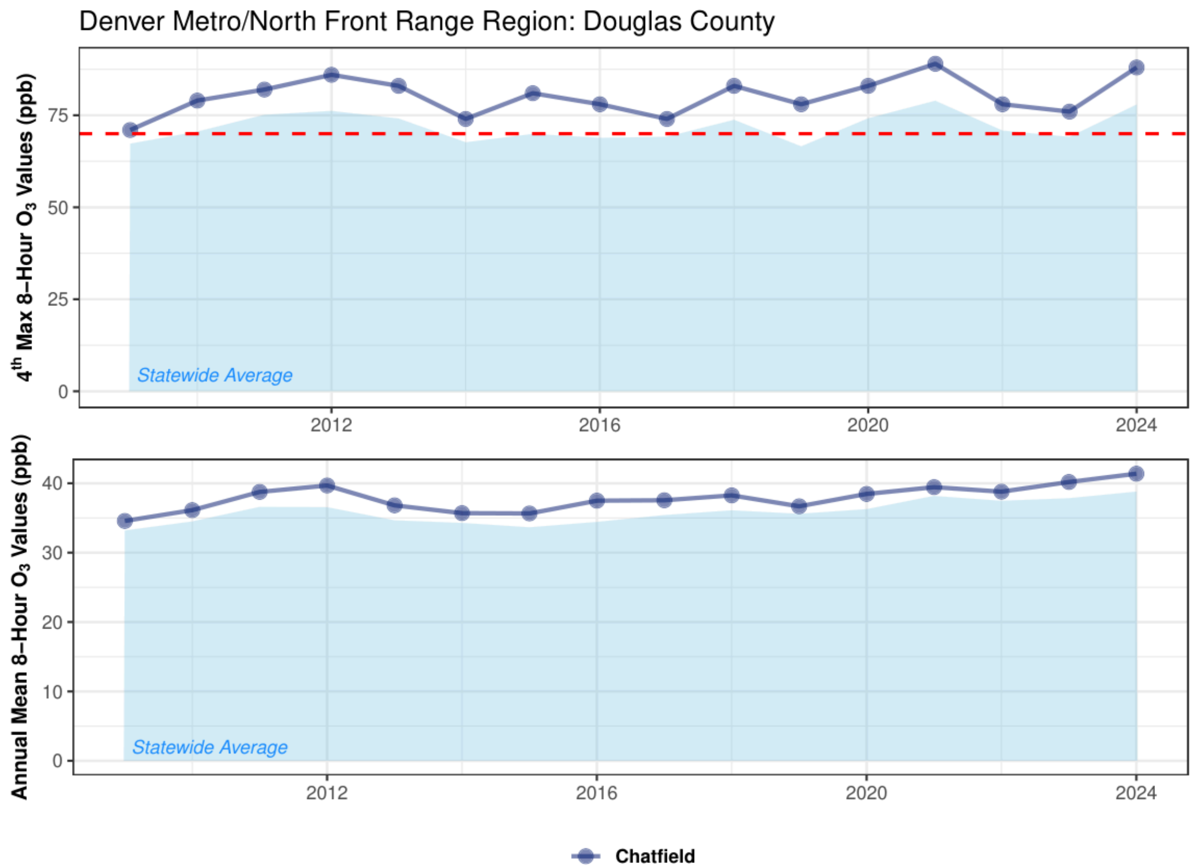

Figure 4.17: Fifteen-year trend in ozone eight-hour NAAQS values (top) and annual mean eight-hour concentrations (bottom) for monitoring sites in Douglas County. The eight-hour NAAQS (70 ppb) is shown as a dashed red line.

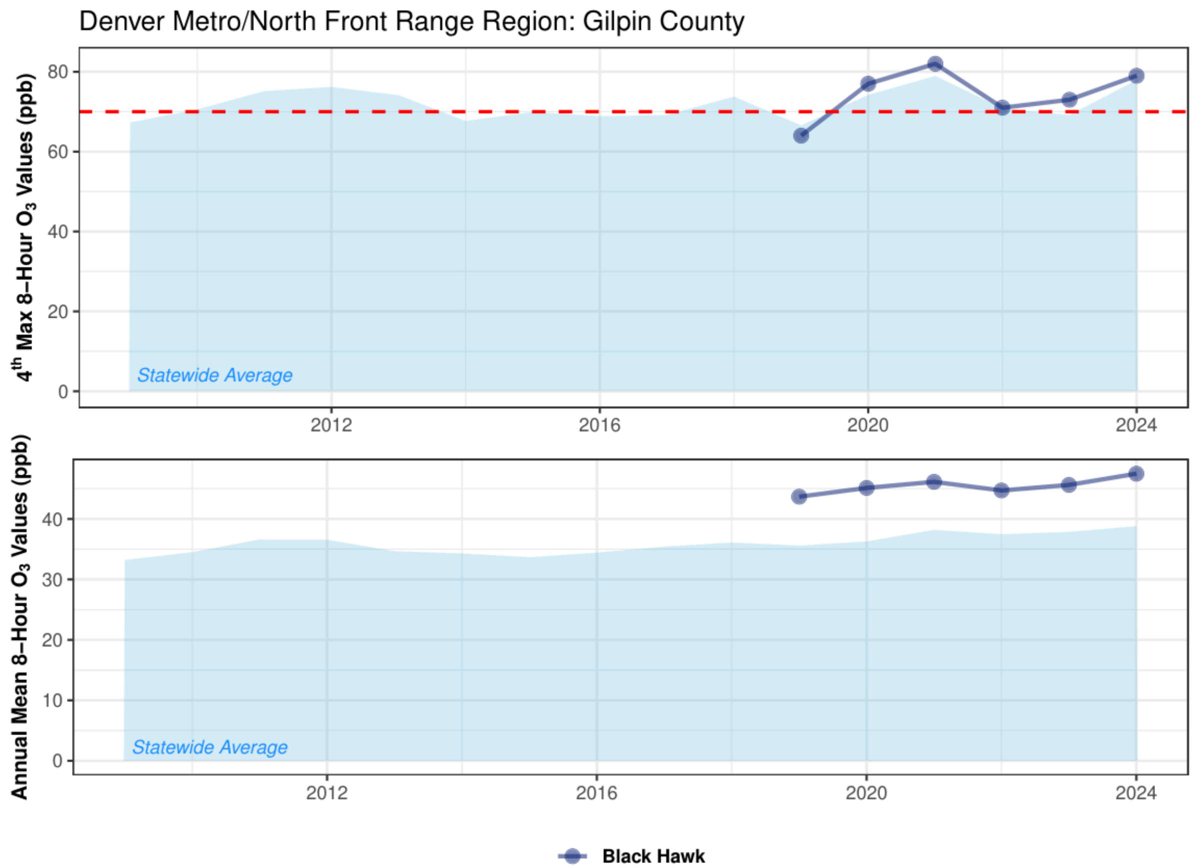

Figure 4.18: Fifteen-year trend in ozone eight-hour NAAQS values (top) and annual mean eight-hour concentrations (bottom) for monitoring sites in Gilpin County. The eight-hour NAAQS (70 ppb) is shown as a dashed red line.

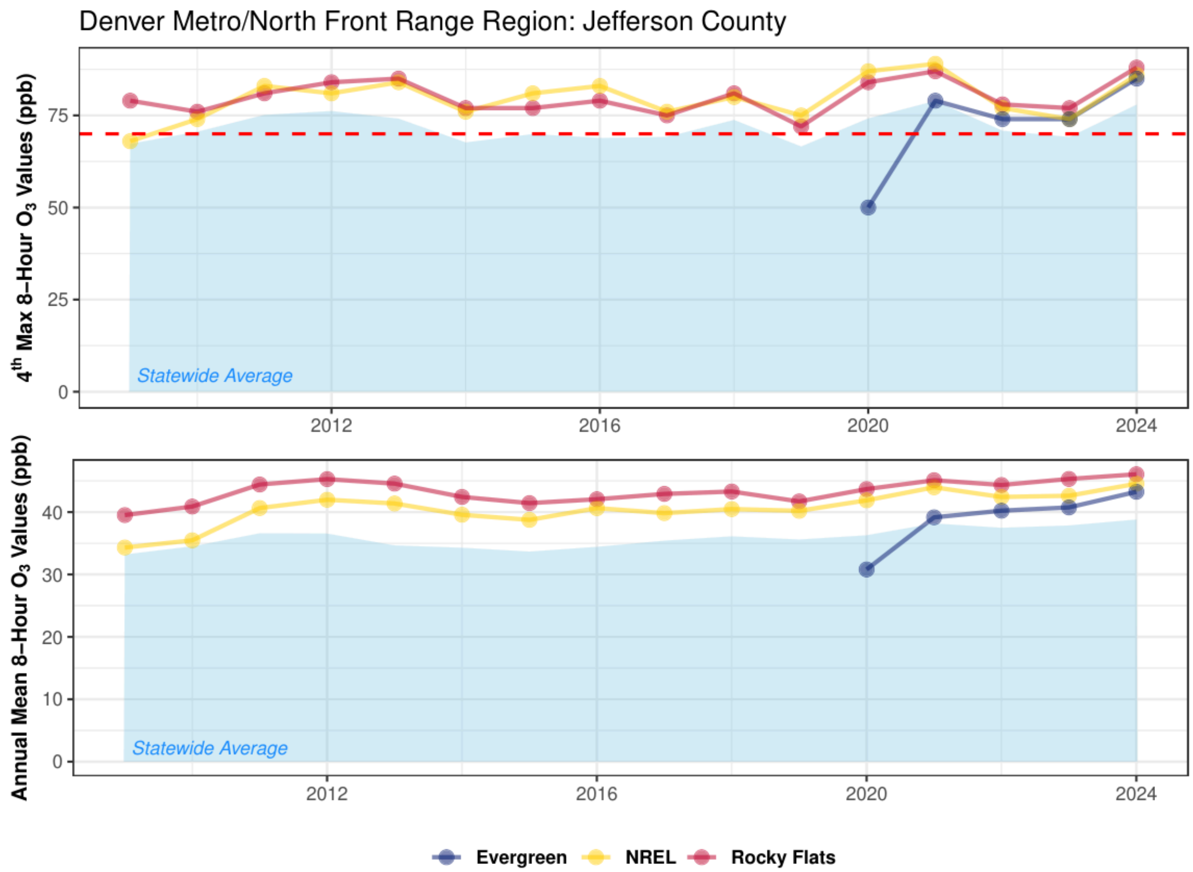

Figure 4.19: Fifteen-year trend in ozone eight-hour NAAQS values (top) and annual mean eight-hour concentrations (bottom) for monitoring sites in Jefferson County. The eight-hour NAAQS (70 ppb) is shown as a dashed red line.

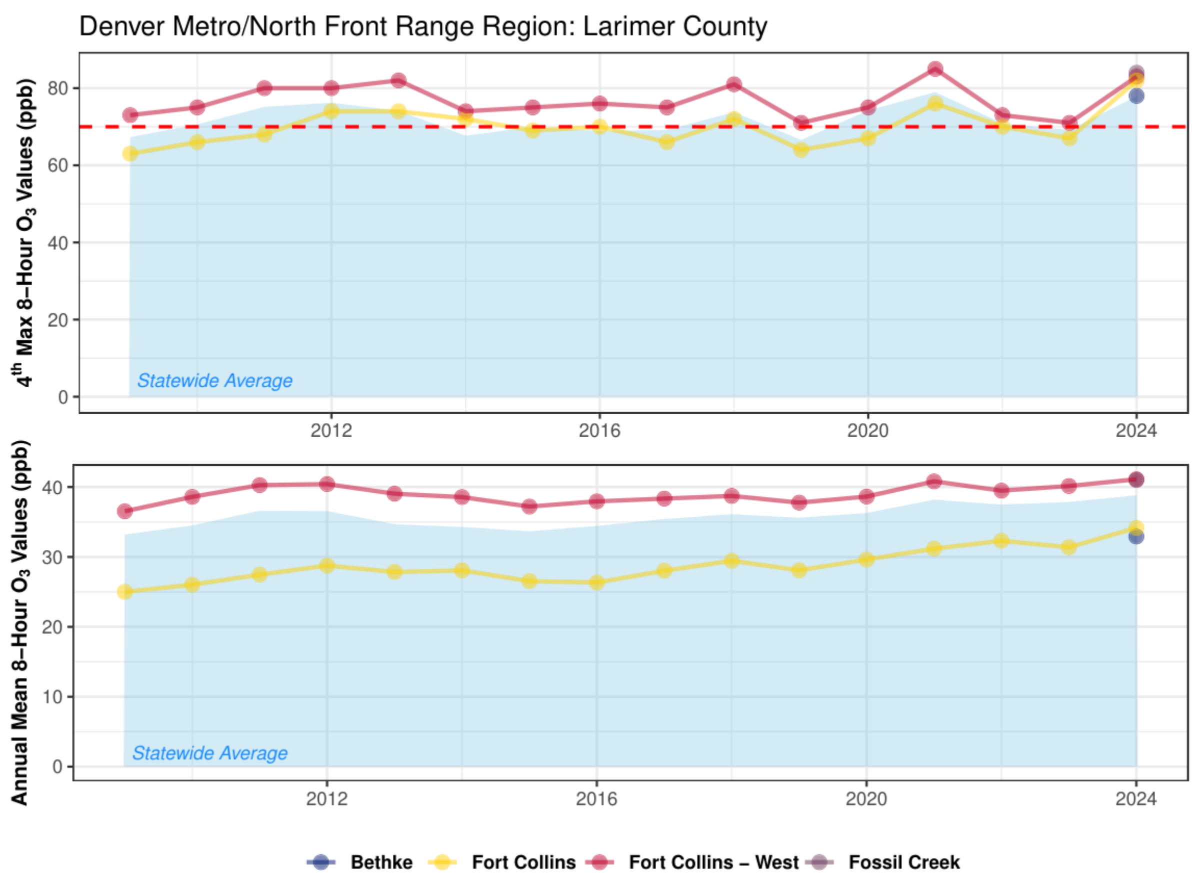

Figure 4.20: Fifteen-year trend in ozone eight-hour NAAQS values (top) and annual mean eight-hour concentrations (bottom) for monitoring sites in Larimer County. The eight-hour NAAQS (70 ppb) is shown as a dashed red line.

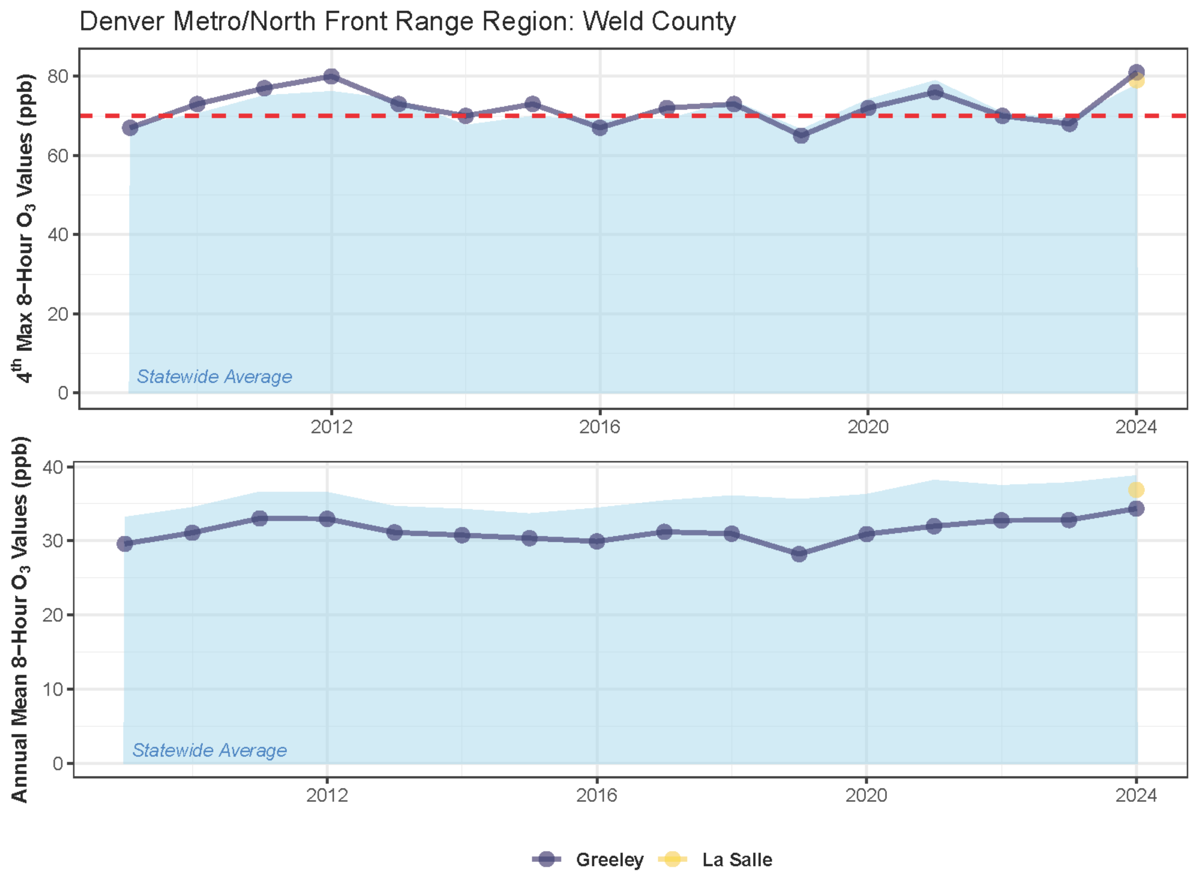

Figure 4.21: Fifteen-year trend in ozone eight-hour NAAQS values (top) and annual mean eight-hour concentrations (bottom) for monitoring sites in Weld County. The eight-hour NAAQS (70 ppb) is shown as a dashed red line.

4.2.4. Nitrogen Dioxide

Table 4.7 and Figures 4.22-4.25 show NO_2 data from the Denver Metro / Northern Front Range region. The entire region was in compliance with NAAQS standards for NO_2 during 2024. Historical trend data from Larimer County monitoring sites is not shown here, since the two sites currently in operation (Bethke and Fossil Creek) have only one year of NO_2 data each.

Table 4.7: Summary of NO_2 values recorded at monitoring stations in the Denver Metro / Northern Front Range region during 2024. The Fossil Creek, Bethke, and La Salle sites are less than three years old, and did not have three years of regulatory monitoring data at the time of this report. Therefore the design values listed for these sites are not directly comparable to the 3-year NAAQS standard for NO_2. The CAMP monitoring site was closed from October 14, 2023 to January 1, 2024 due to access issues, so the three-year design value shown here is not currently valid for this site. NO_2 data from the PAO monitoring site is not included here, as monitoring was decommissioned during 2024.

			NO_2 (ppb)		
Site Name	County	POC	Annual Mean	98^{th} Percentile	3-Year Avg. of 98^{th} percentile
Welby	Adams	1	14.4	51.4	55
CAMP	Denver	1	13.6	57.0	60
La Casa	Denver	1	14.6	50.0	53
I-25	Denver	1	20.3	56.3	59
Globeville	Denver	1	23.3	59.6	63
Rocky Flats - N.	Jefferson	1	2.5	17.6	25
Fossil Creek	Larimer	1	5.4	32.3	32
Bethke	Larimer	1	6.6	31.7	32
La Salle Tower	Weld	1	6.3	36.0	36

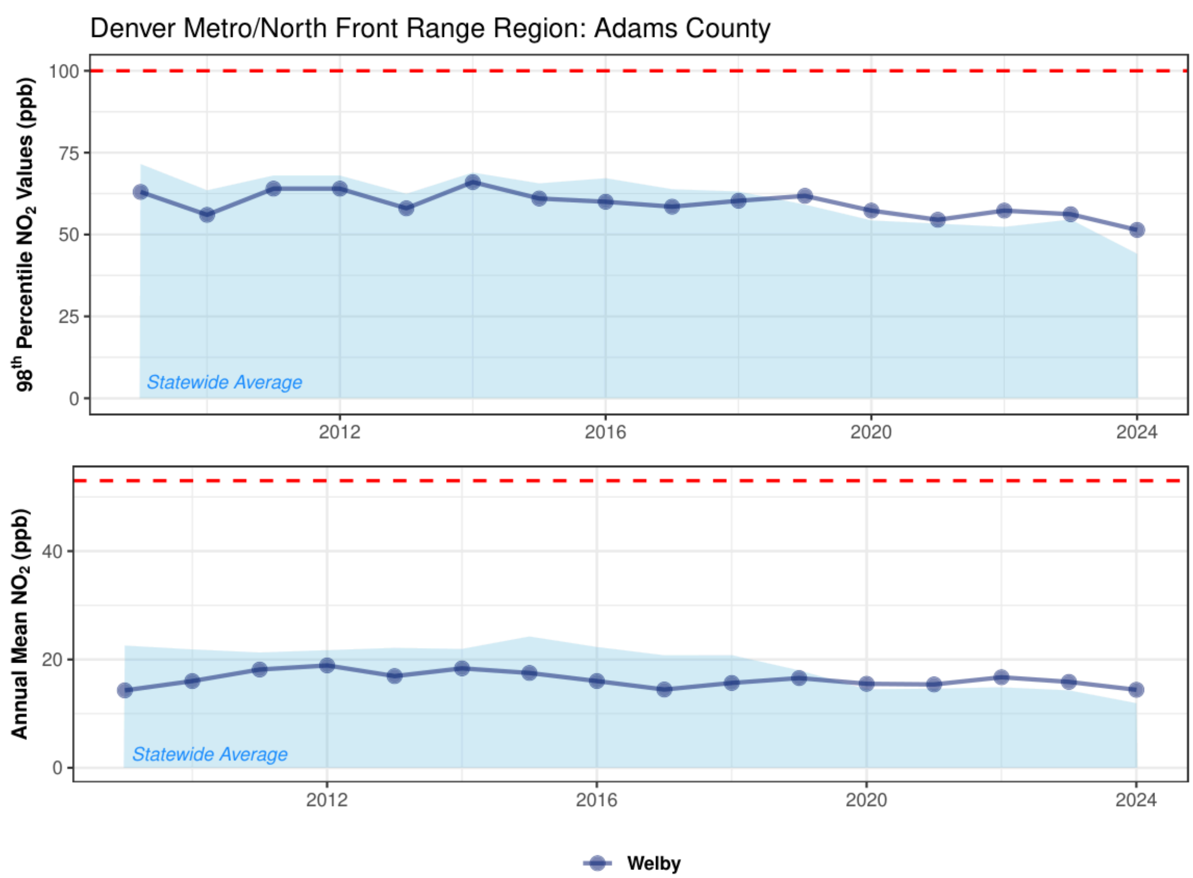

Figure 4.22: Fifteen-year trend in one-hour (top) and annual mean (bottom) nitrogen dioxide NAAQS values for monitoring sites in Adams County. The one-hour and annual mean standards (100 ppb and 53 ppb, respectively) are shown as dashed red lines.

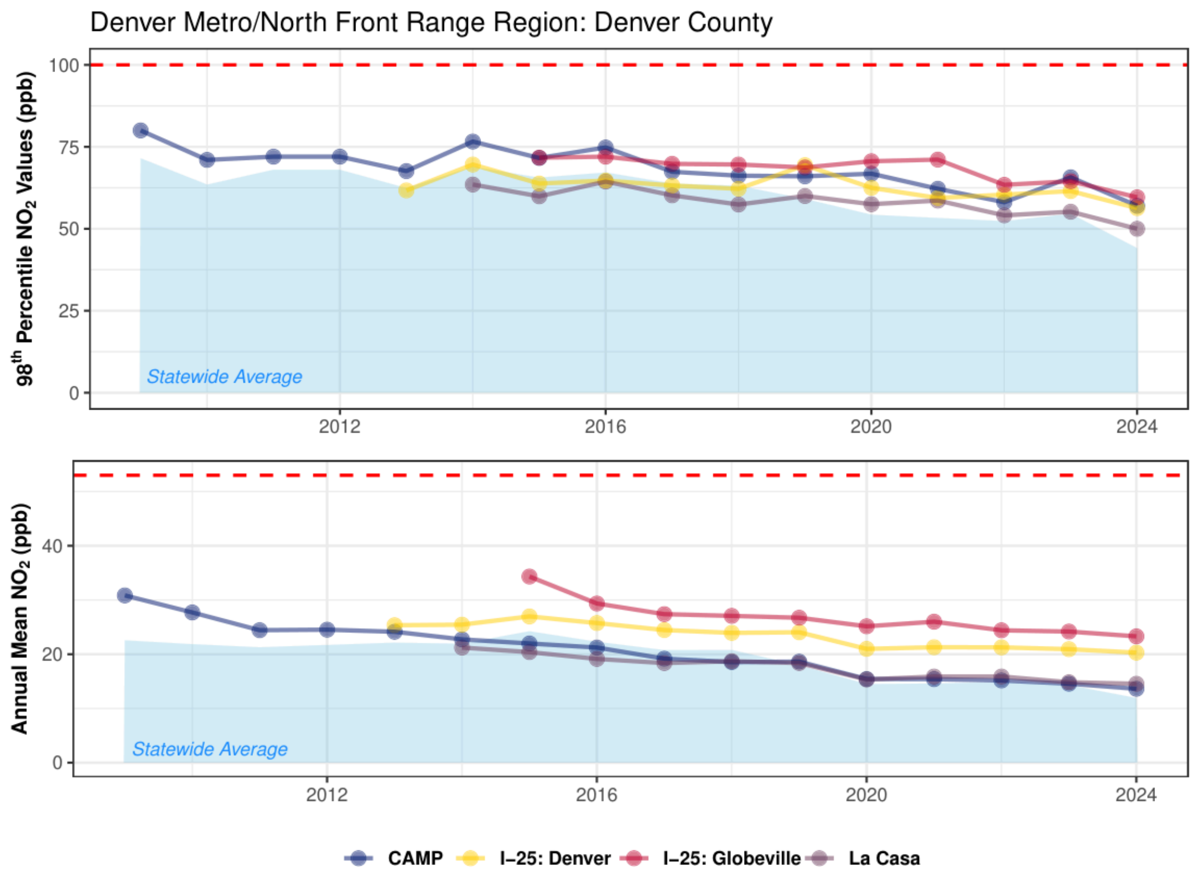

Figure 4.23: Fifteen-year trend in one-hour (top) and annual mean (bottom) nitrogen dioxide NAAQS values for monitoring sites in Denver County. The one-hour and annual mean standards (100 ppb and 53 ppb, respectively) are shown as dashed red lines.

