BUREAU OF LAND MANAGEMENT

COLORADO STATE OFFICE

2023 AIR ANNUAL REPORT

Prepared November 2023

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1. Introduction

1.1 Purpose and Need

This report was prepared in accordance with Section V of the BLM Colorado Air Resource Protection Protocol (CARPP). The CARPP requires the BLM CO Air Resource Specialists (ARS) to annually assess whether the strategies defined within the protocol and implemented during project level authorizations for BLM managed activities that have the potential to significantly impact air resources are effective in meeting the stated goals and objectives outlined within each field office or planning area's applicable Resource Management Plan (RMP). The Federal Land Policy and Management Act of 1976 (FLPMA) and all Colorado RMPs require the BLM to comply with federal and state air quality regulations when authorizing federal actions. Some of the newer RMP revisions also contain specific management actions for meeting compliance and/or desired outcomes for regional air resources. The CARPP strategies provide a holistic approach for protecting air resources by implementing a "Deming Cycle" of planning, implementing, studying, and acting upon the results and insights gained throughout the cycle of planning studies, project authorizations, and subsequent data reviews, for which the Annual Report itself is a component.

The CARPP also requires the BLM to provide prescriptive model validation for the Colorado Air Resources Management Modeling Study (CARMMS). The BLM initiated the CARMMS to assess statewide impacts of projected oil, gas, and coal mining development scenarios. Specific validation measures include reviewing annual oil and gas development and production to determine which CARMMS scenario best approximates the current federal development track. Validation also requires a review of applicable air quality trends to ensure the model results can be adequately relied upon for future project authorizations. The validation process provides an opportunity for the BLM to assess whether specific air resource protection measures should be recommended for application on a regional or statewide basis to mitigate current or reasonably foreseeable cumulative impact concerns. Any mitigation recommendations may require additional analysis and/or interagency coordination (MOU) prior to implementation.

This report focuses exclusively on oil and gas authorizations, as the BLM has determined that these activities have the greatest potential to impact air resources. For all other resources that BLM manages, BLM staff members conduct analyses for actions that have the potential to significantly impact air quality, in accordance with NEPA requirements, on a case-by-case basis. The following BLM Colorado Field Offices contain oil, gas, and/or coal resources for which the BLM has stewardship responsibilities. As such, the areas under the domain of the following field offices will be the focus of the report: Colorado River Valley (CRVFO), Grand Junction (GJFO), Kremmling (KFO), Little Snake (LSFO), Royal Gorge (RGFO), Tres Rios (TRFO), Uncompahgre (UFO), White River (WRFO).

1.2 NEPA Streamlining & Guidance

The Annual Report provides current information for each applicable Colorado Field Office or Planning Area that includes, but is not limited to, resource regulations, air quality trends, federal mineral rates of development and production, emissions inventory data, and detailed analysis. Consistent with CEQ regulation 40 CFR §1502.21, Incorporation by Reference (IBR), and mandates to reduce paperwork and NEPA preparation time, the contents of this Annual Report should be incorporated by reference into subsequent BLM Colorado NEPA analyses. In doing so, future BLM Colorado NEPA analyses will include the affected environment and cumulative impacts analysis, including climate change, associated with the proposed action and alternatives for air related issues requiring detailed analysis or, to support the dismissal of such issues from further analysis.

This entire report is a resource to be incorporated by reference, but the following chapters have explicit connection to NEPA requirements:

Chapter 2. Air Quality Policy and Regulation describes and defines general and specific air quality regulations pertaining to BLM authorizations, as well as the authority for such laws; provides a basic overview of the science and issues associated with the various types of air pollutants (i.e. criteria, hazardous and greenhouse gases) and air quality related values, any applicable metrics for their analysis, and the contexts of such analysis relative to various geographic designations (e.g. attainment, non-attainment, Class I airsheds).

Chapter 3. Analysis Methods and Tools covers the basic science of air resources analysis; refers to the CARPP for project-specific analysis guidelines to be followed for the project-specific NEPA analysis; and outlines the analysis methods used within the Annual Report to track report year oil and gas development and production and compare to CARMMS scenarios. Additionally, this section includes a detailed description of the various tools the BLM has at its disposal for providing appropriate air resources analysis. This section should be referenced to provide support for the methodology of analysis used in project-level NEPA.

Chapter 4. Affected Environment: Statewide Air Quality Conditions and Emissions provides current criteria pollutant monitoring data, air quality related values information, and geographically based national emissions inventory data. This chapter should be referenced to set the context for current statewide conditions in the NEPA air resources analysis.

Chapter 5. Affected Environment: Conditions and Trends by Field Office discusses and interprets the information in Chapter 4. Affected Environment: Statewide Air Quality Conditions and Emissions at the field office level and provides details about the current and trending pace of oil and gas development compared to CARMMS scenarios. This chapter should be referenced to establish the context for current field office conditions in NEPA air resources analysis and to describe the potential (i.e. projected) NEPA cumulative impacts at the field office scale.

Note that greenhouse gas (GHG) and climate change information is now incorporated by reference from the BLM Specialist Report on Annual Greenhouse Gas Emissions. Data from the Annual GHG report are now used to summarize GHG emissions in Chapter 4.7 Greenhouse Gas Emissions of this report.

2. Air Quality Policy and Regulation

2.1 Introduction

Congress gave the Environmental Protection Agency (EPA) regulatory authority for cleaning up air pollution. The Clean Air Act (CAA) authorizes EPA to establish National Ambient Air Quality Standards (NAAQS) to protect public health and public welfare and to regulate emissions of hazardous air pollutants. The CAA also gives EPA the authority to limit emissions of air pollutants coming from sources like chemical plants, utilities, and steel mills.

The Colorado Department of Public Health and Environment (CDPHE) is responsible to ensure that air in Colorado meets health and safety standards established under the CAA. To fulfil this responsibility, the CPDHE is required by the federal government to ensure compliance with the EPA's National Ambient Air Quality Standards (NAAQS) statewide. Additionally, the state ensures compliance with visibility standards through regional haze rules. The CPDHE enacts rules pertaining to air quality standards, develops plans to meet the federal standards, when necessary, issues preconstruction and operating permits to stationary sources, and ensures compliance with state and federal air quality rules.

EPA's Tribal Authority Rule gives Tribes the ability to develop air quality management programs, write rules to reduce air pollution and implement and enforce their rules in Indian Country. While state and local agencies are responsible for all CAA requirements, Tribes may develop and implement only those parts of the CAA that are appropriate for their lands.

While the EPA, State, and Tribes have regulatory authority to control air pollution emissions, it is the mission of the BLM to sustain the health, diversity, and productivity of the public lands for the use and enjoyment of present and future generations.

2.2 Federal Policy and Regulation

2.2.1 Clean Air Act

The CAA of 1963 [42 U.S.C. § 1857 et seq.], as amended and recodified [42 U.S.C. § 7401 et seq.] is the primary federal legislation and provides the framework for protecting and enhancing the quality of the Nation's air resources to promote the public health and welfare and the productive capacity of its population (Section 101(b)(1)). The Act focuses on reducing both criteria air pollutants and hazardous air pollutants. As required by the CAA, EPA has established NAAQS for criteria pollutants (Section 109 (a)(1)(A)). Compliance and enforcement of these federal requirements is delegated to applicable Tribal, State and local regulatory agencies (Sections 107(a), 301(d), 302). The CAA also allows these agencies to establish regulations which are more, but not less, stringent than the federal requirement (Section 116) (EPA, The Plain English Guide to The Clean Air Act, 2007). The BLM has no authority to determine how air quality standards will be achieved nor to determine area designations.

2.2.2 Federal Land Policy and Management Act

The Federal Land Policy and Management Act (FLPMA) of 1976 [43 U.S.C. §§ 1701-1785], often referred to as the BLM's "Organic Act," provides the majority of the BLM's legislated authority, direction policy, and basic management guidance. This Act outlines the BLM's role as a multiple use land management agency and provides for management of the public lands under principles of multiple use and sustained yield. The

Act directs public lands to be managed "in a manner that will protect the quality of scientific, scenic, historical, ecological, environmental, air and atmospheric, water resource, and archeological values" (Sec. 102. [43 U.S.C. 1701] (a) (8)). To meet this responsibility, the BLM is to require "compliance with applicable pollution control laws, including state and federal air, water, noise, or other pollution standards or implementation plans" (Sec. 202. [43 U.S.C. 1712] (a)(8)). This means that the BLM can reasonably rely on compliance with existing air pollution control regulations to insure protection of regulatory air quality standards (e.g. NAAQS). In addition, BLM can reasonably rely on federal or delegated state air pollution control agencies to determine compliance with these regulations, and to enforce these regulatory air quality standards. FLPMA also gives the BLM authority to halt any BLM authorized activity that is found in violation of state or federal air quality regulations, thus ensuring that the BLM can provide compliance with applicable air quality standards, regulations, and implementation plans (Sec. 302. [43 U.S.C. 1732] (a)(c)).

2.2.3 National Environmental Policy Act

The National Environmental Policy Act (NEPA) of 1969 [42 U.S.C. 4321 et seq.]: NEPA ensures that information on the potential environmental and human impact of federal actions is available to public officials and citizens before decisions are made and before actions are taken. One of the purposes of the Act is to "promote efforts which will prevent or eliminate damage to the environment and biosphere," and to promote human health and welfare (Section 2). This Act requires that agencies prepare a detailed statement on the environmental impact of the proposed action for major federal actions expected to significantly affect the quality of the human environment (Section 102 (C)). In addition, agencies are required, to the fullest extent possible, to use a "systematic, interdisciplinary approach" in planning and decision-making processes that may have an impact on the environment (Section 102(A)).

2.3 Oil and Gas Regulations

Authority for regulating oil and gas activities in Colorado rests with four entities; 1) the Colorado Energy and Carbon Management Commission (ECMC), 2) the Colorado Department of Public Health and Environment (CDPHE), 3) the U.S. Environmental Protection Agency (EPA), and 4) Federal Land Management agencies (e.g. BLM, USFS). All emissions resulting from oil and gas exploration, development and production activities must comply with the rules and regulations established for applicable activities and sources as defined and enforced by the ECMC, CDPHE and EPA. Note that prior to July 1, 2023, the ECMC was the Colorado Oil and Gas Conservation Commission (COGCC).

The ECMC regulations that include an air quality component are the Series 300 (Drilling, Development, Production, and Abandonment) and 800 (Aesthetics and Noise Control) rules.

The CDPHE regulations that are most likely to have applicability for oil and gas operations are as follows:

- Regulation 1 - Emission Control for Particulate Matter, Smoke, Carbon Monoxide and Sulfur Oxides
  - III.D Fugitive Particulate Emissions
- Regulation 3 - Stationary Source Permitting and Air Pollutant Emission Notice Requirements
  - Part A - General Provisions Applicable to Air Pollution Emissions Notice Requirements
  - Part B - Construction Permits
- Regulation 6 - Standards of Performance for New Stationary Sources
  - Subpart A - General Provisions

    - Subpart OOOO - Standards of Performance for Crude Oil and Natural Gas Production, Transmission and Distribution
- Regulation 7 - Control of Ozone via Ozone Precursors and Control of Hydrocarbons via Oil and Gas Emissions
    - Part A - Applicability and General Provisions
    - Part B – Oil and Natural Gas Operations

The EPA rules that are most likely to have applicability to oil and gas operations are as follows:

- NSPS Subpart JJJJ - Standards of Performance for Stationary Spark Ignition Internal Combustion Engines
- NESHAP Subpart HH - National Emission Standard for Hazardous Air Pollutants from Oil and Natural Gas Production Facilities
- NESHAP Subpart ZZZZ - National Emission Standard for Hazardous Air Pollutants for Stationary Reciprocating Internal Combustion Engines
- NSPS OOOO Standards of Performance for Crude Oil and Natural Gas Production, Transmission and Distribution - The EPA is currently considering rulemaking to incorporate methane control requirements into NSPS Subpart OOOO, similar to how Colorado includes methane in its Regulation 7 definitions of volatile organic compounds.

Other EPA regulations would also indirectly affect overall emissions from the oil and gas industry, such as the non-road and on-road engine standards. Likewise, the National Highway Traffic Safety Administration (NHTSA) establishes the Corporate Average Fuel Economy (CAFE) requirements.

In addition to the above regulations, activities that involve federal mineral estate would also be required to comply with BLM land use stipulations (federal surface only) and permit-specific Conditions of Approval (COA) that would be determined by analysis at the time of permitting / authorization. The BLM makes land use allocations and stipulation decisions during RMP development. There are typically three stipulation types for lands that are designated as available for future oil, gas, and coal exploration and development: they include No Surface Occupancy (NSO), Controlled Surface Use (CSU), and Timing Limitations (TL). Areas identified as NSO will be unavailable to placement of surface facilities such as oil and gas wells, will be avoidance areas for location of public utilities, and will be closed to new road construction. Areas identified as CSU will require proposals be authorized only according to the controls or constraints specified. Controls will be applicable to all surface use activities, such as oil and gas development and operation, mineral material sales, and public utility location.

The appropriateness and application of each is entirely dependent upon on-the-ground resources. Parcel lease documents typically have stipulations attached when exclusive mineral rights are transferred to an individual or organization after a lease sale. Any subsequent plans for exploration or development on the parcel must comply with the stipulation parameters. Additionally, when the BLM analyzes plans for subsequent exploration or development (as required by NEPA with data required by Onshore Oil and Gas Order No. 1), it may attach COAs to permits authorizing such activities as necessary to mitigate any significantly impacted resources, regardless of surface ownership status. The term COA refers to a site-specific requirement included in an approved permit or sundry notice that may limit or amend the specific actions proposed by the operator to minimize, mitigate, or prevent impacts to public lands or other resources. Both stipulations and COAs are subject to enforcement by the BLM.

2.4 Criteria Air Pollutants

The U.S. Environmental Protection Agency (EPA) has established National Ambient Air Quality Standards (NAAQS) for seven criteria air pollutants (CAPs), which include carbon monoxide (CO), nitrogen dioxide (NO_2), ozone (O_3), particulate matter (PM_{10} and $PM_{2.5}$), sulfur dioxide (SO_2), and lead (Pb). Exposure to air pollutant concentrations greater than the established NAAQS is shown to have a detrimental impact on human health and the environment. Thus, ambient air quality standards must not be violated in areas where the public has access. All criteria pollutants are directly emitted from a variety of source types, except for ground-level ozone and the secondary formation of condensable particulate matter (secondary $PM_{2.5}$). The Clean Air Act (CAA) established two types of NAAQS, primary and secondary. Primary standards set limits to protect public health, including the health of "sensitive" populations (e.g. asthmatics, children, the elderly, etc.), while secondary standards set limits to protect public welfare, including protection against decreased visibility and damage to animals, crops, vegetation, and buildings.

The EPA must review the NAAQS every five years to ensure that the latest science on health effects, risk assessment, and observable data such as hospital admissions are evaluated to determine whether NAAQS levels remain appropriate. Moreover, the EPA can revise any NAAQS if the data support a revision. The Colorado Air Pollution Control Commission can establish state ambient air quality standards for any criteria pollutant. Any state standard must be at least as stringent as the federal standards. Table 1 lists the federal and Colorado ambient air quality standards.

Ambient air quality (i.e. compliance with the NAAQS) is demonstrated by monitoring for ground-level atmospheric air pollutant concentrations. The CDPHE monitors ambient air quality at several locations throughout the state and summarizes the data annually by air quality region to produce an annual report. There are currently eight air quality regions in Colorado that are designed to accurately reflect local air quality conditions. The reports are prepared to inform the public about air quality trends within each region and can be found on the CDPHE's Technical Services Program website. Similarly, several Federal Land Managers (FLMs) like the BLM, U.S. Forest Service (FS), and the National Park Service (NPS), also monitor for NAAQS and Air Quality Related Values (AQRVs) to meet Organic Act requirements. BLM Colorado currently sponsors three federal reference method compliant air quality stations, two stationary and one mobile station. These stations are in Hebron, Rangely, and the Piceance Basin with real-time data and web cameras available here.

Additional information on criteria pollutants, including emissions and modeling significance levels, can be found in the Colorado Modeling Guideline. The Guideline defines levels for emissions to suggest when modeling may be warranted, and when the results of such analysis could trigger the need for additional refined analysis. The Guidance defines Significant Impact Levels (SIL) for all criteria pollutants except for ozone and lead. Furthermore, the EPA also recently published SIL guidance for ozone and fine particulates applicable to Prevention of Significant Deterioration (PSD) permitting actions that regulatory agencies may choose to use when reviewing PSD modeling results on a case-by-case basis (more on PSD below). Both documents are informative to the NEPA process, although not directly applicable.

Table 1. Primary Criteria Pollutant NAAQS.

Pollutant	Primary/ Secondary	Averaging Time	Level*	Form
Carbon Monoxide (CO)	primary	8 hours	9 ppm	Not to be exceeded more than once per year
		1 hour	35 ppm	
Lead (Pb)	primary and secondary	Rolling 3-month average	0.15 μg/m^3	Not to be exceeded
Nitrogen Dioxide (NO_2)	primary	1 hour	100 ppb	98th percentile of 1-hour daily maximum concentrations, averaged over 3 years
	primary and secondary	1 year	53 ppb	Annual Mean
Ozone (O_3)	primary and secondary	8 hours	0.070 ppm	Annual fourth-highest daily maximum 8-hour concentration, averaged over 3 years
Fine Particulate Matter ($PM_{2.5}$)	primary	1 year	12.0 μg/m^3	Annual mean, averaged over 3 years
	secondary	1 year	15.0 μg/m^3	Annual mean, averaged over 3 years
	primary and secondary	24 hours	35 μg/m^3	98th percentile, averaged over 3 years
Coarse Particulate Matter (PM_{10})	primary and secondary	24 hours	150 μg/m^3	Not to be exceeded more than once per year on average over 3 years
Sulfur Dioxide (SO_2)	primary	1 hour	75 ppb	99th percentile of 1-hour daily maximum concentrations, averaged over 3 years
	Secondary	3 hours	0.5 ppm	Not to be exceeded more than once per year
* Units of measure for the standards are parts per million (ppm) by volume, parts per billion (ppb) by volume, and micrograms per cubic meter of air (μg/m^3).				

2.4.1 Carbon Monoxide

Carbon monoxide (CO) is a colorless, odorless gas emitted from combustion processes that can cause harmful health effects by reducing oxygen delivery to the body's organs (like the heart and brain) and tissues. At extremely high levels, CO can cause death (EPA, 2018). The largest sources of CO are cars, trucks and other vehicles or machinery that burn fossil fuels.

2.4.2 Nitrogen Oxides

Nitrogen oxides (NOx) are a group of highly reactive gasses and include nitrogen dioxide (NO2), nitrous acid, and nitric acid. While EPA's NAAQS cover this entire group of NOx, NO2 is the component of greatest interest and the indicator for the larger group of nitrogen oxides. NO2 forms quickly from emissions from cars, trucks and buses, power plants, and off-road equipment. In addition to contributing to the formation of ground-level ozone, and fine particle pollution, NO2 is linked with a number of adverse effects on the respiratory system (EPA, 2018).

2.4.3 Ozone

Ground-level ozone (O_3) is a secondary pollutant. It is formed by a chemical reaction between nitrogen oxides (NOx) and volatile organic compounds (VOCs) in the presence of sunlight (photochemical oxidation). Precursor sources of NOx and VOCs include motor vehicle exhaust, industrial emissions, gasoline vapors, vegetation emissions (i.e., terpenes), wood burning, and chemical solvents. Abundant solar radiation drives the photochemical process and creates ground-level ozone. Primary health effects from ozone exposure range from breathing difficulty to permanent lung damage. High concentrations of ground-level ozone contribute to plant and ecosystem damage.

While ozone is generally considered a summertime air pollutant, in certain parts of the country (e.g. Utah's Uinta Basin) it has become a wintertime issue due to highly concentrated precursor pollutants in low level temperature inversions and additional photochemical reaction from snow reflecting solar radiation back into the atmosphere.

Ozone and its precursors are a regional air quality issue due to possible transport hundreds of miles from origination, thus maximum levels can occur at locations many miles downwind from the sources.

2.4.4 Particulate Matter (PM_{10} AND $PM_{2.5}$)

Airborne particulate matter (PM) consists of tiny coarse-mode (PM_{10}) or fine-mode ($PM_{2.5}$) particles or aerosols combined with dust, dirt, smoke, and liquid droplets. $PM_{2.5}$ have diameters that are 2.5 micrometers or smaller and derive primarily from the incomplete combustion of fuel sources and secondarily formed aerosols. PM_{10} have diameters that are 10 micrometers or smaller and derive primarily from crushing, grinding, or abrasion of surfaces. Sources of particulate matter include industrial processes, power plants, vehicle exhaust, fugitive dust, construction activities, home heating, and fires. Many scientific studies have linked breathing PM to serious health problems, including aggravated asthma, increased respiratory symptoms, difficult or painful breathing, chronic bronchitis, decreased lung function, and premature death. Particulate matter is a major cause of reduced visibility. It can stain and damage stone and other materials, including culturally important objects, such as monuments and statues (EPA, 2018).

2.4.5 Sulfur Dioxide

Sulfur dioxide (SO_2) is one of a group of highly reactive gasses known as “oxides of sulfur.” The largest sources are from fossil fuel combustion at power plants (73%) and other industrial facilities (20%). Smaller sources of emissions include industrial processes such as extracting metal from ore, and the burning. High concentrations of SO_2 can cause adverse effects on the respiratory system (EPA, 2018).

2.4.6 Lead

Lead (Pb) is a metal found naturally in the environment as well as in manufactured products. The major sources of lead emissions have historically been from fuels in on-road motor vehicles (such as cars and trucks) and industrial sources. As a result of EPA's regulatory efforts to remove lead from gasoline, emissions of lead from the transportation sector declined by 95% between 1980 and 1999, and levels of lead in the air decreased by 94% during the same period. Major sources of lead emissions to the air today are ore and metals processing and piston-engine aircraft using leaded aviation gasoline (EPA, 2018).

2.4.7 Volatile Organic Compounds

VOCs are any compound of carbon, excluding carbon monoxide, carbon dioxide, carbonic acid, metallic carbides or carbonates and ammonium carbonate, which participates in atmospheric photochemical reactions, except those designated by EPA as having negligible photochemical reactivity (EPA, 2018). While there is no NAAQS for VOCs, they are regulated by the EPA to prevent the formation of ozone, a constituent of photochemical smog. In Colorado, VOCs originate largely from biological sources such as vegetation and soils, chemical solvents, gasoline vapors, and oil and gas production. Many VOCs are also hazardous air pollutants.

2.5 Hazardous Air Pollutants

Other common pollutants include Air Toxics, otherwise known as Hazardous Air Pollutants (HAPs). HAPs are chemicals or compounds that are known or suspected to cause cancer and other serious health effects, such as birth defects, developmental disorders, and compromises to immune and reproductive systems, and may result from either chronic (i.e. long-term) and/or acute (i.e. short-term) exposure. CAA Sections 111 and 112 establish mechanisms for controlling HAPs from stationary sources, and the EPA is required to control emissions of 187 HAPs. Ambient air quality standards do not exist for HAPs; however, mass-based emissions limits and risk-based exposure thresholds are established as significance criteria to require Maximum Achievable Control Technologies (MACT) under the EPA promulgated National Emissions Standards for Hazardous Air Pollutants (NESHAPs) for 96 industrial source classes.

The primary air toxins of concern for BLM authorized activities are the BTEX compounds (i.e. benzene, toluene, ethyl-benzene, and xylene), formaldehyde, and n-hexane. For the purposes of NEPA disclosure, project level implementation, and mitigation thresholds, an upper limit of a one-in-a-million cancer risk for lifetime exposure (i.e. chronic) level is assessed. Chronic indicators, known as Reference Concentrations (RfC) are defined by the EPA as the daily inhalation concentrations at which no long-term adverse health impacts are expected, based on an annual average concentration in ambient air. Short-term (1-hour) HAPs concentrations will be compared to acute Reference Exposure Levels (RELs). RELs are defined as toxin concentrations below which no adverse health effects are expected. No RELs are available for ethylbenzene and n-hexane; instead, the available Immediately Dangerous to Life or Health (IDLH) divided by 10 (IDLH/10) values are used. These IDLH values are determined by the National Institute for Occupational Safety and Health (NIOSH) and were obtained from EPA's Air Toxics Database (EPA, 2011). These values are approximately comparable to mild effects levels for 1-hour exposures. A list of RELs for several HAPs is provided in Table 2**.**

In Colorado, an Air Pollutant Emission Notice must be filed for each emission point (individual or grouped) that has uncontrolled actual emissions equal to or greater than 250 pounds per year of any non-criteria reportable pollutant. The CDPHE maintains a list of reportable HAPs.

A recent study suggests that unconventional oil and gas development involving hydraulic fracturing (fracking) can create elevated particle radiation downwind (Longxiang, et al., 2020). Radioactive particles are EPA-regulated pollutants under the National Emission Standards for Hazardous Air Pollutants (NESHAP). While the study showed the potential for increased emissions of radioactive particles due to fracking it does not make a link between the emissions and potential dose or exposure to downwind populations. The EPA reports that average indoor radon activity concentrations at 1300 Bq/m3, and the study suggests hydraulic unconventional oil and gas development would cause a downwind increase of just 0.00014 Bq/m3. Elevated background radioactive concentrations due to unconventional oil and gas development are negligible relative to EPA’s estimate of background radiation for indoor environments.

Table 2. Toxic Compound Thresholds.

Pollutant	**Reference Exposure Level (REL) (µg/m^3)**	**Reference Concentration (RfC) (µg/m^3)**
Benzene	1,300	30
Toluene	37,000	400
Ethylbenzene	350,000	1,000
Xylenes	22,000	100
n-Hexane	390,000	200
Formaldehyde	94	9.8

REL = 1hr average, RfC = annual average.

2.6 Airshed Classes and Prevention of Significant Deterioration

Overall air quality in a region is determined by monitoring ground-level pollutants and comparing their measured concentrations to the relevant design values for those pollutants. If the concentrations are below the standard, the area is in compliance with the NAAQS (National Ambient Air Quality Standards). However, areas designated as "nonattainment" are in violation of the standard.

In cases where a formal designation has not been made, two additional subcategories of attainment exist: Attainment/Unclassifiable and Attainment/Maintenance. Attainment/Unclassifiable is typically assigned to rural or natural areas where monitoring data is unavailable. On the other hand, Attainment/Maintenance is designated for areas that have previously violated the NAAQS but have since brought pollutant concentrations below the NAAQS design values.

Additionally, each geographical region is assigned a priority class (i.e., I, II, or III), which indicates the degree to which deterioration of the existing air quality is permissible within that area under the Prevention of Significant Deterioration (PSD) permitting regulations. Class I areas are characterized by their special national or regional significance, such as natural, scenic, recreational, or historical value, and consequently, they allow only minimal degradation of air quality. In contrast, Class II areas permit reasonable industrial and economic growth. There are currently no Class III areas defined in the U.S. A list of the 12 Class I areas in Colorado is provided in Table 3.

Table 3. List of Class I areas in Colorado.

Class I Area	Acres	Nearest IMPROVE Monitor
Black Canyon of the Gunnison National Park	11,180	WEMI1
Eagles Nest Wilderness Area	133,910	WHRI1
Flat Tops Wilderness Area	235,230	WHRI1
Great Sand Dunes National Park	33,450	GRSA1
La Garita Wilderness Area	48,486	WEMI1
Maroon Bells-Snowmass Wilderness Area	71,060	WHRI1
Mesa Verde National Park	51,488	MEVE1
Mount Zirkel Wilderness Area	72,472	MOZI1
Rawah Wilderness Area	26,674	MOZI1
Rocky Mountain National Park	263,138	ROMO1
Weminuche Wilderness Area	400,907	WEMI1
West Elk Wilderness Area	61,412	WHRI1

Although the PSD rule is only applicable to major stationary sources of air pollution, a PSD increment analysis can provide a useful measure for estimating how a new source of pollution would impact regional air quality. A PSD increment is the amount of pollution allowed to increase in an area while preventing air quality in the airshed from deteriorating to the level set by the NAAQS. The NAAQS is a maximum allowable concentration ceiling, while a PSD increment is the maximum allowable increase in concentration allowed to occur above a baseline concentration for a pollutant within the PSD area boundary. The baseline concentration for a pollutant is defined as the ambient concentration existing at the time that the first complete PSD permit application affecting the boundary is submitted. PSD applicable sources are required to provide an analysis to ensure their emissions in conjunction with other applicable emissions increases and decreases within an area will not cause or contribute to a violation of any applicable NAAQS or PSD increment. Significant deterioration occurs when the amount of new pollution exceeds the applicable PSD increment. An official PSD increment analysis is the sole responsibility of the CDPHE. Any subsequent analysis performed for NEPA purposes will be used for informational purposes only.