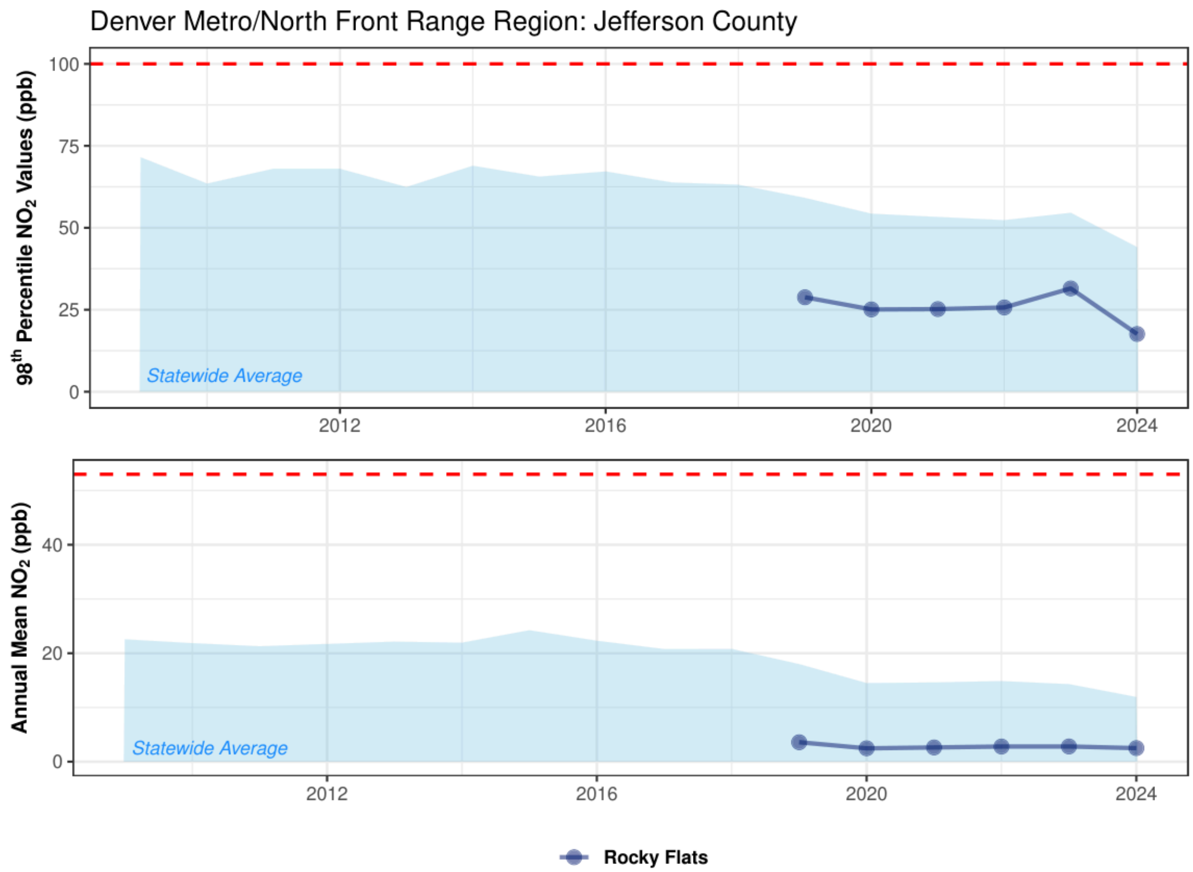

Figure 4.24: Fifteen-year trend in one-hour (top) and annual mean (bottom) nitrogen dioxide NAAQS values for monitoring sites in Jefferson County. The one-hour and annual mean standards (100 ppb and 53 ppb, respectively) are shown as dashed red lines.

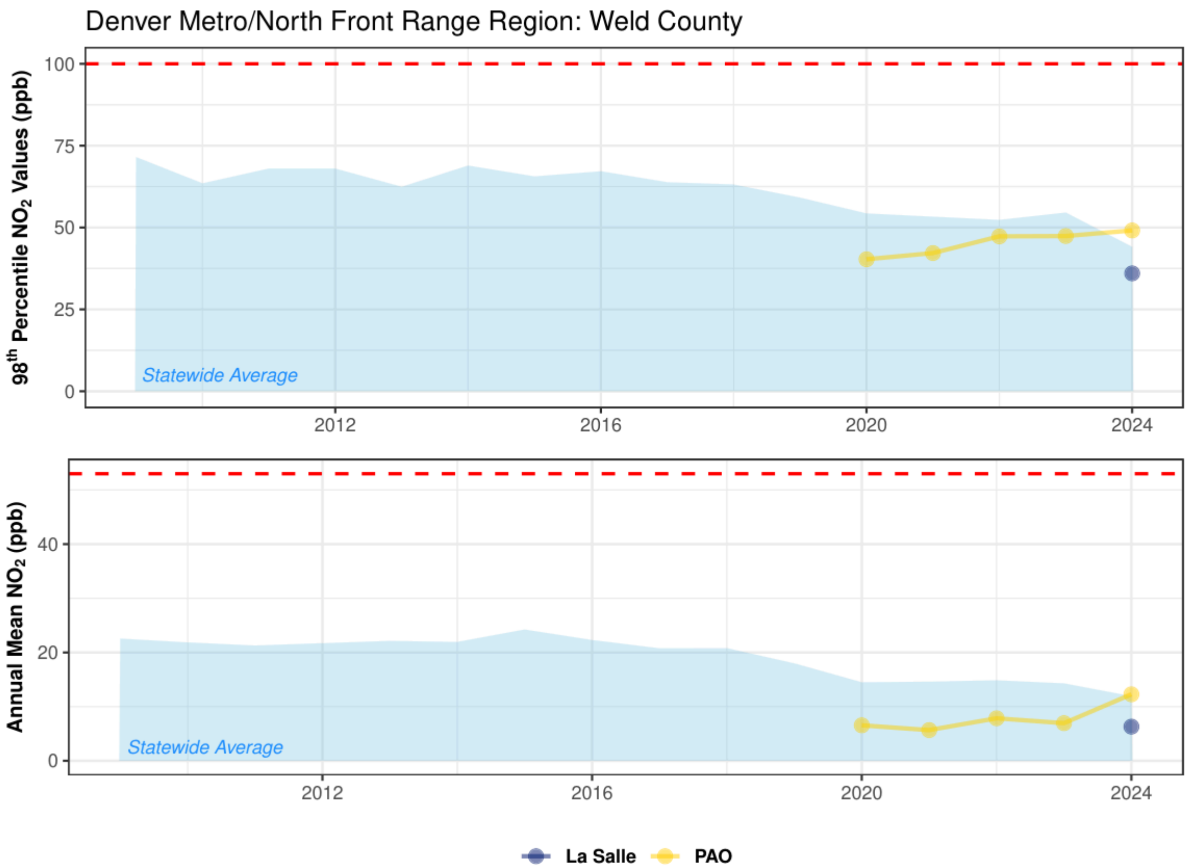

Figure 4.25: Fifteen-year trend in one-hour (top) and annual mean (bottom) nitrogen dioxide NAAQS values for monitoring sites in Weld County. The one-hour and annual mean standards (100 ppb and 53 ppb, respectively) are shown as dashed red lines.

4.2.5. Sulfur Dioxide

Table 4.8: Summary of SO_2 values recorded at monitoring stations in the Denver Metro/Northern Front Range region during 2024. The CAMP monitoring site was closed from October 14, 2023 to January 1, 2024 due to access issues, so the three-year design value shown here is not currently valid for this site.

			SO_2 (ppb)		
Site Name	County	POC	Annual Mean	99th Percentile	3-Year Avg. of 99th percentile
Welby	Adams	2	1.6	4.1	5
CAMP	Denver	1	1.3	4.9	5
La Casa	Denver	1	1.5	5.2	5

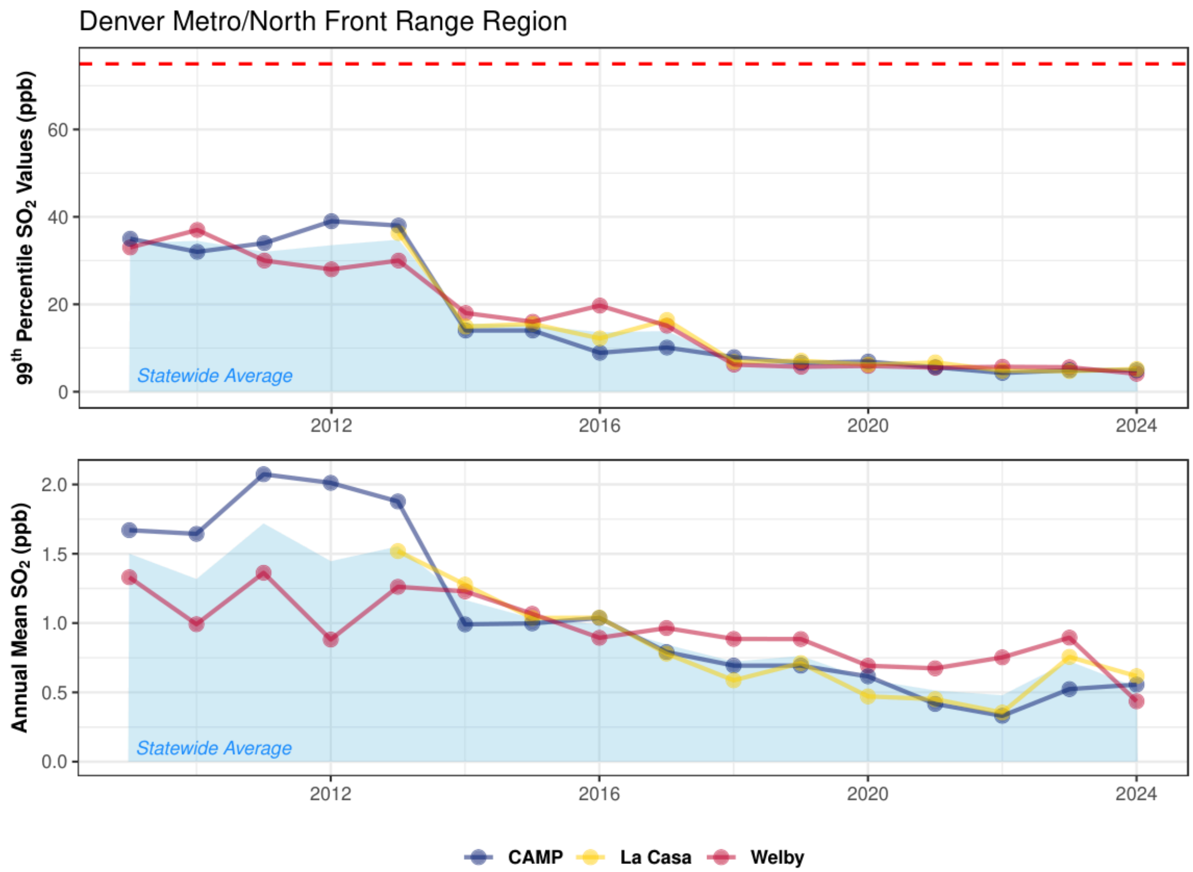

Figure 4.26: Fifteen-year trend in sulfur dioxide one-hour NAAQS values (top) and annual mean one-hour concentrations (bottom) for monitoring sites in the Denver Metro/Northern Front Range region. The one-hour NAAQS (75 ppb) is shown as a dashed red line.

4.2.6. Visibility

Visibility data for Denver is summarized below. Days where the visibility standard was exceeded are classified as "poor" or "extremely poor," while other days are classified as "moderate" or "good." Considering only days with valid data, the standard was exceeded for 22% of the year in Denver.

Table 4.9: Summary of Denver visibility data showing the number of days with extremely poor, poor, moderate, and good visibility, as well as the number of days with missing data and the number of days that were excluded due to high (> 70%) relative humidity.

Month	Extremely Poor	Poor	Moderate	Good	Missing	>70% RH
January	2	5	12	10	0	2
February	1	4	3	16	0	5
March	1	5	4	16	0	5
April	0	6	7	13	0	4
May	0	2	7	21	0	1
June	0	4	12	13	1	0
July	3	8	8	11	1	0
August	1	6	12	10	0	2
September	0	3	16	11	0	0
October	2	18	7	3	0	1
November	0	7	10	8	0	5
December	0	3	8	20	0	0

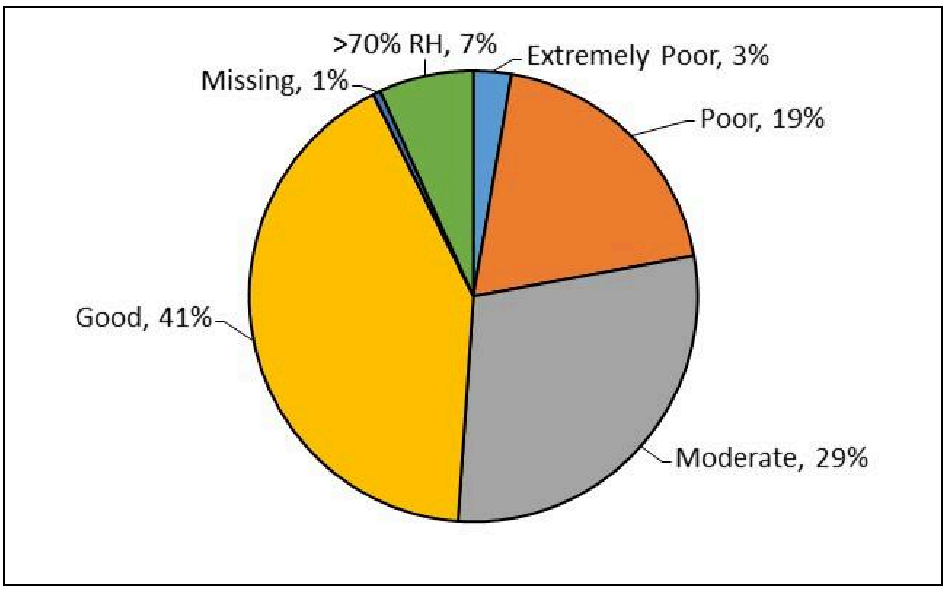

Figure 4.27: Denver visibility data.

4.2.7. Meteorology

See section 3.4 for more details on the wind rose plots below.

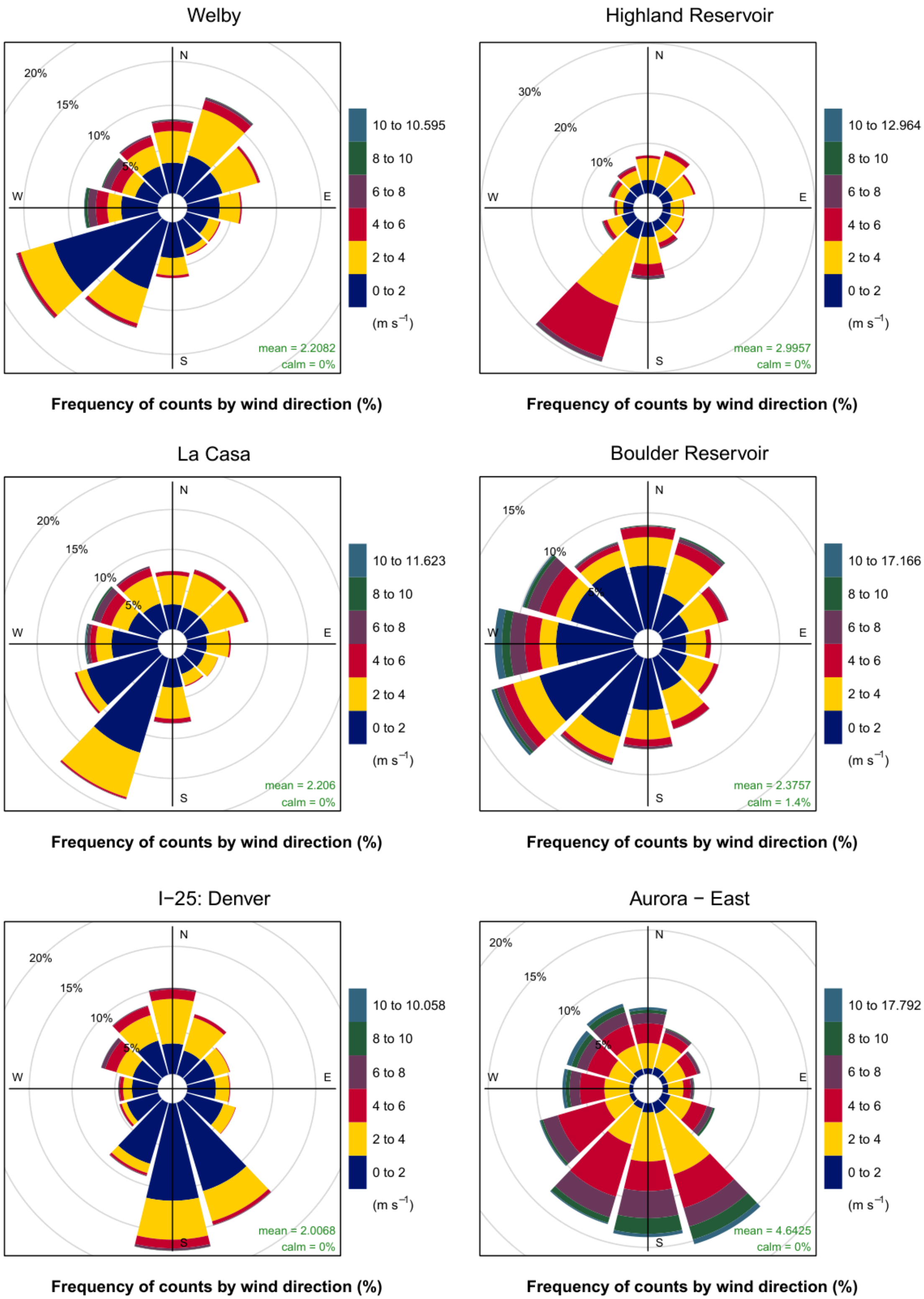

Figure 4.28: Wind roses for sites in the Denver Metro/North Front Range Region during 2024.

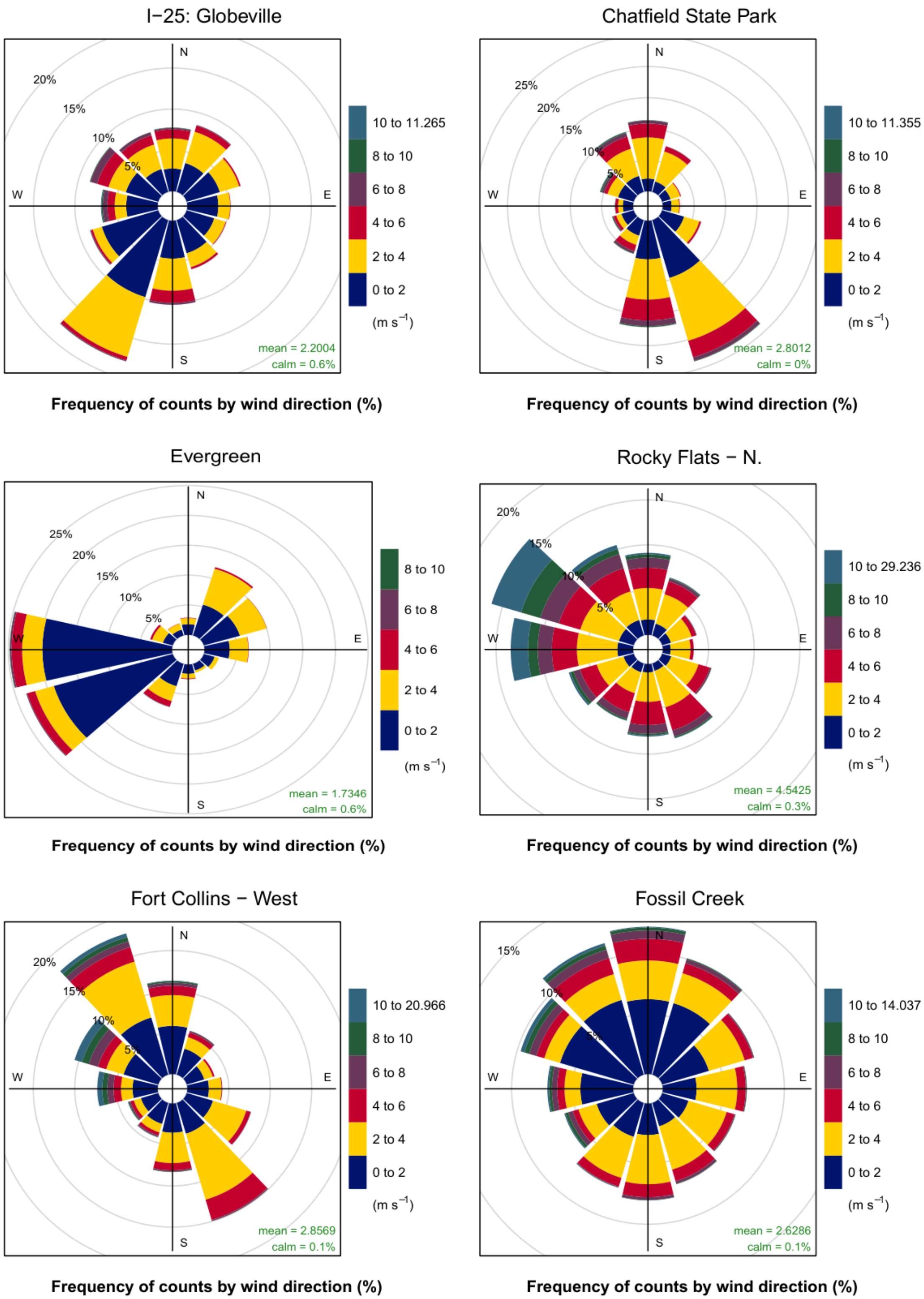

Figure 4.29: Wind roses for sites in the Denver Metro/North Front Range Region during 2024 (continued).

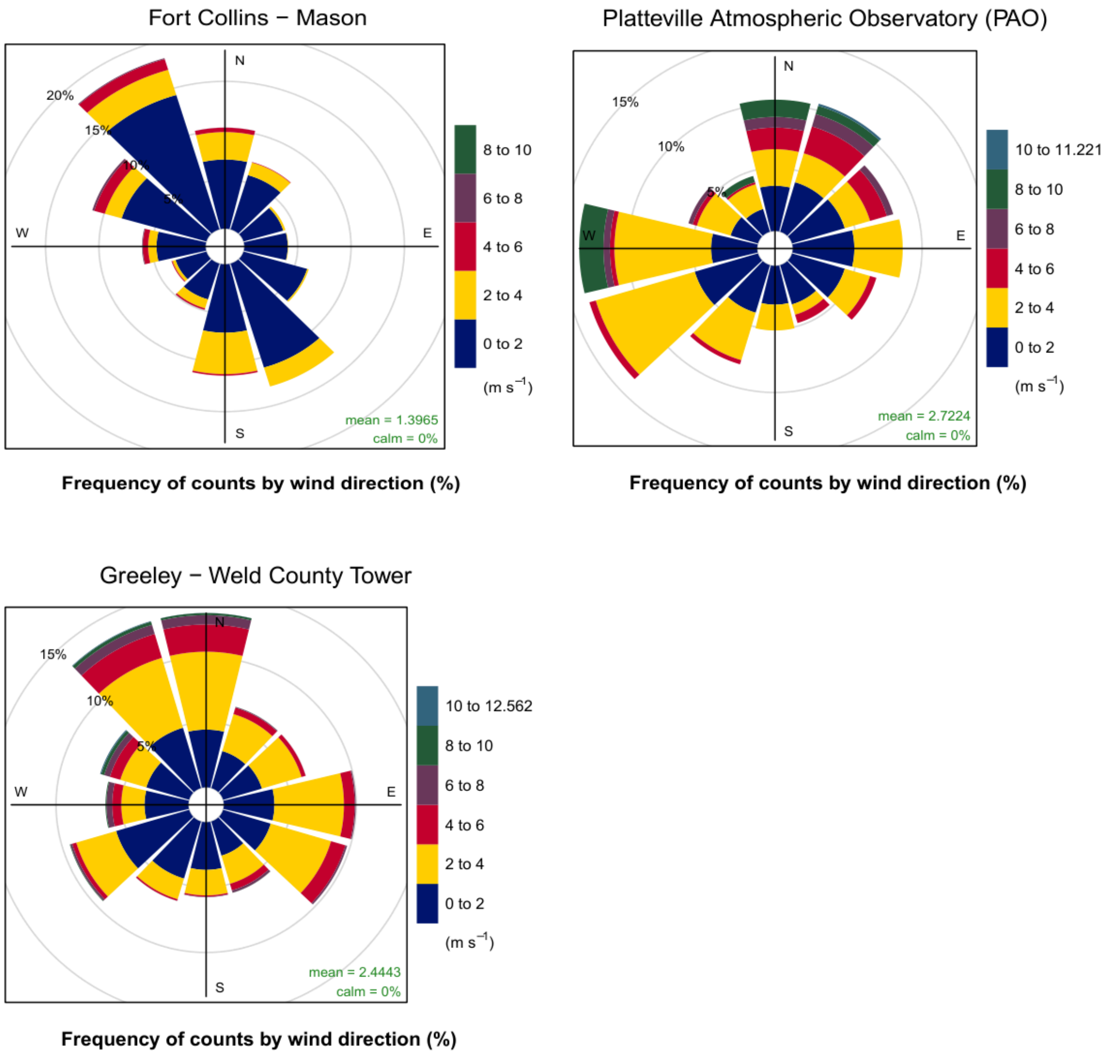

Figure 4.30: Wind roses for sites in the Denver Metro/North Front Range Region during 2024 (continued).

4.3. Eastern High Plains Region

Monitoring data from the eastern high plains monitoring region are shown in tables 4.10-4.11 and figures 4.31-4.32 below.

4.3.1. Particulate Matter

Table 4.10: Summary of PM_{10} values recorded at monitoring stations in the Eastern High Plains region during 2024, with potential exceptional events included. The Lamar Municipal Building PM_{10} monitor is less than three years old, and did not have three years of regulatory monitoring data at the time of this report. Therefore the design value listed for this site is not directly comparable to the 3-year NAAQS standard for PM_{10}.

			PM_{10} (µg m^{-3})		
Site Name	County	POC	Annual Mean	24-Hr Max	3-Year Exceedances
Lamar Municipal Bldg	Prowers	3	24.1	100	0

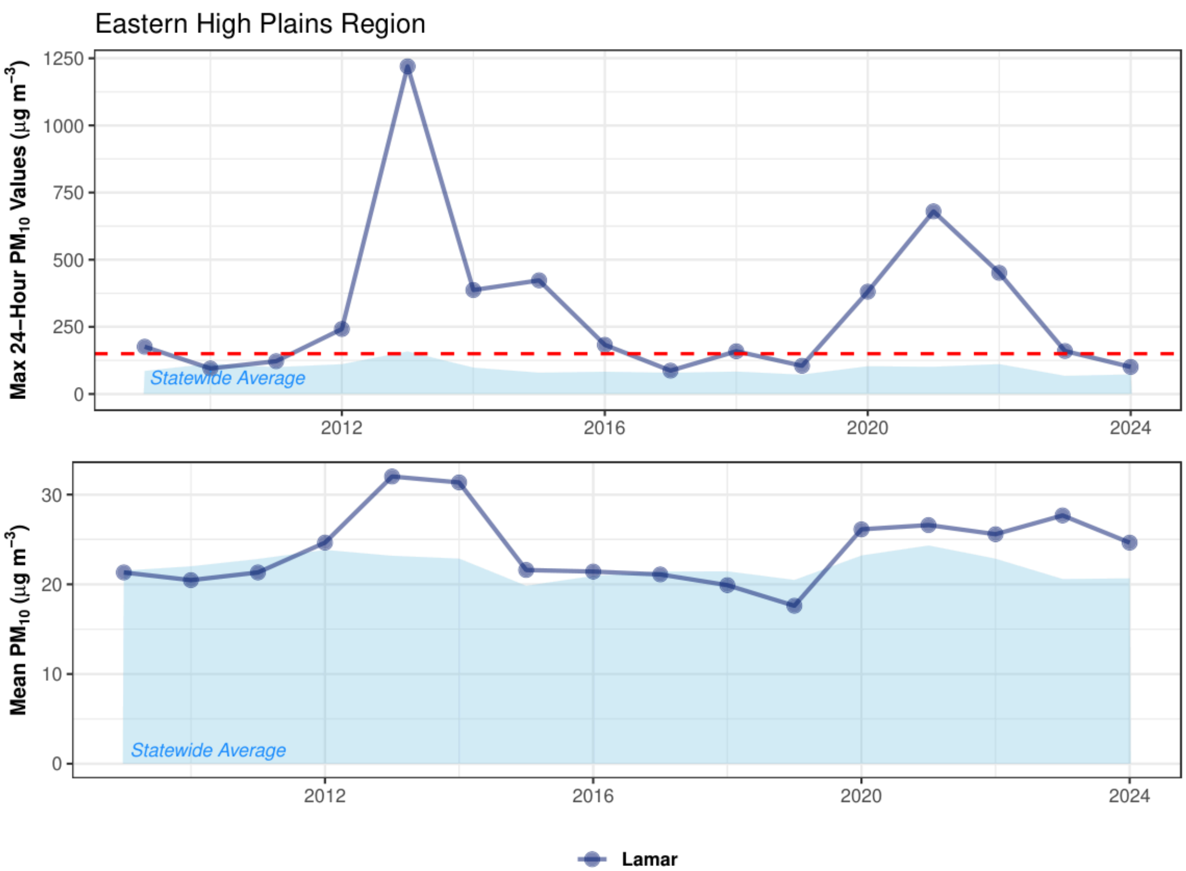

Figure 4.31: Fifteen-year trend in maximum 24-hour PM_{10} values (top) and annual mean concentrations (bottom) for monitoring sites in the Eastern High Plains region. The 24-hour NAAQS (150 mg m^{-3}) is shown as a dashed red line.

Table 4.11: Summary of $PM_{2.5}$ values recorded at monitoring stations in the Eastern High Plains region during 2024. The Lamar Municipal Building $PM_{2.5}$ monitor is less than three years old, and did not have three years of regulatory monitoring data at the time of this report. Therefore the design value listed for this site is not directly comparable to the 3-year NAAQS standard for $PM_{2.5}$.

			$PM_{2.5}$ (µg m^{-3})		
Site Name	County	POC	Annual Mean	98^{th} Percentile	3-Year Avg. of 98^{th} percentile
Lamar Municipal Bldg	Prowers	3	5.5	18.6	14

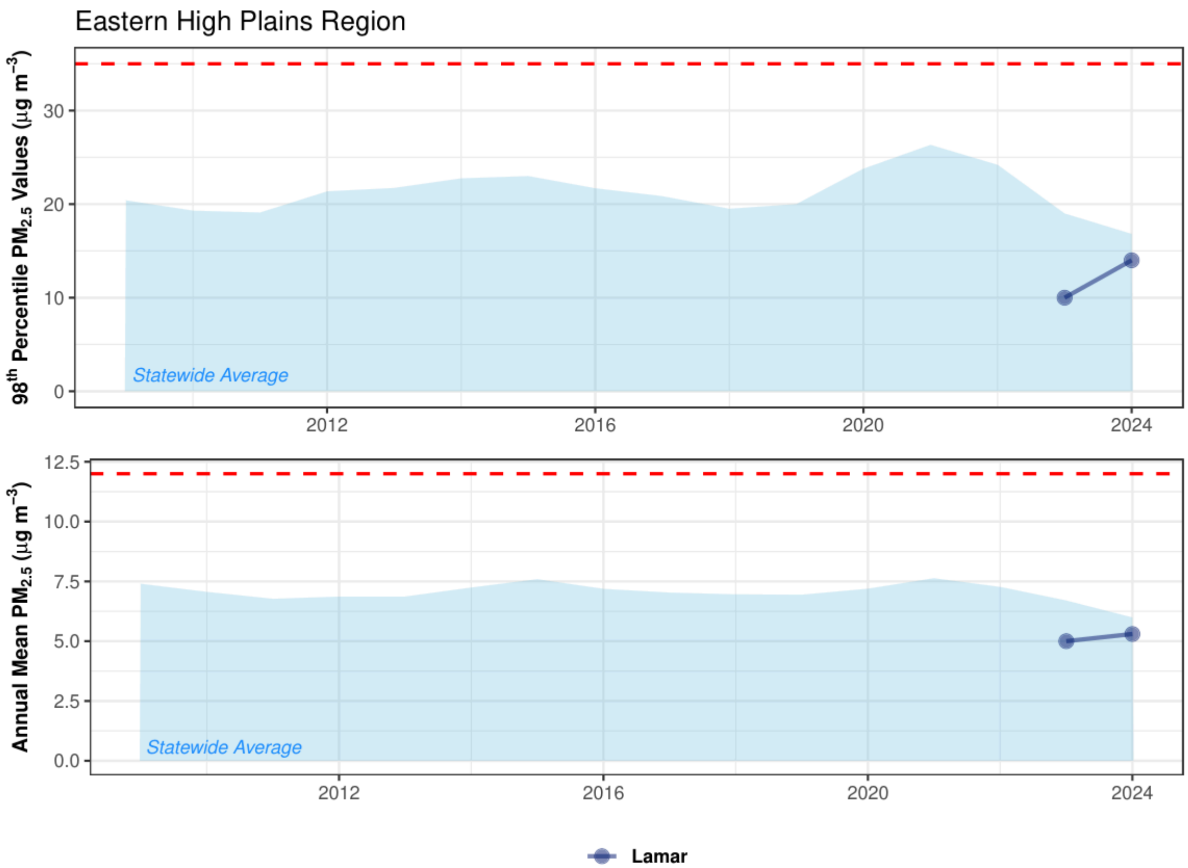

Figure 4.32: Fifteen-year trend in 24-hour $PM_{2.5}$ annual 98th percentile values (top) and annual mean concentrations (bottom) for monitoring sites in the Eastern High Plains region. The 24-hour and annual mean NAAQS (35 mg m^{-3} and 12 mg m^{-3}, respectively) are shown as dashed red lines.

4.4. Pikes Peak Region

Monitoring data from the Pike's Peak monitoring region are shown in tables 4.12-4.15 and figures 4.33-4.35 below.

4.4.1. Particulate Matter

Table 4.12: Summary of PM_{10} values recorded at the Colorado College station during 2024.

			PM_{10} (µg m^{-3})		
Site Name	County	POC	Annual Mean	24-Hr Max	3-Year Exceedances
Colorado College	El Paso	1	15.5	42	0

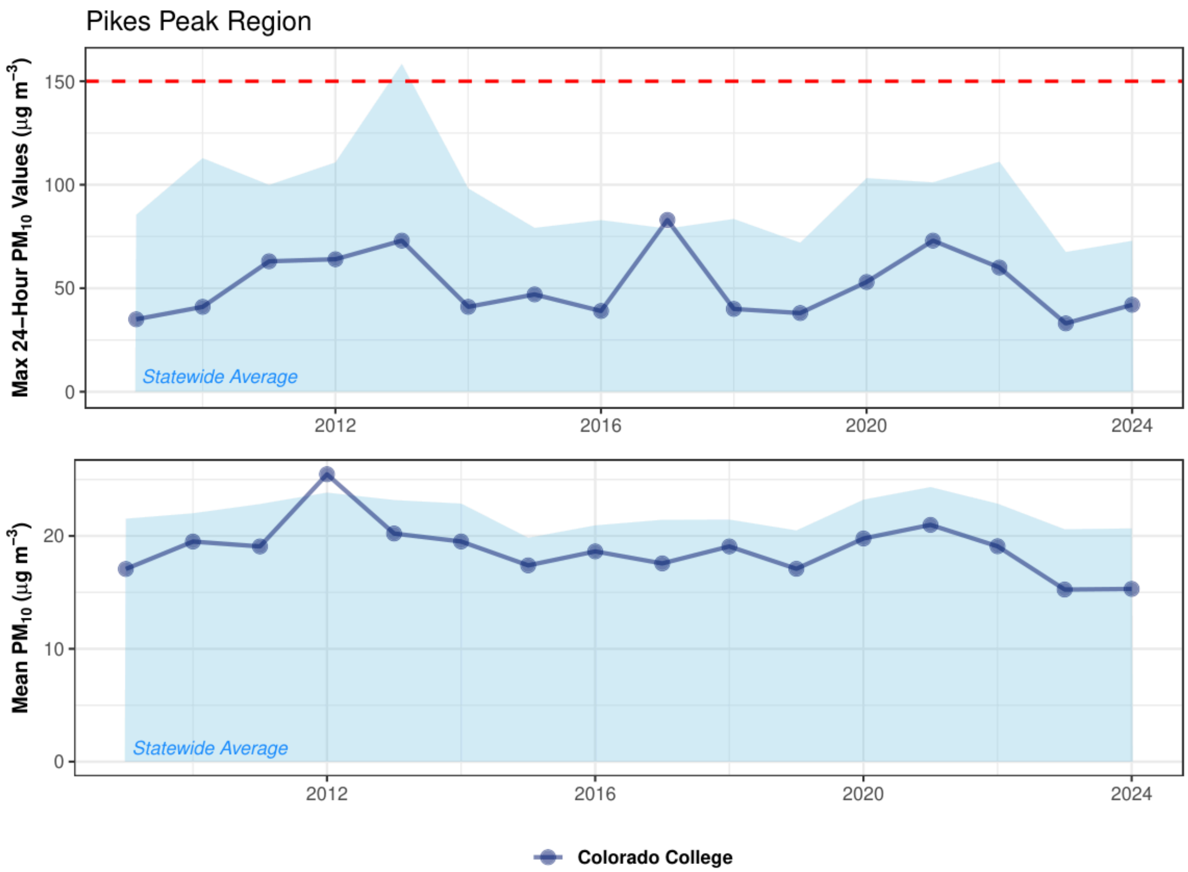

Figure 4.33: Fifteen-year trend in maximum 24-hour PM_{10} values (top) and annual mean concentrations (bottom) for monitoring sites in the Pikes Peak region. The 24-hour NAAQS (150 mg m^{-3}) is shown as a dashed red line.

Table 4.13: Summary of $PM_{2.5}$ values recorded at the Colorado College station during 2024.

			$PM_{2.5}$ (µg m^{-3})		
Site Name	County	POC	Annual Mean	98^{th} Percentile	3-Year Avg. of 98^{th} percentile
Colorado College	El Paso	3	5.7	16.5	14

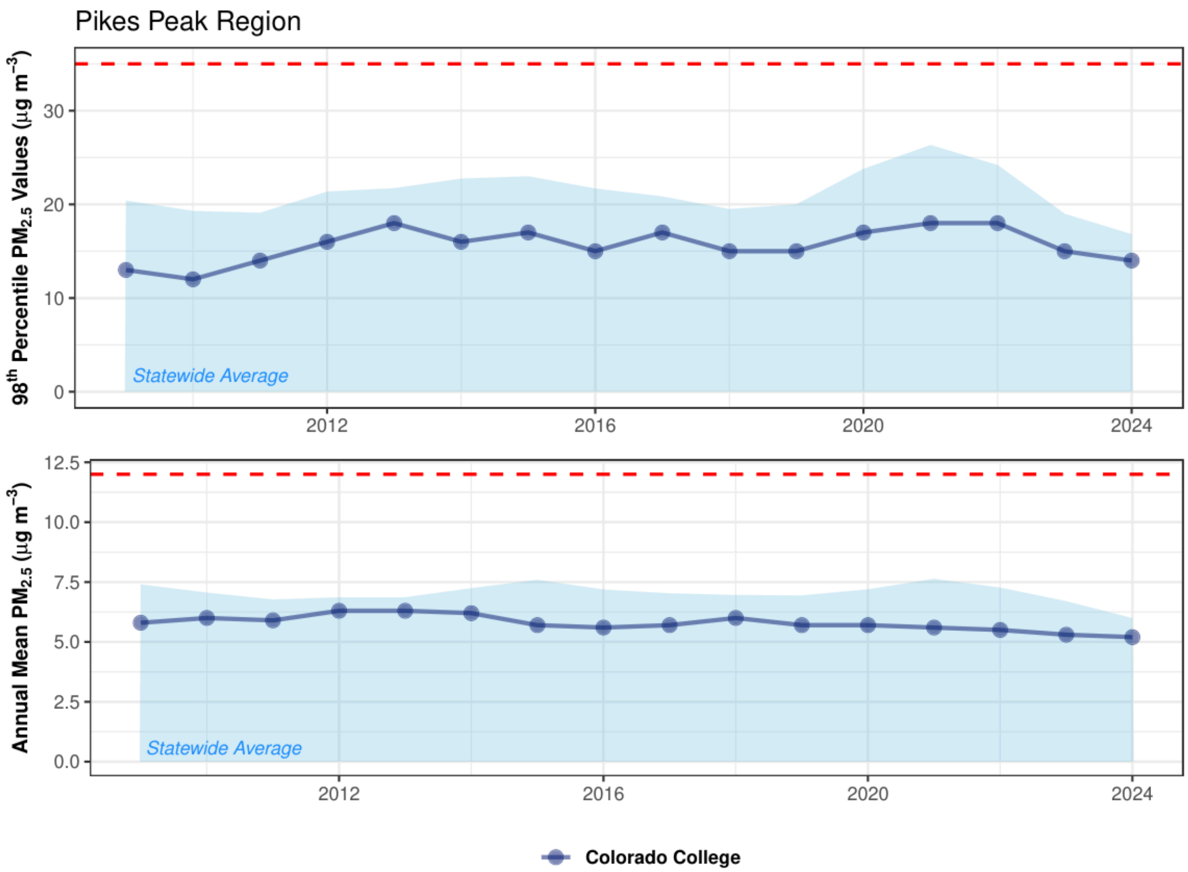

Figure 4.34: Fifteen-year trend in 24-hour $PM_{2.5}$ annual 98th percentile values (top) and annual mean concentrations (bottom) for monitoring sites in the Pikes Peak region. The 24-hour and annual mean NAAQS (35 mg m^{-3} and 12 mg m^{-3}, respectively) are shown as dashed red lines.

4.4.2. Carbon Monoxide

Table 4.14: Summary of CO values recorded at the Colorado College station during 2024.

			CO 1-Hour Avg. (ppm)		CO 8-Hour Avg. (ppm)	
Site Name	County	POC	1st Max Value	2nd Max Value	1st Max Value	2nd Max Value
Colorado College	El Paso	1	1.2	1.1	0.7	0.6

4.4.3. Ozone

Table 4.15: Summary of O_3 values recorded at monitoring stations in the Pikes Peak region during 2024.

			Ozone 8-Hour Avg. (ppm)		
Site Name	County	POC	1st Max Value	4th Max Value	3-Year Avg. of 4th Max (8-Hr)
U.S. Air Force Academy	El Paso	1	0.085	0.078	0.070
Manitou Springs	El Paso	1	0.092	0.082	0.073

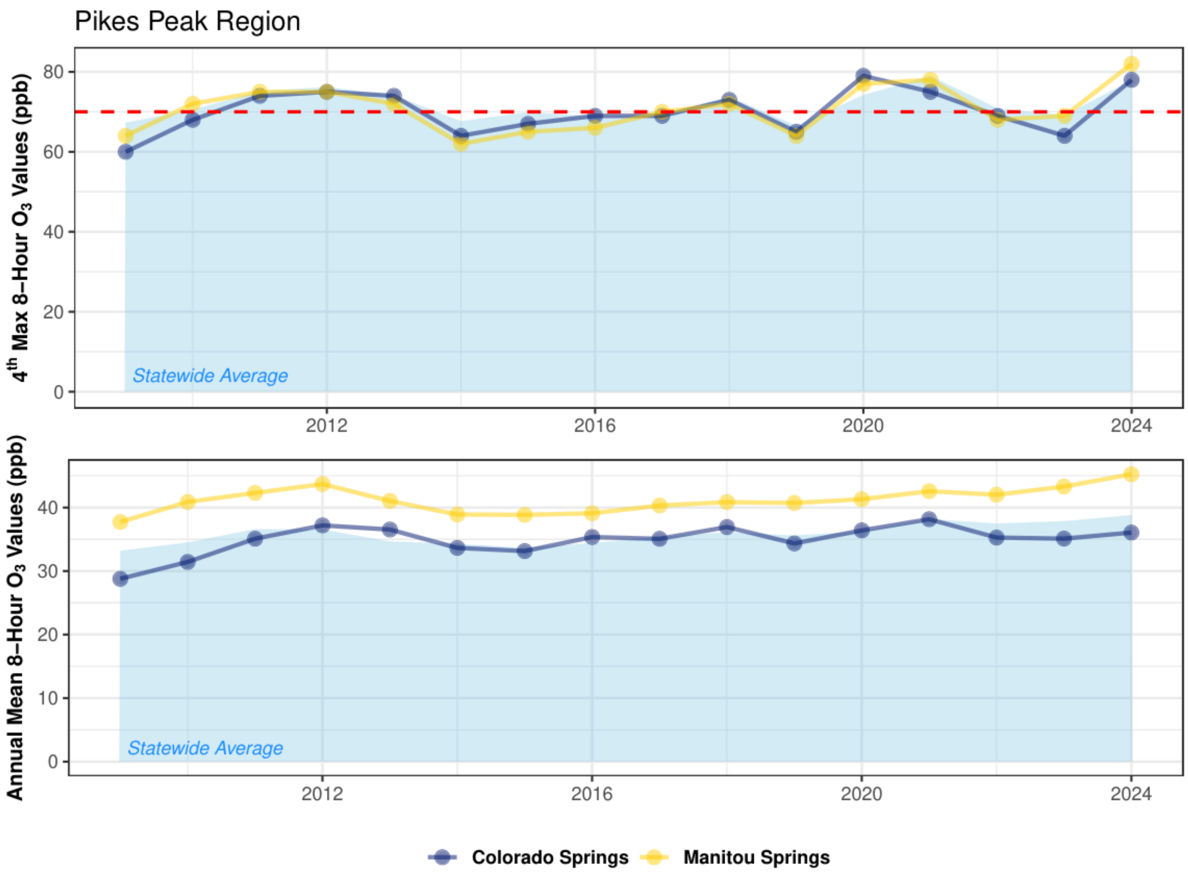

Figure 4.35: Fifteen-year trend in ozone eight-hour NAAQS values (top) and annual mean eight-hour concentrations (bottom) for monitoring sites in the Pikes Peak region. The eight-hour NAAQS (70 ppb) is shown as a dashed red line.

4.5. San Luis Valley Region

Monitoring data from the San Luis Valley monitoring region are shown in tables 4.16-4.17 and figures 4.36-4.37 below.

4.5.1. Particulate Matter

Table 4.16: Summary of PM_{10} values recorded at the Alamosa monitoring station during 2024. The Adams State PM_{10} monitor is less than three years old, and did not have three years of regulatory monitoring data at the time of this report. Therefore the design value listed for this site is not directly comparable to the 3-year NAAQS standard for PM_{10}.

			PM_{10} (µg m^{-3})		
Site Name	County	POC	Annual Mean	24-Hr Max	3-Year Exceedances
Alamosa - Adams State	Alamosa	3	20.5	150	0

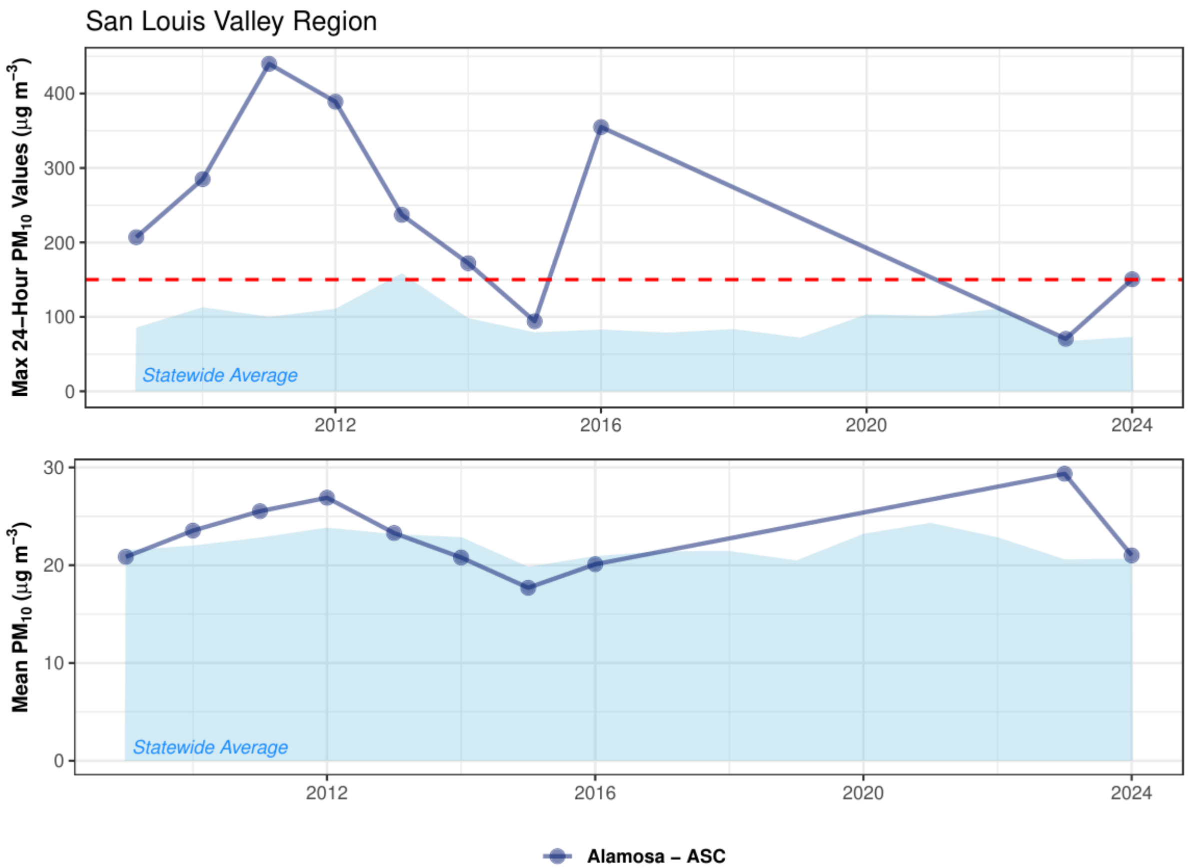

Figure 4.36: Fifteen-year trend in maximum 24-hour PM_{10} values (top) and annual mean concentrations (bottom) for monitoring sites in the San Luis Valley region. The 24-hour NAAQS (150 mg m^{-3}) is shown as a dashed red line.