Table 4. Prevention of Significant Deterioration (PSD) Increments (µg/m³).

Pollutant	Period	Class I	Class II
NO_2	Annual	2.5	25
SO_2	3-hour	25	512
	24-hour	5	91
	Annual	2	20
PM_{10}	24-hour	8	30
	Annual	4	17
$PM_{2.5}$	24-hour	2	9
	Annual	1	4

Source: 40 CFR 51.166(c)

2.7 Air Quality Related Values (AQRVs)

In addition to the NAAQS modeling required for PSD permitting, the PSD program requires the assessment of air pollution impacts to surface waters, soils, vegetation (e.g. deposition, ozone), and visibility. These metrics are commonly referred to as Air Quality Related Values (AQRVs). Measuring and characterizing potential impacts to AQRVs is important at federally mandated Class I lands, which include areas such as national parks, national wilderness areas, and national monuments. Class I areas are granted special air quality protections under Section 162(a) of the federal Clean Air Act (CAA), and the Federal Land Manager (FLM) for any such area is responsible for reviewing PSD actions to compliance. AQRVs are routinely assessed by the BLM during NEPA analyses for actions / authorizations with the potential to impact such areas as required by FLPMA under Section 102 (a)(8).

2.7.1 Deposition

Atmospheric deposition is the process of removing pollutants from the atmosphere via mechanical and chemical processes. When air pollutants such as sulfur and nitrogen are deposited into ecosystems, they can cause acidification or enrichment of soils and surface waters. Atmospheric nitrogen and sulfur deposition may affect water chemistry, resulting in impacts to aquatic vegetation, invertebrate communities, amphibians, and fish. Deposition can also cause chemical changes in soils that alter soil microorganisms, plants, and trees. Although nitrogen is an essential plant nutrient, excess nitrogen from atmospheric deposition can stress ecosystems by favoring some plant species and inhibiting the growth of others. Two distinct methodologies measure these processes: wet and dry deposition monitors.

The National Atmospheric Deposition Program (NADP) is a conglomerate of various wet chemistry monitoring networks designed to measure wet atmospheric deposition and study its effects on the environment. The network currently operates about 250 sites, many since the early 1980s. The Clean Air Status and Trends Network (CASTNET) is a national air quality monitoring network designed to provide data to assess trends in air quality, dry atmospheric deposition, and ecological effects due to changes in air pollutant emissions. CASTNET began collecting data in 1991 with the incorporation of 50 sites from the National Dry Deposition Network. CASTNET provides long-term monitoring of air quality in rural areas to determine trends in regional atmospheric nitrogen, sulfur and ozone concentrations and deposition fluxes of sulfur and nitrogen pollutants.

The FLMs use a deposition data analysis threshold (DAT) of 0.005 kg/ha-yr to determine the potential significance of any given project in the western U.S. as defined under the FLM Air Quality Related Values Work Group guidance (NPS, 2010). Cumulative thresholds, known as critical loads, have also been established for Colorado's Class I areas by the NPS and the USFS. Critical loads are deposition levels, often expressed as a range (i.e. minimum and maximum), below which significant ecosystem effects do not occur and are a property of the individual ecosystem's components (species) functionality. Colorado is primarily composed of three major level I ecoregions (Pardo, et al., 2011) (for which critical loads have been established: the Great Plains (lvl II - South Central Semi-Arid Prairies, 5 to 25 kg/ha-yr), the Northwestern Forested Mountains (lvl II - Western Cordillera, 1.5 to 17 kg/ha-yr), and the North American Deserts (lvl II - Cold Deserts, 3 to 8.4 kg/ha-yr). Critical loads are science-based, however FLMs may also identify a "target" load which can be higher or lower than a critical load based on ecosystem recovery goals, the desired level of resource protection to prevent future resource damage, economic considerations, and stakeholder input. The NPS maintains a list of critical loads for the National Parks and Monuments they manage. Setting a target load plays an important role in guiding policy, management decisions, and regulatory or voluntary measures such as emission reduction strategies for culpable air pollutant sources. Note that BLM-authorized actions do not significantly contribute to sulfur loading in the atmosphere or environment.

2.7.2 Visibility

2.7.2.1 Introduction to Visibility

Pollution in the atmosphere can impair scenic views by degrading the contrast, colors, and distance an observer can see. Visibility impairment results from the absorption and scatting of particles and gases present in the atmosphere. The absorption and scatting leads to a reduction in light from a scene reaching an observer, leading to a decrease in visual distance and diminished visual clarity of objects.

Visibility is often defined as the farthest distance at which an observer can distinguish a black object against the sky at the horizon. A common metric to quantify visibility is the Standard Visual Range (SVR), the maximum distance at which prominent high-contrast objects can be seen and identified under normal daylight conditions. It is used as a reference point for assessing visibility and is typically expressed in terms of miles or kilometers. The determination of SVR considers factors such as atmospheric conditions, lighting, and the size and contrast of the objects being observed. The purpose of establishing a SVR is to provide a consistent measure for evaluating visibility across different locations and situations. Average natural visual range conditions for Class I areas can be found in Table 10 of (NPS, 2010). Among Colorado park and wilderness locations, the natural visual range varies from about 160 miles at Great Sand Dunes National Park to 190 miles in the northern mountains. More information on visibility can be found in (Malm, 1999). An overview of visibility trends for the United States is provided in (Hand, Prenni, Copeland, Schichtel, & Malm, 2020).

2.7.2.2 Regional Haze

"Regional haze" is defined at 40 CFR 51.301 as "visibility impairment that is caused by the emission of air pollutants from numerous anthropogenic sources located over a wide geographic area. Such sources include, but are not limited to, major and minor stationary sources, mobile sources, and area sources." Regional haze is a concern not only for its impact on visibility but also because the fine particles can have adverse effects on human health and the environment. These particles can also contribute to respiratory problems and other health issues when inhaled. In addition, they can also have deleterious effects on ecosystems, air quality, and climate. In the 1977 CAA amendments, Congress set a national goal to remedy existing visibility impairment and to prevent future visibility degradation from manmade air pollution in Class I federal lands such as national parks and wilderness areas. To address this goal, the Regional Haze Rule (RHR) was finalized in 1999 and called on states to establish goals and reduce emissions to improve visibility in 156 mandatory Class I areas.

The primary cause of regional haze is light extinction by particulate matter (PM). For purposes of the Regional Haze Rule (RHR), light extinction is estimated from measurements of particulate matter and its chemical components (sulfate, nitrate, organic mass by carbon (OMC), light absorbing carbon, fine soil, sea salt, and coarse material), assumptions about relative humidity at the monitoring site, and the use of a commonly accepted algorithm. These estimates of light extinction are logarithmically transformed to deciviews (dv). A deciview (dv) is a unit of measurement to quantify human perception of visibility. It is derived from the natural logarithm of atmospheric light extinction coefficient. A one dv change is roughly the smallest perceptible change in visibility.

Visibility varies on a daily to seasonal basis and thus it is useful to characterize visibility by categories such as clearest and haziest days. Following the original *Guidance for Tracking Progress Under the Regional Haze Rule*, states demonstrated progress in meeting RHR goals based on the elimination of anthropogenic impairment on the 20% of days each year with the highest total haze, including natural and anthropogenic sources. However, in the western United States, these haziest days frequently include large amounts of haze from natural sources, chiefly wildfire smoke and windblown dust. Meeting the CAA goal of eliminating anthropogenic haze by focusing on days dominated by natural sources that are essentially uncontrollable is problematic. Accordingly, on August 20, 2019, the EPA issued *Guidance on Regional Haze State Implementation Plans for the Second Implementation Period* to assist states as they develop plans to address visibility impairment for the second implementation period under EPA's RHR.

The RHR revisions and guidance propose a new approach to track progress toward CAA goals, which is to select the 20% of days each year that have the highest *anthropogenic* impairment. These represent the days each year that have the largest apparent change in visibility from what would have existed with no anthropogenic haze. This creates a subset of days that are expected to be most sensitive to emissions control programs. The revision ensures that visibility tracking and RHR progress is based on anthropogenic rather than natural sources (i.e., dust or smoke).

In the original RHR guidance, states evaluated progress towards "natural conditions" by 2064. In the updated RHR guidance, new 2064 goals were established to calculate the Uniform Rate of Progress (URP), sometimes referred to as glidepath. Natural haze levels change from year to year, but the expectation is that the average amount of natural haze on the most impaired days will remain roughly constant over time. When averaged over many years, the natural contributions on the most impaired days are generally uniform temporally and spatially and provide reasonable default values for these 2064 endpoints. Fifteen-year averages of the natural haze levels on the 20% most impaired days are used to derive the 2064 endpoint estimates now used to assess RHR progress.

The recommended 2064 endpoints provide a consistent starting point for generating a URP to track progress within the updated impairment framework. As with the default natural conditions defined in the original RHR guidance, considerable uncertainty exists in these updated endpoints, especially at sites with significant, large natural sources nearby, such as those in Colorado. The 2064 endpoints do not yet reflect international anthropogenic contributions or prescribed fire but may in the future. More information about the EPA's impairment framework can be found at: http://vista.cira.colostate.edu/Improve/impairment/. The EPA's 2019 *Guidance on Regional Haze State Implementation Plans for the Second Implementation Period* provides a detailed explanation on how states can show progress towards the updated metrics.

2.7.2.3 Visibility Monitoring

To assess progress towards CAA goals, visibility monitoring is required in locations representative of the 156 visibility-protected federal Class I areas. To this end, the Interagency Monitoring of Protected Visual Environments (IMPROVE) was designated as the visibility monitoring network to carry out this responsibility. IMPROVE was initially established as a national visibility network in 1985 and consisted of 30 monitoring sites primarily located in national parks, 20 of which began operation in 1987. With the implementation of the RHR in 1999, the IMPROVE network expanded, and 110 monitoring sites were identified that were deemed representative of the regional haze conditions for 155 of the mandatory 156 Class I areas, the Bering Sea Wilderness being the exception. In addition to the 110 sites that are used to represent Class I areas, some IMPROVE protocol sites are in operation to provide expanded spatial coverage for the network. Protocol sites are separately sponsored by state, regional, tribal, and national organizations and use the same instrumentation, monitoring, and analysis protocols as IMPROVE. The use of identical samplers and analysis protocols by the same contractors ensures that data generated by IMPROVE and IMPROVE protocol sites can be treated as directly comparable. A list of Colorado Class I areas and the representative IMPROVE monitor is provided in Table 3. Visibility trends from Colorado IMPROVE sites are discussed in Section 4.6.1 Visibility of this report.

2.7.3 Ozone

Ozone affects sensitive vegetation and ecosystems, including forests, parks, wildlife refuges, and wilderness areas. Common effects on vegetation include reducing photosynthesis potential (i.e. slow plant growth), increasing risk of disease and damage from insects, amplifying harm from other pollutants and severe weather/drought, and causing visible damage to foliage under certain conditions. The effects of ozone on individual plants can have negative impacts on ecosystems, including loss of species diversity, changes to the specific assortment of plants present in a region, decreased habitat quality, and shifts in water and nutrient cycles.

Ozone impacts on trees, plants and ecosystems can be assessed using the "W126 index." The W126 is a seasonal weighted index designed to reflect the cumulative exposures that can damage plants and trees during the growing season, when daytime ozone concentrations are the highest and plant growth is most likely to be affected. The eight-hour primary ozone standard of 0.070 ppm is used to prevent the W126 exposure index from exceeding 17 ppm-hrs. The NPS published recommended benchmarks for the W126 metric based on information in the EPA's *Policy Assessment for the Review of the Ozone National Ambient Air Quality Standards* which outlines the use of the W126 metric for assessing plant response to ground-level ozone. The EPA assessment found that for W126 values less than 7 ppm-hrs, tree seedling biomass loss is under 2% per year in sensitive species; and for values greater than 13 ppm-hrs, tree seedling biomass loss is 4–10% per year in sensitive species. The NPS uses this information to assess park conditions and trends and provides an explanation of air analysis methods.

2.8 Nonattainment and General Conformity

If a nonattainment designation takes effect for any criteria pollutant, the State of Colorado has three years to develop plans outlining how the area will attain and maintain the NAAQS by reducing air pollutant emissions that contribute to the violation. Further, any new major stationary source or major modification to a stationary source (as defined by the CAA and based on the severity of the violation in the area) that emits a nonattainment pollutant or precursor within the nonattainment area boundary would be required to offset the new or modified emissions from the source in a ratio greater than 1:1. Offset emissions or emissions credits (i.e. reductions from other sources) would need to be obtained from within the designated nonattainment area.

Section 176(c) of the CAA, 42 U.S.C. § 7506, prohibits federal entities from approving actions in nonattainment or maintenance areas that do not “conform” to the State Implementation Plan (SIP). The purpose of this conformity requirement is to ensure that federal activities: (1) do not interfere with the budgets in the SIPs, (2) do not cause or contribute to new violations of the NAAQS, and (3) do not impede the ability of regulators to attain or maintain the NAAQS. To implement CAA Section 176(c), the EPA issued the General Conformity Rule (40 C.F.R. Part 93, Subpart B), which applies to all federal actions not funded under U.S.C. Title 23 or the Federal Transit Act. BLM actions are not funded by U.S.C. Title 23 or the Federal Transit Act. The General Conformity Rule established emissions thresholds (40 C.F.R. 93.153) for use in evaluating the conformity of a project (40 C.F.R. 93.153(b)(1)). If the net emissions increase from reasonably foreseeable direct and indirect sources from the project or action are less than the defined thresholds, then no further conformity evaluation is required (40 C.F.R. 93.153(c)(1). If these emissions increases exceed any of the thresholds, a formal conformity determination would be required. The rule also identifies other actions to which the conformity requirements do not apply (40 C.F.R. 93.153(c)(2), (d), (e)), as well as actions that are “presumed to conform” with the applicable SIP (40 C.F.R. 93.153(f)-(i)). A formal conformity determination can entail air quality modeling studies, consultation with the EPA or State air quality agencies to obtain commitments to revise a SIP, or implementation measures to mitigate the air quality impacts (i.e. offset all of the reasonably foreseeable emissions for the action).

The BLM performs a General Conformity Applicability Analysis for each subject action when emissions are reasonably foreseeable such that they can be quantified to enable comparison to the triggering thresholds. For oil and gas projects, virtually all production-related stationary sources will receive a New Source Review (NSR) permit from the CDPHE to authorize operations. Under the Rule, these sources are exempt from applicability considerations. Typically, sources of this variety would include the following:

- Compression and Artificial Lift Pump Engines
- Tanks and Tank Batteries
- Components (e.g. flanges, valves, connectors)
- Pneumatic Devices

Other sources of emissions, such as drill rigs, completion and hydraulic fracturing equipment, on-road and off-road activity support vehicles, and other permit exempted equipment (e.g. separator and tank heaters) are generally subject to the Rule and must be taken into consideration. The BLM makes subject to rule determinations for all emissions sources during project analyses, regardless of classification.

2.9 Greenhouse Gases (GHGs)

Anthropogenic greenhouse gases (GHGs) are commonly emitted air pollutants that include carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), and several fluorinated species of gases such as hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride. Current global climate change is being driven by increasing GHGs, which may persist for decades to centuries. The accumulation of GHGs since the start of the industrial revolution has markedly increased atmospheric concentrations of these compounds compared to historical background levels. Carbon dioxide is by far the most common GHG and is emitted from the combustion of fossil fuels (i.e. oil, natural gas, and coal), wildfires, solid waste, and as a result of certain chemical reactions. Methane is emitted during the production and transport of coal, natural gas, and oil. Methane also results from livestock and other agricultural practices and from the decay of organic waste in municipal solid waste landfills. Nitrous oxide is emitted during agricultural and industrial activities, as well as during combustion of fossil fuels and solid waste. Fluorinated gases are powerful greenhouse gases that are emitted from a variety of industrial processes and are often used as substitutes for ozone-depleting substances (i.e. chlorofluorocarbons, hydrochlorofluorocarbons, and halons), but are not typically associated with BLM authorized activities.

The impact of a given GHG on global warming depends both on its radiative forcing and how long it lasts in the atmosphere. Each GHG varies with respect to its concentration in the atmosphere and the amount of outgoing radiation absorbed by the gas relative to the amount of incoming radiation it allows to pass through (i.e., radiative forcing). Different GHGs also have different atmospheric lifetimes. Some, such as methane, react in the atmosphere relatively quickly (on the order of 12 years); others, such as carbon dioxide, typically last for hundreds of years or longer. Each GHG has a global warming potential (GWP), a metric that accounts for these effects. The GWP is used as a conversion factor to convert a mixture of different GHG emissions into carbon dioxide equivalents (CO_2e). The larger its GWP, the more the specific gas warms the Earth as compared to CO_2. The BLM uses the 100-year time horizon for GWPs in most report metrics, to be consistent with the scientific and regulatory communities that develop climate change assessments and policy. The 100-year GWP (GWP100) was adopted by the United Nations Framework Convention on Climate Change (UNFCCC) and its Kyoto Protocol and is now used widely as the default metric by researchers and regulators. Global Warming Potentials from the IPCC AR 6 are summarized in Table 5.

Table 5. Greenhouse Gases and Their Global Warming Potentials.

Time Horizon	Carbon Dioxide	Methane (CH_4) Fossil	Methan (CH_4) Non-Fossil	Nitrous Oxide (N_2O)
100-year	1	29.8	27.2	273
20-year	1	82.5	80.8	273

Source: (IPCC, 2021)

A detailed discussion of climate change science and predicted impacts, as well as the existing and reasonably foreseeable GHG emissions associated with BLM's actions, are included in the BLM Specialist Report on Annual Greenhouse Gas Emissions and Climate Trends (hereinafter referred to as the Annual GHG Report) (BLM, 2022). The Annual GHG report presents the estimated emissions of greenhouse gases attributable to fossil fuels produced on lands and mineral estate managed by the BLM. A brief summary of Colorado specific information from the Annual GHG report is available in Section 4.7 Greenhouse Gas Emissions of this report.

Greenhouse gases (GHGs) became regulated pollutants on January 2, 2011 under the PSD and Title V Operating Permit Programs (EPA, 2018) because of their contribution to global climate change effects. These gases absorb energy emitted from the earth's surface and re-emit a larger portion of the heat back to the earth, rather than allowing the heat to escape into space, than would be the case under more natural conditions. The EPA's GHG Tailoring Rule (40 CFR § 51, 52, 70, et al.) set initial emissions thresholds for PSD and Title V permitting based on carbon dioxide equivalent (CO_2e). These thresholds apply to stationary sources that emit greater than 100,000 tons CO_2e per year (e.g., power plant, or landfill, etc.) or modifications of major sources with resulting emissions increase greater than 75,000 tons CO_2e per year.

In addition to the Tailoring Rule, the EPA requires reporting of GHGs from facilities with stationary sources that emit 25,000 metric tons CO_2e per year or more in the United States. The Mandatory Reporting Rule (40 CFR § 98, Subpart C) does not require control of GHGs, it only requires that sources above the threshold levels monitor and report emissions. Facilities used for injecting carbon dioxide for geological sequestration must report net emissions regardless of quantity (40 CFR § 98, Subpart RR). This provides a basis for future EPA policy decisions and regulatory initiatives regarding GHGs.

Directed by Executive Order 13990, Protecting Public Health and the Environment and Restoring Science to Tackle the Climate Crisis, on January 9, 2023, the Council on Environmental Quality (CEQ) released updated NEPA Guidance on Consideration of Greenhouse Gas Emissions and Climate Change (88 FR 1196) to help federal agencies better assess and disclose climate impacts as they conduct environmental reviews.

On July 20, 2023, the CPDHE announced a new rule for verifying the intensity of greenhouse gas (GHG) emissions. This rule outlines the methodology that specific oil and gas facilities must employ to calculate their greenhouse gas intensity. Additionally, it mandates ongoing monitoring of their operations to ensure they adhere to the intensity standards and maintain accurate emission records. The term "intensity" pertains to the relationship between the amount of greenhouse gas emissions generated by a facility and the volume of oil and gas it produces. This GHG intensity program targets upstream oil and gas operations, also known as "well sites" or "production" facilities. It comprises two key components: the newly established verification rule and the GHG intensity standards. The verification rule aims to ensure that facilities comply with the intensity standards set in 2021. These standards progressively become more stringent over time in alignment with the 2021 Colorado Greenhouse Gas Pollution Reduction Roadmap, which seeks a 36% reduction in GHG emissions from the oil and gas industry by 2025 and a 60% reduction by 2030. The new rule introduces several requirements, including:

- All facility operators are obligated to employ direct measurement techniques for their emissions inventories.
- Specific facility operators must engage third-party auditors to review their emissions reports, and these auditors must be certified by the division.
- The division will verify facilities' compliance with emissions standards and incorporate aerial and ground air monitoring into emission calculations.
- The division will maintain an emissions database based on a combination of facility reporting and direct measurements.

In May 2023, Colorado passed Senate Bill 16, which committed the state to GHG emissions reductions of at least 65% by 2035, 75% by 2040, and 90% by 2045 below 2005 levels. It also sets a target for net-zero GHG emissions by 2050.

2.10 Emissions Data & Source Classifications

All emissions sources fall into two broad categories for regulatory purposes: stationary and mobile. Each are typically regulated according to their type and classification.

Stationary Sources: These sources include non-moving, fixed-site producers of pollution such as power plants, petro-chemical refineries, manufacturing facilities, and other industrial sites like oil and gas production pads and coal mines. Stationary facilities emit air pollutants via process vents or stacks (i.e. point sources) or by fugitive releases (i.e. emissions that do not pass through a process vent or stack). Stationary sources are also classified as either major or minor. A major source is one that emits, or has the potential to emit, a regulated air pollutant in quantities above a defined threshold. Stationary sources that are not major are considered minor or area sources. A stationary source that takes federally enforceable limits on production, consumption rates, or emissions to avoid major source status are called synthetic minors. The CDPHE Air Pollution Control Division (APCD) has authority under their EPA approved SIP to regulate and issue air permits for stationary sources of pollution in Colorado.

Mobile Sources: These sources include motor vehicles, engines, and equipment that can be moved from one location to another. Due to the large number and variety of these sources and their ability to move across traditional regulatory jurisdictions (i.e. state lines), mobile sources are regulated differently than stationary sources. In general, the EPA and other federal entities retain authority to set emissions standards for these sources depending on their type (i.e. on-road, off-road, and non-road), classification (e.g. light duty, heavy duty, horsepower rating, weight, fuel types, etc.), and the year of manufacture, or in some circumstances, their reconditioning. Mobile sources are not regulated by the state unless they are covered under an applicable SIP, usually as part of an on-road inspection and maintenance program.

2.10.1 Additional Resources

The CDPHE maintains an interactive map of Colorado that includes all designated air sheds (i.e. nonattainment, maintenance, and sensitive Class I and II areas), monitor locations, and a queryable interface that displays stationary source emissions for select pollutants within a given radius of a specified location. Readers are encouraged to explore the CDPHE's data to provide additional context for this report. Alternatively, these data, including historical monitoring data, are available from the EPA through an interactive map. The EPA also provides comprehensive information on Colorado nonattainment/maintenance status for each county for all CAPs.

3. Analysis Methods and Tools

3.1 Background

Air quality for any area is generally influenced by the amount of pollutants that are released within the vicinity and upwind of that area, and it can be highly dependent upon the contaminant's chemical and physical properties. Additionally, an area's terrain and weather (e.g. wind speed and direction, temperature, air pressure, rainfall, cloud cover) can have a direct influence on how pollutants accumulate, form, or disperse in their local and regional environments. Long range transportation potential is another important consideration, as some pollutants can be dispersed over long distances and cause issues in areas far from their origin (e.g. ozone, secondary $PM_{2.5}$, mercury). Analysis indicators for air resources can be described in terms of pollutant classes and concentrations relative to various standards and metrics, which are described in 2.4 Criteria Air Pollutants and 2.5 Hazardous Air Pollutants of this report.

In general, the BLM applies adaptive management when analyzing impacts from authorized activities with the potential to significantly affect air resources. These adaptive management principles include monitoring current conditions, predicting future impacts, and applying conditions of approval to account for any changing circumstances that may either result directly or cumulatively from the authorized action. This methodology allows the BLM to meet mission mandates and complete a timely and appropriate analysis that ensures activities approved by the BLM minimize potential adverse impacts to air quality, comply with NEPA, FLPMA, and applicable elements of the CAA. The remainder of this section introduces key concepts, studies, and tools used to provide analysis for BLM Colorado authorized activities and to produce the Annual Report.

3.2 Colorado Air Resource Management Modeling Study (CARMMS)

The CARMMS study is integral to BLM Colorado's adaptive management strategy for authorizing federal mineral development. CARMMS was developed to help the BLM understand the second element of the adaptive management strategy, which includes predicting future impacts. BLM Colorado provides for project-level authorization analyses, which can include near-field modeling tool assessments. In contrast, the CARMMS study utilizes the Comprehensive Air Quality Model with Extensions (CAMx) to provide a cumulative statewide assessment of potential air resource impacts. The model provides for a full suite of physicochemical state transformation modeling, which includes the ability to model ozone and secondary $PM_{2.5}$ formation and transport and represents the current state-of-the-science practice for NEPA and SIP compliance demonstrations. CAMx models nested domains at various resolutions over the entire CONUS that scale down to an area of interest. The model requires global variable inputs which includes the outermost boundary layer, gridded prognostic meteorological modeling with various horizontal and vertical scales, and cumulative gridded emissions modeling with applicable temporal variability that must include detailed pollutant speciation profiles.

The study was designed to take an iterative approach for predicting future impacts. The BLM acknowledges that all models have a "shelf life", where the inputs and assumptions used to develop the model are subject to change over time, including regional and localized developments. Relying on the model far into the future to provide for an appropriate analysis may not be technically sound. This approach provides for a more adaptive and defensive analysis posture versus a traditional one-off modeling approach performed for many discrete projects as was commonly done in the past.

For all CARMMS iterations, the BLM models three future development scenarios (i.e. low, medium, and high) out to the predefined projection year. Projections for oil and gas development are based on either the most recent Reasonably Foreseeable Development (RFD) document (i.e. high), or by projecting the current five year average development pace forward for ten additional years (i.e. low). The medium scenario includes the same development intensities as the high but assumes restricted emissions for mitigation analyses. Both the high and low scenarios assume current development practices and controls specified by "on-the-books" regulations. Each field office's emissions are modeled using the CAMx source apportionment option. The method provides emissions tracking and enables the BLM to understand how the projected emissions from each field office incrementally contribute to regional air quality and air quality related value impacts. The differences in the impacts between the scenarios and the base year provide insight into how various emissions loading impacts the atmosphere on a relative basis. This insight is useful for making qualitative and quantitative comparisons with emissions levels at the current tracked pace of development, which is how the data are used in the report.

For coal resources, CARMMS provides a single source apportionment group for all Colorado mines that produce federal coal. The mining scenarios are based on each mine's maximum allowable emissions rate, usually tied to a production limit, which were estimated based on CDPHE Air Pollutant Emission Notice (APEN) data and any available NEPA documents prepared for previous mine authorizations. Production estimates were held static across the scenarios. The primary difference between the low and high scenario involved assumptions about the number of potential new mines that could come online and how existing mines might not be operational in the future model year.

BLM Colorado completed the first iteration of CARMMS (1.0) in early 2015. In this study, projected year 2021 regional air quality and related value impacts were modeled using the West-wide Jump-start Air Quality Modeling Study (WestJUMPAQS) year 2008 modeling platform, and the results were published in January 2015. The 1.0 study included analysis of oil and natural gas development and mining emissions in the planning areas of individual BLM Colorado field offices and cumulative AQ and AQRV impacts due to non-Federal oil and gas and mining sources as well as other regional sources. Almost immediately upon completion, a second partial iteration of CARMMS (1.5) was run to capture updates to the Mancos Shale inventory and to consider the October 2015 change to the ozone NAAQS from 0.075 to 0.070 ppm. The results of the second iteration were published in March 2016. The CARMMS 1.5 results and data were used to produce the 2015 Annual Report.

To support newly revised RFD scenarios and ongoing RMP revision efforts, the BLM conducted the full second iteration of CARMMS (2.0) to answer the same air quality and AQRV questions for projected emissions scenarios out to 2025. The 2.0 study leveraged the updated modeling platform derived from the Western Air Quality Study (WAQS) and the Intermountain West Data Warehouse (IWDW). The CARMMS 2.0 results were published in August 2017 and form the basis of analysis for each yearly Annual Report update.

3.3 Annual Report

The Annual Report plays a key role in BLM Colorado's air resource analysis and adaptive management processes and essentially functions as the "check" and "act" portions of cycle, or the first and last elements of the strategy. The results of the report analysis itself provide an additional basis for developing authorization strategies that BLM Colorado can implement for subsequent tracking years, subject to management review and approval.

The Annual Report relies heavily on the CARMMS analysis and observed oil and gas production and development trends to drive adaptive management implementation. External data sources are incorporated to assess current air resource conditions or trends, and total mineral development throughout Colorado. Each year, the BLM collects and analyzes oil and gas development and production data from the Automated Fluid Minerals Support System (AFMSS), ECMC database, and Office of Natural Resources Revenue (ONRR) to determine the total number of new and active wells, as well as the production related values from these wells. The development metrics (i.e. spuds, active well counts, production volumes) are analyzed for each field office and compared to CARMMS high and low development scenarios. In general, spuds are a surrogate for construction related emissions, while active well counts and overall production volumes are surrogates for various production activity emissions.

BLM completed a Regional 2032 Air Quality Modeling Study in 2023 and similar to CARMMS utilizes CAMx source apportionment technology to distinctly predict potential future federal and non-federal oil and gas related air quality impacts (BLM, 2023). In addition to tracking actual oil and gas development and production trends with respect to those modeled for CARMMS, BLM is also tracking against the levels projected and modeled for the Regional Modeling Study and will disclose supplemental information in project-level NEPA analyses.

3.4 Project Level Authorizations

BLM Colorado provides analysis of project design features and recommends mitigation options as necessary to conform to Field Office RMP goals and objectives, which include compliance with federal and State air quality regulations. As such, individual project authorizations are not expected to contribute significantly to air quality impacts on their own. Project authorizations are handled on a case-by-case basis in accordance with the methods outlined in Appendix A of the CARPP. For all oil, gas, and coal development projects requiring NEPA, BLM staff are encouraged to incorporate the contents of this report by reference to describe the air resources affected environment, cumulative impacts, and climate change analysis.

In general, BLM Colorado requires an emissions inventory for each oil, gas, and coal project to utilize as the basis of analysis for any proposed action or alternatives developed for NEPA. Once an emissions inventory for a given project is complete, BLM staff can utilize the procedures below to complete any required analysis and incorporate the results into NEPA documents to disclose the direct, indirect, and cumulative environmental effects as appropriate. To facilitate the generation of the project emissions inventories, air resource specialists recommend proponents and staff utilize internally developed web tools available to support project analyses, including the Emissions Modeling and Impacts Tool (EMIT) discussed below.

3.4.1 Analysis Steps for an Individual Project

The ARS at the Colorado State Office can assist staff and proponents with the nuances of navigating and preparing an applicable and defensible NEPA analysis for air resources at any point in the analysis process, though the earlier, the better.

1. Evaluate the emissions inventories, including the underlying parameters, equipment specifications, and any assumptions to ensure they are reasonable and comprehensive to

fully account for the emissions generating activities and sources for the proposed action and any alternatives (if applicable). Ensure that all stationary sources that will be subject to CDPHE permitting are clearly identified in the inventory. All oil and gas development projects should submit supplemental drilling and completions schedules (e.g. equipment set movements, spatial operational times) to aid in analysis scenario formulation.

2. Is the project in a Nonattainment or Maintenance Area? If "yes", then contact the state office Air Resource Specialist(s) to perform a General Conformity Applicability Analysis and prepare the remainder of the project level analysis to incorporate into the NEPA document.

3. Does the project have maximum annual emissions of any criteria pollutant more than 2 tons per year? If "no", then dismiss air quality as an issue for further analysis since the project has no potential to significantly impact air resources. The basis for this assertion is predicated on the Colorado Air Quality Control Regulation 3.II.D.I, which exempts sources from Air Pollutant Emission Notice (APEN) submissions at emissions rates (uncontrolled actual levels) of less than 2 tons per year for attainment areas and 1 ton per year (NOx and VOC) for ozone non-attainment areas. Colorado regulators have deemed these sources to be negligible in terms of potential air resource impacts. Thus, BLM Colorado shall consider these sources to be of a similar nature for NEPA purposes. NEPA practitioners should incorporate the following language into the issues considered but eliminated from detailed analysis sections of the authorizing NEPA document:

> ***An emissions inventory was prepared for the proposed action (and any applicable alternatives) and provides the rationale for dismissing air quality as an issue to be carried forward for further analysis. The resulting inventories indicate that project criteria pollutant emissions would be less than 2 tons per year (or 1 ton per year in the non-attainment area) for each applicable pollutant. BLM Colorado has adopted the Colorado Department of Public Health and Environment's Air Pollution Emissions Notice (APEN) thresholds as the basis for which the BLM would not consider additional analysis when emissions are below the threshold. Sources or activities that emit less than the applicable APEN threshold level of pollutant on an annual basis are considered negligible for their potential to impact air quality.***

4. Is the project a piece of a larger project level authorization (e.g. a master development plan) or similar to another project that has previous NEPA analysis? If "yes", then confirm that the project parameters (e.g. location, distance to receptors) and emissions profile of the piece or project is consistent with the previous analysis, and that the analysis itself reflects the current standards, thresholds, and any targets from applicable or subsequent NEPA decisions. Briefly describe how the actions are similar and how the emissions have been fully accounted for in the referenced project. Then, tier to or incorporate by reference the analysis that describes the effects of the new piece or project.

5. Does the project have maximum annual emissions of any criteria pollutant in excess of the Colorado Modeling Guideline thresholds? If "no", then a qualitative or screening analysis may be sufficient to describe the environmental effects of the project. The Gridded Emissions Impact Tool and the EMIT can be utilized to complete the screening analysis. If "yes" to the question posed above, then a refined modeling analysis may be appropriate to describe the

environmental effects of the project. Note that depending on the circumstances of the project like duration, number of sources, and distance to receptors or Class I areas, a screening analysis may still be appropriate for the project. Additionally, NEPA practitioners should consider the nature of the project in terms of the No Action or any Connected Actions. In Colorado, it is often the case that a project will co-develop federal and non-federal resources, such that the federal authorization alone may not be significant in terms of air resource impacts, meaning they could occur anyway without the federal approval. Project level analyses need to adequately evaluate complex project scenarios to fully account for and appropriately disclose any potential federal impacts. The Gridded Emissions Impact Tool (discussed below) and the EMIT can be utilized to complete the screening analysis. The EMIT also contains analysis tools that can be utilized to complete a refined analysis. The User's Guide and Technical Support Document (linked below) provides instructions for running a refined analysis, as well as information on the appropriateness of such an analysis that NEPA practitioners can incorporate by reference into the authorizing NEPA document for the project analysis.

Note that any previously completed and “final” NEPA analysis that is published online (i.e. EPlanning) for a project similar to the subject proposed action can be tiered to for completing a new project-level assessment. As described for number 4 above, confirm that the project parameters (e.g. location, distance to receptors) and emissions profile of the subject proposed action is consistent with the completed analysis for the similar project, and that the analysis itself reflects the current standards, thresholds, and any targets from applicable or subsequent NEPA decisions. In situations where a Determination of NEPA Adequacy (DNA) is being used, include description for the previously completed NEPA analysis in the list of documents being tiered to for the DNA and provide rationale for applicability describing potential impacts for the subject proposed action (include any mitigation that may be required consistent with previously completed analysis).

3.4.2 Gridded Emissions Impacts Tool

The Gridded Near-Field Assessment Tool was formulated based on the results of the CARMMS 2.0 modeling study. The tool determines how much new federal and non-federal oil and gas emissions were modeled in the CARMMS "project domain" (the 4km grid cell where the new proposed action would be located and the adjacent grid-cells, encompassing up to 10km radius from the proposed project) for all projected future emissions scenarios (i.e. low, medium, and high). The tool also provides a range of corresponding modeled concentrations of ambient nitrogen dioxide, ozone, and particulate matter (less than 10 and 2.5 microns in diameter) for each scenario, along with federal oil and gas-specific source apportionment concentrations that contribute to the ambient concentrations. These data are useful for determining the relative contribution of federal oil and gas emissions to the cumulative concentrations modeled within the grid cells. Concentration data are also available criteria pollutants of lesser concern like carbon monoxide and sulfur dioxide. In addition to data specific to the project location, the tool also retrieves data for the modeled grid cell from each CARMMS scenario with the closest emissions greater than the project-specific emissions. The scenario with the lowest modeled impacts is used to represent the “project only” modeled emissions. These grid cells are the ones least influenced by neighboring grid cells, where higher neighboring emissions would influence adjacent cell concentrations beyond a project specific source estimate. They are used to determine the project’s contribution to the site-specific concentrations. There are a variety of factors that can affect the overall accuracy of this approach for describing project related impacts. However, as a screening assessment there is a high degree of conservatism in utilizing cumulative projected domain specific data to analyze project impacts, so long as the emissions are fully considered. As a first-tier approach for analysis, this method provides a fast and reliable way to allocate CARMMS gridded emissions and impacts for project tracking assessments at the near-field scale.

3.4.3 Emissions Modeling and Impacts Tool (EMIT)

The Emissions Modeling Impacts Tool (EMIT) is a web application designed to generate project specific emissions inventories and impacts analysis using a variety of estimation methods and regulatory tools. The EMIT is based on many years and iterations of emissions inventory tool development and NEPA analyses that have been widely used and accepted as regular practice. EMIT is primarily comprised of self-contained modules made up of sub-activities that logically group data entries to facilitate emissions estimates or the generation of analysis parameters. Modules exist for most authorized land management activities, and many of the sub-activities within each module allow users to populate form fields with default data sets. When feasible, default data were developed for specific geographical regions or another appropriate metric for the type of data being modeled. Many of the modules offer scalability to quickly allow users to model an individual project or an entire resource management plan. For a more detailed look at the EMIT application, please review the User's Guide and Technical Support Document.

4. Affected Environment: Statewide Air Quality Conditions and Emissions

In this chapter, air quality conditions and emissions throughout the state of Colorado are presented and serve as a foundation to characterize air quality at the field office level. Outdoor air quality data are available from the EPA here in an interactive web-based application.

4.1 National Emissions Inventory

The National Emissions Inventory (NEI) is a comprehensive and detailed estimate of air emissions of criteria pollutants, criteria precursors, and hazardous air pollutants. The NEI is released every three years based primarily upon data provided by State, Local, and Tribal air agencies for sources in their jurisdictions and supplemented by data developed by the EPA (EPA, 2020). The NEI includes emissions estimates for

Table 6. 2020 Colorado Statewide Criteria Air Pollutant Emissions (tpy) by Source.

Source	NH_3	CO	NOx	PM_{10}	$PM_{2.5}$	SOx	VOC
Agriculture	101,184	6,148	200	97,499	20,254	59	4,996
Commercial Cooking	-	1,895	-	4,963	4,610	-	678
Dust - Construction Dust	-	-	-	54,498	5,450	-	-
Dust - Paved Roads	-	-	-	8,064	2,016	-	-
Dust - Unpaved Roads Dust	-	-	-	66,130	6,530	-	-
Fires - Prescribed	71	4,299	60	438	371	33	1,014
Fires - Wildfire	30,256	1,850,393	19,390	183,007	155,091	12,114	434,929
Fuel Combustion - Residential	1,802	60,706	8,258	9,012	8,988	277	9,841
Industrial Processes – Oil and Gas Exploration and Production	0.01	23,585	16,907	114	112	31	68,819
Mobile - Locomotive	-	1,456	35	280	223	3	7,982
Mobile - Non-Road	4	1,302	6,072	156	152	5	250
Mobile - On-Road	32	238,618	11,083	1,570	1,476	14	17,827
Natural Sources (Biogenics)	1,525	269,131	44,381	3,196	1,382	157	20,501
Solvents	-	60,589	18,663	-	-	-	357,367
Waste Disposal	-	-		-	-	-	40,183
State Total	**135,034**	**2,521,310**	**125,267**	**430,092**	**207,714**	**12,731**	**967,305**
Oil and Gas % of State Total	**0.0%**	**0.9%**	**13.5%**	**0.0%**	**0.1%**	**0.3%**	**7.1%**
Wildfires % of State Total	**22.4%**	**73.3%**	**15.5%**	**42.6%**	**74.7%**	**95.2%**	**45.0%**

area, point, and mobile sources. Point sources include large industrial sources, usually with emissions over 100 tons per year., and New Source Performance Standard sources. Area emission sources are those that are too small or too numerous to be treated as point sources. Residential heating, agricultural dust, asphalt paving, solvent use, and oil and gas production are examples of area sources. Biogenic and event sources such as wildfires are also considered area sources but reported separately. Mobile sources include emissions from both on-road and non-road vehicles that use gasoline, diesel, and other fuels. On-road sources include cars, light and heavy-duty trucks, and motorcycles. Non-road sources include lawn and garden equipment, locomotives, airplanes, recreation vehicles, marine vessels and commercial engines. Area sources are collected using local demographic information, energy and agricultural data, and submitted inventories. Mobile data is calculated using vehicle miles traveled and mobile emissions factors from the EPA. The most recent version of the NEI contains data for 2020 with and interactive report and data available at https://www.epa.gov/air-emissions-inventories/2020-national-emissions-inventory-nei-data.

4.2 Criteria Pollutant Emissions

Table 6 contains the 2020 CAP emissions data by sector for the State of Colorado. The 2020 NEI inventory captures the 2020 wildfire season in Colorado, which had over 650,000 acres burned and three of the five largest fires in state history making it the Colorado's largest wildfire year on record. Wildfires accounted for most of the the state's emissions for CO (73%), $PM_{2.5}$ (75%), and SO_x (95%), and a considerable amount for NH (22%), PM_{10} (43%), NO_x (15%), and VOC (45%). Notably, wildfires were responsible for 300 to 400 times more CAP emissions than prescribed fires.

According to the 2020 NEI, Colorado oil and gas exploration and production is responsible for 13.5% of NO_x and 7.1% of VOC emissions statewide, and less than 1% of the remaining CAPs (Table 6). The 2020 NEI CAP data by field office are presented in Table 7 to serve as context and comparison to potential project-level emissions associated with BLM actions.

Table 7. 2020 NEI Colorado Criteria Air Pollutant Emissions (tpy) by Field Office.

Field Office	NH_3	CO	NOx	PM_{10}	$PM_{2.5}$	SOx	VOC
CRVFO	5,313	250,933	8,377	29,627	21,023	1,767	89,329
GJFO	1,854	35,186	3,234	6,212	2,538	165	22,455
KFO	14,217	834,416	9,374	86,493	69,223	5,086	210,664
LSFO	4,139	158,355	3,348	19,063	13,015	844	59,306
RGFO	96,551	1,158,813	89,308	254,644	94,165	4,685	425,372
SLVFO	3,781	12,792	2,380	8,937	1,865	18	24,655
TRFO	3,759	43,950	4,615	13,674	3,425	109	67,310
UFO	3,880	19,637	3,266	9,460	1,904	30	36,368
WRFO	1,539	7,229	1,367	1,980	556	29	31,846
TOTAL	**135,034**	**2,521,310**	**125,267**	**430,092**	**207,714**	**12,731**	**967,305**

Table 8. 2020 NEI Colorado Oil and Gas Criteria Air Pollutant Emissions (tpy) by Field Office.

Field Office	CO	NOx	PM_{10}	$PM_{2.5}$	SOx	VOC
CRVFO	1,332	1,387	27	27	8	6,309
GJFO	174	110	2	2	0.04	407
KFO	418	108	1	1	4	639
LSFO	421	265	3	3	0.16	1,596
RGFO	18,031	13,863	67	66	19	41,180
TRFO	2,551	610	2	2	0.13	251
UFO	31	33	0.45	0.45	0.01	12
WRFO	627	531	12	12	0.14	18,366
TOTAL	**23,585**	**16,907**	**114**	**112**	**31**	**68,759**

Note: Oil and Gas Exploration and Production produces less than 1 tpy of NH_3 statewide.

In Table 8, 2020 NEI CAP information for by field office is provided for additional context and comparison to the emissions information presented in Table 6 and Table 7. Most of the oil and gas emissions recorded in the 2020 NEI occurred in three field offices, CRVFO, RGFO, and WRFO (Table 8). These three field offices combined accounted for over 90% of VOC, NOx, and particulate matter emissions from the oil and gas sector in Colorado. Note that Table 8 contains federal and non-federal sources, and does not include downstream (e.g. combustion) emissions.

The 2020 NEI also provides estimates of yearly emissions information dating back to 2002 that allows for an analysis of statewide air pollution trends. Applying least-squares regression to the yearly data reveals total statewide emissions of NH_3, PM_{10}, and $PM_{2.5}$ increased by 75%, 25%, and 80%, respectively. However, there is considerable interannual variability in each due to wildfire emissions. In the same period, there has been a statistically significant decrease in emissions of NOx (64%) and SOx (92%). While both CO and VOC emissions peaked in 2020, there is no statistically significant trend in either due to high interannual variability driven by wildfire emissions.

4.3 Hazardous Air Pollutants

HAPs, also known as toxic air pollutants, are known or suspected to cause cancer or other serious health effects. Common HAPs emitted in the oil and gas industry include benzene, toluene, ethyl benzene, mixed xylenes, formaldehyde, normal-hexane, acetaldehyde, and methanol. Air toxics are released naturally and through human activities. Additionally, mixing of various chemicals in the air can lead to the formation of certain air toxics. Wildfires produce air toxics, such as methanol, formaldehyde, and acetaldehyde. The quantity of air toxics generated by wildfires fluctuates significantly from year to year. The CDPHE indicates that in 2020, wildfires produced 10 times more air toxics than in previous reporting year. As shown in Figure 1, HAP emissions in Colorado from wildfires exceeded that from human activities and all other natural sources combined. Other natural sources include plants and animals that produce air toxics. These are known as biogenic sources. For example, methanol, formaldehyde, and acetaldehyde are released from forests. Among human sources of Colorado HAP emissions, industry, which includes oil and gas exploration and production, accounts for 39% of anthropogenic HAP emissions (Figure 2). Fossil-fuel use is the primary driver of the mobile emissions displayed in Figure 2. The 2020 NEI HAP emissions for each field office is provided in Table 9 and can be used to contextualize project level emissions. Overall, 4.7% of the 2020 NEI HAP emissions in Colorado were from oil and gas exploration and production. The oil and gas emissions for each field office are provided in Table 10. Note that Table 10 contains federal and non-federal sources, and does not include downstream (e.g. combustion) emissions.

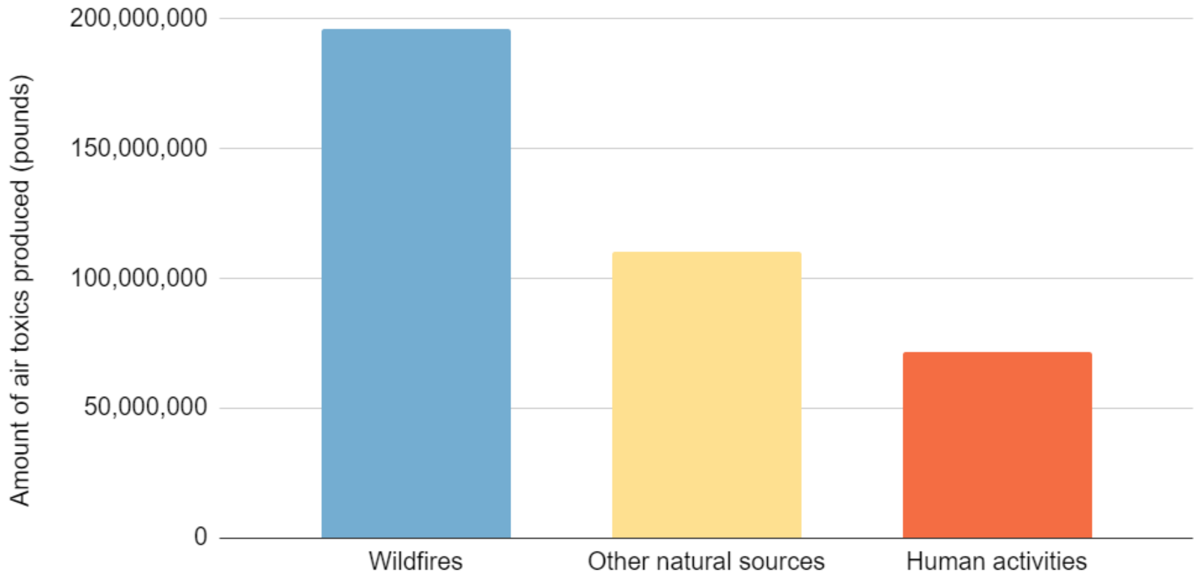

Figure 1. Natural vs Human Sources of Colorado HAP emissions. Source: CDPHE

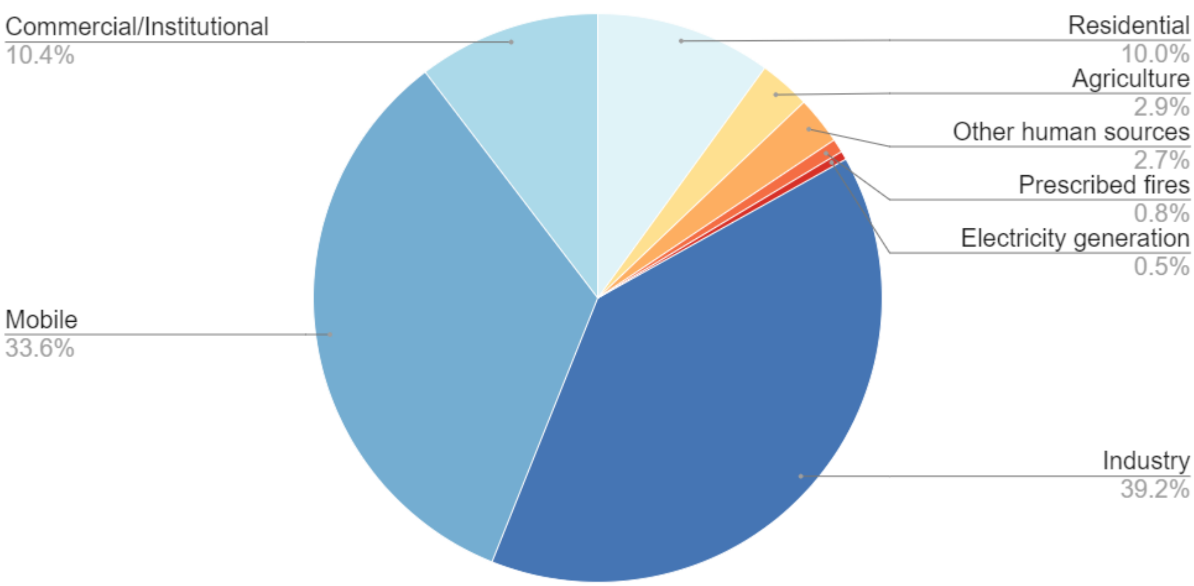

Figure 2. Human Sources of HAPs in Colorado. Source: CDPHE.

Table 9. 2020 NEI Colorado HAPs (tpy) by Field Office.

Field Office	Acetaldehyde	Benzene	Ethylbenzene	Formaldehyde	Hexane	Methanol	Naphthalene	Toluene	Xylenes
CRVFO	2,548	641	31	4,961	188	6,488	594	602	460
GJFO	510	88	23	817	38	1,896	62	184	121
KFO	6,066	1,581	18	11,948	180	14,256	1,692	1,276	1,070
LSFO	1,396	293	10	2,542	73	4,588	283	262	219
RGFO	10,453	2,739	677	18,554	1,559	32,363	1,772	5,343	3,547
SLVFO	459	27	15	626	14	2,227	8	80	54
TRFO	1,153	98	57	1,808	43	4,689	45	284	213
UFO	623	44	23	861	24	2,806	13	135	86
WRFO	643	218	11	1,058	494	1,447	10	164	143
TOTAL	**23,851**	**5,727**	**865**	**43,175**	**2,614**	**70,760**	**4,478**	**8,330**	**5,912**

Table 10. 2020 NEI Colorado Oil and Gas HAPs (tpy) by Field Office.

Field Office	Acetaldehyde	Benzene	Ethylbenzene	Formaldehyde	Hexane	Methanol	Naphthalene	Toluene	Xylenes
CRVFO	115	65	5	401	103	43	1	47	17
GJFO	7	6	0	37	5	5	0	4	4
KFO	1	1	0	6	0	1	0	0	0
LSFO	24	20	1	68	36	7	0	14	19
RGFO	741	399	12	2,595	650	298	10	258	108
SLVFO	0	0	0	0	0	0	0	0	0
TRFO	7	4	0	41	2	6	0	2	0
UFO	0	0	0	3	0	0	0	0	0
WRFO	376	204	8	674	490	41	0	141	126
TOTAL	**1,271**	**700**	**27**	**3,825**	**1,287**	**401**	**11**	**466**	**274**
Oil and Gas % of State Total	**5.3%**	**12.2%**	**3.1%**	**8.9%**	**49.2%**	**0.6%**	**0.2%**	**5.6%**	**4.6%**

4.4 Air Quality Index

The Air Quality Index (AQI) is a standardized measurement used to communicate how clean or polluted the air is in a specific location. It is based on several major CAPs regulated by environmental, including ground-level ozone, particulate matter ($PM_{2.5}$ and PM_{10}), carbon monoxide, sulfur dioxide, and nitrogen dioxide. The AQI typically ranges from 0 to 500, with higher values indicating poorer air quality.

The AQI helps individuals and communities understand the potential health effects associated with different pollution levels, providing guidance on protective measures, especially for vulnerable populations, during periods of poor air quality. The EPA calculates a daily AQI based on local air monitoring data. The terms "Good", "Moderate", and "Unhealthy" help to interpret the AQI. When the AQI value is in the good range, pollutant concentrations are well below the NAAQS and air pollution poses little or no risk. Moderate AQI values occur when pollution is below but near the NAAQS and voluntary emission reduction measures are encouraged. The AQI is considered unhealthy when the NAAQS is exceeded, and major pollution sources are often required to implement mandatory emission reduction measures. Counties without AQI data usually have fewer air pollutant sources and are assumed to have good air quality.

Summary AQI data for Colorado from 2020 to 2022 were obtained from the EPA Air Quality Index Summary Report are provided in Table 11. Information for border counties in Utah (Uintah) and Wyoming (Sweetwater) is provided because they both have sizable fossil-fuel production and there is a marginal NAA for ozone within the Uinta Basin below 6,250 feet in elevation. The AQI data examined in this report can be obtained from the EPA Air Quality Index Summary Report. The data in Table 11 show that air quality varies considerably across the state, with the highest frequency of good AQI days in the rural and mountain regions of the state, while the lowest frequency of good AQI days is found in the metro areas of the Front Range which are within the RGFO.