Table 4.17: Summary of $PM_{2.5}$ values recorded at the Alamosa monitoring station during 2024. The Adams State $PM_{2.5}$ monitor is less than three years old, and did not have three years of regulatory monitoring data at the time of this report. Therefore the design value listed for this site is not directly comparable to the 3-year NAAQS standard for $PM_{2.5}$.

			$PM_{2.5}$ (µg m^{-3})		
Site Name	County	POC	Annual Mean	98^{th} Percentile	3-Year Avg. of 98^{th} percentile
Alamosa - Adams State	Alamosa	3	5.1	12.8	15

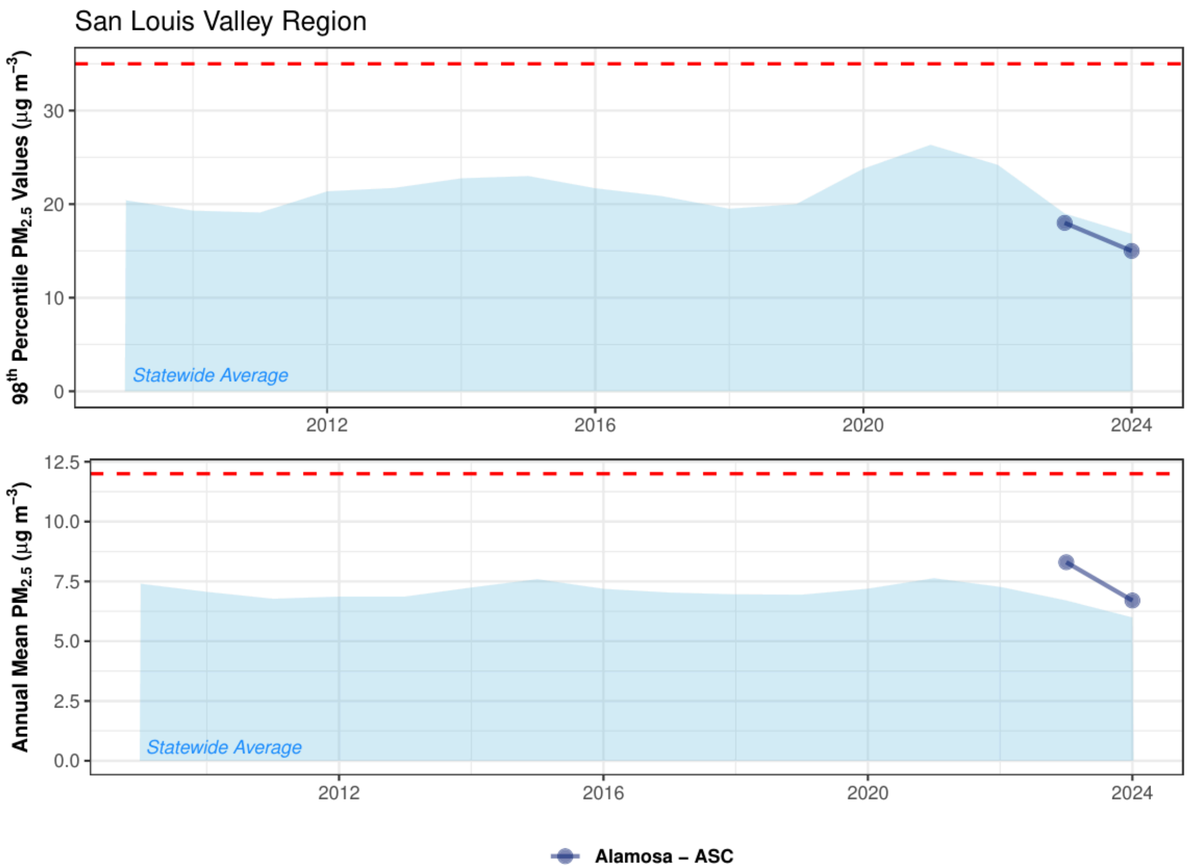

Figure 4.37: Fifteen-year trend in 24-hour $PM_{2.5}$ annual 98th percentile values (top) and annual mean concentrations (bottom) for monitoring sites in the San Luis Valley region. The 24-hour and annual mean NAAQS (35 mg m^{-3} and 12 mg m^{-3}, respectively) are shown as dashed red lines.

4.6. South Central Region

Monitoring data from the south central monitoring region are shown in tables 4.18-4.20 and figures 4.38-4.40 below.

4.6.1. Particulate Matter

Table 4.18: Summary of PM_{10} values recorded at the Pueblo monitoring station during 2024. The Pueblo Fountain School PM_{10} monitor is less than three years old, and did not have three years of regulatory monitoring data at the time of this report. Therefore the design value listed for this site is not directly comparable to the 3-year NAAQS standard for PM_{10}.

			PM_{10} (µg m^{-3})		
Site Name	County	POC	Annual Mean	24-Hr Max	3-Year Exceedances
Pueblo - Fountain School	Pueblo	3	18.0	78	0

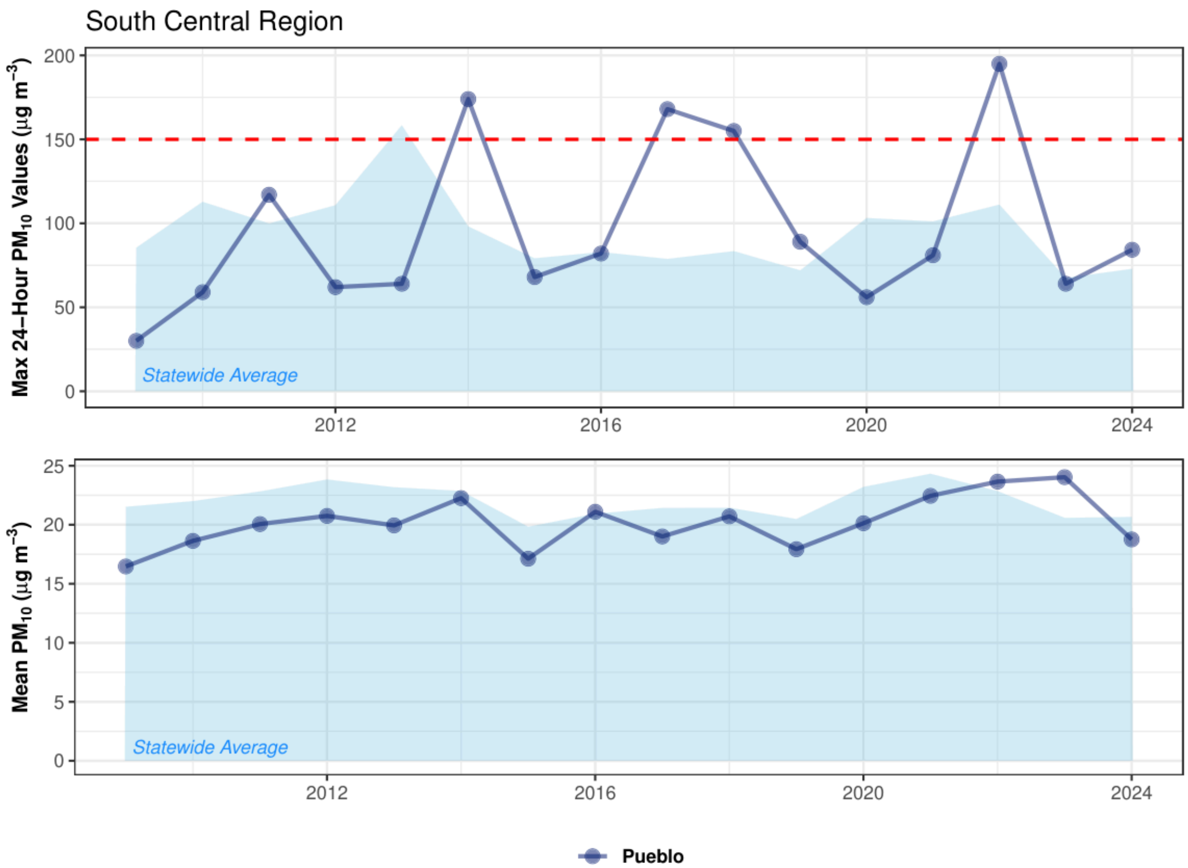

Figure 4.38: Fifteen-year trend in maximum 24-hour PM_{10} values (top) and annual mean concentrations (bottom) for monitoring sites in the South Central region (including potential exceptional events). The 24-hour NAAQS (150 mg m^{-3}) is shown as a dashed red line.

Table 4.19: Summary of $PM_{2.5}$ values recorded at the Pueblo monitoring station during 2024.

			$PM_{2.5}$ ($\mu g\ m^{-3}$)		
Site Name	County	POC	Annual Mean	98th Percentile	3-Year Avg. of 98th percentile
Pueblo - Fountain School	Pueblo	3	4.7	12.5	13

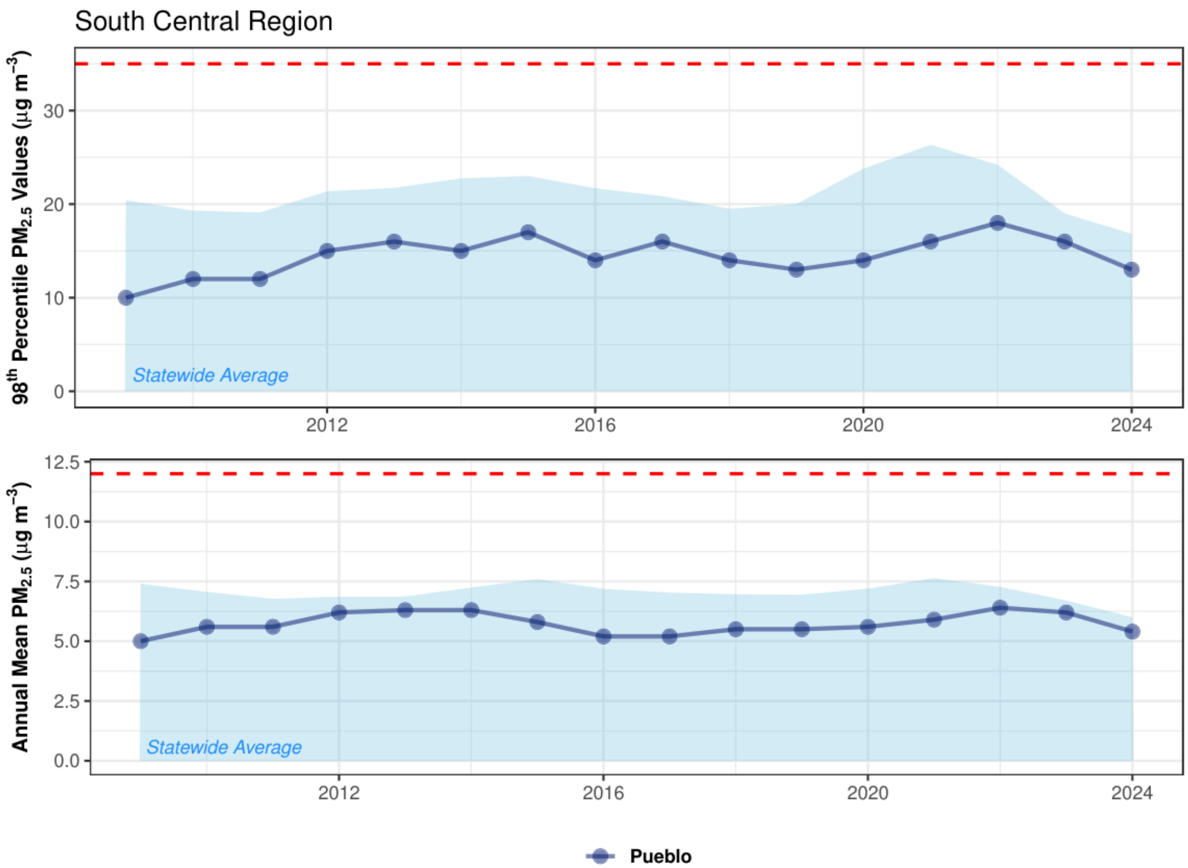

Figure 4.39: Fifteen-year trend in 24-hour $PM_{2.5}$ annual 98th percentile values (top) and annual mean concentrations (bottom) for monitoring sites in the South Central region. The 24-hour and annual mean NAAQS (35 mg m^{-3} and 12 mg m^{-3}, respectively) are shown as dashed red lines.

4.6.2. Ozone

Table 4.20: Summary of O_3 values recorded at monitoring stations in the South Central region during 2024. The Pueblo West site is less than three years old, and did not have three years of regulatory monitoring data at the time of this report. Therefore the design value listed for this site is not directly comparable to the 3-year NAAQS standard for ozone.

			Ozone 8-Hour Avg. (ppm)		
Site Name	County	POC	1st Max Value	4th Max Value	3-Year Avg. of 4th Max (8-Hr)
Pueblo West	Pueblo	1	0.083	0.076	0.071

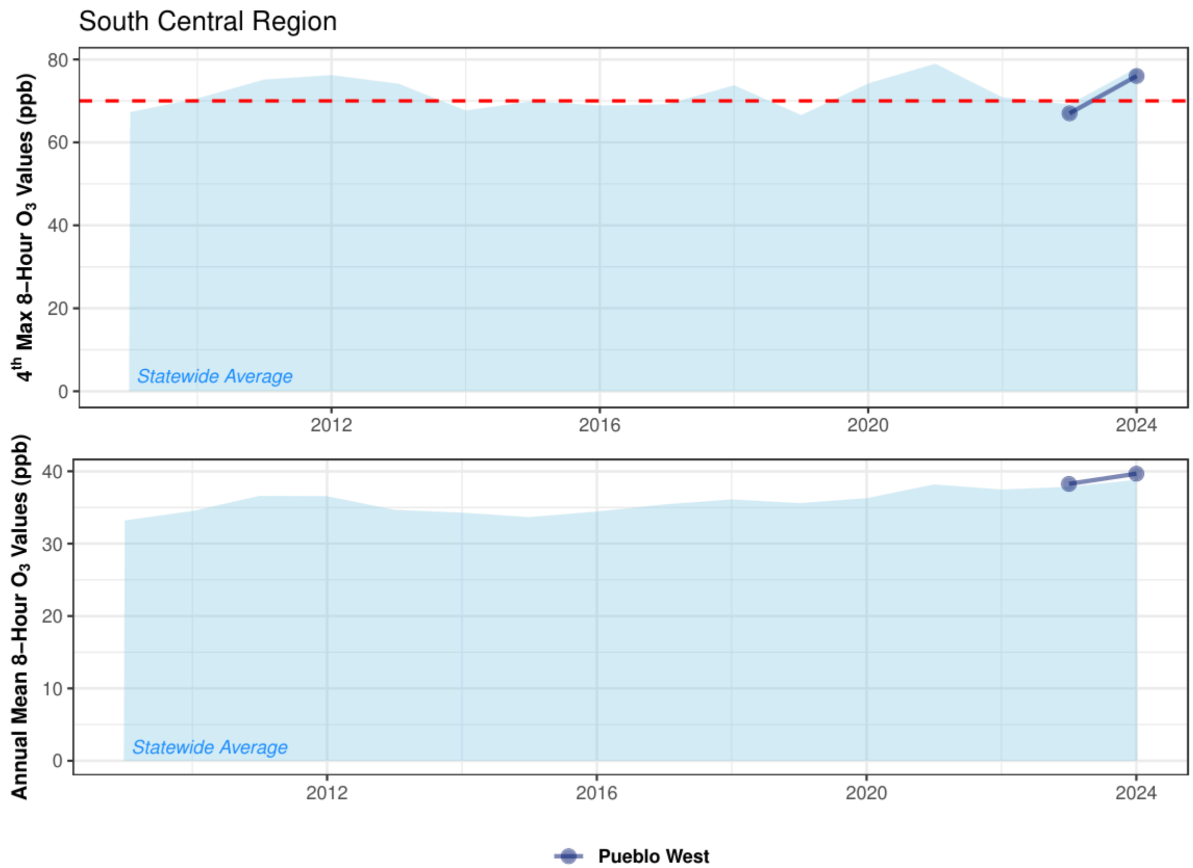

Figure 4.40: Fifteen-year trend in ozone eight-hour NAAQS values (top) and annual mean eight-hour concentrations (bottom) for monitoring sites in the South Central region. The eight-hour NAAQS (70 ppb) is shown as a dashed red line.

4.7. Southwest Region

Monitoring data from the southwest monitoring region are shown in tables 4.21-4.22 and figures 4.41-4.42 below.

4.7.1. Particulate Matter

Table 4.21: Summary of PM_{10} values recorded at monitoring sites in the Southwest region during 2024.

			PM_{10} ($\mu g\ m^{-3}$)		
Site Name	County	POC	Annual Mean	24-Hr Max	3-Year Exceedances
Pagosa Springs School	Archuleta	4	20.7	76	0

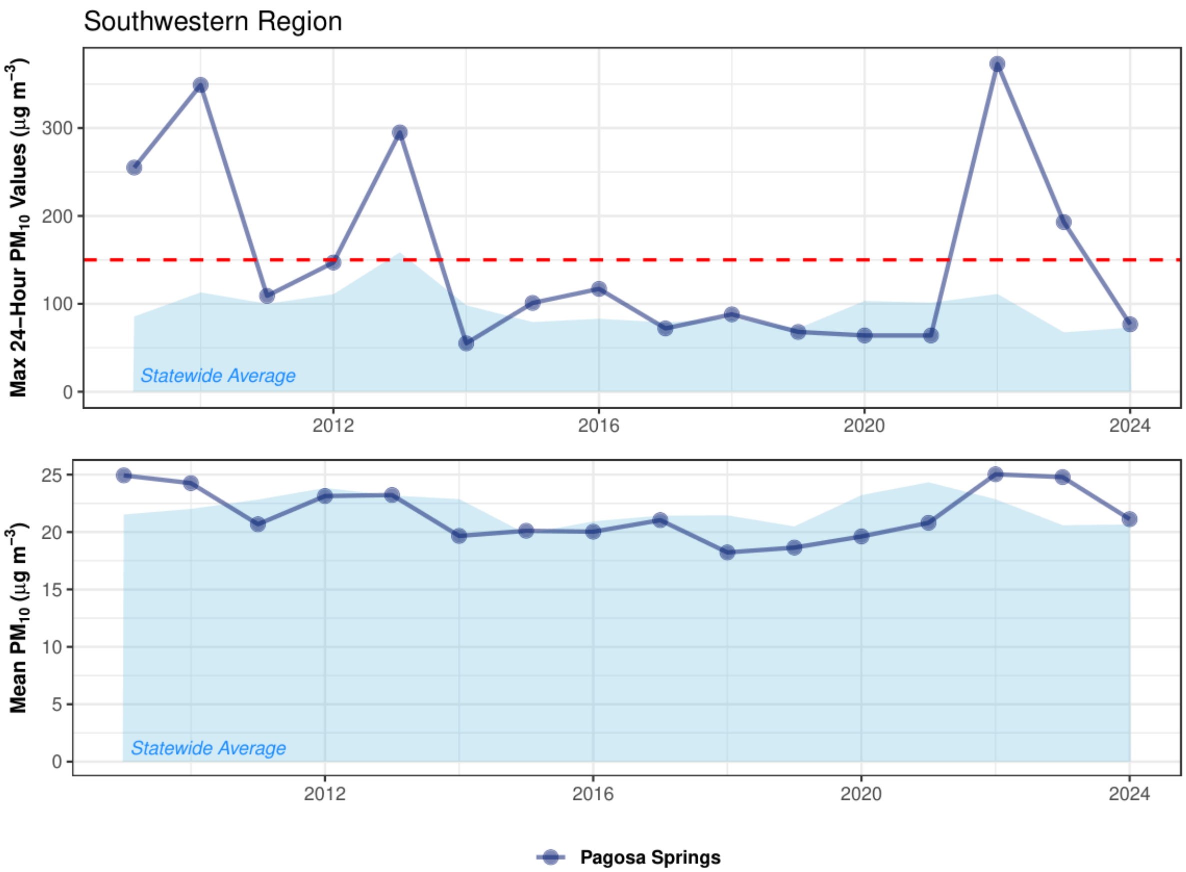

Figure 4.41: Fifteen-year trend in maximum 24-hour PM_{10} values (top) and annual mean concentrations (bottom) for monitoring sites in the Southwest region (including potential exceptional events). The 24-hour NAAQS (150 mg m^{-3}) is shown as a dashed red line.

4.7.2. Ozone

Table 4.22: Summary of O_3 values recorded at the monitoring station in the Southwest region during 2024.

			Ozone 8-Hour Avg. (ppm)		
Site Name	County	POC	1^{st} Max Value	4^{th} Max Value	3-Year Avg. of 4^{th} Max (8-Hr)
Cortez - Health Dept	Montezuma	1	0.069	0.065	0.062

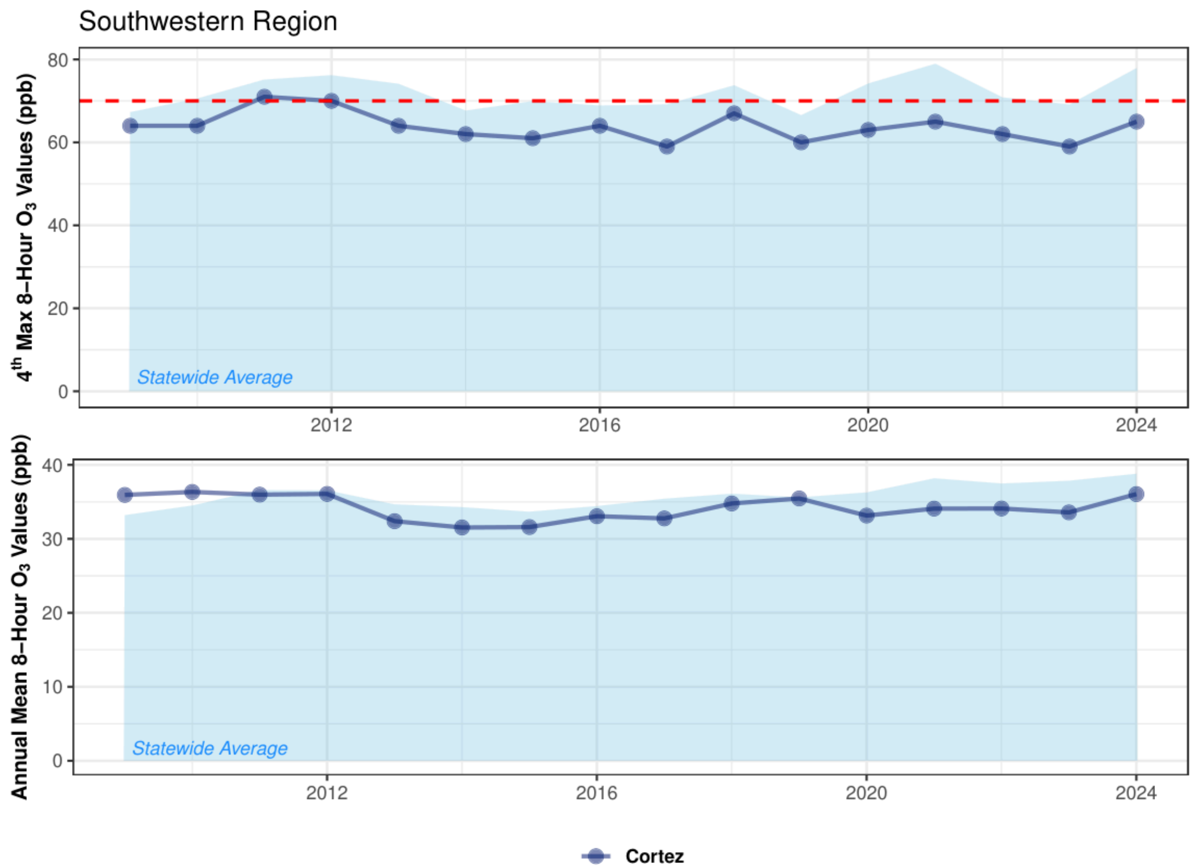

Figure 4.42: Fifteen-year trend in ozone eight-hour NAAQS values (top) and annual mean eight-hour concentrations (bottom) for monitoring sites in the Southwest region. The eight-hour NAAQS (70 ppb) is shown as a dashed red line.