Table 11. AQI Index Summary Statistics by County.

2020-2022			Percentage of Days Rated			
County	Field Office	# Days with AQI	Good	Moderate	Unhealthy for Sensitive Groups	Unhealthy
Adams	RGFO	1096	57%	38%	4%	0%
Alamosa	SLVFO	355	97%	3%	1%	0%
Arapahoe	RGFO	1096	65%	30%	5%	0%
Archuleta	TRFO	1095	81%	19%	0%	0%
Boulder	RGFO	1096	61%	33%	5%	0%
Clear Creek	RGFO	904	67%	31%	2%	0%
Delta	UFO	873	86%	13%	0%	0%
Denver	RGFO	1096	50%	44%	5%	0%
Douglas	RGFO	1084	65%	28%	6%	1%
El Paso	RGFO	1096	68%	28%	3%	0%
Fremont	RGFO	221	98%	2%	0%	0%
Garfield	CRVFO	1095	75%	24%	1%	0%
Gilpin	RGFO	1085	75%	22%	3%	0%
Gunnison	UFO	1060	82%	18%	0%	0%
Jackson	KFO	433	93%	7%	0%	0%
Jefferson	RGFO	1096	63%	27%	9%	1%

La Plata	TRFO	1095	73%	26%	1%	0%
Larimer	RGFO	1096	58%	37%	5%	0%
Mesa	GJFO	1096	81%	19%	1%	0%
Montezuma	TRFO	1096	81%	19%	0%	0%
Pitkin	CRVFO	364	97%	3%	0%	0%
Prowers	RGFO	1065	94%	5%	0%	0%
Pueblo	RGFO	665	94%	5%	1%	0%
Rio Blanco	WRFO	1095	76%	23%	1%	0%
Routt	LSFO	1068	99%	1%	0%	0%
San Juan	TRFO	357	98%	2%	0%	0%
San Miguel	TRFO	355	98%	2%	0%	0%
Weld	RGFO	1096	57%	38%	5%	0%
Sweetwater (Wyoming)	-	1096	57%	38%	4%	0%
Uintah (Utah)	-	1096	67%	32%	1%	0%

4.5 Air Quality Design Values

A design value is a statistic describing the air quality status of a given location relative to the NAAQS. Design values are computed and published annually by EPA with the most recently data available here and through an interactive map. As with AQI, counties without design value values typically have fewer air pollutant sources and good air quality.

The $PM_{2.5}$, NO_2, and O_3 design values for Colorado are presented in Table 12, Table 13, Table 14, Table 15 and Table 16. Design values for CO, SOx, and Pb are well below the NAAQS. The design value for PM_{10} is expressed as the number of days per year with PM_{10} exceeding 150 $\mu g/m^3$. Across Colorado, this ranges from 0 days to several days per year. Ozone design values exceed the NAAQS in northern Front Range counties comprising the Denver Metro/North Front Range (DMNFR) ozone NAA. On October 7, 2022, the EPA finalized a rule that redesignated the Denver Metro/North Front Range (DMNFR) ozone nonattainment area from “serious” to “severe” for the 2008 ozone NAAQS. The rule went into effect on November 7, 2022, triggering a one-year period for affected facilities to evaluate and confirm compliance. The ozone design values for the CRVFO, TRFO, UFO, and WRFO range from about 92% to 94% of the NAAQS (Table 16).

Table 12. County-level Design Value History for the PM2.5 Annual NAAQS (12 µg/m^3).

County	Field Office	2016-2018	2017-2019	2018-2020	2019-2021	2020-2022
Adams	RGFO	N/A	9.6	N/A	N/A	N/A
Arapahoe	RGFO	6.0	6.1	6.1	6.4	6.1
Boulder	RGFO	7.0	7.2	8.1	9.0	8.7
Denver	RGFO	9.2	9.4	9.9	10.2	9.3
Douglas	RGFO	6.2	6.6	6.9	7.0	6.7
El Paso	RGFO	6.0	5.7	5.7	5.6	5.5
Larimer	RGFO	7.3	7.0	7.2	7.5	7.7
Mesa	GJFO	5.9	5.5	5.7	5.8	5.8
Pueblo	RGFO	5.5	5.5	N/A	N/A	N/A
Rio Blanco	WRFO	7.9	8.0	8.3	8.6	8.5
Weld	RGFO	9.1	9.1	9.5	9.5	8.8

Table 13. County-level Design Value History for the $PM_{2.5}$ 24-hour NAAQS (35 µg/m^3). Shaded cells indicate levels above the NAAQS.

County	Field Office	2016-2018	2017-2019	2018-2020	2019-2021	2020-2022
Adams	RGFO	-	25	-	-	-
Arapahoe	RGFO	17	22	24	25	20
Boulder	RGFO	25	28	39	47	44
Denver	RGFO	24	25	28	30	26
Douglas	RGFO	25	30	35	36	34
El Paso	RGFO	15	15	17	18	18
Larimer	RGFO	19	19	29	32	31
Mesa	GJFO	17	16	17	18	18
Pueblo	RGFO	14	13	-	-	-
Rio Blanco	WRFO	16	16	19	20	21
Weld	RGFO	24	24	29	31	30

Table 14. County-level Design Value History for the NO_2 1-hour NAAQS (100 ppb).

County	Field Office	2016-2018	2017-2019	2018-2020	2019-2021	2020-2022
Adams	RGFO	60	60	60	58	56
Archuleta	TRFO	N/A	N/A	15	15	15
Denver	RGFO	70	69	70	70	68
Jefferson	RGFO	N/A	N/A	N/A	26	25
La Plata	TRFO	8	N/A	N/A	N/A	7
Rio Blanco	WRFO	18	22	25	24	20

Table 15. County-level Design Value History for the NO_2 Annual NAAQS (53 ppb).

County	Field Office	2016-2018	2017-2019	2018-2020	2019-2021	2020-2022
Adams	RGFO	16	17	16	15	17
Archuleta	TRFO	2	2	3	3	2
Denver	RGFO	27	27	25	26	24
Jefferson	RGFO	N/A	4	2	3	3
La Plata	TRFO	5	5	5	5	4
Rio Blanco	WRFO	2	3	2	2	1
Weld	RGFO	N/A	N/A	N/A	6	8

Table 16. County-level Design Value History for the Ozone 8-Hour NAAQS (0.070 ppm). Shaded cells indicate levels above the NAAQS.

County	Field Office	2016-2018	2017-2019	2018-2020	2019-2021	2020-2022
Adams	RGFO	0.067	0.065	0.069	0.072	0.077
Arapahoe	RGFO	0.073	0.074	0.077	0.080	0.080
Archuleta	TRFO	N/A	N/A	N/A	N/A	0.064
Boulder	RGFO	N/A	0.073	0.074	0.075	0.076
Denver	RGFO	0.069	0.068	0.071	0.075	0.077
Douglas	RGFO	0.078	0.078	0.081	0.083	0.083
El Paso	RGFO	0.069	0.068	0.071	0.073	0.074
Garfield	CRVFO	0.061	0.060	0.061	0.061	0.062
Gilpin	RGFO	N/A	N/A	N/A	0.074	0.076
Gunnison	UFO	0.065	0.066	0.067	0.065	0.065
Jefferson	RGFO	0.079	0.076	0.080	0.083	0.084
La Plata	TRFO	0.069	N/A	N/A	N/A	0.066
Larimer	RGFO	0.077	0.075	0.075	0.077	0.077
Mesa	GJFO	0.065	0.065	0.065	0.065	0.065
Montezuma	TRFO	0.068	0.067	0.068	0.066	0.066
Rio Blanco	WRFO	0.064	0.065	0.065	0.066	0.065
Weld	RGFO	0.070	0.070	0.070	0.071	0.072

4.6 Air Quality Related Values

In this section, the most recent AQRV information on visibility and deposition is presented. For background information on each, including a description of the IMPROVE network, refer to Section 2.7 Air Quality Related Values (AQRVs) in this report.

4.6.1 Visibility

There are eight IMPROVE visibility monitoring locations within Colorado that have at least nine years of data (Table 17). The IMPROVE monitors are used to assess current visibility and aerosol conditions in Class I areas; identify chemical species and emission sources responsible for anthropogenic visibility impairment; document long-term trends in visibility; and provide regional haze monitoring representing all visibility-protected federal Class I areas. A list of Class I areas in Colorado and representative IMPROVE monitors is provided in Table 3 of this report. Note that the Great Sand Dunes (GRSA1), Mesa Verde (MEVE1) and Weminuche Wilderness (WEMI1) locations were established at the beginning of the IMPROVE program, giving each the longest period of observation in the network at 35 years. The period of observation at the Rocky Mountain (ROMO1) is just two years shorter and nearly 30 years of data are available from the Mount Zirkel (MOZI1) location. The relatively long period of observation and good geographic coverage of IMPROVE sites provides for a good assessment of Colorado visibility following CAA amendments of 1990.

Visibility trends for Colorado IMPROVE locations are presented in Figure 3 through Figure 10. At each location, there are annual visibility (dv) data for the haziest, clearest, and most impaired days. Following the most recent RHR guidance, progress towards CAA visibility goals is demonstrated by improvement on the most impaired days. The haziest days are no longer used in a regulatory context but are provided for comparison to the new RHR metric, most impaired days. The CAA goal for the clearest days is simply no degradation from the 2000-2004 baseline clearest days. Nearly all sites in the network are meeting that requirement. However, there is no regulatory requirement for these locations to approach natural conditions on the clearest days. A summary of visibility trends (dv/year) for each location is presented in Table 18.

Table 17. List of IMPROVE Monitors in Colorado.

IMPROVE Site	Name	Field Office	Period of Record
FLTO1	Flat Tops	WRFO	2012 – 2020
GRSA1	Great Sand Dunes NP	SLVFO	1989 – present
MEVE1	Mesa Verde NP	TRFO	1989 – present
MOZI1	Mount Zirkel	KFO	1995 – present
ROMO1	Rocky Mountain NP	RGFO	1991 – present
SHMI1	Shamrock Mine	TRFO	2005 – 2021
WEMI1	Weminuche Wilderness	TRFO	1989 – present
WHRI1	White River NF	CRVFO	2001 – present

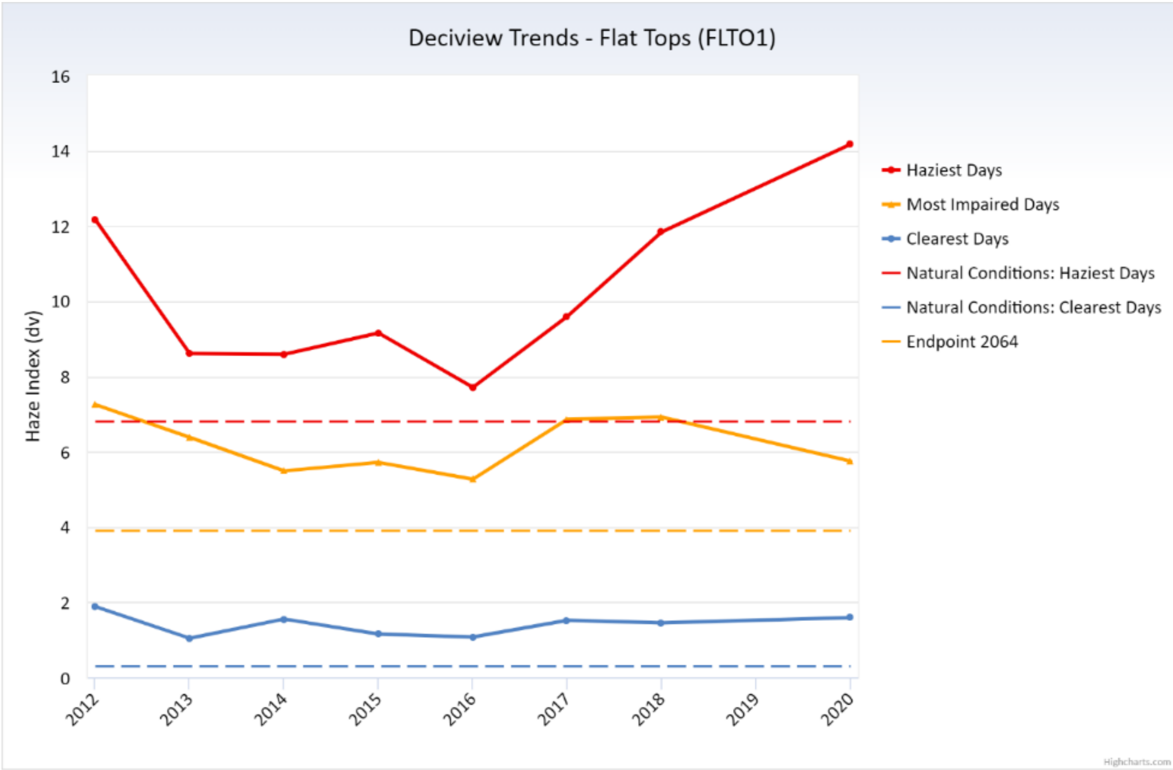

Figure 3. Visibility Trends at Flat Tops (FLTO1).

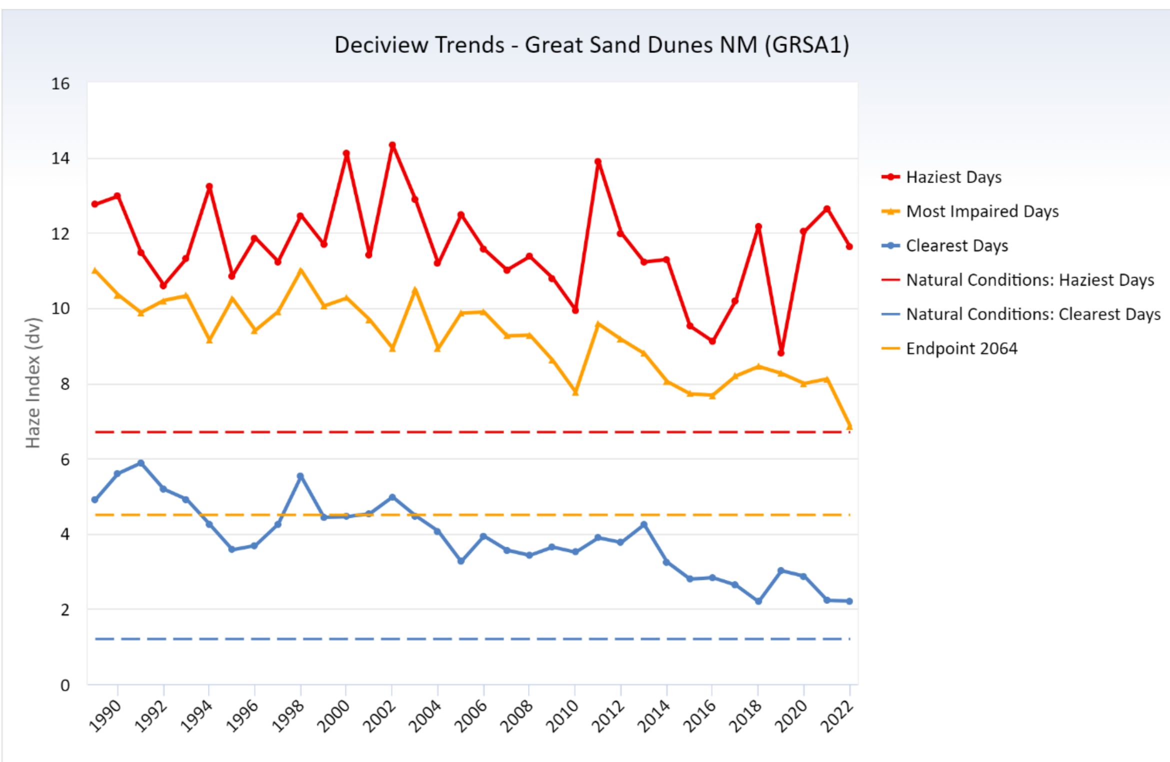

Figure 4. Visibility Trends at Great Sand Dunes NP (GRSA1).

The short period of record (2012-2020) at the Flat Tops (FLTO1) location precludes any determination of trends, but it still allows for an assessment of prevailing conditions in the WRFO and the mountains of western Colorado more broadly. As with most IMPROVE sites in the western United States, there is large interannual variability in the haziest days at the FLTO1 location (Figure 3) due to wildfire smoke. Observed visibility on the clearest days is only slightly above natural conditions and the low haze index for clearest and most impaired days reveals that background visibility at the FLTO1 location is good.

At the Great Sand Dunes (GRSA1) location (Figure 4) there has been a statistically significant trend ($\rho < 0.01$) trend towards improved visibility on the most impaired (anthropogenic) and clearest days. For both, the observed trend is -0.09 dv/year resulting in a decrease of about 3 dv over the period of observation. The visibility trend for most impaired days at Great Sand Dunes demonstrates steady progress towards RHR 2064 endpoints.

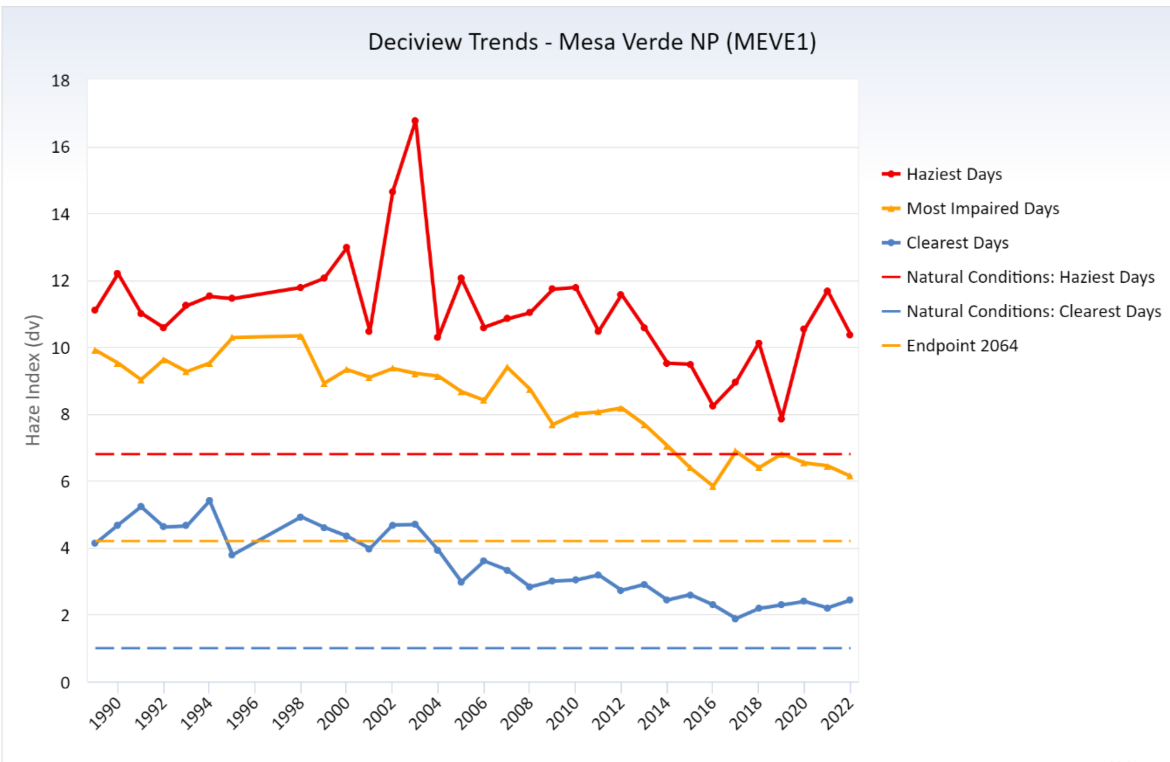

Figure 5. Visibility Trends at Mesa Verde NP (MEVI1).

There has been statistically significant improvement observed in each of the three haze categories at the Mesa Verde NP (Figure 5). Monitoring at Mesa Verde (MEVI1) extends back to 1989 making it among the longest established monitors within the IMPROVE network. Since 1989, the haze index on the most impaired days decreased by 0.12 dv/year, resulting in a decrease over 4 dv for the period of observation. The trend for the clearest days indicates steady improvement towards natural conditions by 2064, while the trend for most impaired days demonstrates progress towards the 2064 endpoint established in the latest RHR guidance. Overall visibility at Mesa Verde NP is good, improving, and representative of prevailing conditions and trends in southwestern Colorado.

Visibility improved on the clearest and most impaired days at the Mount Zirkel (MOZI1) location, with a decrease of about 0.13 dv/year in the most impaired days over the period of record. During the best visibility years, the clearest days have approached natural conditions at MOZI1 location (Figure 6). Notably, the haze index on the clearest and most impaired days at MOZI1 is among the lowest in Colorado with only the WHRI site commonly observing lower haze indices. The trend for most impaired days at the MOZI1 site indicates steady improvement towards the 2064 endpoint set forth by the latest RHR guidance.

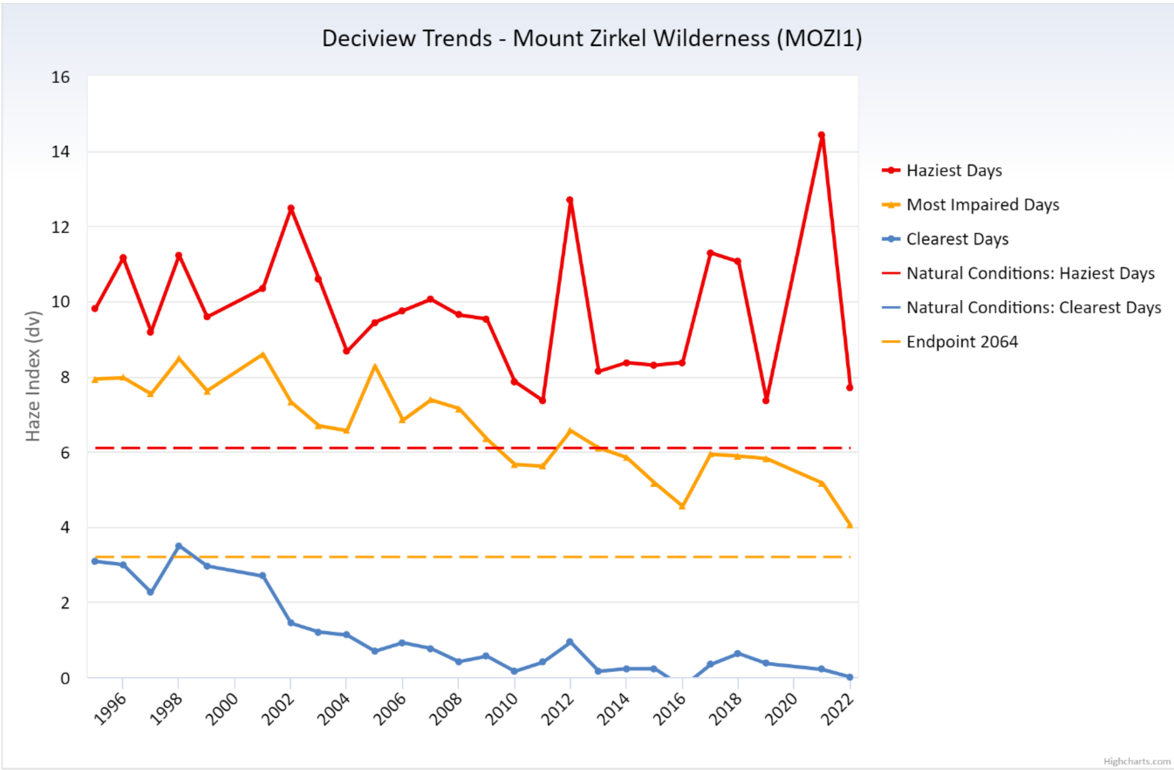

Figure 6. Visibility Trends at Mount Zirkel Wilderness (MOZI1).

At Rocky Mountain National Park (ROMO1), visibility monitoring has been conducted since 1991 with steady improvement on the clearest and most impaired days (Figure 7). The haze index for the most impaired days decreased by about 0.14 dv/year since 1991, resulting in approximately 4.5 dv improvement. Visibility on the haziest days improved slightly at the ROMO1 location, but this countered by the high wildfire smoke experienced in 2020 and 2021. Nevertheless, the long-term record at ROMO1 shows that overall visibility has improved with the visibility on the most impaired days demonstrating progress towards the 2064 endpoint established in the latest RHR guidance.

Visibility at the Shamrock Mine (SHMI1) location in southwestern Colorado has improved on the clearest and most impaired days (Figure 8). Note there are no data available for 2022 at SHMI1.

Visibility monitoring dates to 1989 at the Weminuche Wilderness (WEMI1) location making it one of the longest established IMPROVE monitors. Since 1989, the haze index for the most impaired days decreased by about 0.10 dv per year (Figure 9). Visibility on the clearest days is only slightly above natural conditions with some of the lowest haze index values within Colorado. The steady trend towards the 2064 endpoint for most impaired days demonstrates progress in meeting RHR visibility goals for the WEMI1 location.

The White River NF (WHRI1) IMPROVE monitor (Figure 10), which is broadly representative of the western Colorado mountains, shows improvement in visibility on the clearest and most impaired days dating back to 2001. Prevailing visibility at WHRI1 is generally the best in Colorado with only the MOZI1 site typically observing such low haze indices.

Collectively, the IMPROVE monitors across Colorado display a common pattern with statistically significant improvement in visibility on the clearest and most impaired days at each location (Table 18). The trend towards improved visibility on the most impaired days at all locations shows that Colorado Class I areas are making solid progress towards RHR goals. At all locations, wildfire smoke episodes have led to some of the haziest conditions ever recorded. However, the clearest days currently observed are better than at any time in the period of record, and most impaired days are trending towards the 2064 endpoint goal. This highlights the strong improvements in visibility owed to the CAA and RHR, while also demonstrating the challenge of managing and mitigating smoke impacts in an era of increasing wildfire frequency and intensity.

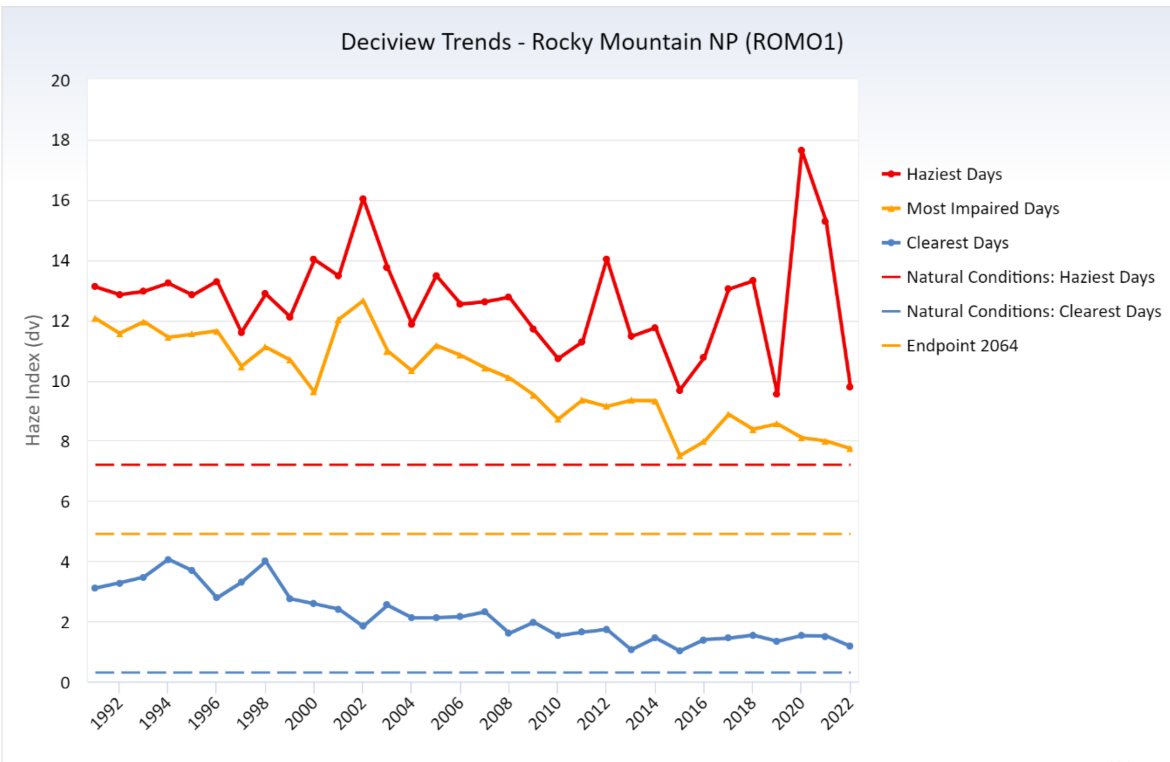

Figure 7. Visibility Trends at Rocky Mountain NP (ROMO1).

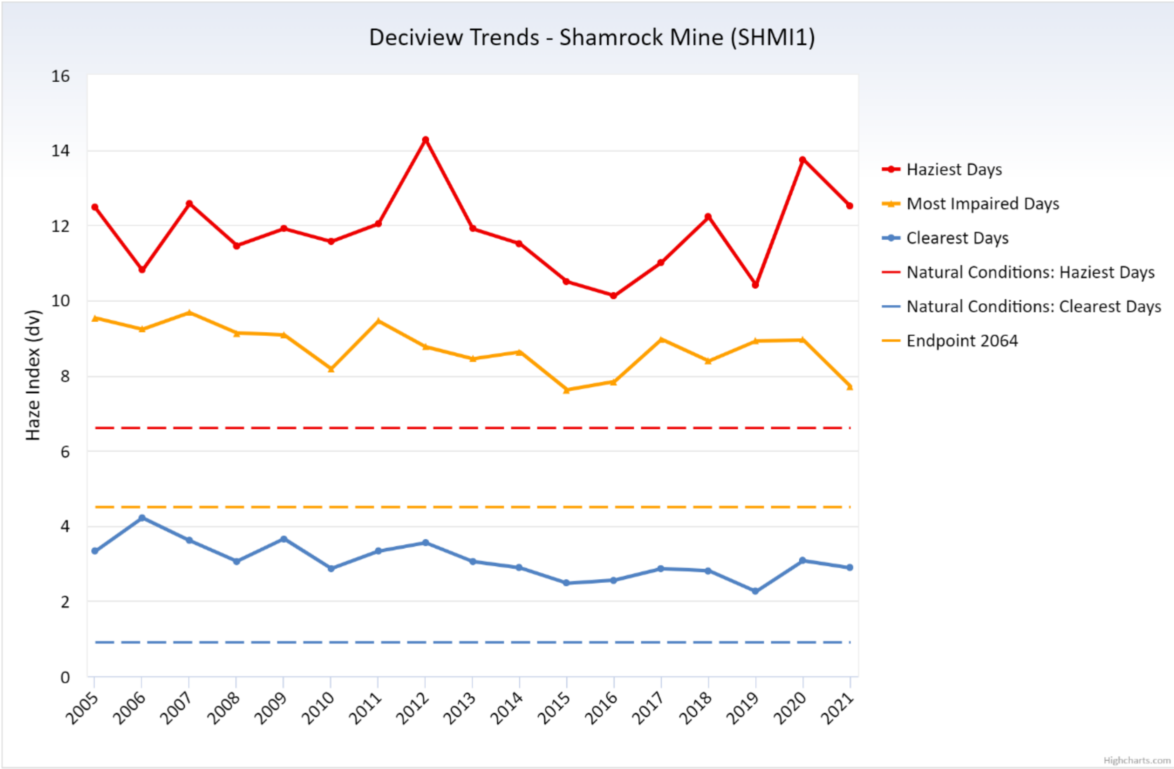

Figure 8. Visibility Trends at Shamrock Mine1 (SHMI1).

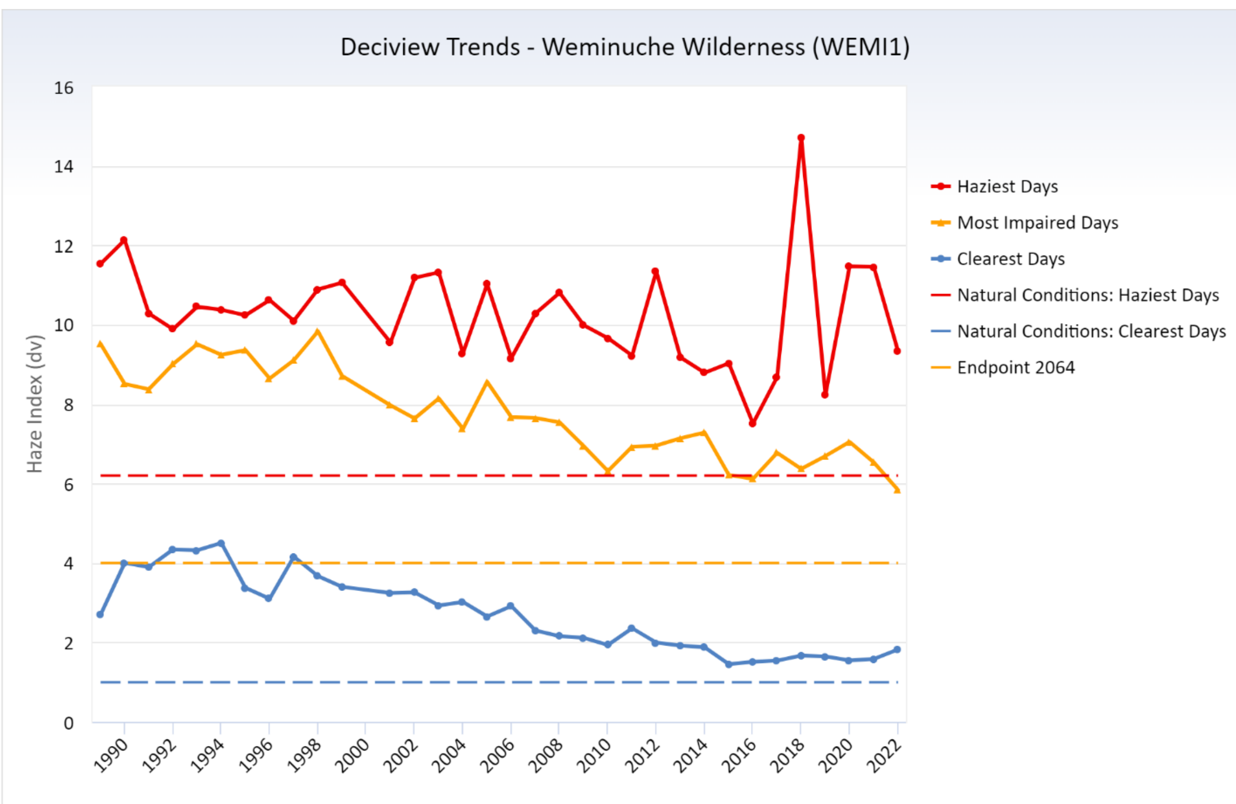

Figure 9. Visibility Trends at Weminuche Wilderness (WEMI1).

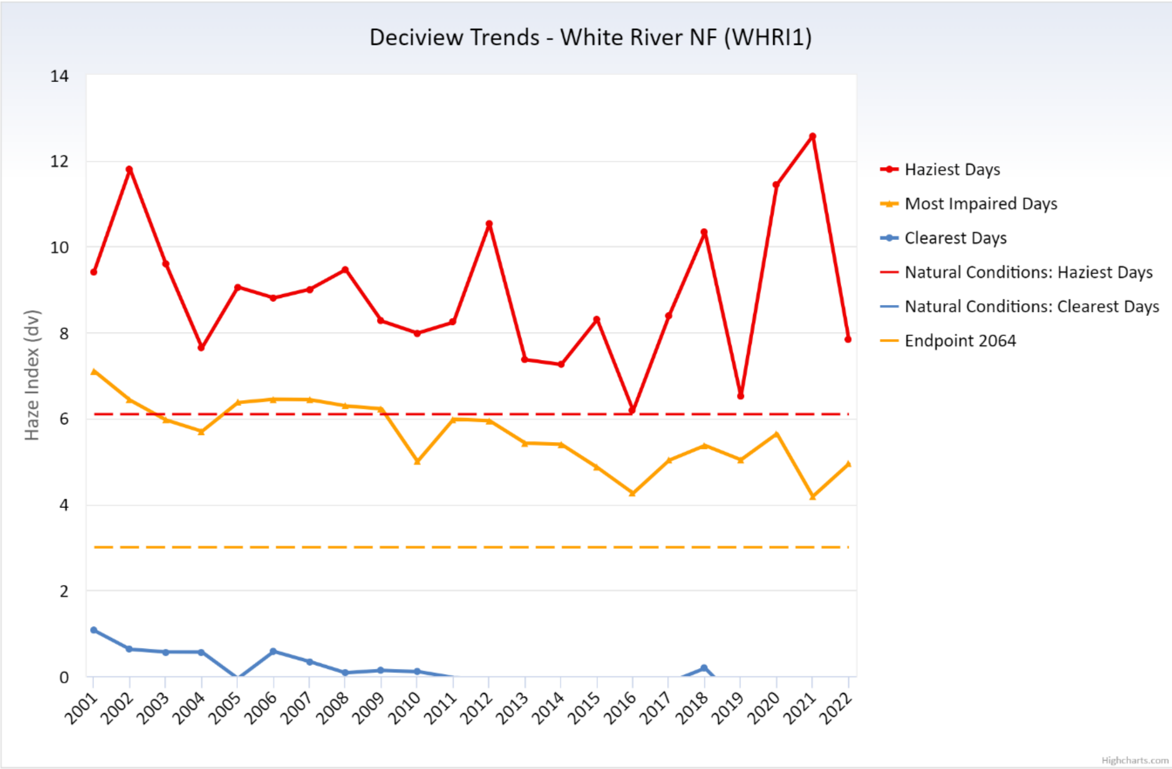

Figure 10. Visibility Trends at White River NF (WHRI1).

Table 18. Summary of Colorado Visibility Trends (dv/year). Shaded cells indicate a statistically significant trend (ρ < 0.05).

IMPROVE Site	Period	Clearest Days	Most Impaired Days	Haziest Days
GRSA1	1989 – 2022	-0.09	-0.09	-0.037
FLTO1	2012 – 2020	N/A	N/A	N/A
MEVE1	1989 – 2022	-0.10	-0.12	-0.06
MOZI1	1995 – 2022	-0.11	-0.13	-0.08
ROMO1	1991 – 2022	-0.08	-0.14	-0.05
SHMI1	2005 – 2021	-0.07	-0.07	-0.02
WEMI1	1989 – 2022	-0.09	-0.10	-0.05
WHRI1	2001 – 2022	-0.06	-0.10	-0.07

Source: Federal Land Manager Environmental Database Note: Data rounded to hundredths place.

4.6.2 Deposition and Park Conditions

Atmospheric deposition occurs when gaseous and particulate air pollutants are deposited on the ground, water bodies or vegetation. The pollutants may settle as dust or be washed from the atmosphere in rain, fog, or snow. When air pollutants such as sulfur and nitrogen are deposited into ecosystems, they may cause acidification, or enrichment of soils and surface waters. Atmospheric nitrogen and sulfur deposition may affect water chemistry, resulting in impacts to aquatic vegetation, invertebrate communities, amphibians, and fish. Deposition can also cause chemical changes in soils that alter soil microorganisms, plants, and trees. Excess nitrogen from atmospheric deposition can stress ecosystems by favoring some plant species and inhibiting the growth of others.

To assess deposition impacts, critical loads (also discussed in Section 2.7.1 Deposition) can be compared to observed deposition amounts. A "critical load" is the amount of pollution that leads to harmful changes in an ecosystem and is usually expressed as kilograms per hectare per year (kg N ha^{-1} yr^{-1}) of wet or total (wet and dry) deposition. Critical loads can be used to assess responses to nitrogen and sulfur deposition, including changes in aquatic and terrestrial plant diversity, soil nutrient levels, or fish health. Critical loads vary considerably because some ecosystem components are more sensitive than others. Epiphytic lichen will typically have low critical load values, as they are often the first thing to respond to increased pollution and they acquire all their nutrients from the atmosphere. On the other hand, many soils have high critical loads, because their structure helps them buffer the impacts of deposition, so they can sustain more cumulative deposition before they begin to change. When critical loads are exceeded, the environmental effects can cascade and impact ecosystem services. For the alpine environment of Rocky Mountain National Park, (Bowman, Murgel, Blett, & Porter, 2012) recommend N critical loads less than 10 kg N ha^{-1} yr^{-1} to prevent future acidification of soils and surface waters and less than 3 kg N ha^{-1} yr^{-1} for vegetation to protect natural plant communities and ecosystem services in the park.

The EPA's Clean Air Status and Trends Network (CASTNET) is a long-term environmental monitoring network with 95 sites located throughout the United States and Canada. CASTNET is managed and operated by the U.S. Environmental Protection Agency (EPA) in cooperation with the National Park Service (NPS); Bureau of Land Management, Wyoming State Office (BLM); and other federal, state, and local partners including six Native American tribes that operate CASTNET sites on tribal lands. The network was established under the 1991 CAA Amendments to assess the trends in acidic deposition due to emission reduction programs. CASTNET is the only network in the United States that provides a consistent, long-term data record of acidic dry deposition fluxes. CASTNET complements the National Atmospheric Deposition Program's (NADP's) National Trends Network (NTN). The NTN is considered the nation's primary source of wet deposition data and provides weekly wet deposition fluxes at more than 250 sites across the contiguous United States, Canada, Alaska, Puerto Rico, and the U.S. Virgin Islands. Nearly all CASTNET sites are collocated with or near an NTN site. Together, these two monitoring programs provide data necessary to estimate long-term temporal and spatial trends in total deposition (dry and wet) as well as ecosystem health.

As of November 2023, there are 21 active NTN sites in Colorado, with one other – Sunlight Peak – decommissioned in 2022 (Table 19). In addition, there are four active CASTNET locations in Colorado: One each in Gothic (GTH161) and Mesa Verde NP (MEV405), and two in Rocky Mountain NP (ROM206, ROM406). Additional stations at Dinosaur National Monument (DIN431) and Canyonlands NP (CAN407) in Utah may be representative of conditions in western Colorado, while central Wyoming's Centennial (CNT169) site is just north of the Colorado border.

The NTN data show that nitrogen deposition in Colorado is generally low compared to the critical loads recommended by (Bowman, Murgel, Blett, & Porter, 2012) and as such, unlikely to result in widespread degradation to soil, vegetation, or water. However, some species and ecosystems are more sensitive to nitrogen deposition, thus conditions for individual ecosystem components may indicate potential ecosystem harm.

Trends in nitrogen deposition are difficult to assess because there are many years with incomplete data for most NTN sites shown in Table 19. For sites with adequate data available over the entire period of record, nitrogen deposition has largely remained unchanged throughout the observational period. However, at the Alamosa, Las Animas Fish Hatchery, and Rocky Mountain National Park-Beaver Meadows locations, recent nitrogen deposition values have trended slightly higher. At each of the four active CASTNET stations in Colorado, nitrogen deposition has generally remained unchanged throughout the period of record.

The NPS also monitors and evaluates deposition and overall air quality to determine parks most at risk and where conditions are declining or improving. Park specific information can be found at the NPS Air Quality Conditions and Trends webpage. The NPS provides a rationale for each park's rating that considers a wide range of factors including ecosystem sensitivity to deposition, ozone risk to vegetation, visibility trends, etc. Accordingly, this information may be more holistic and indicative of AQRVs than strict quantitative metrics such as AQI or design values.

Table 19. Colorado National Trends Network (NTN) Sites.

Site ID	Site Name	County	Field Office	Start Year	2021 Nitrogen Deposition (kg ha^{-1})	2022 Nitrogen Deposition (kg ha^{-1})
CO00	Alamosa	Alamosa	SLVFO	1980	1.13	1.31
CO01	Las Animas Fish Hatchery	Bent	RGFO	1983	3.03	2.99
CO02	Niwot Saddle	Boulder	RGFO	1984	2.46	1.55
CO08	Four Mile Park	Garfield	CRVFO	1987	1.99	1.52
CO09	Kawuneechee Meadow	Grand	KFO	2012	N/A	N/A
CO10	Gothic	Gunnison	UFO	1999	1.51	1.31
CO15	Sand Spring	Moffat	LSFO	1979	1.23	N/A
CO19	Rocky Mountain National Park-Beaver Meadows	Larimer	RGFO	1980	2.59	2.38
CO21	Manitou	Teller	RGFO	1978	1.67	N/A
CO22	Pawnee	Weld	RGFO	1979	N/A	N/A
CO80	Akron 4E	Washington	RGFO	2022	N/A	N/A
CO81	Missile Site Park	Weld	RGFO	2020	3.19	3.41
CO82	Orchard	Weld	RGFO	2021	N/A	N/A
CO90	Niwot Ridge-Southeast	Boulder	RGFO	2006	3.04	N/A
CO91	Wolf Creek Pass	Mineral	TRFO	1992	N/A	2.31
CO93	Buffalo Pass - Dry Lake	Routt	LSFO	1986	1.53	N/A
CO94	Sugarloaf	Boulder	RGFO	1986	2.43	3.06
CO96	Molas Pass	San Juan	TRFO	1986	N/A	N/A
CO97	Buffalo Pass - Summit Lake	Routt	LSFO	1984	2.43	N/A
CO98	Rocky Mountain National Park-Loch Vale	Larimer	RGFO	1983	3.99	2.38
CO99	Mesa Verde National Park-Chapin Mesa	Montezuma	TRFO	1981	1.87	1.61
CO92	Sunlight Peak	Garfield	CRVFO	1988	2.00	N/A

4.7 Greenhouse Gas Emissions

In this section, a summary of Colorado specific information contained in the Annual GHG report is presented along with GHG data and trends pertaining to Colorado's GHG reduction goals.

4.7.1 State, National, and Global GHG Emissions

Global emissions were obtained from the Emissions Database for Global Atmospheric Research (EDGAR), release EDGAR v8.0_GHG (1970 - 2022) of October 2023. The United States GHG emissions comes from The EPA Inventory of US Greenhouse Gases Emission and Sinks 1990-2021 (EPA, 2023). The fossil fuel contribution from the United States is reported in the Annual GHG report. Colorado state GHG data are available from the 2021 Colorado GHG Reduction Roadmap. Note that GHG emissions information may vary between sources though differences are generally only a few percent.

Table 20 indicates that 2022 global GHG emissions increased by 61.7% and 27.1% since 1990 and 2005, respectively. In contrast, 2021 United States GHG emissions decreased by 2.3% since 1990, and by 15.3% since 2005. In Colorado, GHG emissions decreased by 13.7% from 2005 to 2020. The impact of the COVID-19 pandemic can be seen in the GHG emissions decrease from 2019 to 2020 at the world, country, and state level. Globally, the use of all fossil fuels and the CO_2 emissions associated with the combustion of these fuels continue to rise. Figure 11 shows global CO_2 emissions from total fossil fuel consumption.

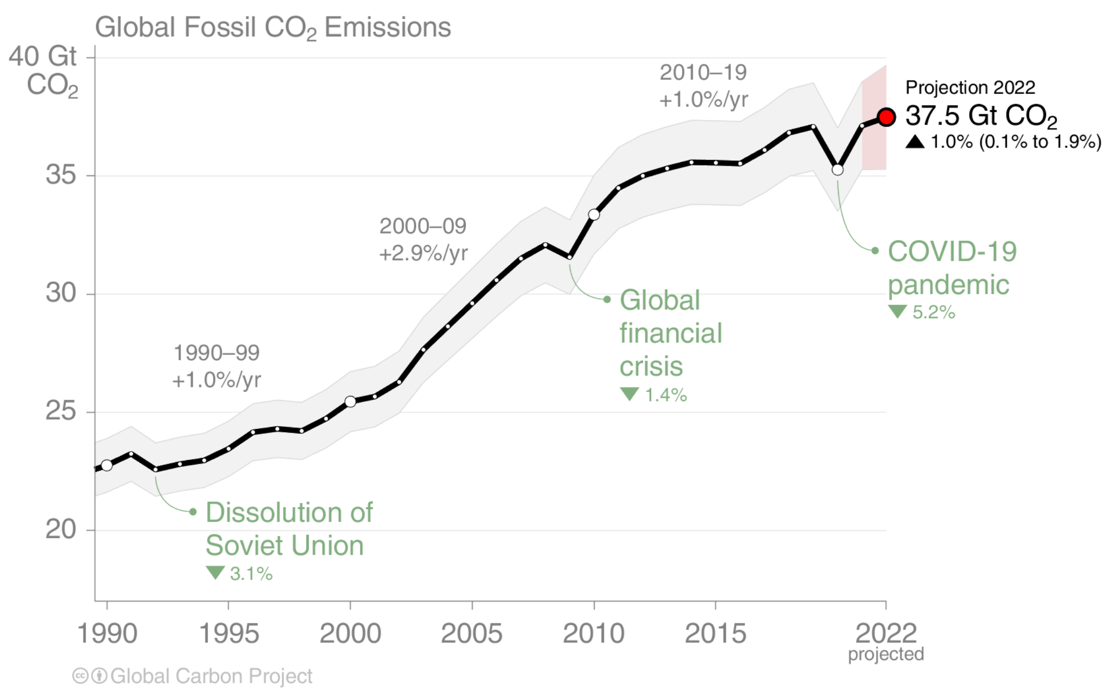

Figure 11. Global Fossil CO_2 Emissions.

During the 2019 legislative session, Colorado passed House Bill 19-1261, the *Climate Action Plan to Reduce Pollution*, which called for reducing statewide GHG emissions 26% by 2025, 50% by 2030, and 90% by 2050 from 2005 emissions. In May 2023, Colorado passed Senate Bill 16, which committed the state to GHG emissions reductions of at least 65% by 2035, 75% by 2040, and 90% by 2045 below 2005 levels. It also sets a target for net-zero GHG emissions by 2050.

In late 2023, the Rocky Mountain Institute (RMI) reported that Colorado is not cutting GHG emissions enough to meet the 2025 or 2030 goals established by House Bill 19-1261 or the net-zero goal mandated by Senate Bill 16 (Booth, 2023). The RMI report estimates that 2030 Colorado emissions would be about 85 MMt CO_2e, a 39% reduction in GHG emissions from 2005 levels, but almost 12 MMt CO_2e short of the mandate set in House Bill 19-1261. The gap between estimated GHG emissions and GHG emissions targets increases to over 20 MMt CO_2e. Major sectors like buildings, industry, oil and gas, and electricity generation are set to meet or approach the first set of goals. But Colorado is only set to achieve 9% of its 2025 goal for the transportation sector and 41% of its 2030 target (Minor & Brasch, 2023).

The CDPHE has been assessing statewide GHG emissions since 1990 with inventory reports in 2002, 2007, 2014, 2019, 2021 and 2023. In 2019, Senate Bill 19-096 was adopted requiring updates to the statewide greenhouse gas inventory no less frequently than every two years. The latest Colorado GHG inventory is available here.

Table 20. Annual State, National, and Global GHG Emissions (MMt CO2e).

Area	1990	2005	2018	2019	2020	2021	2022
Global[1]	33,268	42,319	52,399	52,558	50,633	53,057	53,787
United States[2]	6,487	7,477	6,755	6,618	6,026	6,340	-
US Fossil Fuels[2]	4,728	5,747	4,990	4,856	4,345	4,639	-
Colorado[3]	-	139	-	126	120	-	-

[1] Source: EDGAR - Emissions Database for Global Atmospheric Research

[2] Source: BLM Annual GHG Report

[3] Source: Colorado 2021 Greenhouse Gas Inventory Update

4.7.2 Federal Fossil Fuel Emissions in Colorado

Estimated annual GHG emissions from existing (e.g. held-by-production) oil and gas wells for fiscal year 2022 are incorporated from the Annual GHG report (BLM, 2022) and presented in Table 21. The values in Table 21 were obtained by adding the GHG emissions from Table 7-4 and Table 7-11 in the Annual GHG report. The estimates presented here include emissions from the full oil and gas lifecycle, including emissions arising from activities outside of the BLM's jurisdiction (such as emissions associated with refining and processing). Emissions from coal production on the federal mineral estate in FY 2022 are provided in Table 22.

For the 2022 fiscal year, total GHG emissions from existing federal oil and gas in Colorado was 46.16 Mt CO_2e, which is a 1% increase from the previous year. Colorado's oil production from existing wells ranked fourth among the states while natural gas was third. Overall, Colorado's GHG emissions from existing oil and gas operations represent 8.5% of the total onshore federal (BLM) mineral estate. For the entire BLM, total lifecycle GHG emissions from existing oil and gas operations in fiscal year 2022 was 542.05 Mt CO_2e, a 16.4% increase over the previous year. Colorado's coal production for fiscal year 2022 also ranked fourth among the states, with 3.2% of the BLM GHG emissions from existing coal operations. Note that Colorado's federal coal production comes almost entirely from just four counties – Gunnison, La Plata, Moffat, and Rio Blanco – which collectively account for 99.7% of federal coal production in Colorado over the previous five years. Colorado's 2022 coal production decreased by 15.2% from 2021 and has decreased by at least 10% year over year for each of the last five years.

Table 21. Federal Oil and Gas Emissions - Held-By-Production Lands 2022 (Mt CO2e)[1].

Area	Oil and Gas Extraction	Oil and Gas Processing	Oil and Gas Transport	Oil and Gas Combustion	Total Oil and Gas
Colorado	3.85	1.60	6.77	33.94	46.16
BLM Total	55.83	31.32	49.97	404.94	542.05

[1] Source: Annual GHG Report (BLM, 2022)

Table 22. Federal Coal Emissions - Held-By-Production Lands 2022 (Mt CO_2e)[1].

Area	2022 Production (tons)	Coal Extraction	Coal Processing	Coal Transport	Coal Combustion	Total Coal
Colorado	6,331,968	0.41	0.19	0.04	14.85	15.47
BLM Total	270,220,938	4.80	1.40	9.17	475.79	491.15

[1] Source: Annual GHG Report (BLM, 2022)

4.7.3 Foreseeable Federal Oil and Gas Emissions

An assessment of GHG emissions from BLM's fossil fuel authorizations including coal leasing and oil and gas development is included in the Chapter 7 of the 2022 Annual GHG Report. The Annual GHG Report includes estimates of reasonably foreseeable GHG emissions related to federal leases and is the best estimate of aggregate GHG emissions from the federal fossil fuel leasing program based on actual production and statistical trends. The Annual GHG Report provides an estimate of short-term and long-term GHG emissions from federal leases across the BLM. The short-term methodology presented in the Annual Report includes a trends analysis of (1) leased federal lands that are held-by-production, (2) approved applications for permit to drill (APDs), and (3) leased lands from competitive lease sales occurring over the next annual reporting cycle (12 months), to provide a 30-year projection of potential emissions from federal lease actions over the next 12 months. The long-term methodology uses oil and gas production forecasts from the Energy Information Administration (EIA) to estimate GHG emissions out to 2050 that could occur from past, present, and future oil and gas development. Table 23 shows the estimated GHG emissions from existing and foreseeable development and production of oil and gas on federal leases using the methodology described above. The information in Table 23 was obtained by summing Table 7-6, Table 7-8, Table 7-10, Table 7-13, Table 7-15, and Table 7-17 from the 2022 Annual GHG Report. The foreseeable short-term GHG emissions from coal are provided in Table 24 and can also be found in Table 7-3 of the 2022 Annual GHG report. The short-term foreseeable GHG emissions estimates from oil and gas wells in Colorado are presented graphically on an annual basis in Figure 12.

Table 23. Foreseeable Short-Term Oil and Gas GHG Emissions from Federal Leases (Mt CO_2e)[1].

Area	Oil and Gas Extraction	Oil and Gas Processing	Oil and Gas Transport	Oil and Gas Combustion	Total Oil and Gas
Colorado	37.76	15.71	66.27	332.78	452.53
BLM Total	617.44	343.89	567.12	4,504.53	6,032.98

[1] Source: Annual GHG Report, Chapter 7.