4.8. Western Slope Region

Monitoring data from the western slope monitoring region are shown in tables 4.23-4.25 and figures 4.43-4.46 below.

4.8.1. Particulate Matter

Table 4.23: Summary of PM_{10} values recorded at monitoring sites in the Western Slope region during 2024.

			PM_{10} ($\mu g\ m^{-3}$)		
Site Name	County	POC	Annual Mean	24-Hr Max	3-Year Exceedances
Grand Junction - Powell Bldg.	Mesa	1	15.2	50	0
Telluride	San Miguel	3	16.0	72	0

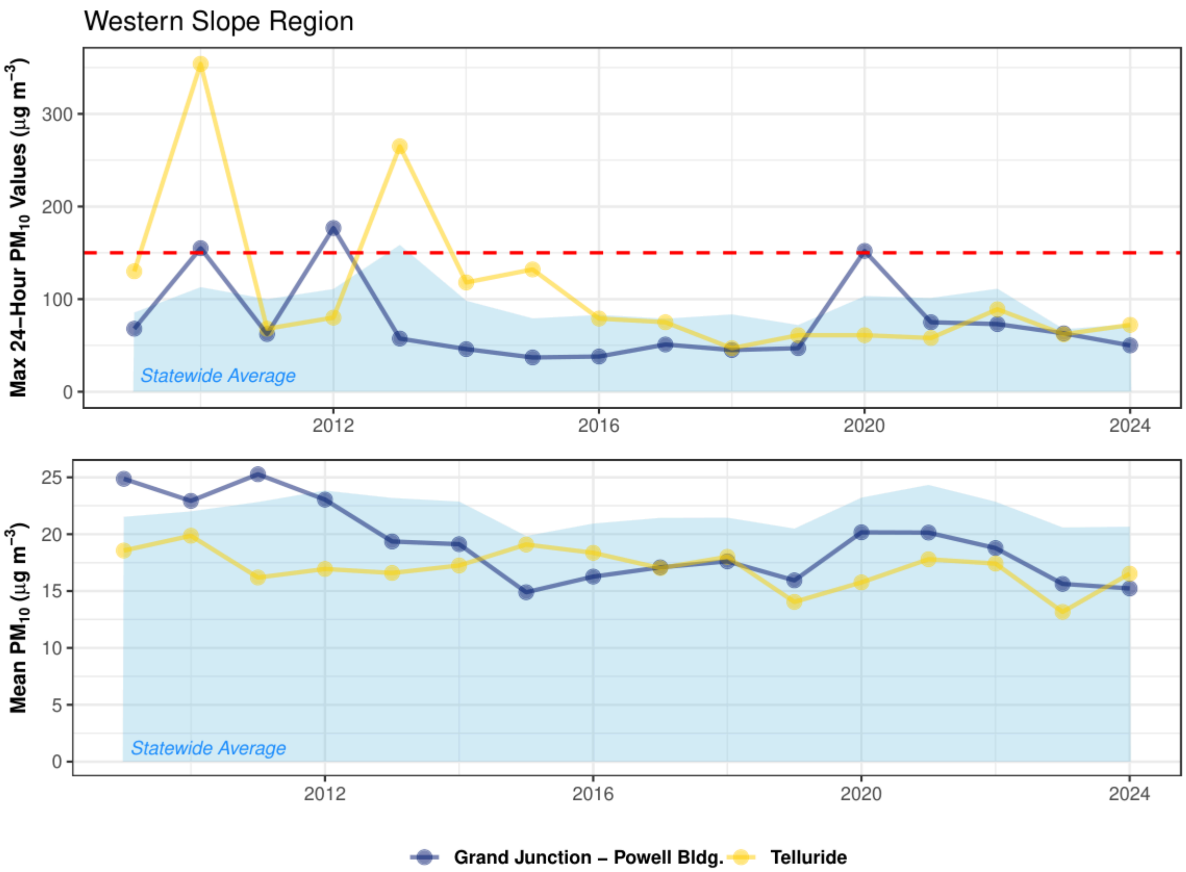

Figure 4.43: Fifteen-year trend in maximum 24-hour PM_{10} values (top) and annual mean concentrations (bottom) for monitoring sites in the Western Slope region (including potential exceptional events). The 24-hour NAAQS (150 mg m^{-3}) is shown as a dashed red line.

Table 4.24: Summary of $PM_{2.5}$ values recorded at the Grand Junction - Powell Bldg. monitoring site during 2024.

			$PM_{2.5}$ (µg m^{-3})		
Site Name	County	POC	Annual Mean	98th Percentile	3-Year Avg. of 98th percentile
Grand Junction - Powell Bldg.	Mesa	3	4.9	14.1	13

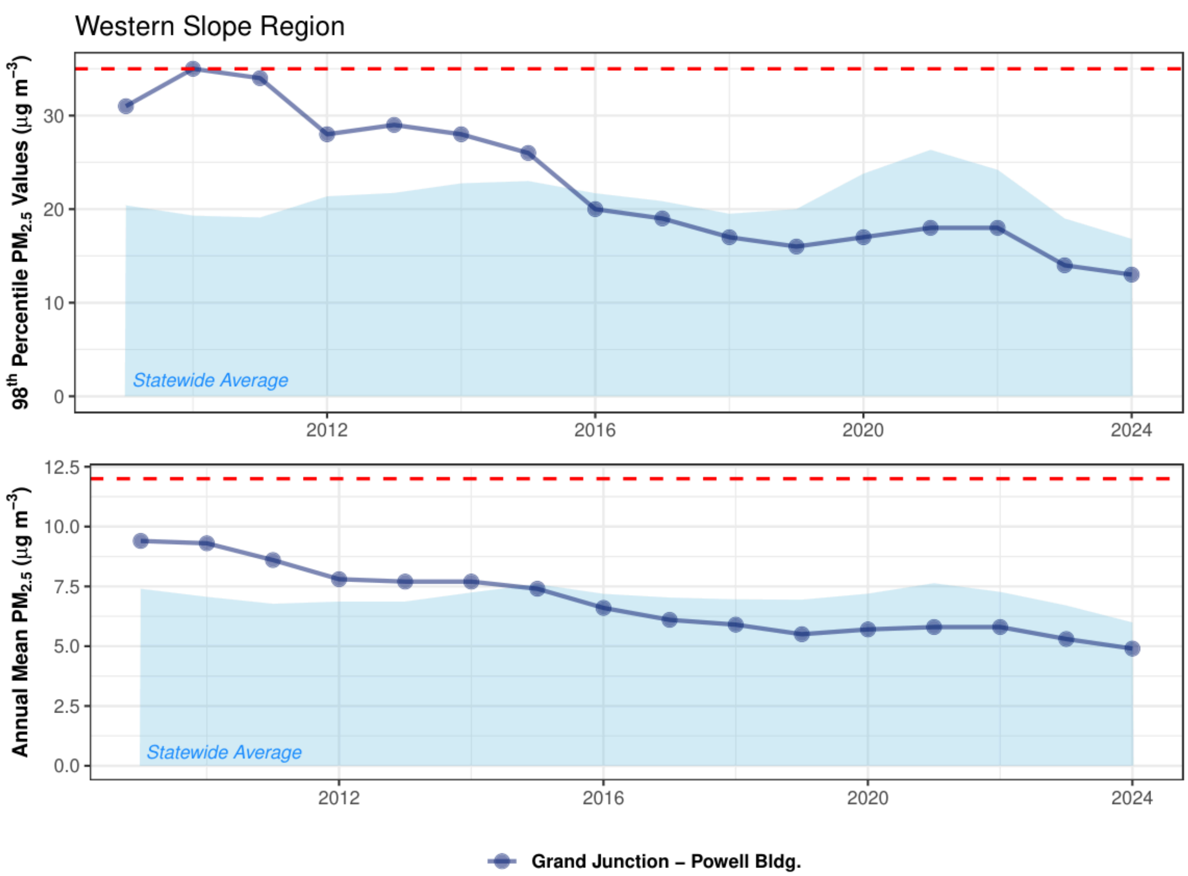

Figure 4.44: Fifteen-year trend in 24-hour $PM_{2.5}$ annual 98th percentile values (top) and annual mean concentrations (bottom) for monitoring sites in the Western Slope region. The 24-hour and annual mean NAAQS (35 mg m^{-3} and 12 mg m^{-3}, respectively) are shown as dashed red lines.

4.8.2. Ozone

Table 4.25: Summary of O_3 values recorded at monitoring stations in the Western Slope region during 2024.

			Ozone 8-Hour Avg. (ppm)		
Site Name	County	POC	1st Max Value	4th Max Value	3-Year Avg. of 4th Max (8-Hr)
Rifle-Health Dept	Garfield	1	0.072	0.063	0.059
Palisade-Water Treatment	Mesa	1	0.078	0.067	0.063

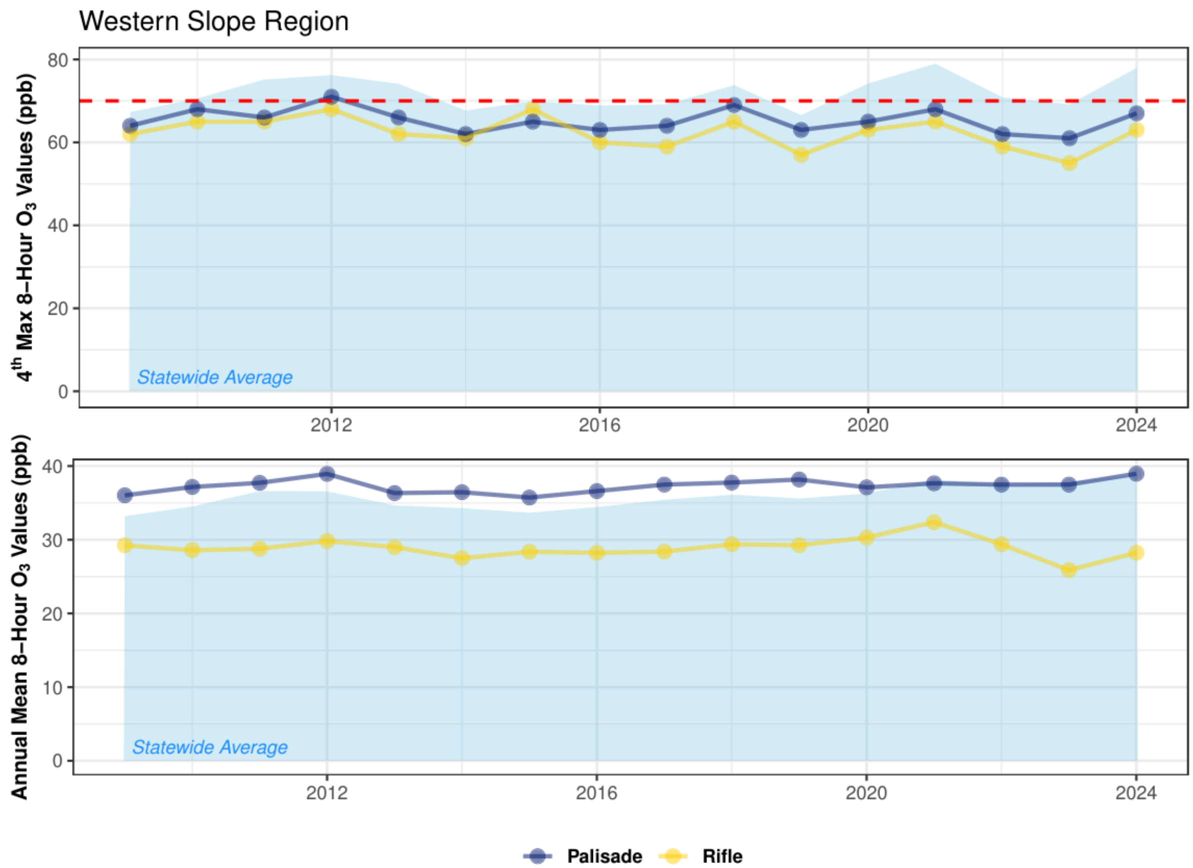

Figure 4.45: Fifteen-year trend in ozone eight-hour NAAQS values (top) and annual mean eight-hour concentrations (bottom) for monitoring sites in the Western Slope region. The eight-hour NAAQS (70 ppb) is shown as a dashed red line.

4.8.3. Meteorology

See section 3.4 for more details on the wind rose plot below.

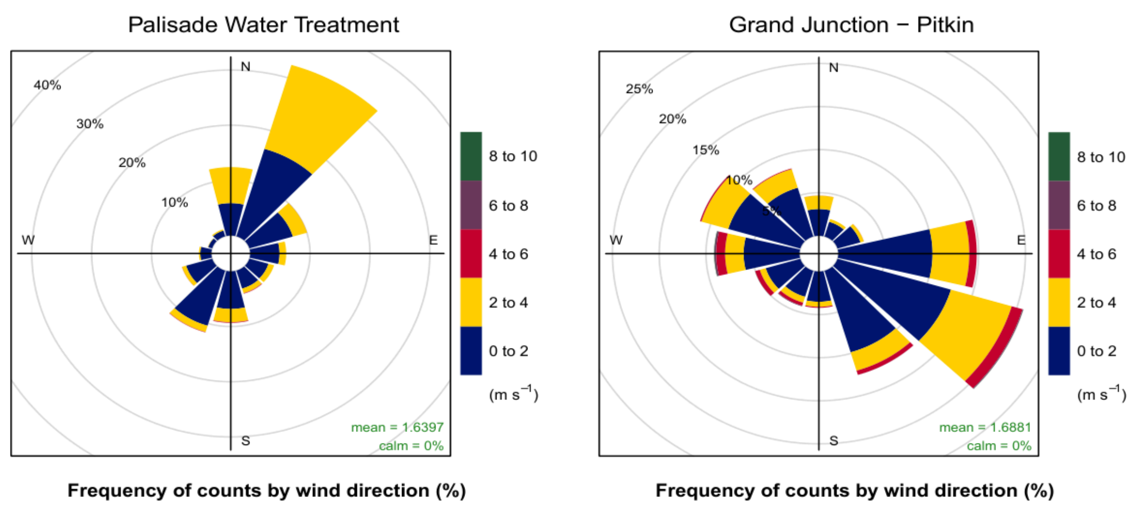

Figure 4.46: Wind roses for sites in the Western Slope Region during 2024.

5. Seasonal Variability in Air Quality

Data has been presented in this report to give an overall picture of the progress of air quality through the years and to compare measured concentrations against the NAAQS. However, APCD collects data as hourly averages (which are themselves the result of even more brief intervals being averaged together) for select criteria pollutants at each site. In this section, monthly averages will be presented for each site.

In some sense, there is little interpretation to be done concerning the air quality information presented in this section. It is not intended to compare Colorado's air quality against the standards, other states, or past air quality. This section is only to suggest a more detailed picture of the air quality in our state throughout the year.

In all of the graphs in this section, the range is illustrated as blue shading, where the lower and upper limits are defined as the minimum and maximum monthly averages, respectively. This is the range for the entire state. The sites are not grouped by monitoring region in this section, rather they are presented in order of their Air Quality Site ID, which is an EPA designated code derived from the state and county where the site is located, along with a unique site number. Each graph has been limited in the number of sites it presents for clarity's sake, but for each pollutant set, the minimum and maximum state-wide range is the same. Data in the graphs below may include exceptional events (see subsection 2.2.5.4).

5.1. Carbon Monoxide

CO is normally higher in the winter months and lower in the summer, for reasons previously discussed (see subsection 2.2.1).

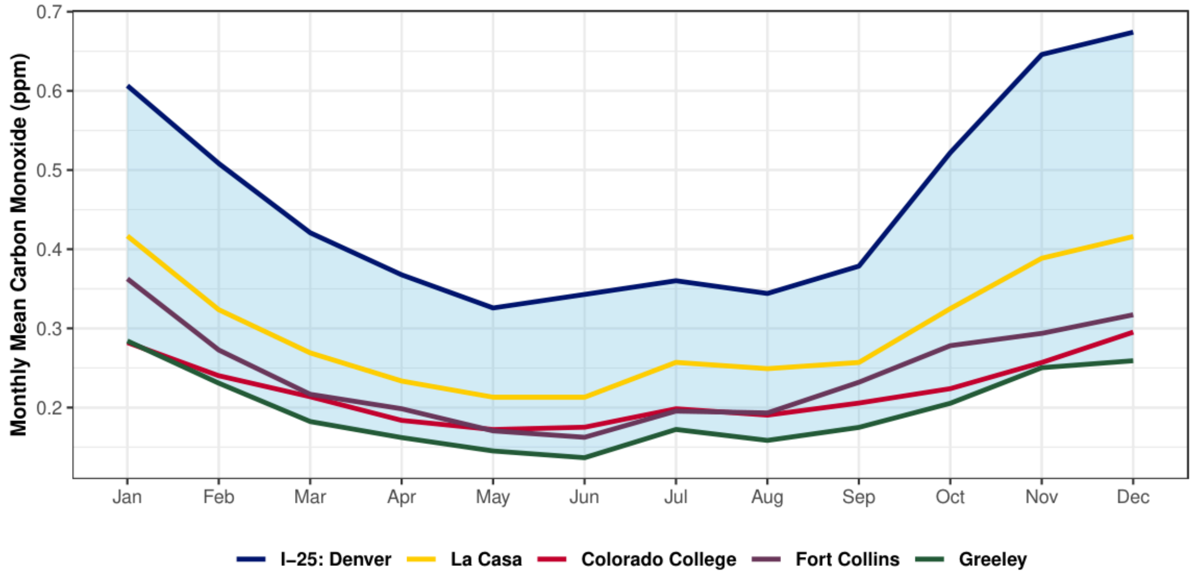

Figure 5.1: Monthly mean carbon monoxide concentrations. The blue shaded region shows the statewide range of monthly mean values.

5.2. Sulfur Dioxide

Sulfur dioxide was measured at three stations during 2024 by APCD in Colorado: Welby, La Casa, and CAMP. Sulfur dioxide generally follows the same pattern as that for CO, typically being lower in concentration during the warmer months and higher in concentration during the colder months.

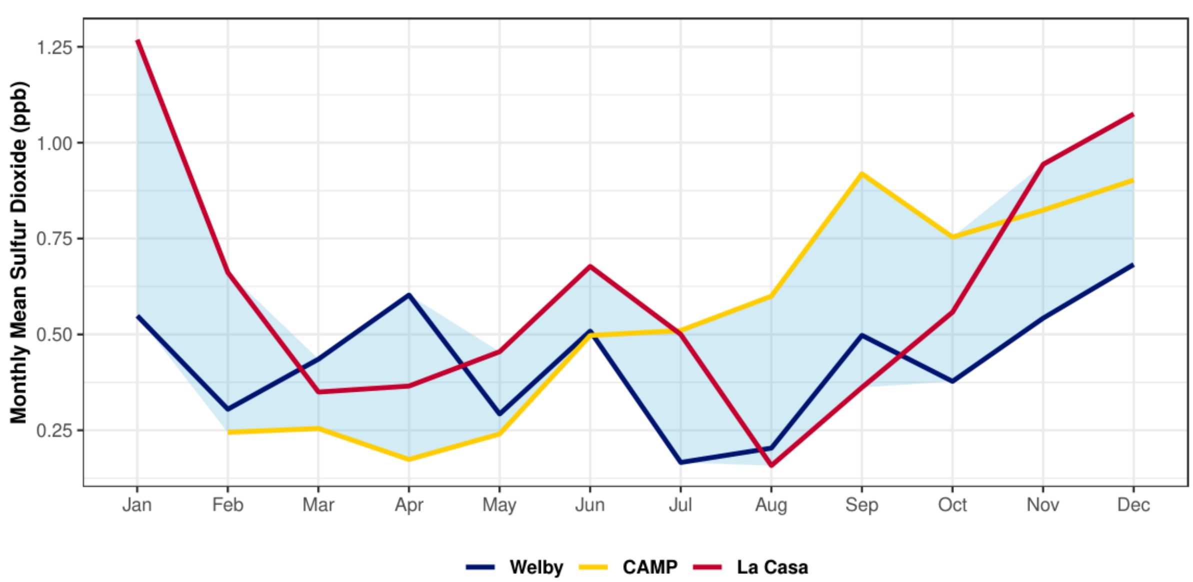

Figure 5.2: Monthly mean sulfur dioxide concentrations. The blue shaded region shows the statewide range of monthly mean values.

5.3. Ozone

Ozone follows an opposite seasonal pattern relative to CO. The summer months see high ozone and the winter experiences lower levels, in part because of seasonal variations in day length and the angle of the sun relative to the ground. Remember that ozone may be indicative of ground-level smog or the "Denver Brown Cloud." Generally speaking, sites in the Northern Front Range counties experienced higher concentrations of ozone than other areas (especially sites directly west of, and at higher elevation than, metro Denver), though sites outside the Front Range occasionally had the highest averages.

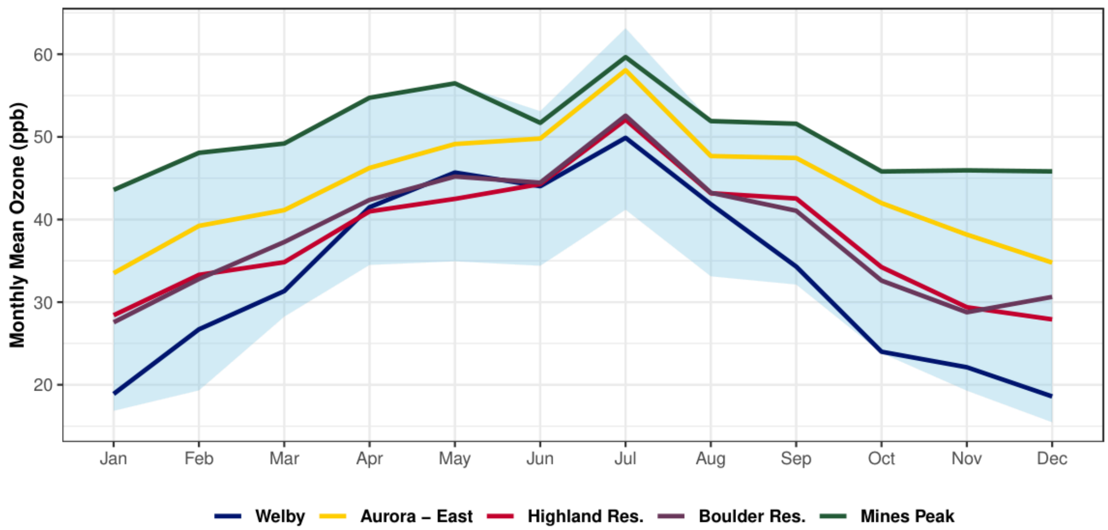

Figure 5.3: Monthly mean ozone concentrations. The blue shaded region shows the statewide range of monthly mean values.

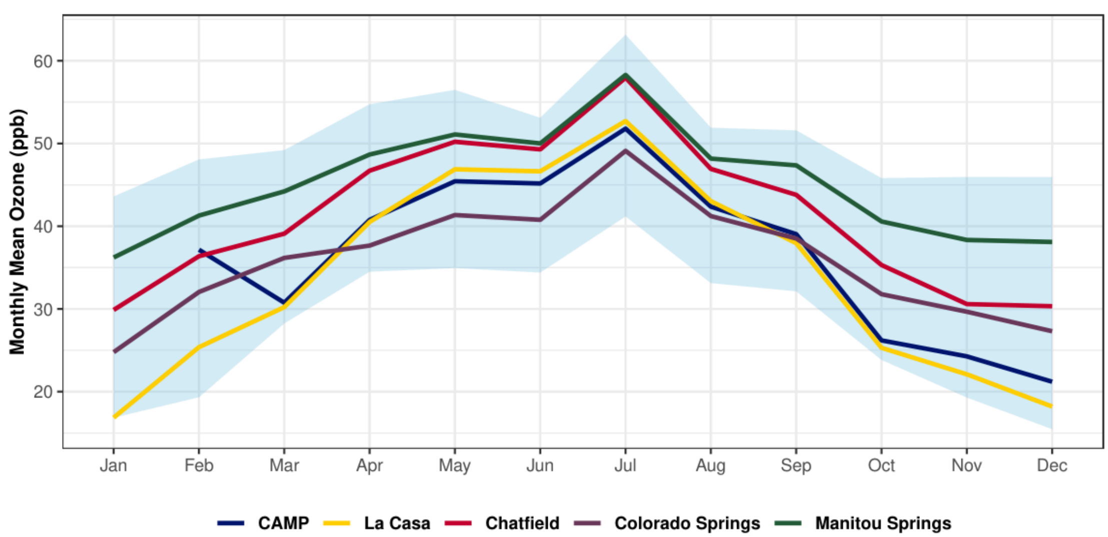

Figure 5.4: Monthly mean ozone concentrations. The blue shaded region shows the statewide range of monthly mean values.