Table 24. Foreseeable Short-Term Coal GHG Emissions (Mt CO_2e)[1].

Area	Coal Extraction	Coal Processing	Coal Transport	Coal Combustion	Total Coal
Colorado	6.08	1.63	0.22	126.39	134.31
BLM Total	128.33	19.26	152.74	6,873.39	7,173.72

[1] Source: Annual GHG Report, Chapter 7, Table 7-3.

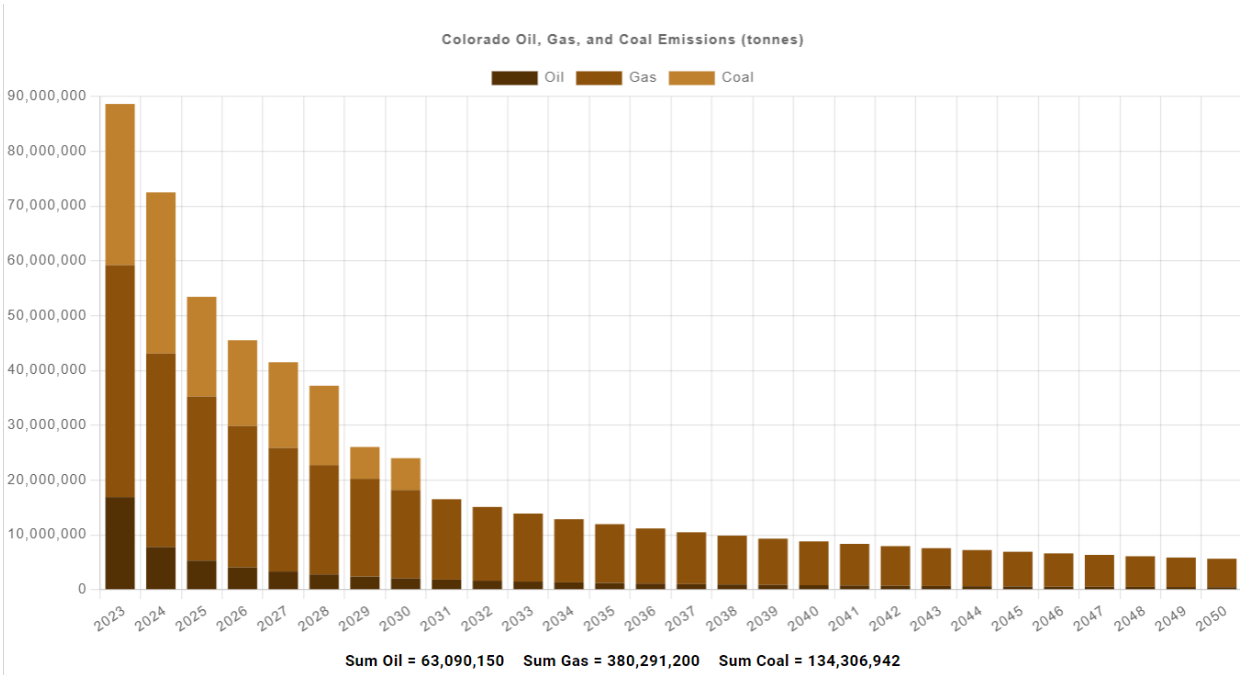

Figure 12. Projected short-term life-of-project Colorado Oil, Gas, and Coal CO_2e Emissions (tonnes).

Table 25. Foreseeable Long-Term Federal Coal, Oil, and Gas GHG Emissions (Mt CO_2e)[1].

Area	Oil	Gas	Coal	Total
Colorado	194.62	1,201.27	251.27	1,647.16
BLM Total	8,307.79	8,152.13	7,975.34	24,498.26

[1] Source: Annual GHG Report, Chapter 7, Table 7-19.

The long-term emissions estimates presented in Table 25 are based on EIA's Annual Energy Outlook (AEO) reference case. The Annual GHG report provides emissions projections for all AEO cases. The projections made from the 2022 AEO data show that fossil fuel mineral development on federal land accounts for approximately 14.2% of total U.S. GHG emissions (reference case). The difference (or delta) between the aggregate short-term emissions previously described and the long-term emissions estimates can be thought of as the level of additional development that could be authorized to sustain the existing federal fraction of EIA projected energy demand over the longer term.

5. Affected Environment: Conditions and Trends by Field Office

In this chapter, recent oil and gas development and production at the field office level is compared to CARMMS scenarios to evaluate whether model oil and gas activity is still representative and valid. Air quality conditions and trends discussed in Chapter 4. Affected Environment: Statewide Air Quality Conditions and Emissions are used to assess air quality and AQRVs at the field office level.

Please see Section VI – Oil and Gas Development Emissions Reduction Strategies and BMPs within the CARPP for management strategies and emissions controls that could be required because of project-level or broader-scale analyses. Depending on the state of current air quality conditions, how oil and gas is tracking when new projects are proposed, and projected impacts for project-level and cumulative federal oil and gas impacts, any combination of the emissions controls listed in Section VI of CARPP might be required.

Federal oil and gas development and production data were obtained from the Automated Fluid Minerals Support System (AFMSS) and Office of Natural Resources Revenue (ONRR). Total (federal and non-federal) production and wells data were obtained from the report year ECMC production value, which contains both federal and non-federal sources. This information can be used to deduce the non-federal production component by subtracting the federal (ONRR) production from the ECMC (total) production. Federal spud counts were obtained from AFMSS and added to the previous year's federal active well count to determine the report year information, which provides a conservative estimate for federal active wells. The development metrics (i.e. spuds, active well counts, production volumes) are analyzed for each field office and compared to CARMMS high and low development scenarios. In general, spuds are a surrogate for construction related emissions, while active well counts and overall production volumes are surrogates for various production activity emissions.

5.1 Oil and Gas Development and Production

In this section, overall Colorado federal oil and gas development and production statistics are presented. Table 26 provides a summary of the ONRR oil production during the past 5 years and includes the high and low CARMMS scenarios for total (new and existing) production. The total U.S. oil production includes the federal and nonfederal portion and onshore and offshore sources. Table 27 shows the ONRR data and CARMMS scenarios for federal gas production.

Over the previous 5 years, federal oil production averaged 23.3% of the U.S. total, with onshore (BLM) production representing a little over one-third of the federal total. Approximately two-thirds of federal oil production comes from offshore sources. Colorado's federal 5-year oil production averaged 2.4% of the BLM total and 0.8% of the federal amount. Five-year federal oil production in Colorado averaged about half of the CARMMS high scenario and 102% of the low scenario. For 2022, total Colorado federal oil production was 62.6% of the CARMMS high scenario.

During the previous five years, federal gas production averaged slightly over 10% of the U.S. total, with onshore (BLM) production representing about 79% of the federal total. Colorado's 5-year average gas production represents 17.3% of the BLM total, 13.7% of the federal total, and 1.5% of the U.S. total. Five-year federal gas production in Colorado averaged 68.7% of the CARMMS high scenario and 141% of the low scenario. For 2022, total Colorado federal gas production was 56.6% of the CARMMS high scenario.

Table 28 indicates that federal Colorado leasing slowed considerably in 2022 and APDs were the lowest recorded during the previous five years. However, spuds increased in 2022 compared to the previous two years.

Table 26. Federal Oil Production (bbl).

Area	2018	2019	2020	2021	2022
U.S. Total	3,997,971,000	4,494,995,000	4,142,277,000	4,107,585,000	4,337,716,000
Fed Total	845,773,523	982,330,048	979,803,867	1,008,290,586	1,106,343,804
BLM Total	224,937,918	293,093,636	325,871,515	396,961,469	478,226,183
BLM Colorado	6,796,690	5,993,015	7,368,001	9,618,212	11,118,967
CARMMS-High	15,025,874	15,752,951	16,422,025	17,083,143	17,767,882
BLM Colorado % of High	45.2%	38.0%	44.9%	56.3%	62.6%
CARMMS-Low	8,490,461	8,096,964	7,861,553	7,777,479	7,840,090
BLM Colorado % of Low	80.1%	74.0%	93.7%	123.7%	141.8%

Table 27. Federal Gas Production (mcf).

Area	2018	2019	2020	2021	2022
U.S. Total	37,325,539,000	40,780,210,000	40,613,767,000	41,666,118,000	43,378,280,000
Fed Total	4,323,237,689	4,445,535,657	4,240,731,210	4,171,974,915	4,441,410,027
BLM Total	3,331,459,200	3,384,738,929	3,320,856,149	3,376,154,592	3,626,318,224
BLM Colorado	646,171,767	654,594,870	589,486,815	530,216,422	534,362,548
CARMMS-High	762,190,008	821,179,527	868,510,599	908,441,256	943,354,612
BLM Colorado % of High	84.8%	79.7%	67.9%	58.4%	56.6%
CARMMS-Low	434,546,462	425,936,541	418,134,564	411,113,073	404,921,128
BLM Colorado % of Low	148.7%	153.7%	141.0%	129.0%	132.0%

Table 28. 5-year Colorado[1] Oil and Gas Statistics.

Statistic	2018	2019	2020	2021	2022
Acres Under Lease	2,692,029	2,515,627	2,373,847	2,363,950	2,251,666
Producing Acres	1,502,100	1,484,195	1,468,209	1,476,291	1,452,441
Acres Held by Production (%)*	55.8%	59%	61.9%	62.5%	64.5%
New Lease Acres (sold)	85,835	25,235	13,678	117,207	365
Number of APDs Approved	402	354	250	282	96
Number of Wells Spud[2]	214	269	140	142	248
Number of Producible Wells	7,272	7,406	7,539	7,343	7,427

[1] Federal portion

[2] Source: AFMSS

Table 29. 2022 Colorado Oil Statistics.

Field Office	Fed Oil (bbl)	Non-Fed Oil (bbl)	Total Oil (bbl)	% Fed Oil	% Fed 1st Yr Oil	Fed Oil % CARMMS-High	Fed Oil % CARMMS-Low
CRVFO	386,184	608,004	994,188	38.8%	8.3%	36.2%	46.6%
GJFO	18,484	32,869	51,353	36.0%	2.2%	2.0%	42.7%
KFO	66,362	530,468	596,830	11.1%	-	38.0%	42.3%
LSFO	117,078	113,458	230,536	50.8%	-	14.6%	84.0%
RGFO	8,365,219	146,516,547	154,881,766	5.4%	29.0%	69.1%	160.7%
TRFO	62,228	38,629	100,857	61.7%	-	107.3%	122.8%
UFO	171	178	349	49.0%	-	0.3%	7.6%
WRFO	1,578,333	1,527,289	3,105,622	50.8%	-	61.4%	111.6%
Total	**10,594,059**	**149,367,442**	**159,961,501**	**6.6%**	**23.2%**	**59.6%**	**135.1%**

Table 30. 2022 Colorado Gas Statistics.

Field Office	Fed Gas (mcf)	Non-Fed Gas (bbl)	Total Gas (bbl)	% Fed Gas	% Fed 1st Yr Gas	Fed Gas % CARMMS-High	Fed Gas % CARMMS-Low
CRVFO	173,611,709	199,153,419	372,765,128	46.6%	3.0%	57.9%	71.4%
GJFO	11,996,195	19,317,313	31,313,508	38.3%	2.3%	10.1%	64.8%
KFO	72,422	1,060,883	1,133,305	6.4%	-	1.4%	11.1%
LSFO	6,307,007	660,926	6,967,933	90.5%	-	17.4%	67.0%
RGFO	30,952,671	1,091,563,613	1,122,516,284	2.8%	24.1%	95.5%	324.1%
TRFO	257,018,522	282,864,057	539,882,579	47.6%	-	391.5%	845.5%
UFO	3,206,287	1,527,742	4,734,029	67.7%	-	15.1%	119.4%
WRFO	51,784,418	64,192,767	115,977,185	44.7%	-	14.2%	57.2%
Total	**534,949,231**	**1,660,340,720**	**2,195,289,951**	**24.4%**	**3.6%**	**56.7%**	**132.1%**

A summary of 2022 Colorado oil and gas statistics by field office is provided in Table 29 and Table 30, respectively. The RGFO, WRFO, and CRVFO combined account for over 96% of the federal oil production in Colorado (Table 29). While the RGFO is the major BLM Colorado oil producer with nearly 80% of the BLM's statewide total, the federal portion is only about 5% of the total amount within the field office.

Statewide oil production in Colorado during 2022 was just under 60% of the CARMMS high scenario, and each field office except the TRFO had production levels below the high scenario. Since CARMMS tracking commenced in 2016, total oil production for each field office besides the TRFO has consistently been less than the high scenario, and below the low scenario in the CRVFO, GJFO, KFO, LSFO, and UFO. Total (new and existing) gas production in 2022 on BLM Colorado lands was 56.7% of the high scenario, with each field office except for the TRFO recording production less than the high scenario. The total TRFO gas production is much higher than projected in CARMMS, but this is nearly all from existing (pre-CARMMS) gas production. New federal gas production in the TRFO has been much less than projected in CARMMS, which will be discussed in more detail in Section 5.7.1 Tres Rios Field Office Oil and Gas Development and Production.

5.1.1 Oil and Gas Criteria Pollutant Emissions

The 2020 NEI oil and gas CAP emissions in Table 8 include federal and non-federal sources. To get a rough estimate of the federal portion of the CAP emissions from Table 8, the values can be scaled by the average of the federal portion of oil and gas production within each field office. For example, in the CRVFO, 38.8% of 2022 oil production (Table 29) and 46.6% of 2022 gas production (Table 30) was federal, resulting in an average of 42.7% of all production and accordingly, the same percentage of CAPs for the field office. Using this methodology, the CAPs related to oil and gas exploration and production for each field office are presented in Table 31. Note that the values are estimated and are provided only for context and comparison to other sources of pollution within the state. Overall, using this methodology, about 1.6% of Colorado NO_x emissions and about 1.5% of VOCs are from federal oil and gas.

Table 31. Estimated Federal Oil and Gas CAP Emissions (tpy) by Field Office.

Field Office	CO	NOx	PM_{10}	$PM_{2.5}$	SOx	VOC
CRVFO	569	592	12	12	3	2,695
GJFO	65	41	1	1	0	151
KFO	37	9	0	0	0	56
LSFO	297	187	2	2	0	1,128
RGFO	736	566	3	3	1	1,680
TRFO	1,394	333	1	1	0	137
UFO	18	19	0	0	0	7
WRFO	299	253	6	6	0	8,767
BLM TOTAL	**3,415**	**2,002**	**24**	**24**	**5**	**14,620**
% of State Total	**0.1%**	**1.6%**	**0.0%**	**0.0%**	**0.0%**	**1.5%**

5.2 Colorado River Valley Field Office

The Colorado River Valley Field Office (CRVFO) is in the Northwest District within the west central portion of the state. The CRVFO provides administrative management for approximately 567,000 surface acres of public land and roughly 750,000 acres of subsurface federal mineral estate within Garfield, Mesa, Eagle, Pitkin, Routt, and Rio Blanco counties. The major urban areas within the field office are located along the I-70 corridor from Vail Valley past Glenwood Springs and along State Highway 82 in the Aspen Valley. The RMP providing direction for CRVFO management actions was finalized in 2015. As of 2023, the CRVFO RMP is undergoing revision with the ROD expected in Q3 of FY 2024. The need for the supplemental is to comply with the settlement agreements in litigation of the CRVFO RMP (Wilderness Workshop v. BLM, 16-cv-01822) and subsequent oil and gas leasing in both field offices (Wilderness Workshop v. BLM, 18-cv-00987). The purpose of supplemental EIS is to broaden the range of alternatives in the 2015 CRVFO and GJFO Approved RMPs with respect to the lands that are allocated as open or closed for oil and gas leasing. The supplemental RMP will also provide additional air quality analysis for the fluid mineral management alternatives considered in the 2015 RMP. The 2015 RMP contains provisions to protect air quality and AQRVs by complying with applicable federal, state, and local air quality laws, regulations, standards, and implementation plans. Within the scope of the BLM's authority, the goals of the RMP are to limit air quality degradation by implementing actions to minimize emissions that may cause or contribute to negative impacts to air quality or air quality-related values (i.e. AQRVs) in Class I Airsheds affected by actions in the planning area.

5.2.1 Colorado River Valley Field Office Oil and Gas Development and Production

Table 32 shows the 2022 oil and gas development and production statistics for the CRVFO. Overall, there were 42 spuds and 3,363 active wells in the CRVFO during the most recent reporting year. Oil production decreased by 8.5% from 2021 amounts while gas was down by 1.9%.

Table 32. 2022 CRVFO Oil and Gas Statistics.

Description	Federal	% Federal	% CARMMS-High	% CARMMS-Low
New Wells (Spuds)	42	89.4%	14.6%	23.3%
Active Wells	3,362	28.2%	43.0%	47.6%
Oil Production (bbl)	386,184	38.8%	36.2%	46.6%
Gas Production (mcf)	173,611,709	46.6%	57.9%	71.4%

For 2022, federal spuds in the CRVFO were 14.6% of the CARMMS high scenario, with active well counts 43% of the high scenario. Since tracking began in 2016, spuds have averaged 23% of the high scenario. In the same period, active well counts have averaged less than half of the high scenario. Because construction emissions are driven by spud counts, CRVFO spuds tracking at 14.6% of the CARMMS high scenario for 2022 means that report year construction emissions also tracked at 14.6% of the 2025 high scenario. With active well counts less than half of the low scenario, active well emissions are well below those projected in CARMMS. Figure 13 and Figure 14 show that CRVFO federal production has been consistently less than the CARMMS low scenario for both oil and gas. Since CARMMS tracking commenced in 2016, CRVFO first year federal oil production has averaged less than 5% of the federal field office total, with 8.3% the most recent value. First year gas production during 2022 was 3% of the federal portion within the field office and has averaged about 6% over the tracking period.

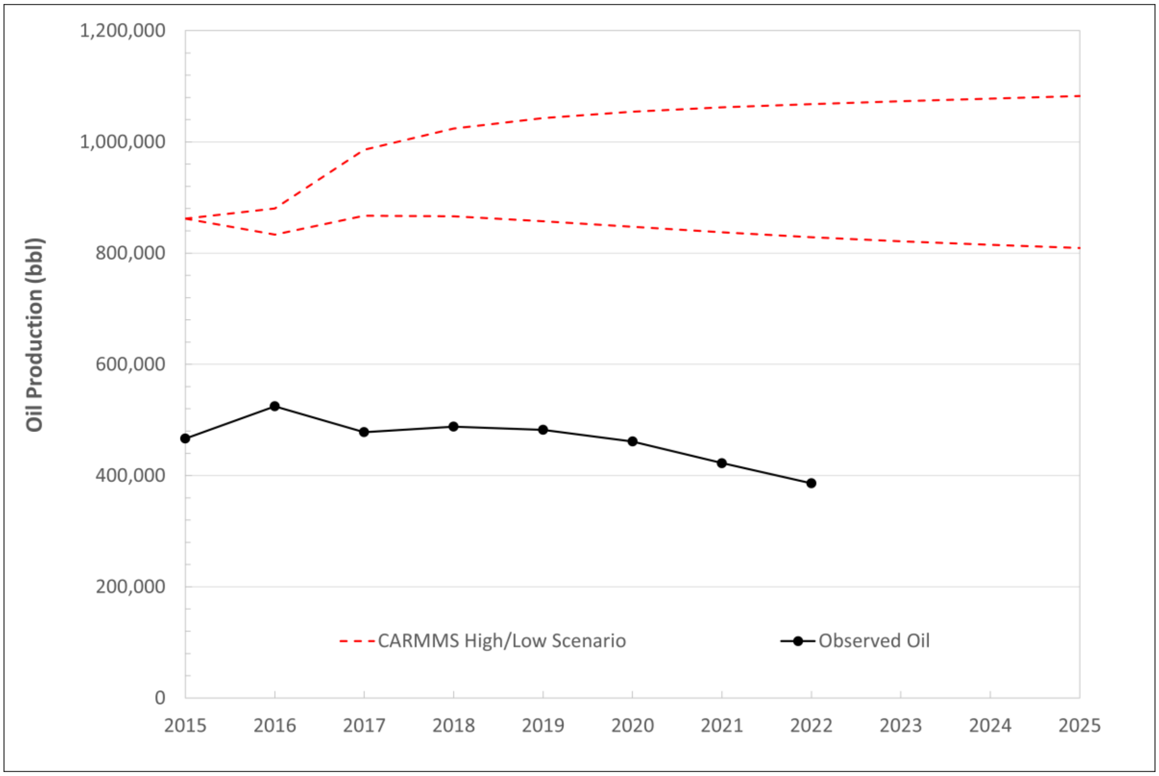

Figure 13. CRVFO Oil Production vs. CARMMS Scenarios.

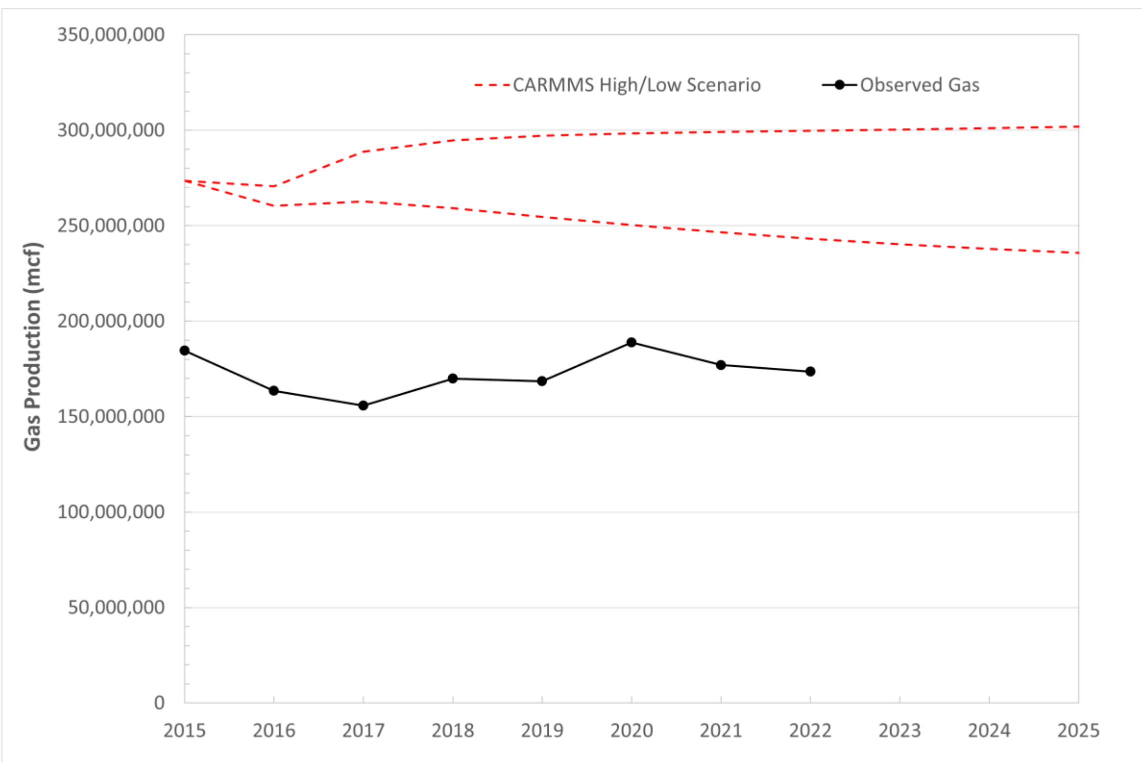

Figure 14. CRVFO Gas Production vs. CARMMS Scenarios.

Overall production and spud counts have tracked below the low CARMMS scenario, and air quality trends for the CRVFO (discussed in Section 5.2.2 Colorado River Valley Field Office Air Trends) generally indicate stable or improving conditions. Accordingly, the CRVFO is currently meeting the objectives of the governing RMP and BLM's adaptive management strategy. Nevertheless, individual projects will still undergo site-specific analysis where any project close to residences could require modeling or additional analysis (beyond CARMMS, Regional Modeling Study, etc.) to show that CRVFO is meeting air resource objectives.

5.2.2 Colorado River Valley Field Office Air Trends

The CRVFO is split almost equally between CDPHE's Central Mountains and Western Slope air quality regions. The CDPHE notes that the primary monitoring concern in the Central Mountains region is particulate pollution from wood burning and road dust. In the Western Slope region, ozone is the primary pollutant of concern.

The 2022 CDPHE Annual Data Report indicates that both the Central Mountains and Western Slope region complied with federal air quality standards during 2022. As indicated in Table 16, the most recent ozone design value for Garfield County is 0.062 ppm, or 89% of the NAAQS, with little variation since 2016. Notably, of the sixteen counties with valid ozone design values, Garfield County has the lowest ozone in the state. The AQI data in Table 11 show that 75% of the days in Garfield County over the previous three years were classified as good, with ozone the main pollutant on nearly all days. The AQI data for Pitkin County indicates that 97% of the days recorded good air quality, with PM_{10} the main pollutant on about two-thirds of the days, $PM_{2.5}$ for the remaining one-third. The CRVFO does contain a PM Maintenance Area around the city of Aspen. Figure 4-1 from the 2022 CDPHE Annual Data Report shows the PM_{10} has varied little in Aspen since 2015 and is currently less than the statewide average. There were no exceedances of the 24-hour PM_{10} NAAQS (150 µg m^{-3}) observed in 2022 and the highest recorded value was less than half of the NAAQS.

The White River NF (WHRI1) IMPROVE monitor located in the CRVFO allows for an evaluation of visibility trends. Since observations began in 2001, visibility at this location has improved considerably (Table 18) on the clearest and most impaired days. Prevailing visibility at WHRI1 is generally among the best in Colorado with only the Mount Zirkel location typically observing such low haze indices.

The two NTN nitrogren deposition monitoring locations in the CRVFO (Table 19) indicate that total deposition at these sites is relatively low and less than critical load values recommended by (Pardo, et al., 2011) and (Bowman, Murgel, Blett, & Porter, 2012). However, certain species may have greater nitrogen sensitivity, and previous editions of the BLM Colorado Air Annual Report (BLM, 2021) note that deposition impacts within the CRVFO have exceeded the deposition data analysis threshold (DAT) of 0.005 kg $ha^{-1}yr^{-1}$ established by (NPS, 2010) to determine the potential significance of a given project. Accordingly, deposition trends should be carefully reviewed in future annual report updates.

5.3 Grand Junction Field Office

The Grand Junction Field Office (GJFO) is administratively part of the BLM Colorado Southwest District and manages 1.27 million surface acres of public land and almost 936 thousand acres of federal fluid mineral estate. Located mostly within Mesa and Garfield Counties, the GJFO includes Grand Junction, the largest metropolitan area on the Western Slope. This region, along with the Central Mountains, are projected to be the fastest growing areas of Colorado through 2020 according to the Colorado Department of Local Affairs.

The RMP providing direction for GJFO management actions was finalized in 2015. As of November 2023, the [GJFO RMP](#) is undergoing revision with the ROD expected in Q3 of FY 2024. The purpose of supplemental EIS is to broaden the range of alternatives in the 2015 CRVFO and GJFO Approved RMPs with respect to the lands that are allocated as open or closed for oil and gas leasing. The supplemental RMP will also provide additional air quality analysis for the fluid mineral management alternatives considered in the 2015 RMP. The 2015 RMP contains provisions to protect air quality and AQRVs by complying with applicable federal, state, and local air quality laws, regulations, standards, and implementation plans. Within the scope of the BLM's authority, the goals of the RMP are to limit air quality degradation by implementing actions to minimize emissions that may cause or contribute to negative impacts to air quality or air quality-related values (i.e. AQRVs) in Class I Airsheds affected by actions in the planning area.

5.3.1 Grand Junction Field Office Oil and Gas Development and Production

Table 33 shows the 2022 oil and gas development and production statistics for the GJFO. Overall, there were 7 spuds and 425 active wells in the GJFO during the most recent reporting year. Oil and gas production decreased by approximately 12% and 10% in 2022, respectively, compared to 2021 amounts.