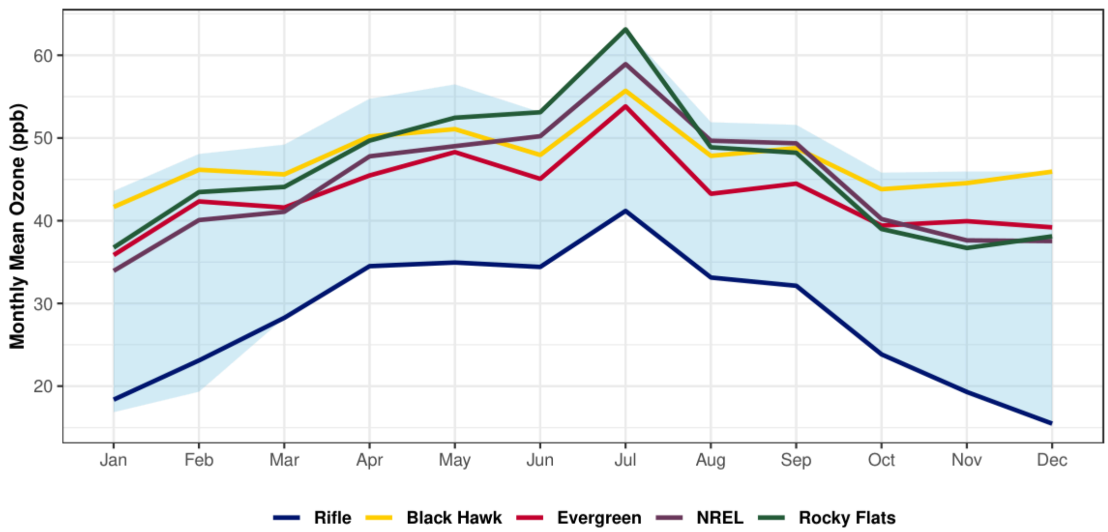

Figure 5.5: Monthly mean ozone concentrations. The blue shaded region shows the statewide range of monthly mean values.

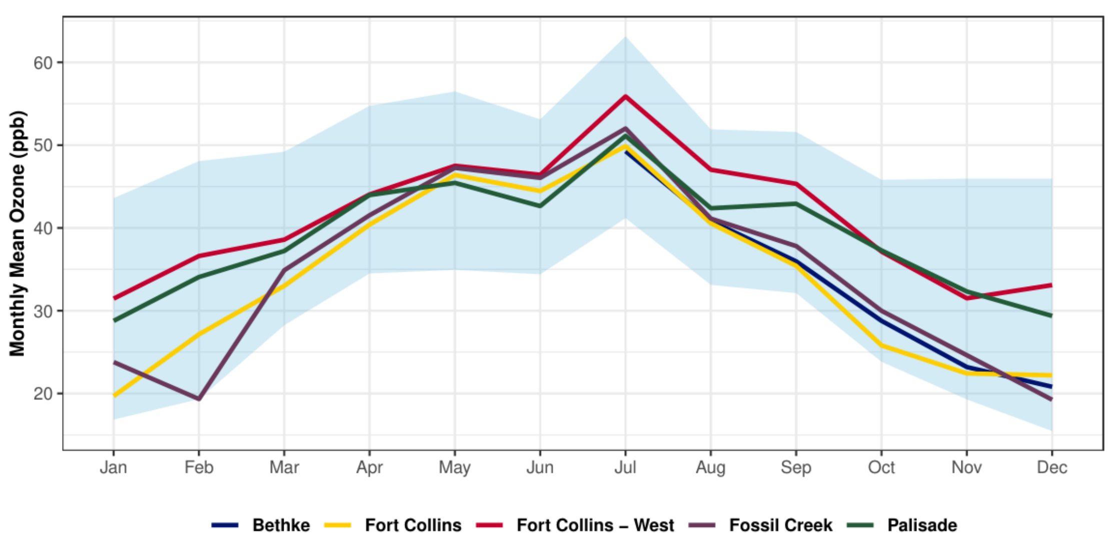

Figure 5.6: Monthly mean ozone concentrations. The blue shaded region shows the statewide range of monthly mean values.

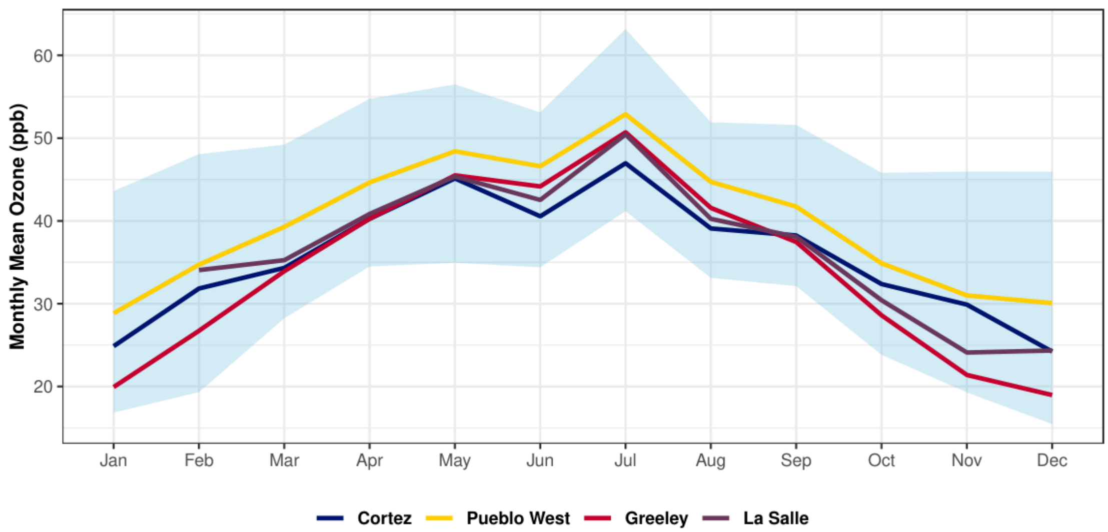

Figure 5.7: Monthly mean ozone concentrations. The blue shaded region shows the statewide range of monthly mean values.

5.4. Nitrogen Dioxide

Nitrogen dioxide was measured at nine stations during 2024 by APCD in Colorado: Welby, CAMP, La Casa, I-25 Globeville, I-25 Denver, Rocky Flats, Bethke, Fossil Creek, and La Salle. Nitrogen dioxide generally follows the same pattern as that for CO, typically being lower in concentration during the warmer months and higher in concentration during the colder months. NO_2 concentrations at sites in fairly close proximity appear to track well with one another.

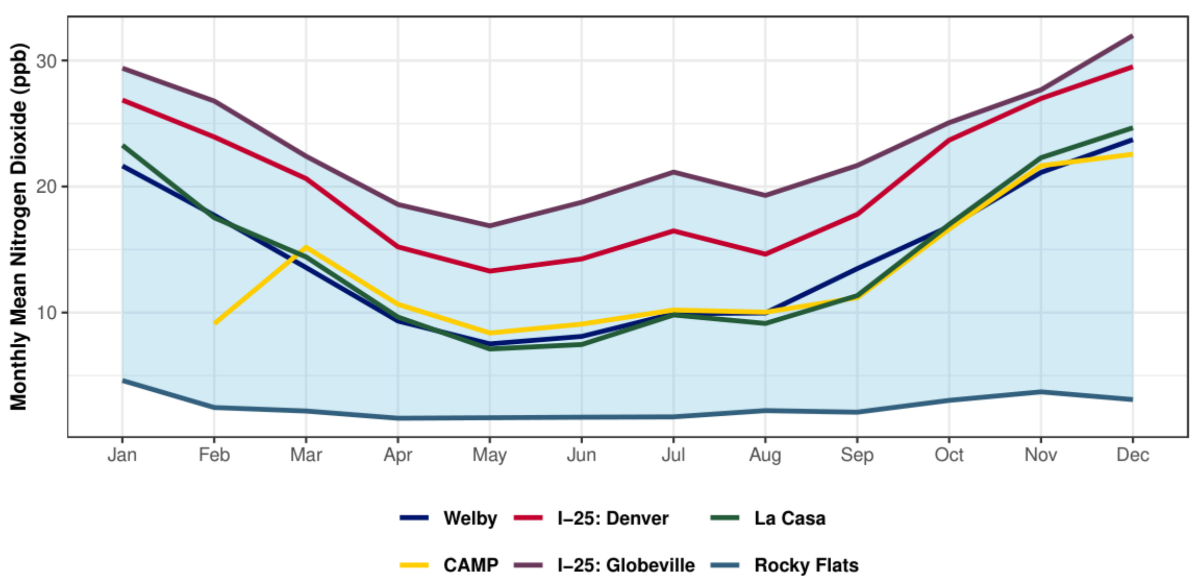

Figure 5.8: Monthly mean nitrogen dioxide concentrations. The blue shaded region shows the statewide range of monthly mean values.

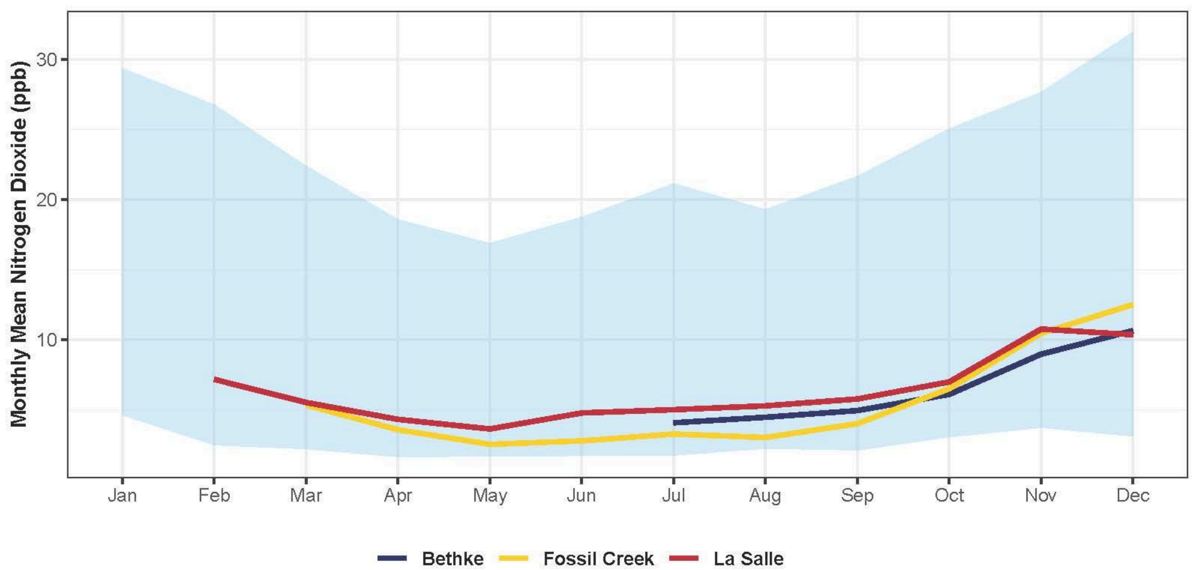

Figure 5.9: Monthly mean nitrogen dioxide concentrations. The blue shaded region shows the statewide range of monthly mean values.

5.5. PM_{10}

PM_{10} concentrations can be elevated for a variety of reasons, including both anthropogenic and natural occurrences. Higher PM_{10} concentrations might be expected during dry months and or droughts, since the soil has a chance to dry out and be entrained by the winds. This is reflected somewhat in the range of PM_{10} concentrations found in the following graphs, but the peaks in concentrations are often due to single-point high-concentration events, typically associated with high winds and blowing dust. The data below contains exceptional events. See subsubsection 2.2.5.4 for an explanation of exceptional events. Many of these exceptional events will be analyzed and documented as natural events and be demonstrated as beyond reasonable control and or not preventable. The documentation package is then sent to the EPA for concurrence. If the EPA concurs with the APCD’s analysis, then the exceedance or high PM_{10} reading will be removed from regulatory consideration and will not be used in NAAQS calculations.

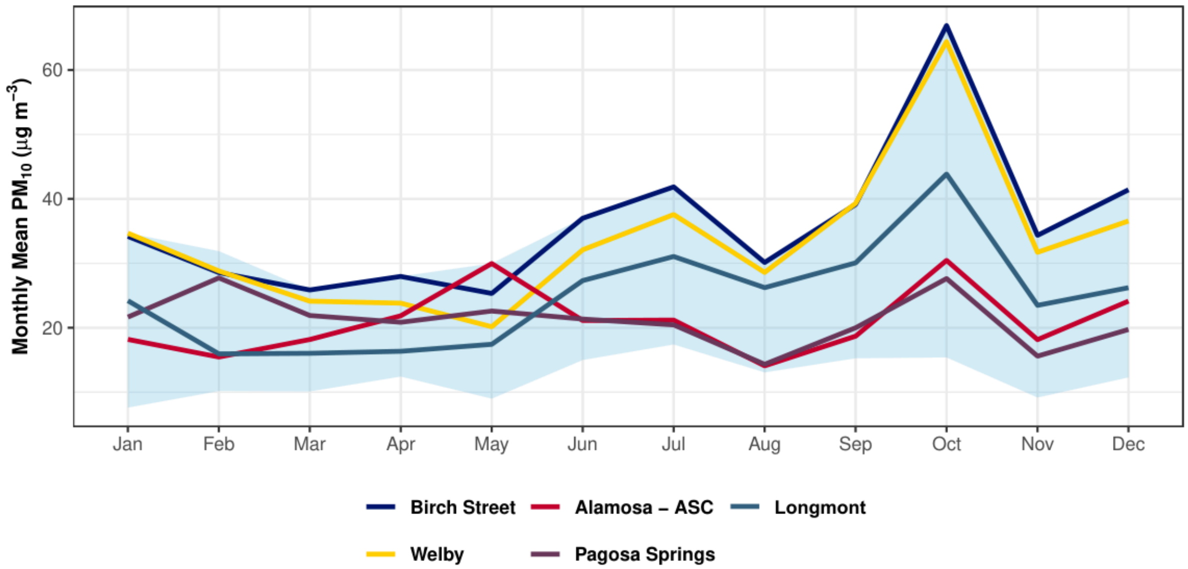

Figure 5.10: Monthly mean PM_{10} concentrations. The blue shaded region shows the statewide range of monthly mean values.

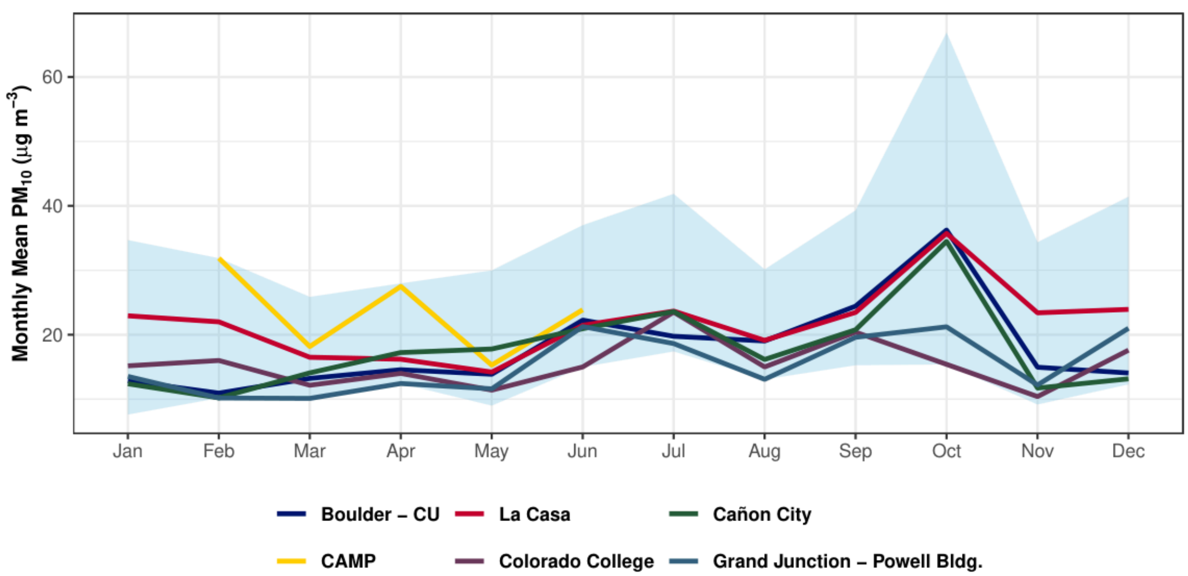

Figure 5.11: Monthly mean PM_{10} concentrations. The blue shaded region shows the statewide range of monthly mean values.

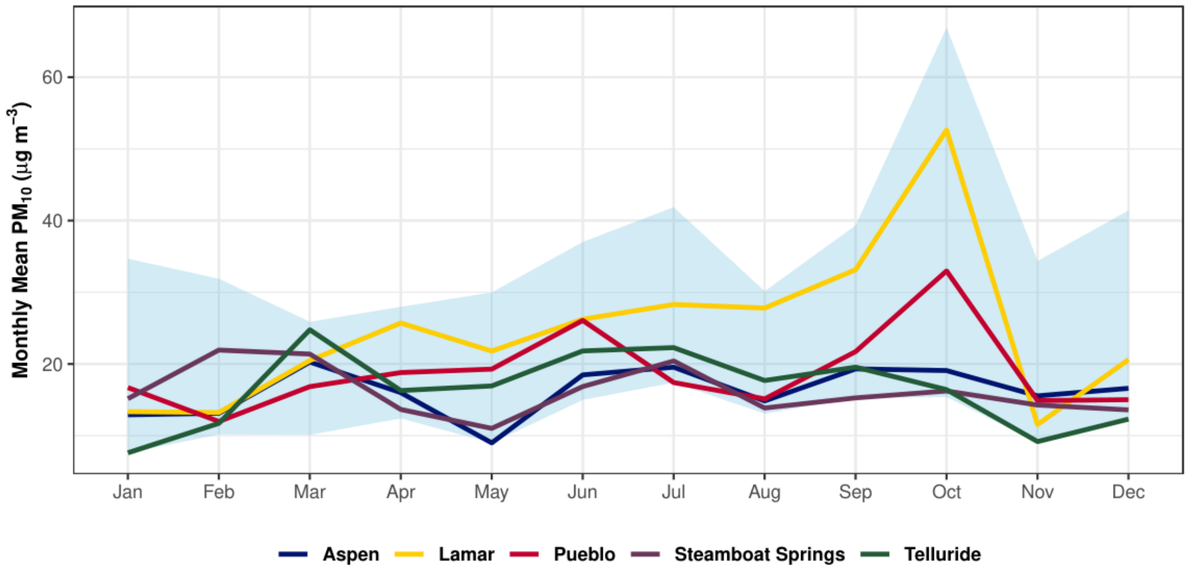

Figure 5.12: Monthly mean PM_{10} concentrations. The blue shaded region shows the statewide range of monthly mean values.

5.6. $PM_{2.5}$

$PM_{2.5}$ concentrations are generally stable throughout much of the year, and relatively similar values are measured at sites throughout the state. The graphs here may include exceptional event data.

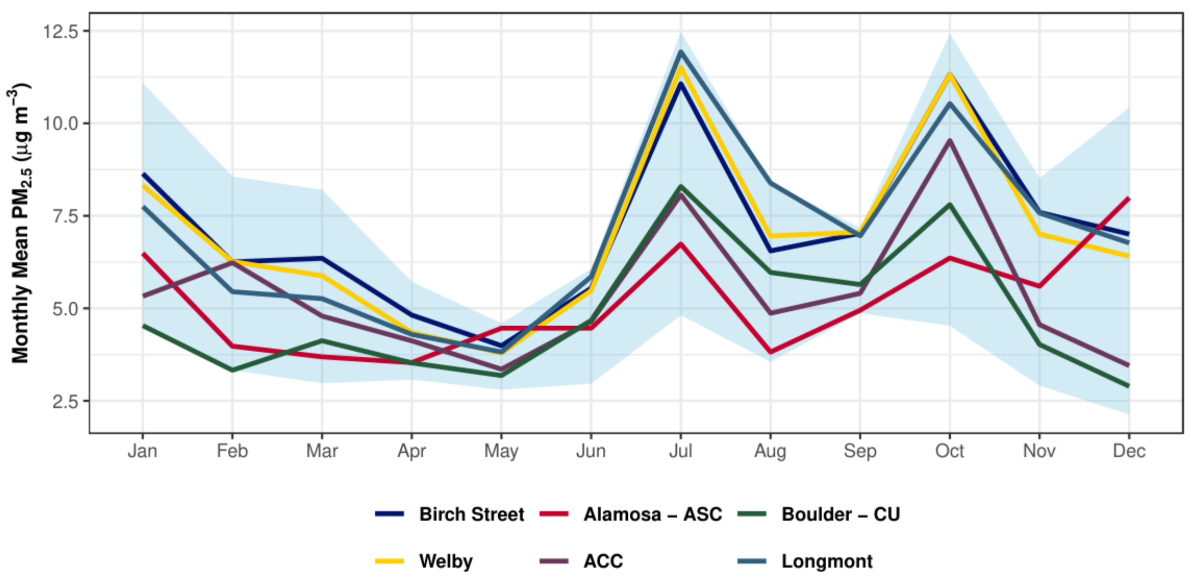

Figure 5.13: Monthly mean $PM_{2.5}$ concentrations. The blue shaded region shows the statewide range of monthly mean values.

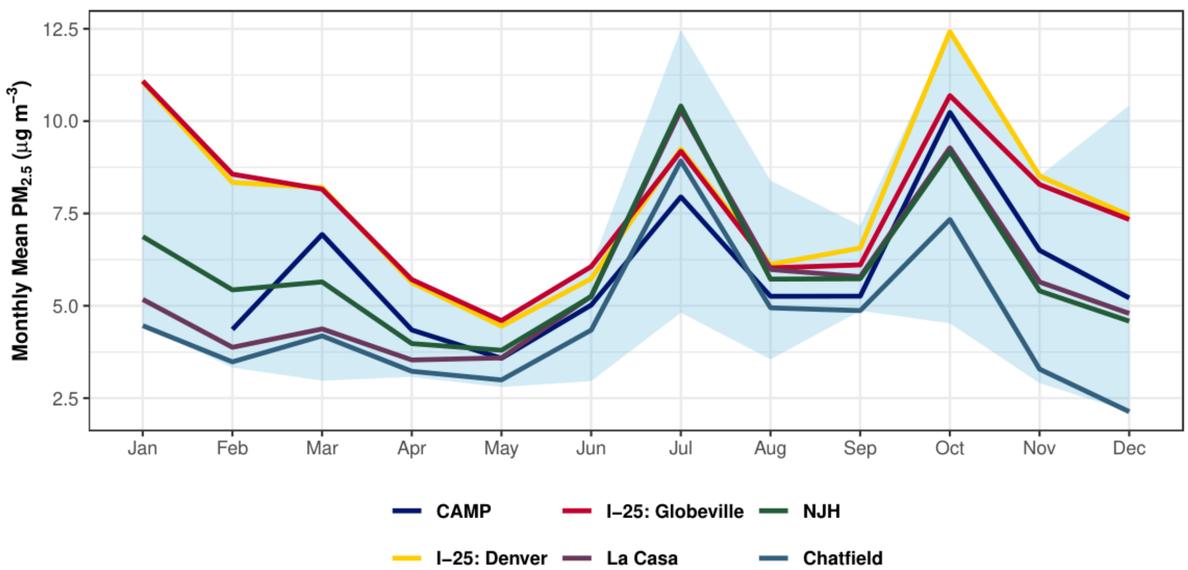

Figure 5.14: Monthly mean $PM_{2.5}$ concentrations. The blue shaded region shows the statewide range of monthly mean values.

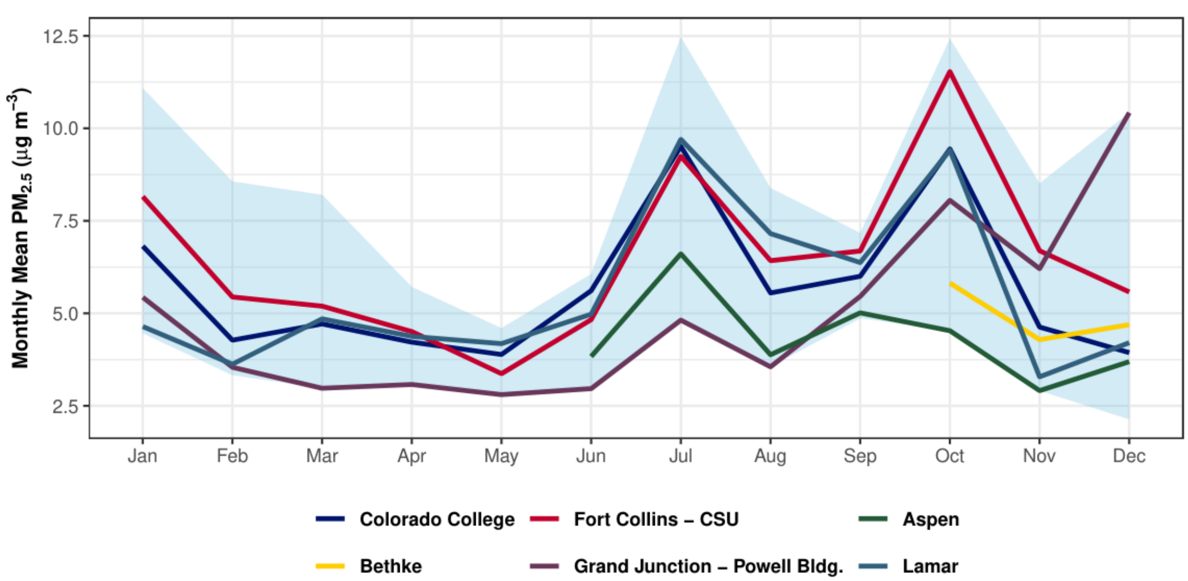

Figure 5.15: Monthly mean $PM_{2.5}$ concentrations. The blue shaded region shows the statewide range of monthly mean values.