Table 33. 2022 GJFO Oil and Gas Statistics.

Description	Federal	% Federal	% CARMMS-High	% CARMMS-Low
New Wells (Spuds)	7	31.8%	3.6%	120.7%
Active Wells	425	35.2%	17.8%	40.7%
Oil Production (bbl)	18,484	36.0%	42.7%	2.0%
Gas Production (mcf)	11,996,195	38.3%	10.1%	64.8%

The 7 federal spuds for 2022 in the GJFO represent just 3.6% of the CARMMS high scenario, while the 425 active wells are 40.7% of the high scenario. Since tracking began in 2016, spuds have averaged only 5% of the high scenario. In the same period, active well counts have averaged about one-quarter of the high scenario. Because construction emissions are driven by spud counts, GJFO spuds tracking at 3.6% of the CARMMS high scenario for 2022 means that report year construction emissions also tracked at 3.6% of the 2025 high scenario. With active well counts less than half of the low scenario, active well emissions are well below those projected in CARMMS.

Figure 15 and Figure 16 show that GJFO federal production has been consistently less than the CARMMS low scenario. For both oil and gas, first year federal production within the field office has averaged about 5% of the federal total since tracking began in 2016, with 2% recorded in 2022. Overall oil and gas development and production has tracked below the low CARMMS scenario, and air quality trends for the GJFO (5.3.2 Grand Junction Field Office Air Trends) generally indicate stable or improving conditions. Accordingly, the GJFO is currently meeting the objectives of the governing RMP and BLM's adaptive management strategy. Nevertheless, individual projects will still undergo site-specific analysis where any project close to residences could require modeling or additional analysis (beyond CARMMS, Regional Modeling Study, etc.) to show that GJFO is meeting air resource objectives.

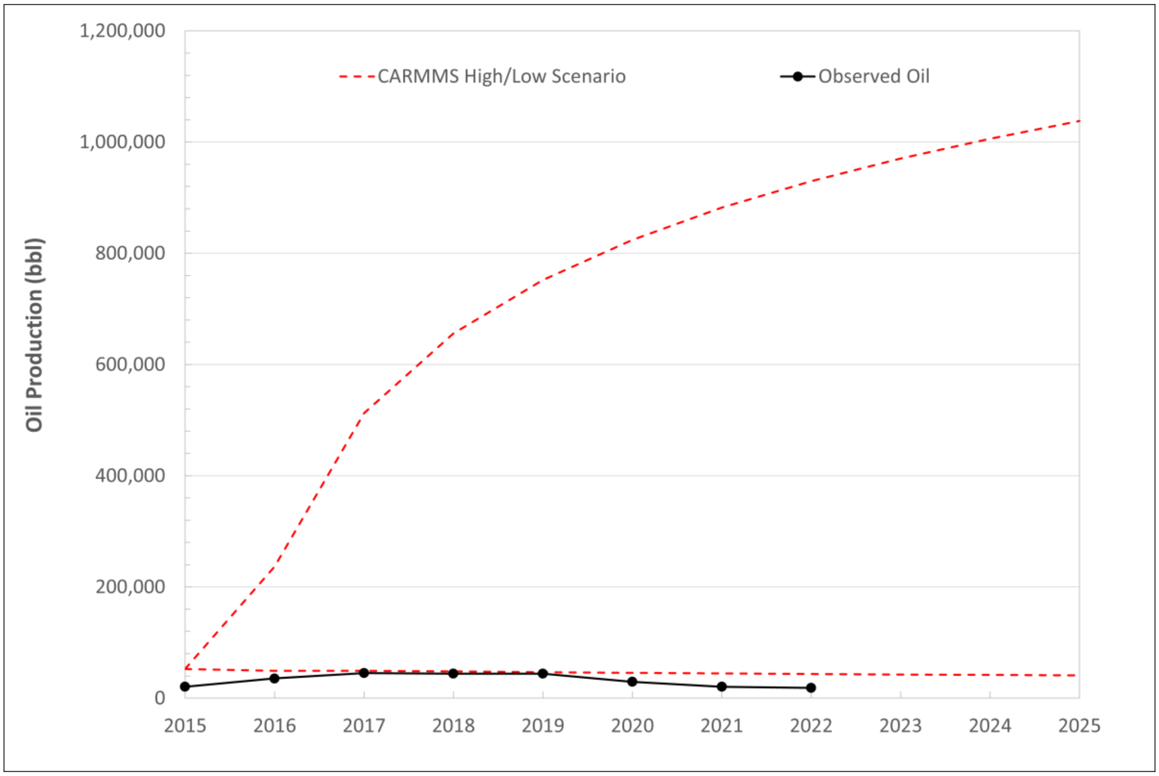

Figure 15. GJFO Oil Production vs. CARMMS Scenarios.

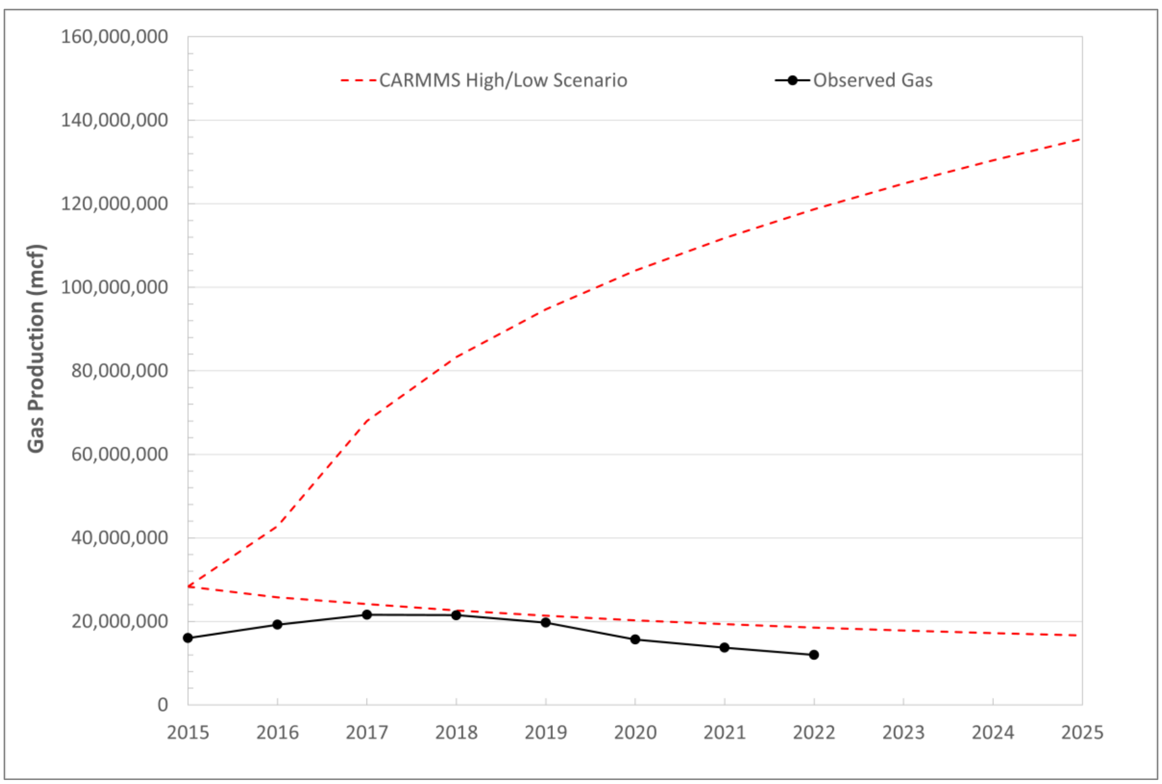

Figure 16. GJFO Gas Production vs. CARMMS Scenarios.

5.3.2 Grand Junction Field Office Air Trends

The GJFO is within the CDPHE's Western Slope air quality region (designated as attainment) and is in full compliance with the NAAQS for the report year. The field office is also free from any maintenance areas. In the Western Slope region, ozone is the primary pollutant of concern.

As indicated in Table 16, the most recent ozone design value for Mesa County is 0.065 ppm, or 93% of the NAAQS, with no variation since 2016. The AQI data in Table 11 show that 89% of the days in Mesa County over the previous three years were classified as good, with ozone the main pollutant on most days. Figure 4-40 from the 2022 CDPHE Annual Data Report shows that the annual mean PM_{10} concentration has decreased over the past twenty years at Grand Junction. Figure 4-41 from the 2022 CDPHE Annual Data Report shows that $PM_{2.5}$ amounts have also decreased over the same period. There is no trend in ozone at Palisade and Rifle.

There are no IMPROVE monitors located in the GJFO, but the White River NF (WHRI1) IMPROVE monitor located in the adjacent CRVFO allows for an evaluation of visibility trends. Since observations began in 2001, visibility at this location has improved considerably on the clearest and most impaired days (Table 18). Prevailing visibility at WHRI1 is generally among the best in Colorado with only the Mount Zirkel location typically observing such low haze indices.

There are no NTN sites located within the GJFO, but the Dinosaur National Monument (DIN431) CASTNET site in northeastern Utah may be representative of conditions in western Colorado. There is no long-term trend in nitrogren deposition at the DIN431 location, with values ranging from about 1.65 kg ha^{-1} yr^{-1} to 2.45 kg ha^{-1} yr^{-1}. The average nitrogren deposition for the previous five years (2017-2021) at DIN431 is 1.91 kg ha^{-1} yr^{-1}. The two NTN nitrogren deposition monitoring locations in the adjacent CRVFO (Table 19) indicate that total deposition at these sites is similar and generally less than critical load values reported in (Pardo, et al., 2011) and (Bowman, Murgel, Blett, & Porter, 2012).

5.4 Kremmling Field Office

The Kremmling Field Office (KFO) is composed of the North Park, Middle Park, and Laramie River Valley regions of Colorado and has a varied landscape of open sagebrush plains and high mountain peaks. The KFO contains Jackson, Grand, and Summit counties in their entirety, as well as portions of Eagle, Larimer, and Routt counties. Administratively, the KFO is part of the BLM Colorado Northwest District and manages approximately 377,351 surface acres and 2,232,460 acres of federal minerals. The RMP providing direction for KFO management actions was finalized in 2015 and contains provisions to protect air quality and AQRVs by complying with applicable federal, state, and local air quality laws, regulations, standards, and implementation plans

5.4.1 Kremmling Field Office Oil and Gas Development and Production

Table 34 shows the 2022 oil and gas development and production statistics for the KFO. Overall, there were 7 spuds and 95 active wells in the KFO during the most recent reporting year. Oil production increased by 26.5 % from 2021, while gas production decreased by 6.1%.

Table 34. 2022 KFO Oil and Gas Statistics.

Description	Federal	% Federal	% CARMMS-High	% CARMMS-Low
New Wells (Spuds)	7	77.8%	72.9%	700%
Active Wells	95	44.0%	62.0%	102.2%
Oil Production (bbl)	66,362	11.1%	38.0%	42.3%
Gas Production (mcf)	72,422	6.4%	1.4%	11.1%

The federal spuds and active well counts for 2022 in the KFO were about 73% and 62%, respectively, of the CARMMS high scenario for the year. Since tracking began in 2016, spuds have averaged only 13% of the high scenario. In the same period, active well counts have averaged about 73% of the high scenario. Because construction emissions are driven by spud counts, KFO spuds tracking at 73% of the CARMMS high scenario for 2022 means that report year construction emissions also tracked at 73% of the 2025 high scenario. Active well emissions are well below those projected in CARMMS high scenario. Figure 17 and Figure 18 show that KFO federal production has been less than the CARMMS low scenario throughout the tracking period. There has been no first-year federal oil and gas production within the KFO for the past five years, therefore, the oil and gas production indicated in Table 34 is almost entirely from existing sources.

Air quality trends for the KFO (discussed in 5.4.2 Kremmling Field Office Air Trends) generally indicate stable or improving conditions. Accordingly, the KFO is currently meeting the objectives of the governing RMP and BLM's adaptive management strategy. Nevertheless, individual projects will still undergo site-specific analysis where any project close to residences could require modeling or additional analysis (beyond CARMMS, Regional Modeling Study, etc.) to show that KFO is meeting air resource objectives.

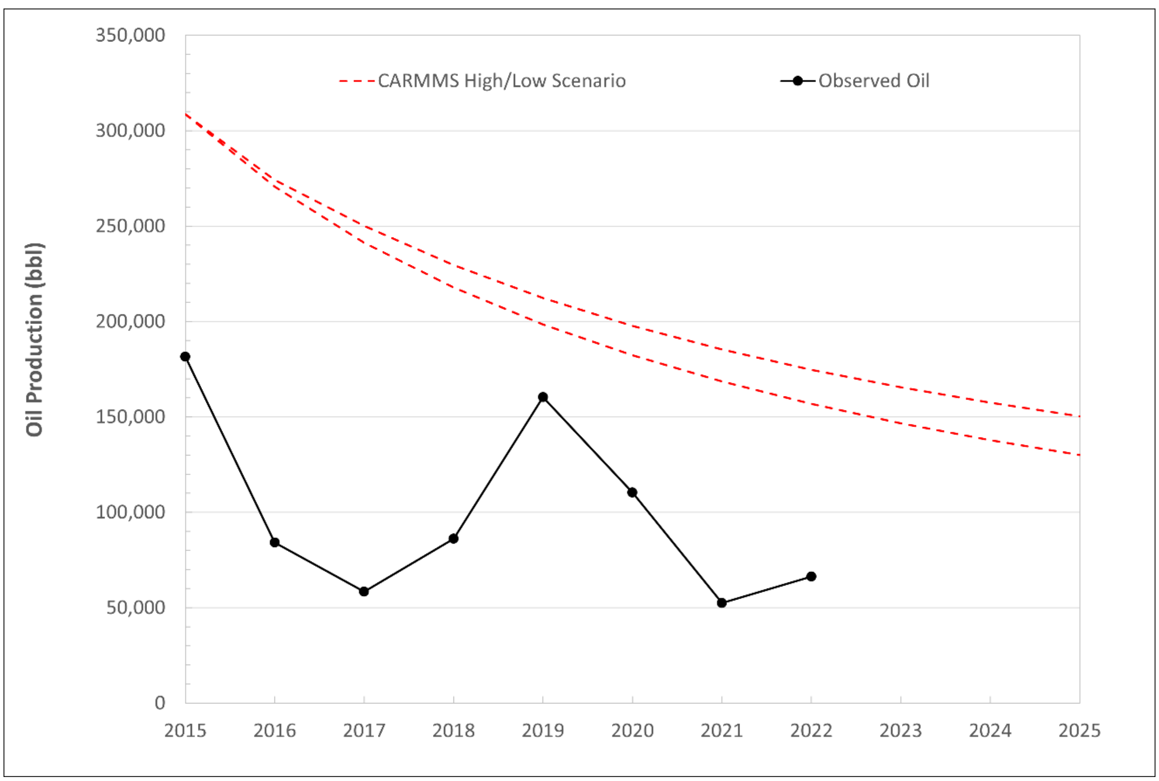

Figure 17. KFO Oil Production vs. CARMMS Scenarios.

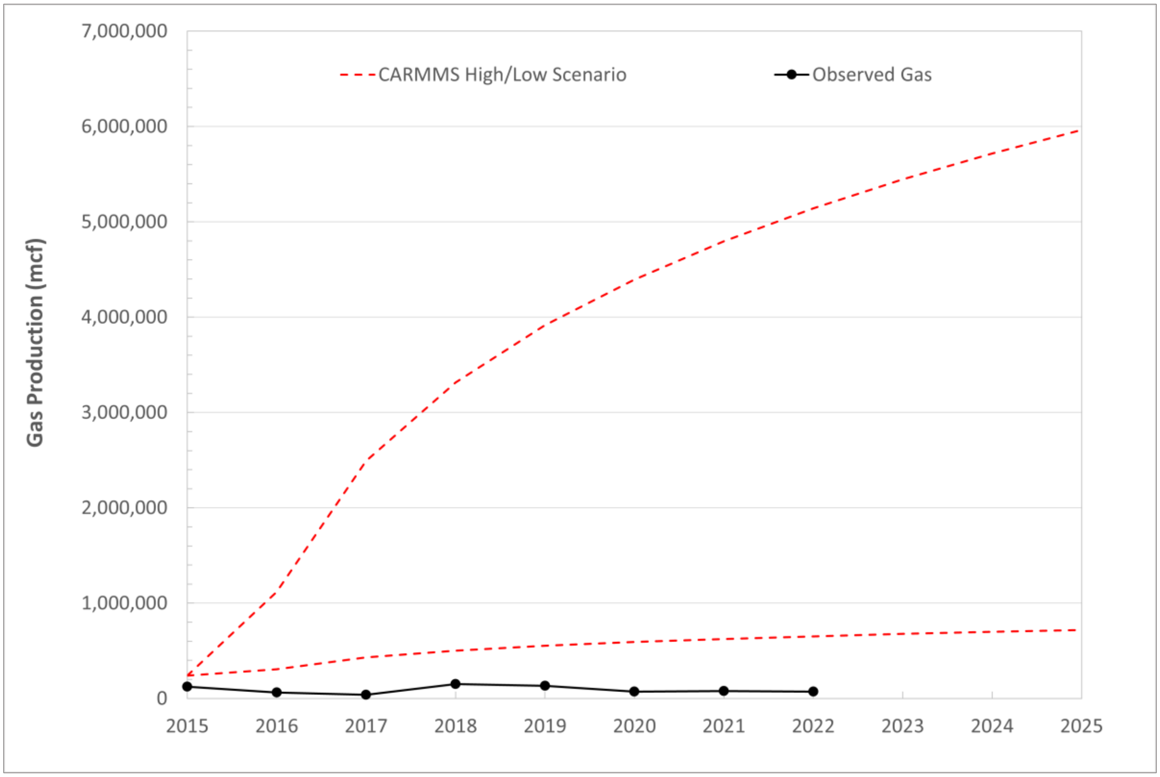

Figure 18. KFO Gas Production vs. CARMMS Scenarios.

5.4.2 Kremmling Field Office Air Trends

The KFO is mostly contained within the CDPHE's Central Mountains air quality region, though the eastern edge of the field office extends into the Denver Metro - Northern Front Range region. The primary monitoring concern in this region is centered around particulate pollution from wood burning and road dust. The KFO complies with all federal air quality standards.

While there is little long-term air quality monitoring in the KFO, the BLM Colorado State Office has operated the Hebron Air Quality Monitoring mobile station (AQS ID 08-057-0005) in Jackson County just south of Walden since July 2022. The mobile unit measures ozone, oxides of nitrogen, particulate matter, and meteorological conditions, and adheres to operational protocols established and accepted by the EPA to provide scientifically defensible air quality data. There were no NAAQS exceedances of any measured pollutants at the Hebron location during 2022, and most days had an AQI characterized as "good" with the remaining days considered "moderate." Ozone was the pollutant with the highest concentrations relative to NAAQS standards with a 4th highest daily maximum value of 58 ppb (NAAQS 70 ppb). Comparing this to the values in Table 16 demonstrates that ozone at Hebron is lower than at any other routinely monitored located. Nitrogen dioxide and particulate matter were very low with concentrations well below the NAAQS. However, it is expected that particulate matter will be significantly elevated when there are nearby wildfires, which do not appear to have caused any major impacts during summer and fall of 2022 in North Park.

The IMPROVE monitors at Mount Zirkel and Rocky Mountain provide representative AQRV observations for the KFO. Visibility has improved on the clearest and most impaired days at the Mount Zirkel (MOZI1) location, with a decrease of about 0.13 dv per year in the most impaired days over the period of record.

Visibility on the clearest days is near natural conditions (Figure 6). The trend for most impaired days at the MOZI1 site indicates steady improvement towards the 2064 endpoint set forth by the latest RHR guidance. At the Rocky Mountain (ROMO1) IMPROVE site, the haze index for the most impaired days has decreased by about 0.14 dv per since 1991, resulting in approximately 4.5 dv improvement. Visibility on the haziest days has improved slightly at the ROMO1 location, but this countered by the high wildfire smoke experienced in 2020 and 2021. The long-term record at ROMO1 shows that overall visibility has improved with conditions on the most impaired days demonstrating progress towards the 2064 endpoint established in the latest RHR guidance.

Nitrogen deposition is monitored within the KFO at the Kawuneechee Meadow (Table 19) site. Despite ongoing monitoring at this location since 2012, only four years – 2014, 2015, 2016, and 2018 – have met NADP's data completeness criteria. Accordingly, a trend assessment is not possible. However, the observations during the four years indicate that nitrogen deposition is quite low with annual values ranging from 0.69 kg ha^{-1} in 2018 to 1.59 kg ha^{-1} in 2014. The four-year average of valid observations at Kawuneeche Meadow is 1.13 kg ha^{-1}, which is lower than any value for other Colorado locations in Table 19, and near or below key critical loads in the area.

5.5 Little Snake Field Office

The LSFO is in the BLM Colorado Northwest District and provides administrative management for approximately 1.3 million acres (32 percent of the total surface area) of public land within Moffat, Routt, and Rio Blanco counties. The LSFO is bordered on the north by the State of Wyoming, on the west by the State of Utah, on the south by the BLM WRFO and on the east by Routt National Forest. Additionally, 1.1 million acres of private and State lands are underlain by federally managed minerals. The major urban areas within the LSFO include the towns of Craig and Steamboat Springs. The RMP providing direction for the LSFO management actions was updated in 2010 and contains provisions to protect air quality and AQRVs by complying with applicable federal, state, and local air quality laws, regulations, standards, and implementation plans. The RMP also states that the BLM will collaborate, as necessary, with federal and state partners to achieve standards and address air quality issues.

5.5.1 Little Snake Field Office Oil and Gas Development and Production

Table 35 shows the 2022 LSFO oil and gas development and production statistics. For 2022, there were 342 active federal wells in the LSFO. There were no spuds developed during 2022 and there have only been 10 spuds dating back to the start of CARMMS tracking in 2016. The low amount of new development contrasts with the CARMMS scenarios which projected between 38 (low scenario) and 543 total spuds for the seven-year period between 2016 and 2022. Active well counts were about one-third of the CARMMS high scenario for 2022. Oil and gas production have also been less than anticipated with production consistently below the CARMMS low scenario as shown in Figure 19 and Figure 20. There has been no first-year oil and gas production in six of the seven CARMMS tracking years with 2017 the only year with new production. Accordingly, LSFO development and production is tracking well below the CARMMS low scenarios.

Table 35. 2022 LSFO Oil and Gas Statistics.

Description	Federal	% Federal	% CARMMS-High	% CARMMS-Low
New Wells (Spuds)	0	-	-	-
Active Wells	342	63.6%	33.5%	66.4%
Oil Production (bbl)	117,078	50.8%	14.6%	84.0%
Gas Production (mcf)	6,307,007	90.5%	17.4%	67.0%

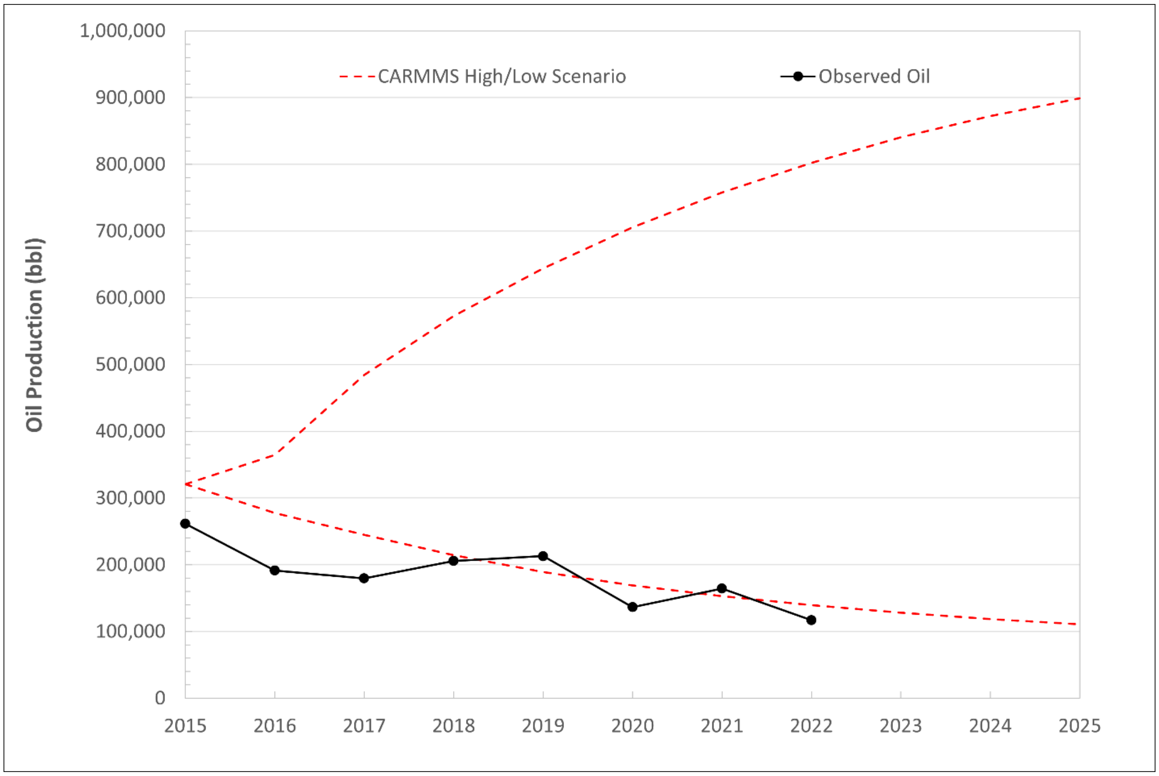

Figure 19. LSFO Oil Production vs. CARMMS Scenarios.

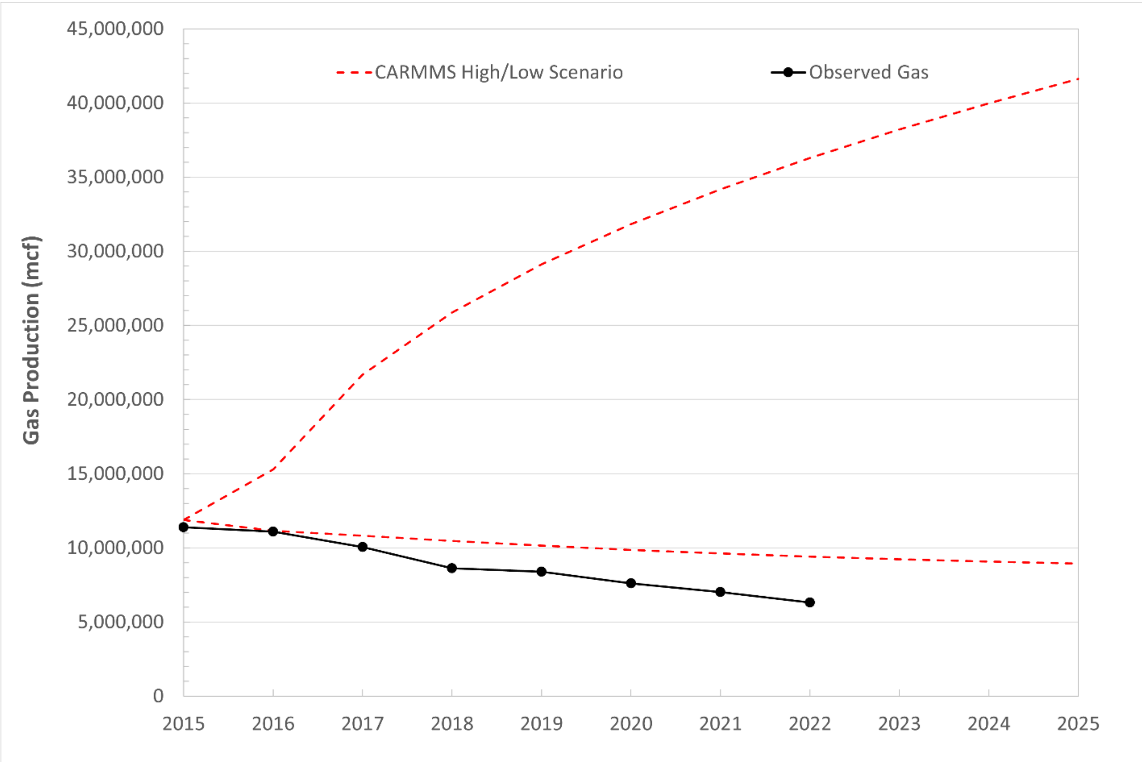

Figure 20. LSFO Gas Production vs. CARMMS Scenarios.