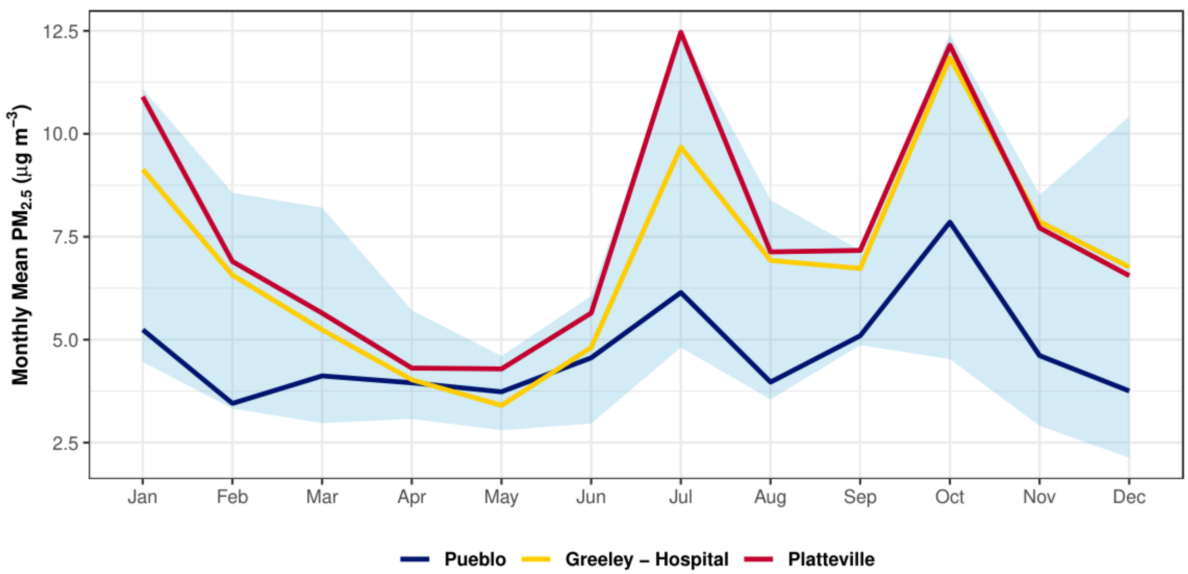

Figure 5.16: Monthly mean $PM_{2.5}$ concentrations. The blue shaded region shows the statewide range of monthly mean values.

6. Data Quality Assurance / Quality Control

This section describes the APCD Technical Services Program's success in meeting its data quality objectives for ambient air pollution monitoring data of criteria pollutants. This section has been prepared in accordance with 40 CFR Part 58 requirements. The statistical methodology used in this assessment is described in detail in the document "*Guideline on the Meaning and Use of Precision and Accuracy Data Required by 40 CFR Part 58 Appendix A*."

Other quality objectives were assessed via laboratory and site system audits. The results of these audits indicate compliance with APCD's standard operating procedures and EPA acceptance criteria. Copies of APCD laboratory audits may be obtained from the Quality Assurance Unit of the APCD.

Other audits were performed and can be made available for review, including National Air Toxics Trends Station (NATTS) audits, Speciation Trend Network (STN) audits, and audits conducted within Colorado by other organizations. These results are not included in this report because other agencies perform the data assessments for these audits. CDPHE meteorological network audits are not included in this report, as meteorological data is not considered a priority pollutant and so a statistical assessment of this data is not provided.

6.1. Data Quality

In order to provide decision makers with data of adequate quality, the CDPHE uses the Data Quality Objectives (DQO) process to develop performance and acceptance criteria (or data quality objectives) that specify tolerable levels of potential decision errors that will be used as the basis for establishing the quality and quantity of data needed to support decisions. Quality objectives for measurement data are designed to ensure that the data end user's DQOs are met. Measurement quality objectives include quantitative objectives, such as representativeness, completeness, accuracy, precision, and detection level, as well as qualitative objectives, such as site placement, operator training, and sample handling techniques. There are some data quality indicators underlying the DQOs that relate directly to the measurement system being used to collect ambient air measurements. These data quality indicators include precision, bias, completeness, and sampling frequency. These variables need to be maintained within certain acceptable ranges so that end data users can make decisions with specified levels of confidence.

6.2. Quality Assurance Procedures

Quality assurance is a general term for the procedures used to ensure that a particular measurement meets the quality requirements for its intended use. In addition to performing tests to determine bias and precision, additional quality indicators (such as sensitivity, representativeness, completeness, timeliness, documentation quality, and sample custody control) are also evaluated. Quality assurance procedures fall under two categories:

- Quality Control (QC): procedures built into the daily sampling and analysis methodologies to ensure data quality, and
- Quality Assessment (QA): periodic independent evaluations of data quality.

Some ambient air monitoring is performed by automated equipment located at field sites, while other measurements are made by taking samples from the field to the laboratory for analysis. For this reason, we will divide quality assurance procedures into two parts: field and laboratory quality assurance.

6.2.1. Field Quality Assurance

Quality assurance is a general term for the procedures used to ensure that a particular measurement meets the quality requirements for its intended use. Quality control of continuous analyzers consists of precision checks and/or flow verifications. The overall precision of filter-based sampling methods is measured using collocated samplers. Quality assurance is evaluated by periodic performance and system audits.

Automated analyzers (except O_3) are calibrated by challenging the instrument's response to a known concentration of EPA protocol gas delivered through a dilution system. The analyzer is then adjusted to produce the correct response. O_3 analyzers are calibrated by challenging the analyzer's response with O_3 produced by an independently certified NIST-traceable ozone generator. The site's analyzer is then adjusted to produce the same measured concentration as the traceable analyzer. Manual samplers are calibrated by comparing their volumetric flow rate at one or more levels to the flow measured by a flow transfer standard. Calibrations are performed when an instrument is first installed and at assigned intervals thereafter depending on the analyzer type. Calibrations are also performed after instrument repairs or when quality control charts indicate a drift in response to quality control checks.

Precision is a measure of the variability of an instrument or the variability of the testing source. The precision of continuous gaseous analyzers are evaluated by comparing a sample of a known concentration against the instrument's response. The precision of filter-based particulate samplers is determined by collocated sampling (i.e., the simultaneous operation of two identical samplers placed side by side). The difference in the results of the two samplers is used to estimate the precision of the entire measurement process (i.e., both field and laboratory precision). Precision of manual particulate samplers is assessed by regular periodic flow checks. Precision of continuous particulate samplers is assessed through the comparison of the ambient data to the FRM data and by regular periodic flow checks. Manual samplers are calibrated by comparing their volumetric flow rate at one or more levels to the flow measured by a flow transfer standard. Calibrations are performed when an instrument is first installed and at assigned intervals thereafter depending on the analyzer type. Calibrations are also performed after instrument repairs or when quality control charts indicate a drift in response to quality control checks.

The bias of automated methods is assessed through field performance evaluations (also called accuracy audits) and through site precision checks. Performance audits are conducted by challenging the instrument with a gas of known NIST-traceable concentration. Bias is evaluated by comparing the measured response to the known value. Typically, performance evaluations are performed biannually using samples of several different concentrations.

System audits indicate how well a sampling site and site operator conforms to the standard operating procedures as well as how well the site is located with respect to its mission (e.g., urban or rural sampling, SLAMS or special purpose sampling site, etc.). Some areas reviewed include: site location (possible obstruction, presence of nearby pollutant sources), site security, site characteristics (urban versus suburban or rural), site maintenance, physical facilities (maintenance, type and operational quality of equipment, buildings, etc.), record-keeping, sample handling, storage, and transport.

6.2.2. Laboratory Quality Control

Laboratory quality control includes calibration of analytical instrumentation, analysis of blank samples to check for contamination, analysis of spikes to evaluate interferences and target analyte matrix recovery, and analysis of duplicate samples to evaluate precision. Quality assurance is accomplished through laboratory performance and system audits.

Laboratory analytical instruments are calibrated by comparing the instrument's response with standards of a known concentration level. The differences between the measured and known concentrations are then used to adjust the instrument to produce the correct response.

A blank sample is one that has intentionally not been exposed to the pollutant of interest. Analysis of blank samples reveals possible contamination in the laboratory, during field handling, or during transportation.

Duplicate analyses of the same sample are performed to monitor the precision of the analytical method.

A regular sample is spiked with a known concentration to determine if the sample matrix is interfering with detection capabilities of the instrumentation. Regular performance audits are conducted by having the laboratory analyze samples whose physical or chemical properties have been certified by an external laboratory or standards organization. The difference between the laboratory's reported value and the certified value is used to evaluate the analytical method's accuracy.

System audits indicate how well the laboratory conforms to its standard operating procedures. System audits involve sending a QA Auditor to the laboratory to review compliance with standard operating conditions. Areas examined include: record keeping, sample custody, equipment maintenance, personnel training and qualifications, and a general review of facilities and equipment.

6.3. Gaseous Criteria Pollutants

6.3.1. Quality Objectives for Measurement Data

Data Quality Objectives for the APCD's ambient air monitoring program for gaseous criteria pollutants are shown in Table 6.1.

Table 6.1: Data quality objectives for gaseous criteria pollutants.

Data Quality Indicator	APCD Goal	EPA Requirement
Precision for O_3	7%	7%
Precision for CO, SO_2, NO_2	10%	10%
Precision Completeness	90%	75%
Bias for O_3	7%	7%
Bias for CO, SO_2, NO_2	10%	10%
Accuracy for O_3	15%	15%
Accuracy Audits Completeness	2 audits per analyzer per year	25% of analyzers quarterly
90% Probability Intervals	Meet EPA requirement	95% of audit values
NPAP TTP Audits for O_3	Meet EPA requirement	10%
NPAP TTP Audits for for CO, SO_2, NO_2	Meet EPA requirement	15%
Overall Data Completeness	90%	75%

6.3.2. Gaseous Data Quality Assessment

6.3.2.1. Summary

Assessment of the data for APCD gaseous criteria pollutants showed that all gaseous analyzers met the minimum EPA criteria and most monitoring sites met APCD goals for precision, bias, accuracy, national performance evaluations, and completeness.

Table 6.2: Summary of precision, accuracy, bias, and completeness for site-level gaseous monitoring data.

Site	Parameter	Precision Count	Precision Complete (%)	CV (%)	Bias (%)	Prob. Limits		Data Complete (%)
						Lower	Upper	
La Casa	CO	26	100	4.22	+/-3.66	-5.82	8.59	98
I-25: Denver	CO	26	100	3.67	+/-3.13	-5.20	7.34	95
Colorado College	CO	26	100	1.05	+2.85	0.84	4.42	100
Fort Collins - CSU - Mason	CO	26	100	2.03	+3.46	-0.53	6.41	99
Greeley - Weld County Tower	CO	26	100	2.54	+/-3.07	-2.11	6.56	99
Welby	SO_2	26	100	3.40	+/-2.78	-5.61	6.00	95
CAMP	SO_2	22	85	3.04	+2.93	-3.40	6.83	83
La Casa	SO_2	26	100	3.66	+3.62	-4.13	8.34	92
Welby	NO_2	26	100	2.08	+3.74	-0.23	6.87	95
CAMP	NO_2	22	85	2.69	-5.04	-8.94	0.12	77
La Casa	NO_2	26	100	3.90	+/-3.16	-5.47	7.84	90
I-25: Denver	NO_2	26	100	3.37	+/-2.89	-6.02	5.49	93
I-25: Globeville	NO_2	26	100	2.55	+4.88	-0.09	8.61	93
Rocky Flats - N	NO_2	26	100	3.57	+4.85	-2.33	9.85	93
Fossil Creek	NO_2	25	96	10.92	+/-9.00	-19.82	18.37	69
Bethke	NO_2	12	92	1.94	+/-1.58	-2.56	3.43	88
La Salle	NO_2	23	100	2.17	+4.60	0.40	7.74	92
Welby	O_3	26	100	3.30	+/-2.70	-5.87	5.40	88
Highlands	O_3	26	100	2.05	+/-1.63	-3.75	3.26	97
Aurora East	O_3	26	100	2.52	+2.84	-2.26	6.36	99
Boulder Reservoir	O_3	26	100	3.32	+/-2.80	-5.85	5.47	92
CAMP	O_3	22	85	3.15	+/-2.88	-6.61	4.01	81
La Casa	O_3	26	100	3.68	+/-3.08	-6.73	5.83	91
Chatfield State Park	O_3	26	100	2.39	+/-2.32	-5.47	2.70	97
U.S. Air Force Academy (USAFA)	O_3	26	100	2.57	+/-2.20	-3.42	5.34	96
Manitou Springs	O_3	26	100	1.61	+2.04	-1.09	4.39	100
Rifle - Health Dept	O_3	26	100	1.58	+/-1.36	-2.11	3.29	97
Black Hawk	O_3	26	100	3.75	+/-3.28	-6.82	5.97	99
Rocky Flats - N	O_3	25	96	3.74	+/-3.26	-7.03	5.73	98
NREL	O_3	26	100	2.52	+/-2.32	-3.23	5.38	98
Evergreen	O_3	26	100	2.74	+/-2.29	-5.17	4.17	97
Fort Collins - West	O_3	26	100	3.37	+/-3.19	-7.27	4.22	96
Fossil Creek	O_3	24	92	5.02	+4.72	-6.70	11.21	70
Bethke	O_3	13	100	3.65	+/-3.51	-7.65	4.03	83
Fort Collins - CSU - Mason	O_3	26	100	3.26	+/-2.71	-5.18	5.95	98
Palisade - Water Treatment	O_3	26	100	3.19	+/-2.93	-3.90	6.97	99
Cortez - Health Dept.	O_3	26	100	2.06	+2.17	-2.06	4.90	90
Pueblo West	O_3	26	100	3.55	+/-3.10	-5.08	7.03	94
Greeley - Weld County Tower	O_3	26	100	3.11	+/-2.56	-5.27	5.34	98
La Salle	O_3	23	100	3.16	-3.71	-7.89	2.79	94

6.3.2.2. Coefficient of Variation (CV)

At least once every two weeks, precision is determined by sampling a gas of known concentration for every gaseous analyzer. The table above summarizes the number of precision checks that were performed (precision count) by site (Table 6.2) as well as the percent completeness of those precision checks. Table 6.2 also summarizes the statistical data quality assessment of these precision checks for all gaseous criteria pollutants. The coefficient of variation (CV) for the precision checks is summarized annually by site. The equations used to calculate precision, bias, and upper and lower confidence limits for the 90% probability intervals using the bi-weekly precision checks are described in detail in the document "*Guideline on the Meaning and Use of Precision and Accuracy Data Required by 40 CFR Part 58 Appendix A.*"

6.3.2.3. Bias

For gaseous pollutants the bias is also calculated using the bi-weekly precision checks. Bias is summarized in Table 6.2 by the same groupings as CV. A plus or minus bias is assigned to the annual site and organization grouping levels based on an evaluation of where the 25^{th} and 75^{th} percentiles of percent differences for the precision data fell. If both percentiles fell below zero then the bias was assigned a minus sign, and if both percentiles fell above zero, then the bias was assigned a plus sign. If one bias was positive and one bias was negative (i.e., straddling zero), no sign was associated with the bias.

Organizationally, CO showed a positive bias of 3.02% in 2024. SO_2 showed a non-signed bias of 2.91%. O_3 showed a non-signed bias of 2.55% for 2024. There was no sign associated with the calculated bias (4.52%) for the NO_2 precision checks for the organization as a whole in 2024.

6.3.2.4. Performance Evaluation (Accuracy Audits)

Audits were performed at least twice on every gaseous analyzer within the APCD network during the 2024 calendar year. The primary goal of these audits is to evaluate the analyzer performance and calibration. Other factors are also noted during these audits such as operator performance, station operational criteria, record keeping, site upkeep issues, and general safety problems.

With the exception of NO_2 at the Fossil Creek monitoring site, all Performance Evaluations (accuracy audits) performed for all gaseous analyzers during 2024 passed the EPA criteria of 15%.

6.3.2.5. Probability Intervals (Upper and Lower Confidence Limits)

Probability intervals (upper and lower confidence limits) are calculated per 40 CFR 58 Appendix A section 4, by using the percent differences retrieved from station precision checks. The EPA has established that 95% of the independent audit points taken for a given year should fall within this calculated probability interval to validate the bias calculated from the precision checks. The percent differences between the audit concentrations and the indicated concentrations taken in 2024 for CO were compared to the probability intervals. Out of the 40 audit concentration points taken for CO in 2024, 63% fell between the probability intervals for the organization. There were 172 audit concentration points taken during 2024 for the APCD’s O_3 network. Of those 172 ozone audit points, 28 fell outside the probability intervals. This means that 84% of the audit points for O_3 fell between the probability intervals in 2024. Out of the 151 audit points taken in 2024 for NO_2, 79% fell between the confidence limits. Out of the 24 audit points taken for SO_2 in 2024, 67% fell between the probability intervals. Therefore, all four gaseous criteria pollutants do not meet the requirement that specifies that ninety-five percent of the individual percent differences (all audit concentration levels) for the performance evaluations should be captured within the probability intervals for the primary quality assurance organization (40CFR 58 Appendix A).

APCD believes the reason it did not meet the above requirement in 2024 is due to the fact that the probability intervals are calculated based on precision checks that are closer to the middle of the calibration scale, which give small percent differences and tight probability intervals. CFR requirements are pushing APCD to audit in the lower portion of the site instrumentation's calibration scale, due to the fact that this is where 80% of the ambient data is being captured. By auditing at the low end of the calibration scale, APCD is seeing higher percent differences between the audit concentration and the instrument response. APCD believes this is due in part to the low audit concentration differences producing large percent differences and partly because the instruments are calibrated on a higher scale than that where the audits are being conducted. The instruments are being calibrated at a higher scale than where 80% of the ambient data falls due to the relatively small number of episodes that do produce high ambient concentrations which have an effect on public health. Recently, APCD has begun to lower the calibration range on most pollutants and lower the precision values at most of its sites. This will hopefully help to rectify this problem but still allow APCD to capture the higher concentration pollution episodes within the instrument's calibration range.

6.3.2.6. Completeness

Table 6.2 summarizes completeness statistics by site for 2024. Data completeness is evaluated as the percentage of expected data uploaded to AQS for the year, while precision completeness is shown as the number of precision checks performed and submitted to AQS, evaluated against the number of checks that should have been completed at each site. Data completeness values met or exceeded EPA requirements for all but one (Fossil Creek NO_2) gaseous monitor during 2024. Data completeness values also met or exceeded APCD DQO goals for 79% of all gaseous monitors operated in 2024. Precision completeness values met or exceeded EPA requirements and exceeded APCD DQO goals for all gaseous monitors besides three monitors at the CAMP monitoring site (SO_2, NO_2, and O_3). Completeness for accuracy audits in 2024 met or exceeded APCD DQO goals for every gaseous analyzer, with a minimum of two accuracy audits performed on each analyzer.

6.4. Particulate Data Quality Assessment

6.4.1. Summary

Assessment of the data quality for APCD particulate criteria pollutants showed that most samplers met minimum EPA criteria and most monitoring sites met APCD goals for accuracy, precision, completeness, and bias. Table 6.3 summarizes statistical evaluations for particulate matter measurements. The basis for these calculations can be found in 40 CFR 58 Appendix A.

6.4.2. Precision

The CV for filter-based particulate monitoring is determined from the collocated precision data collected (i.e., two identical samplers operated in an identical manner at the same site). Due to the anticipated poor precision for very low levels of pollutants, only collocated measurements at or above a minimum level (greater than or equal to 15 µg m^{-3} for PM_{10} and 3 µg m^{-3} for $PM_{2.5}$) would be called valid pairs and are used to evaluate precision. The calculations for the statistical presentations in Table 6.3 are found in 40 CFR 58 Appendix A section 4.2.

The CV for continuous based particulate monitoring is determined by monthly flow verifications (precision checks) performed on the continuous particulate monitors. The calculations for the statistical presentations in Table 6.3 are the same calculations that were performed on the precision data for gaseous analyzers.

6.4.3. Bias

Results of the flow rate verifications conducted by APCD personnel are shown in Table 6.3 below. For the filter-based particulate monitoring, Table 6.3 summarizes bias based on the verifications that were performed during the year, since APCD performs particulate audits four times more frequently than the EPA requires.

The bias for the continuous particulate monitoring was calculated on the monthly flow verification precision checks with the same calculations that were used to determine the gaseous bias.

6.4.4. Performance Evaluation (Accuracy Audits)

Audits were performed at least quarterly on every particulate sampler within the APCD network during the 2024 calendar year. The primary goal of these audits is to evaluate the analyzer performance and calibration. Other factors are also noted during these audits such as operator performance, station operational criteria, record keeping, site upkeep issues, and general safety problems.

6.4.5. Completeness

Precision completeness for the year is shown by site in Table 6.3. Precision completeness is based on the number of monthly flow verifications that were performed. Precision completeness is evaluated against the number of verification checks that should have been performed at each site during the year. Completeness for accuracy audits met or exceeded APCD DQO goals for most particulate analyzers, with a minimum of two audits performed on every analyzer per year.

6.4.6. Results

Table 6.3 below summarizes statistical evaluations for all particulate completeness, bias, and precision (percent difference). The values were calculated as described in 40 CFR 58 Appendix A Section 4.2.

Table 6.3: Summary of completeness, bias, and precision (percent difference) for particulate monitoring data.

Site	Parameter	Verification Count	Verification Complete (%)	Bias (%)	Mean % Difference	Std. Dev. % Difference	Data Complete (%)
Birch Street (1)	PM_{10}	8	100	-0.93	-0.41	0.68	97
Birch Street (3)	PM_{10}	46	100	+/-1.01	-0.23	1.00	99
Welby (3)	PM_{10}	57	100	+/-1.11	-0.46	1.14	96
Welby (4)	PM_{10}	31	100	+/-1.85	-0.16	1.88	94
Alamosa - Adams State (ASC)	PM_{10}	33	100	+/-1.36	0.33	1.40	99
Pagosa Springs School	PM_{10}	24	100	+/-1.00	-0.02	1.04	98
Longmont - Municipal Bldg.	PM_{10}	40	100	+/-0.93	0.31	0.91	99
Boulder - CU - Athens	PM_{10}	34	100	+/-1.07	0.06	1.09	98
CAMP (1)	PM_{10}	1	50	-2.20	-2.20		71
CAMP (2)	PM_{10}	0	0	+/-0.00			68
La Casa (1)	PM_{10}	12	100	-1.37	-0.87	0.90	99
La Casa (2)	PM_{10}	15	100	+/-0.89	-0.11	0.84	98
Colorado College	PM_{10}	24	100	+1.01	0.46	0.88	95
Cañon City - City Hall	PM_{10}	29	100	+/-1.56	-0.46	1.52	99
Grand Junction - Powell Bldg. (1)	PM_{10}	17	100	+/-1.22	0.65	1.01	94
Grand Junction - Powell Bldg. (2)	PM_{10}	7	100	+/-0.92	-0.26	0.73	100
Aspen (1)	PM_{10}	2	100	+0.93	0.49	0.10	87
Aspen (3)	PM_{10}	16	100	+/-1.35	0.65	1.21	98
Lamar Municipal Bldg.	PM_{10}	22	100	+/-1.32	0.43	1.21	100
Pueblo - Fountain School	PM_{10}	46	100	+/-2.01	-0.47	2.19	97
Steamboat Springs	PM_{10}	31	100	+/-1.58	0.86	1.38	99
Telluride	PM_{10}	26	100	+/-0.72	0.00	0.74	98
Birch Street (2)	$PM_{2.5}$	12	100	+/-0.66	-0.04	0.61	97
Birch Street (3)	$PM_{2.5}$	46	100	+/-1.01	-0.23	1.00	99
Welby (3)	$PM_{2.5}$	55	100	+/-1.12	-0.46	1.15	97
Welby (4)	$PM_{2.5}$	31	100	+/-1.85	-0.16	1.88	99
Alamosa - Adams State (ASC)	$PM_{2.5}$	32	100	+/-1.34	0.28	1.39	99
Arapahoe Community College (1)	$PM_{2.5}$	3	100	+/-0.61	-0.24	0.31	94
Arapahoe Community College (3)	$PM_{2.5}$	17	100	+/-1.68	-0.12	1.60	97
Longmont - Municipal Bldg. (1)	$PM_{2.5}$	6	100	+1.53	1.24	0.35	88
Longmont - Municipal Bldg. (3)	$PM_{2.5}$	1	100	+0.61	0.61		
Longmont - Municipal Bldg. (4)	$PM_{2.5}$	40	100	+/-0.93	0.31	0.91	99
Boulder - CU - Athens	$PM_{2.5}$	34	100	+/-1.07	0.06	1.09	98
CAMP (1)	$PM_{2.5}$	18	100	+/-0.81	0.36	0.68	85
CAMP (2)	$PM_{2.5}$	11	92	+/-0.65	-0.04	0.59	87
CAMP (3)	$PM_{2.5}$	20	100	+/-2.39	0.59	2.21	
National Jewish Health (NJH)	$PM_{2.5}$	24	100	+/-1.24	-0.76	0.92	99
La Casa (1)	$PM_{2.5}$	13	100	+/-0.74	0.03	0.70	98
La Casa (3)	$PM_{2.5}$	21	100	-1.45	-0.96	1.06	99
I-25: Denver (1)	$PM_{2.5}$	13	100	+/-1.13	0.78	0.67	98
I-25: Denver (3)	$PM_{2.5}$	23	100	+/-3.09	-0.87	3.23	99
I-25: Globeville	$PM_{2.5}$	22	100	+/-2.30	-1.13	1.92	99
Chatfield State Park	$PM_{2.5}$	24	100	+/-1.18	-0.69	0.97	98
Colorado College	$PM_{2.5}$	22	100	+/-1.72	0.10	1.70	98
Fort Collins - CSU - Edison	$PM_{2.5}$	39	100	-2.12	-1.30	1.70	99
Bethke	$PM_{2.5}$	7	100	+2.15	1.12	1.38	99
Grand Junction - Powell Bldg.	$PM_{2.5}$	25	100	+/-2.95	0.82	2.84	99
Aspen	$PM_{2.5}$	16	100	+/-1.35	0.65	1.21	99
Lamar Municipal Bldg.	$PM_{2.5}$	22	100	+/-1.32	0.43	1.21	100
Pueblo - Fountain School	$PM_{2.5}$	45	100	+/-1.90	-0.36	2.07	99
Greeley - Hospital	$PM_{2.5}$	24	100	+/-2.26	0.64	2.23	99
Platteville - Middle School (1)	$PM_{2.5}$	12	100	+/-0.48	0.01	0.44	98
Platteville - Middle School (3)	$PM_{2.5}$	13	100	+/-1.01	0.32	0.88	99

Table 6.4: Collocated QC check statistics for particulate monitoring data.

Site	Parameter	Total Valid Pairs	CV
Welby	PM_{10}	444	3.43
Longmont	PM_{10}	5	23.48
CAMP	PM_{10}	17	6.59
La Casa	PM_{10}	59	6.52
Grand Junction - Powell Building	PM_{10}	30	7.07
Birch Street	$PM_{2.5}$	58	20.99
Welby	$PM_{2.5}$	432	4.26
CAMP	$PM_{2.5}$	45	6.72
La Casa	$PM_{2.5}$	96	16.09
I-25 Denver	$PM_{2.5}$	59	16.78

Appendix A: Monitoring Site Descriptions

AQS #	Site Name / Parameter	Address / POC	Site Start / Start	Elevation (m) / Orient/Scale	Latitude / Monitor	Longitude / Type
Adams						
080010010	Birch Street	7275 Birch St	Jul 2023	1569	39.8281	-104.93647
	PM_{10}	3	Jul 2023	P.O. Neigh	Met One - E-Seq	SLAMS
	$PM_{2.5}$	3	Jul 2023	P.O. Neigh	URG - 3000-N	SLAMS
	PM_{10}	3	Sep 2023	P.O. Neigh		SLAMS
	PM_{10}	1	Dec 2023	P.O. Neigh		SLAMS
	$PM_{2.5}$	2	Dec 2023	P.O. Neigh		SLAMS
080013001	Welby	3174 E. 78TH AVE.	Jan 1975	1554	39.838119	-104.94984
	Temperature	1	Jan 1975		Met One - 062MP	OTHER
	Wind Speed	1	Jan 1992		RM Young - 05305V	OTHER
	Wind Direction	1	Jan 1992			OTHER
	SO_2	2	Jan 2006	P.O. Neigh	TAPI - T100	SLAMS
	O_3	2	Sep 2007	P.O. Neigh	TAPI - T400	SLAMS
	NO_2	1	Nov 2019	P.O. Urban	TAPI - T200	SLAMS
	PM_{10}	3	Jan 2023	P.O. Neigh		SLAMS
	PM_{10}	3	Jan 2024	Back Micro	TAPI - 640X	SLAMS
	$PM_{2.5}$	3	Jan 2024	P.O. Neigh		SLAMS
	PM_{10}	4	May 2024	P.O. Neigh		SLAMS
	PM_{10}	4	May 2024	P.O. Neigh	TAPI - 640X	SLAMS
	$PM_{2.5}$	4	May 2024	P.O. Neigh		SLAMS
Alamosa						
080030001	Alamosa - Adams State	208 EDGEMONT BLVD.	Oct 2023	2302	37.469391	-105.878691
	PM_{10}	3	Oct 2023	P.O. Neigh		SLAMS
	PM_{10}	3	Oct 2023	P.O. Neigh		SLAMS
	$PM_{2.5}$	3	Oct 2023	P.O. Neigh		SLAMS
Arapahoe						
080050002	HIGHLAND RESERVOIR	8100 S. UNIVERSITY BLVD	Jun 1978	1747	39.567887	-104.957193
	O_3	1	Sep 2015	H.C. Neigh	TAPI - T400	SLAMS
	Wind Speed	1	Sep 2015		Met One - 010C	OTHER
	Wind Direction	1	Sep 2015		Met One - 020C	OTHER
	Temperature	1	Sep 2015		Met One - 062	OTHER
080050005	Arapahoe Community College	6190 S. SANTA FE DR.	Apr 2024	1636	39.604399	-105.019526
	PM_{10}	3	Apr 2024	P.O. Neigh		SPM
	$PM_{2.5}$	3	Apr 2024	P.O. Neigh	Grimm - EDM 180	SLAMS
080050006	Aurora East	36001 E. Quincy Ave.	Jun 2009	1799	39.638522	-104.569335
	O_3	1	Jun 2009	P.O. Urban	TAPI - T400	SLAMS
	Wind Speed	1	Jun 2009	P.O. Urban	Met One - 010C	OTHER
	Wind Direction	1	Jun 2009	P.O. Urban	Met One - 020C	OTHER
	Temperature	1	Jun 2009	P.O. Urban	Met One - 060	OTHER
Archuleta						
080070001	PAGOSA SPRINGS SCHOOL	309 LEWIS ST.	Nov 2023	2165	37.26842	-107.009659
	PM_{10}	4	Nov 2023	P.O. Neigh		SLAMS
	PM_{10}	4	Nov 2023	P.O. Neigh	TAPI - 640X	SLAMS
	$PM_{2.5}$	4	Jan 2025	P.O. Neigh		SLAMS
Boulder						
080130003	LONGMONT - MUNICIPAL BLDG	350 KIMBARK ST.	Jan 2024	1520	40.164576	-105.100856
	PM_{10}	4	Jan 2024	P.O. Neigh		SLAMS
	PM_{10}	4	Jan 2024	P.O. Neigh	TAPI - 640X	SPM
	$PM_{2.5}$	4	Jan 2024	P.O. Neigh		SLAMS
080130014	Boulder Reservoir	5545 Reservoir Road.	Sep 2016	1586	40.070016	-105.220238
	O_3	1	Sep 2016	P.O. Urban	TAPI - 400E	SLAMS
	Wind Speed	1	Sep 2016	P.O.	RM Young - 05305V	OTHER
	Wind Direction	1	Sep 2016	P.O.		OTHER
	Temperature	1	Sep 2016	P.O.	RM Young - 41372V	OTHER
	Relative Humidity	1	Sep 2016	P.O.		OTHER
080131001	BOULDER - CU-ATHENS	2102 ATHENS ST.	Aug 2023	1622	40.012969	-105.267212
	$PM_{2.5}$	3	Aug 2023	P.O. Neigh		SLAMS
	PM_{10}	3	Aug 2023	P.O. Neigh		SLAMS
	PM_{10}	3	Sep 2023	P.O. Neigh	TAPI - 640X	SLAMS

AQS #	Site Name / Parameter	Address / POC	Site Start / Start	Elevation (m) / Orient/Scale	Latitude / Monitor	Longitude / Type
	Site Name	***Address***	***Site Start***	***Elevation (m)***	***Latitude***	***Longitude***
	Parameter	***POC***	***Start***	***Orient/Scale***	***Monitor***	***Type***
Clear Creek						
080190006	Mines Peak	Near summit of Berthoud Pass off US Highway 40	Jul 2014	3806	39.794391	-105.76398
	O_3	1	Jul 2014	Back Region	TAPI - T400	SPM
Denver						
080310002	DENVER - CAMP	2105 BROADWAY	Jan 1985	1593	39.751184	-104.987625
	Temperature	1	Jan 1985			OTHER
	Wind Speed	1	Jan 1992			OTHER
	Wind Direction	1	Jan 1992			OTHER
	SO_2	1	Nov 2005	H.C. Neigh	TAPI - T100	SLAMS
	O_3	6	Jan 2012	P.O. Neigh	TAPI - T400	SLAMS
	$PM_{2.5}$	3	Apr 2013	H.C. Micro	Grimm - EDM 180	SPM
	NO_2	1	Jan 2014	H.C. Neigh	TAPI - T200U	SLAMS
	PM_{10}	3	Feb 2015	H.C. Micro		SPM
	$PM_{2.5}$	1	Feb 2024	P.O. Micro	R&P - Partisol 2025	SLAMS
	$PM_{2.5}$	2	Feb 2024	P.O. Micro		SLAMS
080310013	DENVER - NJH-E	14TH AVE. & ALBION ST.	Mar 2018	1620	39.738578	-104.939925
	PM_{10}	3	Jul 2023	P.O. Middle		SPM
	$PM_{2.5}$	3	Jul 2023	P.O. Neigh	TAPI - 640	SLAMS
080310026	La Casa	4545 Navajo St.	Jan 2013	1602	39.77949	-105.00518
	CO	1	Jan 2013	P.O. Neigh	Thermo - 48i-TL	SLAMS
	NOy	1	Jan 2013	P.O. Neigh		SLAMS
	NOy - NO	1	Jan 2013	P.O. Neigh	TAPI - T200U-NOY	SLAMS
	O_3	1	Jan 2013	P.O. Neigh	TAPI - T400	SLAMS
	Wind Speed	1	Jan 2013	P.O. Neigh	Met One - 010C	SLAMS
	Wind Direction	1	Jan 2013	P.O. Neigh	Met One - 020C	SLAMS
	Temperature	1	Jan 2013	P.O. Neigh	Met One - 010C	SLAMS
	Temperature	2	Jan 2013	P.O. Neigh	Met One - 010C	SLAMS
	SO_2	1	Apr 2013	P.O. Neigh	TAPI - T100U	SLAMS
	NO_2	1	Jul 2014	P.O. Neigh	TAPI - T500U	SLAMS
	Relative Humidity	1	Nov 2014	P.O. Neigh	Met One - 083E-1-35	SLAMS
	Solar radiation	1	Apr 2018	P.O. Neigh	KIPP&ZONEN - CMP11	SLAMS
	$PM_{2.5}$	3	Jul 2023	P.O. Neigh	TAPI - 640	SLAMS
	PM_{10}	3	Sep 2023	P.O. Neigh		SLAMS
	PM_{10}	1	Apr 2024	P.O. Neigh	Met One - E-Seq	SLAMS
	PM_{10}	2	Apr 2024	P.O. Neigh		SLAMS
	PM_{10}	1	Apr 2024	P.O. Neigh		SLAMS
	PM_{10}	2	Apr 2024	P.O. Neigh		SLAMS
	$PM_{2.5}$	1	Apr 2024	P.O. Neigh	Met One - E-Seq	SLAMS
080310027	I-25	971 Yuma Street	Jun 2013	1583	39.73217	-105.0153
	CO	1	Jun 2013	P.O. Micro	Thermo - 48i-TL	SLAMS
	Wind Speed	1	Jun 2013	P.O.	RM Young - 05305V	OTHER
	Wind Direction	1	Jun 2013	P.O.		OTHER
	Temperature	1	Jun 2013	P.O.	RM Young - 41372V	OTHER
	$PM_{2.5}$	3	Jan 2014	P.O. Micro	Grimm - EDM 180	SLAMS
	PM_{10}	3	Feb 2015	P.O. Micro		SLAMS
	Relative Humidity	1	May 2020	P.O.	RM Young - 41372V	OTHER
	NO_2	1	May 2021	P.O. Micro	TAPI - T200	SLAMS
	$PM_{2.5}$	1	Sep 2023	P.O. Micro	R&P - Partisol 2025	SLAMS
080310028	Globeville	4903 Acoma St.	Oct 2015	1587	39.7861	-104.9886
	NO_2	1	Oct 2015	P.O. Micro	TAPI - T200	SLAMS
	Temperature	1	Oct 2015	P.O.	RM Young - 41372V	OTHER
	Relative Humidity	1	Oct 2015	P.O.		OTHER
	PM_{10}	3	Oct 2015	P.O. Micro		SLAMS
	$PM_{2.5}$	3	Oct 2015	P.O. Micro	Grimm - EDM 180	SLAMS
	Wind Speed	1	Mar 2020	P.O.	RM Young - 05305V	OTHER
	Wind Direction	1	Mar 2020	P.O.		OTHER
Douglas						
080350004	Chatfield State Park	11500 N. Roxborough Park Rd.	Apr 2004	1676	39.534488	-105.070358
	Wind Speed	1	Apr 2004		Met One - 010C	OTHER
	Wind Direction	1	Apr 2004		Met One - 020C	OTHER
	Temperature	1	Apr 2004			OTHER
	PM_{10}	3	Jul 2023	P.O. Neigh		SPM

AQS #	Site Name	Address	Site Start	Elevation (m)	Latitude	Longitude
	Parameter	**POC**	**Start**	**Orient/Scale**	**Monitor**	**Type**
	$PM_{2.5}$	3	Jul 2023	P.O. Neigh	TAPI - 640	SLAMS
	O_3	1	Aug 2024	H.C. Urban	TAPI - T265	SLAMS
El Paso						
080410013	U.S. AIR FORCE ACADEMY	ROAD 640, USAF ACADEMY	Jun 1996	1971	38.958341	-104.817215
	O_3	1	Aug 2010	H.C. Urban	TAPI - T400	SLAMS
080410016	MANITOU SPRINGS	101 BANKS PL.	Apr 2004	1955	38.853097	-104.901289
	O_3	1	Oct 2007	H.C. Neigh	TAPI - T400	SLAMS
080410017	COLORADO SPRINGS - COLLEGE COLLEGE	130 W. CACHE LA POUDRE	Jun 2016	1832	38.848014	-104.828564
	PM_{10}	3	Jun 2016	P.O. Neigh		SLAMS
	$PM_{2.5}$	3	Jun 2016	P.O. Neigh		SLAMS
	CO	1	Dec 2023	P.O. Neigh	Thermo - 48i-TL	SLAMS
	PM_{10}	1	Sep 2024	P.O. Neigh	R&P - Partisol 2025	SLAMS
	PM_{10}	1	Sep 2024	P.O. Neigh		SLAMS
Fremont						
080430003	CANON CITY - CITY HALL	128 MAIN ST.	Oct 2023	1626	38.43829	-105.24504
	PM_{10}	3	Oct 2023	P.O. Neigh		SLAMS
	PM_{10}	3	Oct 2023	P.O. Neigh	TAPI - 640X	SLAMS
	$PM_{2.5}$	3	Jan 2025	P.O. Neigh		SLAMS
Garfield						
080450012	Rifle-Health Dept	195 W. 14th St.	Jun 2008	1640	39.54182	-107.784125
	O_3	1	Jun 2008	P.O. Neigh		SLAMS
Gilpin						
080470003	Black Hawk	831 Miners Mesa Road, Black Hawk Colorado 80422	Jul 2019	2633	39.792519	-105.49127
	O_3	1	Jul 2019	P.O. Urban	TAPI - 400E	SLAMS
Jefferson						
080590006	ROCKY FLATS-N	16600 W COLO #128	Jun 1992	1802	39.912799	-105.188587
	Wind Speed	1	Jun 1992		RM Young - 05305V	OTHER
	Wind Direction	1	Jun 1992			OTHER
	Temperature	1	Jun 1992		RM Young - 41372V	OTHER
	Temperature	2	May 2018		RM Young - 41372V	OTHER
	Relative Humidity	1	Jun 2018	Back Neigh	RM Young - 41372V	OTHER
	Barometric pressure	1	Jun 2018	Back Neigh	RM Young - 61302V	OTHER
	NOy	1	Feb 2019	H.C. Urban	TAPI - 501Y	SLAMS
	NO_2	1	Feb 2019	Urban	TAPI - T500U	SLAMS
	NOy - NO	1	Feb 2019	H.C. Urban	TAPI - T200U-NOY	SLAMS
	Solar radiation	1	Jun 2019	Urban	KIPP&ZONEN - CMP11	SLAMS
	O_3	1	Jul 2024	H.C. Urban	TAPI - T265	SLAMS
080590011	NATIONAL RENEWABLE ENERGY LABS - NREL	2054 QUAKER ST.	Jun 1994	1832	39.743724	-105.177989
	O_3	1	Jul 2024	H.C. Urban	TAPI - T265	SLAMS
080590014	Evergreen	5124 South Hatch Drive	Oct 2020	2225	39.620408	-105.33872
	O_3	1	Oct 2020	P.O. Urban	TAPI - T400	SLAMS
	Wind Speed	1	Oct 2020	P.O. Urban	RM Young - 05305V	OTHER
	Wind Direction	1	Oct 2020	P.O. Urban		OTHER
	Temperature	1	Oct 2020	P.O. Urban	RM Young - 41372V	OTHER
	Relative Humidity	1	Oct 2020	P.O. Urban		OTHER
Larimer						
080690009	FORT COLLINS - CSU - Edison	251 EDISON DR.	Jun 2009	1524	40.571288	-105.079693
	PM_{10}	3	Jun 2015	P.O. Neigh		SPM
	$PM_{2.5}$	3	Jun 2015	P.O. Neigh		SLAMS
080690011	FORT COLLINS - WEST	3416 LA PORTE AVE.	Aug 2023	1571	40.592543	-105.141122
	Wind Speed	1	Aug 2023	Urban	RM Young - 05305V	SPM
	Wind Direction	1	Aug 2023	Urban		SPM
	Temperature	1	Aug 2023	Urban	RM Young - 41372V	SPM
	Temperature	2	Aug 2023	Urban	RM Young - 41372V	SPM
	Relative Humidity	1	Aug 2023	Urban	RM Young - 41372V	SPM
	Solar radiation	1	Aug 2023	Urban	KIPP&ZONEN - CMP11	SPM
	Barometric pressure	1	Aug 2023	Urban	RM Young - 61402V	SPM
	O_3	1	Jul 2024	H.C. Urban	TAPI - T265	SLAMS

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	Parameter	***POC***	***Start***	***Orient/Scale***	***Monitor***	***Type***
080690015	Fossil Creek	3340 CO 392	Jan 2024	1489	40.48346	-105.01618
	NO_2	1	Jan 2024	H.C. Urban		SLAMS
	O_3	1	Jan 2024	H.C. Urban	TAPI - T400	SLAMS
	Wind Speed	1	Jan 2024	Urban	RM Young - 05305V	SPM
	Wind Direction	1	Jan 2024	Urban		SPM
	Temperature	1	Jan 2024	Urban	RM Young - 41372V	SPM
	Temperature	2	Jan 2024	Urban	RM Young - 41372V	SPM
	Relative Humidity	1	Jan 2024	Urban	RM Young - 41372V	SPM
	Solar radiation	1	Jan 2024	Urban		SPM
	Barometric pressure	1	Jan 2024	Urban	RM Young - 61402V	SPM
080690016	Bethke	5100 School House Dr	Jun 2024	1472	40.515109	-104.949932
	NO_2	1	Jun 2024	H.C. Urban		SLAMS
	O_3	1	Jun 2024	H.C. Urban	TAPI - T400	SLAMS
	PM_{10}	3	Oct 2024	P.O. Urban		SLAMS
	$PM_{2.5}$	3	Oct 2024	P.O. Urban		SLAMS
080691004	Fort Collins - CSU - S. Mason	708 S. Mason St.	Jan 1981	1524	40.57747	-105.07892
	Temperature	1	Jan 1981			OTHER
	Wind Speed	1	Jan 1992			OTHER
	Wind Direction	1	Jan 1992		RM Young - 05305V	OTHER
	O_3	1	May 2004	P.O. Neigh	TAPI - T400	SLAMS
	CO	1	May 2016	P.O. Neigh	Thermo - 48i-TL	SLAMS
Mesa						
080770017	GRAND JUNCTION - POWELL BLDG	650 SOUTH AVE.	Jan 2014	1398	39.063798	-108.561173
	$PM_{2.5}$	3	Jan 2014	P.O. Neigh		SLAMS
	PM_{10}	3	Feb 2015	P.O. Neigh		SLAMS
	PM_{10}	1	Jul 2024	P.O. Neigh	R&P - Partisol 2025	SLAMS
	PM_{10}	1	Jul 2024	P.O. Neigh		SLAMS
080770018	GRAND JUNCTION - PITKIN	645 1/4 PITKIN AVE.	Jan 2004	1398	39.064289	-108.56155
	Wind Speed	1	Jan 2004			OTHER
	Wind Direction	1	Jan 2004			OTHER
	Temperature	1	Jan 2004			OTHER
	Relative Humidity	1	Nov 2014			OTHER
	Barometric pressure	1	Sep 2020			OTHER
080770020	Palisade-Water Treatment	865 Rapid Creek Rd.	May 2008	1521	39.130575	-108.313835
	O_3	1	May 2008	P.O. Urban	TAPI - T400	SLAMS
	Wind Speed	1	May 2008	P.O. Urban		SPM
	Wind Direction	1	May 2008	P.O. Urban	RM Young - 05305V	SPM
	Temperature	1	May 2008	P.O. Urban		SPM
Montezuma						
080830006	Cortez - Health Dept	106 W. North Street	Jun 2008	1890	37.350054	-108.592334
	O_3	1	Jun 2008	P.O. Neigh		SLAMS
Pitkin						
080970008	Aspen Yellow Brick Building	215 N. Garmisch	Jun 2024	2408	39.19296	-106.82323
	PM_{10}	3	Jun 2024	P.O. Neigh	TAPI - 640X	SLAMS
	PM_{10}	3	Jun 2024	P.O. Neigh		SLAMS
	$PM_{2.5}$	3	Jun 2024	P.O. Neigh		SLAMS
Prowers						
080990002	Lamar Municipal Bldg	104 E. PARMENTER ST.	Oct 2023	1107	38.084688	-102.618641
	PM_{10}	3	Oct 2023	P.O. Neigh		SLAMS
	PM_{10}	3	Oct 2023	P.O. Neigh	TAPI - 640X	SLAMS
	$PM_{2.5}$	3	Oct 2023	P.O. Neigh		SLAMS
Pueblo						
081010015	Pueblo - Fountain School	925 N. GLENDALE AVE.	Sep 2023	1433	38.276099	-104.597613
	PM_{10}	3	Sep 2023	P.O. Neigh		SLAMS
	PM_{10}	3	Sep 2023	P.O. Neigh	TAPI - 640X	SLAMS
	$PM_{2.5}$	3	Sep 2023	P.O. Neigh		SLAMS
	Pueblo West	803 South Cellini Circle	Feb 2023	1564	38.30333	-104.7225

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081010016	O_3	1	Feb 2023	H.C. Neigh	TAPI - T400	SLAMS
	Wind Speed	1	Mar 2023	H.C. Neigh	RM Young - 05305V	SLAMS
	Wind Direction	1	Mar 2023	H.C. Neigh		SLAMS
	Temperature	1	Mar 2023	H.C. Neigh	RM Young - 41372V	SLAMS
Routt						
081070003	Steamboat Springs	136 6TH ST.	Sep 2023	2054	40.485201	-106.831625
	PM_{10}	4	Sep 2023	P.O. Neigh		SLAMS
	PM_{10}	4	Sep 2023	P.O. Neigh	TAPI - 640X	SLAMS
	$PM_{2.5}$	4	Jan 2025	P.O. Neigh		SLAMS
San Miguel						
081130004	Telluride	333 W. COLORADO AVE.	Nov 2023	2684	37.937872	-107.813061
	PM_{10}	3	Nov 2023	P.O. Neigh		SLAMS
	PM_{10}	3	Nov 2023	P.O. Neigh	TAPI - 640X	SLAMS
	$PM_{2.5}$	3	Jan 2025	P.O. Neigh		SLAMS
Weld						
081230006	Greeley - Hospital	1516 HOSPITAL RD.	Jun 2016	1441	40.414877	-104.70693
	PM_{10}	3	Jun 2016	P.O.		SLAMS
	$PM_{2.5}$	3	Jun 2016	P.O.	Grimm - EDM 180	SLAMS
081230008	Platteville - Middle School	1004 MAIN ST.	Jun 2024	1469	40.209387	-104.82405
	PM_{10}	3	Jun 2024	P.O. Region		SLAMS
	$PM_{2.5}$	3	Jun 2024	P.O. Region	TAPI - 640	SLAMS
081230009	Greeley - Weld County Tower	3101 35TH AVE.	Jun 2002	1484	40.386368	-104.73744
	O_3	1	Jan 2004	P.O. Neigh	TAPI - T400	SLAMS
	Wind Speed	1	Feb 2012	P.O.	Met One - 010C	OTHER
	Wind Direction	1	Feb 2012	P.O.	Met One - 020C	OTHER
	Temperature	1	Feb 2012	P.O.	Met One - 060A	OTHER
	CO	1	Apr 2016	P.O. Neigh	Thermo - 48i-TL	SLAMS
081230015	La Salle Tower	18490 County Road 38	Feb 2024	1719	40.2614	-104.70645
	NO_2	1	Feb 2024	S.O. Region	TAPI - T200	SLAMS
	O_3	1	Feb 2024	S.O. Region	TAPI - T400	SLAMS