5.5.2 Little Snake Field Office Air Trends

The LSFO is primarily within the CDPHE's Western Slope air quality region, but also extends into the Central Mountains region on the eastern side of the field office boundary. The available air quality data within the LSFO show that the area is designated as attainment and is in full compliance with the NAAQS. The field office is also free from any maintenance areas.

The only active air quality monitoring within the LSFO is for PM_{10} in Steamboat Springs. There is ozone monitoring at Ripple Creek just south of the LSFO boundary near the eastern WRFO border. Additionally, BLM Colorado operates two monitors south of the LSFO in the WRFO at Rangely and the Piceance Basin.

As indicated in Table 11, 99% of the days in Routt County recorded a “good” air quality index (AQI) for the most recent three-year reporting period, 2020-2022, with PM_{10} the primary pollutant of concern for the county. In adjacent Sweetwater County, WY located to the north of the LSFO, AQI data for 2020-2022 show that approximately 70% of days were characterized as “good,” while 28% were rated as “moderate.” The Sweetwater County AQI data indicate that the primary pollutant of concern is ozone. Moffat County does not have AQI information. Mean annual PM_{10} concentrations at Steamboat Springs have decreased over the past two decades per the most recent CDPHE annual report. The 24-hour PM_{10} data from Steamboat Springs indicates large interannual variability, with no apparent long-term trend. As seen in Table 16, the ozone design value in Rio Blanco County is above 60 ppb, where the highest 3-year average is approximately 65 ppb or 93% of the NAAQS. However, during 2022, there were no 8-hour ozone exceedances observed at the Rangely site, and just one exceedance at Piceance Basin and Ripple Creek.

To characterize visibility trends, the Mount Zirkel (MOZO1) IMPROVE site located near the border of the LSFO and KFO provides representative AQRV observations for the area. Visibility has improved on the clearest and most impaired days at the Mount Zirkel (MOZI1) location, with a decrease of about 0.13 dv per year on the most impaired days over the period of record. Visibility on the clearest days is near natural conditions (Figure 6). The trend for most impaired days at the MOZI1 site indicates steady improvement towards the 2064 endpoint set forth by the latest RHR guidance. In 2018, an IMPROVE location in Dinosaur National Monument (DINO1) was established and may be used in the future to assess long-term visibility trends within the LSFO.

Three NTN sites – Sand Spring, Buffalo Pass (Dry Lake), and Buffalo Pass (Summit Lake) – can be used to assess nitrogen deposition in the LSFO (Table 19). The Sand Spring (CO15) location was established in 1979, though 15 years in the period of observation do not have valid annual data. Nevertheless, nitrogen deposition at Sand Spring appears stable with observations over the past twenty years typically ranging from 0.80 kg ha^{-1} to 1.30 kg ha^{-1}. This level of nitrogen deposition is relatively low and generally less than critical load thresholds, though ecosystems at Dinosaur National Monument may be highly sensitive to nitrogen-enrichment effects. Nitrogen deposition has improved slightly at the Buffalo Pass – Dry Lake (CO93) over the period of record, though missing annual summary data make long-term trend assessments less certain. The most recent observation of 1.53 kg ha^{-1} is above the NPS benchmark of 1 kg ha^{-1} but generally less than critical load thresholds reported by (Pardo, et al., 2011) and (Bowman, Murgel, Blett, & Porter, 2012). Similar conditions and missing data issues exist at the Buffalo Pass – Summit Lake (CO97) location.

5.6 Royal Gorge Field Office

The Royal Gorge Field Office (RGFO) contains all of eastern Colorado and constitutes over half of the land area in the state. Administratively, the RGFO is part of the BLM Colorado Rocky Mountain District and manages approximately 658,200 surface acres and 3,311,900 acres of federal minerals. Nearly 81% of the federal mineral estate is underneath private or State-owned surface, which is otherwise known as split estate. In June 2015, the BLM published a notice of intent (NOI) in the Federal Register, initiating the planning process to revise the 1986 Northeast Resource Management Plan (RMP) (BLM, 1986) and 1996 Royal Gorge Resource Area RMP (BLM, 1996) and consolidate the revisions into one resource management plan/environmental impact statement (RMP/EIS). The ROD for the updated Eastern Colorado RMP is anticipated in FY 2024.

5.6.1 Royal Gorge Field Office Oil and Gas Development and Production

Table 36 shows the 2022 oil and gas development and production statistics for the RGFO. Overall, there were 134 spuds and 886 active wells in the RGFO during the most recent reporting year. As shown in Figure 21 and Figure 22, oil and gas production has increased considerably since CARMMS tracking began in 2016. Nearly 80% of BLM Colorado oil production and about 6% of gas production during 2022 occurred in the RGFO. Both amounts are a small fraction of the total (federal and non-federal) production in the field office (Table 36). The majority of RGFO development is in the Denver Julesburg Basin, north of the Denver metro area and east of the I-25 corridor.

Table 36. 2022 RGFO Oil and Gas Statistics.

Description	Federal	% Federal	% CARMMS-High	% CARMMS-Low
New Wells (Spuds)	134	16.8%	79.9%	2168.3%
Active Wells	886	3.0%	49.5%	211.3%
Oil Production (bbl)	8,365,219	5.4%	69.1%	160.7%
Gas Production (mcf)	30,952,671	2.8%	95.5%	324.1%

For 2022, federal spuds in the RGFO were about 80% and active well counts around half of the CARMMS high scenario. Since tracking began in 2016, spuds have averaged 44% of the high scenario. In general, spuds are a surrogate for construction emissions, thus report year emissions from construction would be expected to be around 80% of the CARMMS high scenario. With active well counts about half of the high scenario, active well emissions should be below those projected in CARMMS. Figure 21 and Figure 22 show that RGFO federal production has been increasing and is currently about 69% and 96% of the high scenario for oil and gas, respectively. While spuds and well counts have been below the high scenario, the production totals on a per well basis are considerably higher than what was estimated for CARMMS. First year production during 2022 was approximately 29% and 24% for oil and gas, respectively, with both values the highest observed since 2016.

Federal development in the RGFO has been tracking below the high scenario pace based solely on new well counts. However, initial production from these wells is much higher than anticipated and is likely an artifact from the switch over from vertical to horizontal development that makes up the majority of new well bores in the area and may have not been fully captured within the BLM's original CARMMS 2.0 production estimates. Overall, the RGFO emissions are tracking around the medium CARMMS scenario, but VOCs have likely been above the high scenario for the past several years.

The major air quality issues in the RGFO are the ozone NAA and the elevated nitrogen deposition rates at Rocky Mountain National Park. Most new oil and gas development is occurring within the ozone NAA area or just north and east of the NAA boundary. This trend is concerning for the future of federal mineral development given the redesignation of the area to severe in 2023. Development occurring in the NAA is subject to the general conformity rule, and as such BLM project level analyses for federal permit actions that comply with the rule do not cause or contribute to continuing exceedances and violations. The decrease in de minimis levels from 50 tpy to 25 tpy due to the recent severe redesignation is likely to have a considerable impact on the BLM's ability to approve projects under the general conformity rules using existing methodologies. More information on the Denver NAA is available from the CDPHE's Severe Ozone Planning website.

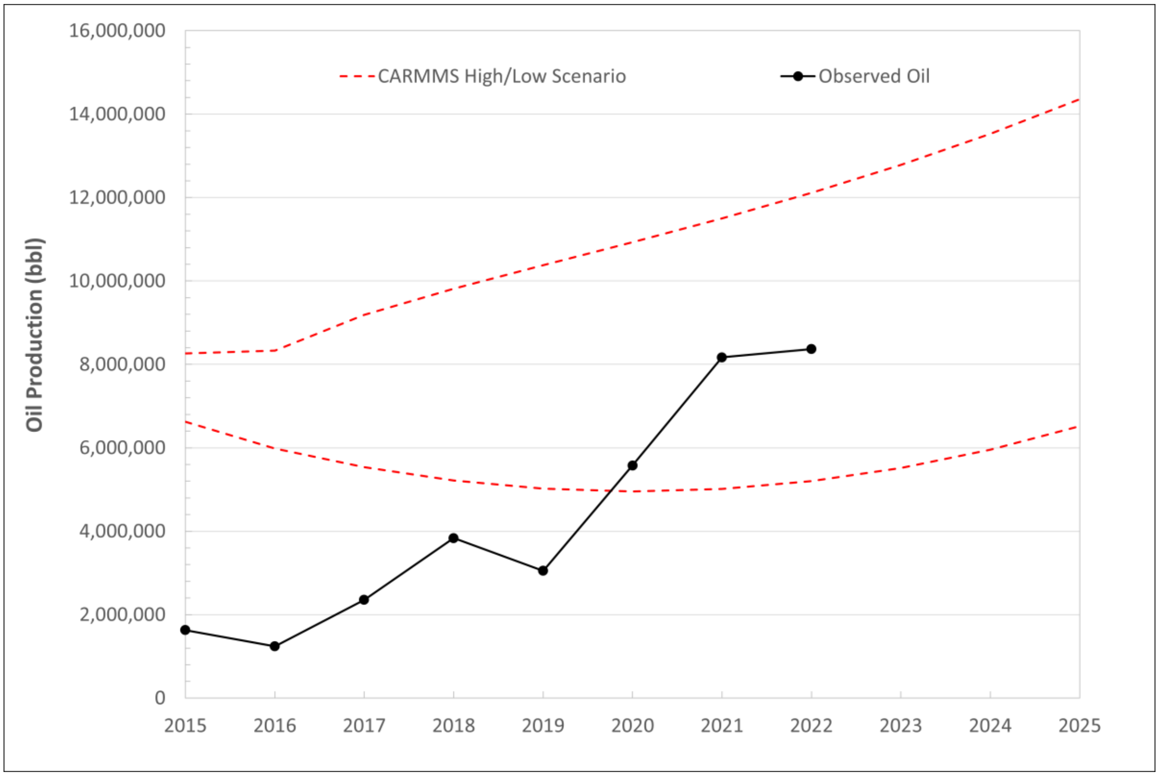

Figure 21. RGFO Oil Production vs. CARMMS Scenarios.

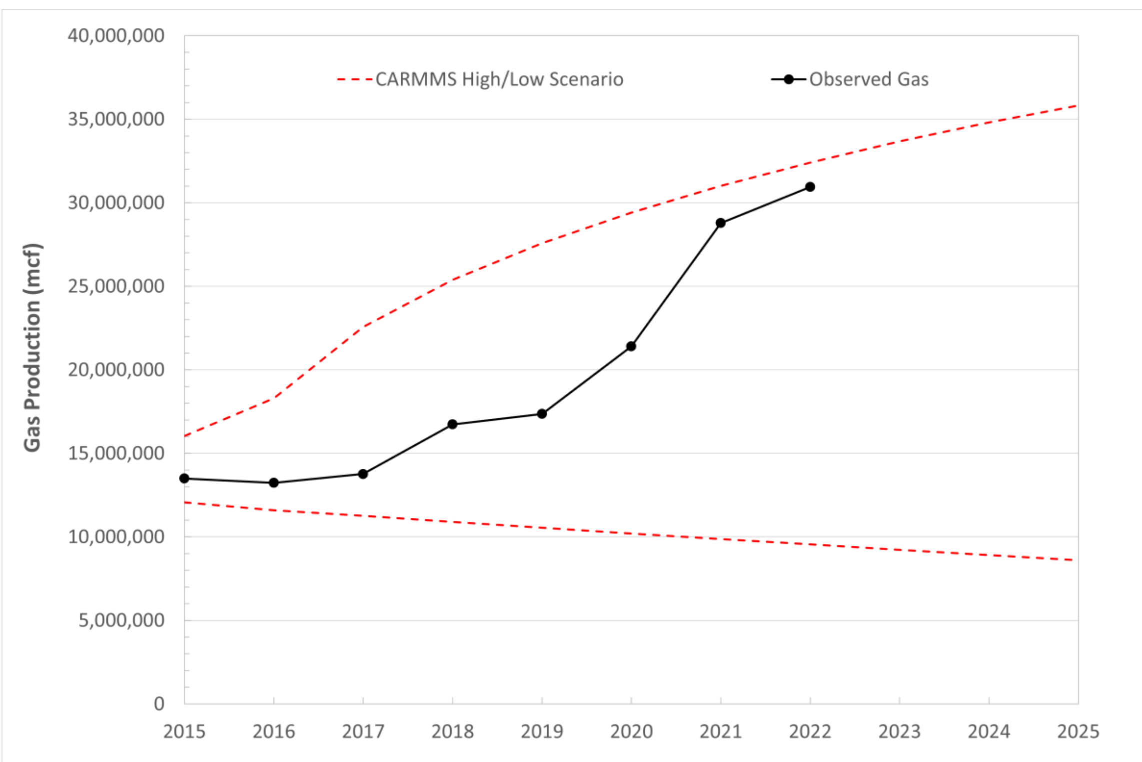

Figure 22. RGFO Gas Production vs. CARMMS Scenarios.

5.6.2 Royal Gorge Field Office Air Trends

The Field Office spans four of the CDPHE's air quality regions, including the Denver Metro - Northern Front Range, Eastern High Plains, South Central, and Pikes Peak areas. The Eastern High Plains, Pikes Peak, and South Central regions comply with federal air quality standards, but the state's most challenging air quality issue exists in and around the Denver metropolitan area.

The Denver Metro/North Front Range contains much of Colorado's population with over 4 million people living in the area according to the 2020 U.S. Census. Since 2002, the region has complied with all NAAQS, except for ozone. Unfortunately, it has been surpassing the EPA's ozone standards since the early 2000s. In 2007, the region received NAA status which persisted until 2012 when the EPA labeled the region as a "marginal" NAA due to the adoption of a more stringent ozone standard in 2008. In 2015, the EPA revised primary and secondary 8-hour ozone standards to a level of 0.070 ppm. Subsequently, in June 2018, the region was classified 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. However, the region failed to meet this standard, leading to a reclassification as a "serious" NAA under the 2008 ozone standard in January 2020. The attainment deadline for the 2008 standard was July 20, 2021, based on 2018-2020 ozone season data. Failing to attain this standard, the area was recently downgraded to a "severe" NAA for ozone.

Historically, the Denver-metropolitan area has violated health-based air quality standards for carbon monoxide and fine particles. In response, air quality improvement plans were developed and implemented to mitigate these pollutants. Fort Collins, Longmont, and Greeley in the Northern Front Range were NAAs for carbon monoxide in the 1980s and early 1990s but have adhered to federal standards since 1995.

The vast majority of air quality monitoring within Colorado is conducted near and within the Denver metropolitan region. During 2022, there were 50 air quality and meteorological monitors at 25 individual sites in the Northern Front Range Region. There were six CO monitors, 15 O_3 monitors, seven NO_2 monitors, three SO_2 monitors, as well as six PM_{10} monitors, 13 $PM_{2.5}$ monitors, and 14 meteorological towers. There were also two air toxics monitoring sites, one located at CAMP (downtown Denver), and one at Platteville. The CAMP site monitors urban air toxics, while the Platteville site monitors air toxics in a region of oil and gas development.

There is considerable AQI variability for the fourteen RGFO counties with available data (Table 11). The average of the fourteen counties is around 70% of days classified as good for the most recent three-year period (2020-2022). The best air quality within the RGFO is in Fremont County, where 98% of days had good air quality, followed by Prowers and Pueblo counties where nearly 95% of days had good air quality. In contrast, Denver County only had about half of the days with a good AQI. A relatively high percentage of days, from 4% to 9%, had air quality characterized as unhealthy for sensitive groups.

None of the locations within the RGFO are at risk of violating the annual $PM_{2.5}$ standard (Table 12), but there have been recent exceedances of the 24-hour $PM_{2.5}$ standard in Boulder and Douglas counties (Table 13). The NO_2 data show that concentrations are highest in Denver County, where 1-hour values have been around 70% of the NAAQS (Table 14). For the annual average, the maximum monitor is trending near 50% of the NAAQS (Table 15). No exceedances were recorded for either form of the NO_2 standard. Figure 2-14 and Figure 2-15 from the 2022 CDPHE Air Quality Data Report shows that NO_2 has decreased markedly at the CAMP and Welby locations over the past few decades. Most of the area PM_{10} monitors are well below the NAAQS at approximately 60%, where the highest readings are typically not more than 120 ug m^{-1}. In 2022, PM_{10} exceedances were recorded at two RGFO locations – Pueblo and Lamar – with three events in Pueblo and two events in Lamar. Each of the RGFO counties has ozone design values higher than the NAAQS (Table 16). More information on the spatial and temporal variability of ozone across the Denver metro area can be found in Section 4.2.3 of the 2022 CDPHE Air Quality Data Report.

Visibility monitoring at Rocky Mountain National Park (ROMO1) since 1991 indicates improvement on both the clearest and most impaired days (Figure 7). The haze index for the most impaired days has decreased by about 0.14 dv per year since 1991, resulting in approximately 4.5 dv improvement. Visibility trends at the park demonstrate progress towards the 2064 endpoint established in the latest RHR guidance.

Eleven locations within the RGFO have NTN monitoring sites (Table 19) with recent values ranging from 1.55 kg ha^{-1} to 3.99 kg ha^{-1}. Nitrogen deposition in the field office has generally remained unchanged over the period of observation at most locations and remains elevated above NPS standards and critical loads for aquatic eutrophication, tree growth and mycorrhizal communities.

5.7 Tres Rios Field Office

The TRFO is in the southwest corner of Colorado and oversees the administration of more than 600,000 acres of public surface lands and 2.6 million acres of subsurface federal mineral estate. The TRFO also has trust responsibility for mineral management on 800,000 acres of Tribal lands. The TRFO consists of Archuleta, Dolores, La Plata, and Montezuma counties in their entirety and contains portions of Hinsdale, Mineral, San Juan, and San Miguel counties. The major population centers include the cities of Cortez, Durango and Pagosa Springs. The RMP providing direction for the TRFO management actions was finalized in 2015 and includes provisions to protect air quality and AQRVs by complying with applicable federal, state, and local air quality laws, regulations, standards, and implementation plans.

5.7.1 Tres Rios Field Office Oil and Gas Development and Production

In 2022, there were 11 federal spuds in the TRFO, which is less than a third of the CARMMS high scenario (Table 37). Over the past seven years, spuds have been about 16% of the high scenario. Active wells are currently 56.5% of the high scenario. Total oil production was less than the low scenario through 2020 but has since increased above both scenarios, though the range between the two cases is quite narrow (Figure 23). Total (new and existing) gas production is very high compared to CARMMS scenarios (Figure 24), but this is almost entirely from existing (pre-CARMMS) sources as first year gas production in the TRFO has been less than one percent of the total since 2016. Accordingly, new federal oil and gas emissions have been well below the high CARMMS scenario as discussed in the 2020 BLM Colorado Air Annual Report (BLM, 2021).

Table 37. 2022 TRFO Oil and Gas Statistics.

Description	Federal	% Federal	% CARMMS-High	% CARMMS-Low
New Wells (Spuds)	11	61.1%	31.5%	263.7%
Active Wells	402	10.8%	56.5%	81.0%
Oil Production (bbl)	62,228	61.7%	107.3%	122.8%
Gas Production (mcf)	257,018,522	47.6%	391.5%	845.5%

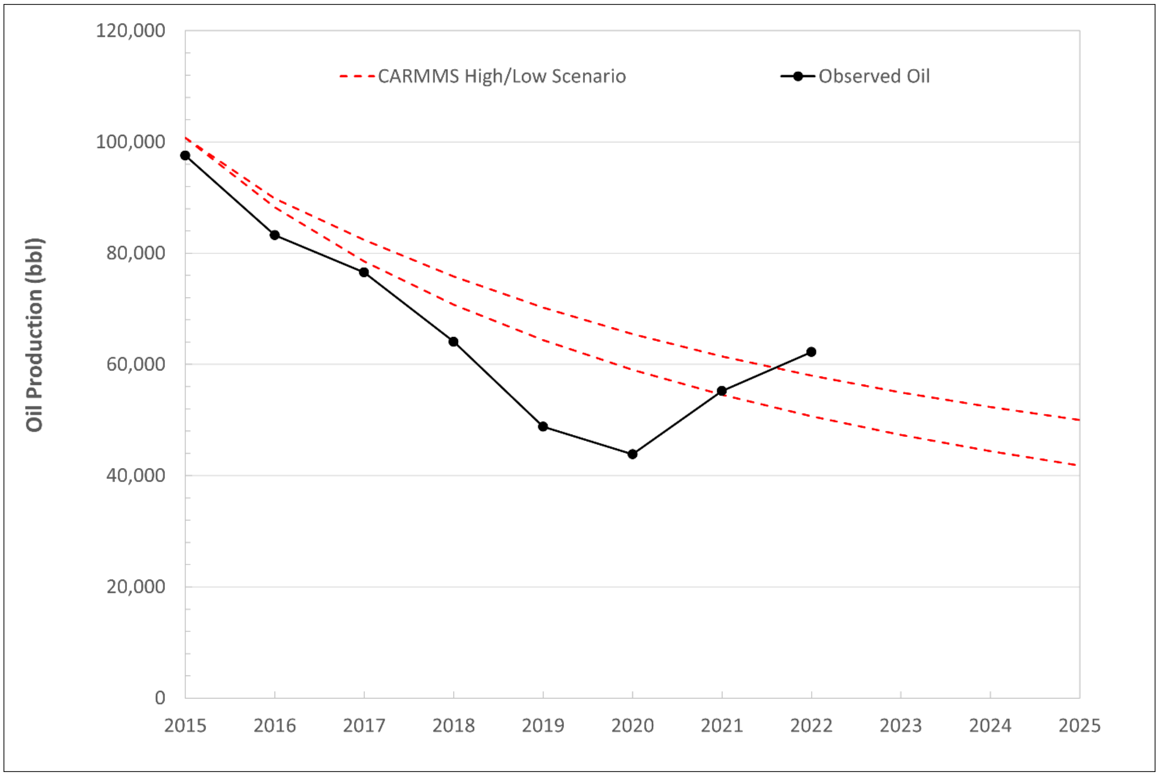

Figure 23. TRFO Oil Production vs. CARMMS Scenarios.

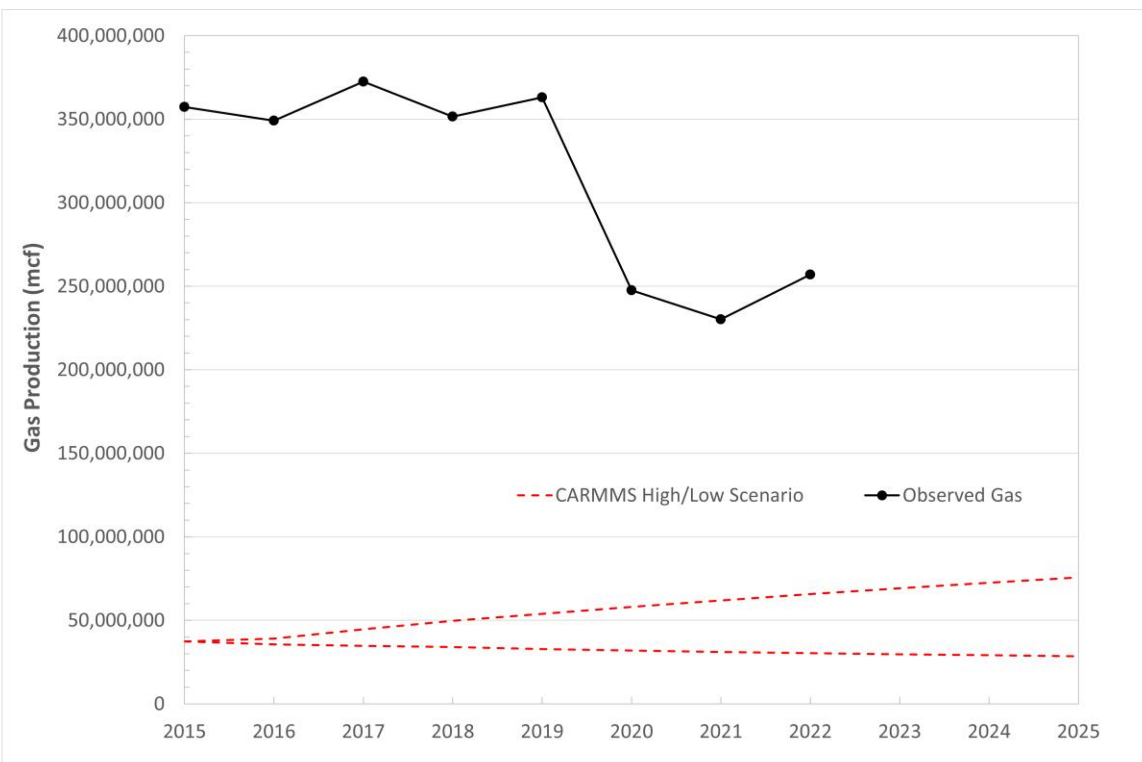

Figure 24. TRFO Gas Production vs. CARMMS Scenarios.

5.7.2 Tres Rios Field Office Air Trends

The TRFO is mostly contained within the CDPHE's Southwestern and Western Slope air quality regions. Air quality within the field office is designated as attainment and is in full compliance with the NAAQS for the report year. The TRFO has two PM_{10} maintenance areas around the towns of Pagosa Springs and Telluride. There is good air quality monitoring coverage throughout the TRFO with observations of CO, NO_2, PM_{10}, O_3, and SO_2 available. Additionally, the field office has three IMPROVE sites (Table 17).

The AQI data in Table 11 indicates that the best air quality in the TRFO is in San Juan and San Miguel counties where 98% of days between 2020 and 2022 had a good AQI. In La Plata County where the TRFO's largest city Durango is located, the AQI was good on 73% of days for the same period. Ozone is the primary pollutant of concern for most days throughout the TRFO, though occasionally particulate matter is the chief pollutant.

The NO_2 design values for the TRFO in Table 14 and Table 15 show that concentrations are low and far below the NAAQS. Ozone is elevated in the TRFO but below the NAAQS with values between 0.064 ppm and 0.066 ppm (Table 16) and no exceedances were recorded in 2022. Figure 4-39 in the 2022 CDPHE Air Quality Data Report indicates that ozone concentrations have remained relatively unchanged over the past decade.

Visibility within the TRFO can be assessed with three IMPROVE sites – Mesa Verde NP (MEVE1), Shamrock Mine (SHMI1), and Weminuche Wilderness (WEME1). At each of the locations, there has been a statistically significant decrease in haze on the clearest and most impaired days (Table 18).

Nitrogen deposition is monitored at three locations in the TRFO – Wolf Creek Pass (CO91), Molas Pass (CO96), and Mesa Verde NP (CO99) – with recent values between 1.61 kg ha^{-1} and 2.31 kg ha^{-1} (Table 19). Nitrogen deposition is relatively unchanged at CO99 while missing data at CO91 and CO96 preclude a definitive trend assessment. In general, nitrogen deposition is elevated above NPS benchmark standards, but near or below critical loads for many ecosystem components as described in (Pardo, et al., 2011) and (Bowman, Murgel, Blett, & Porter, 2012). Overall, air resources is meeting the objectives of the governing RMP and BLM's adaptive management strategy.

5.8 Uncompahgre Field Office

The UFO manages nearly 900,000 surface acres of public land in BLM Colorado's Southwest District and provides administrative services for approximately 971,000 acres of federal subsurface mineral estate within the planning area. The UFO encompasses a majority of Delta, Ouray, and Montrose counties, and portions of Mesa, San Miguel, and Gunnison counties. The major population center is the city of Montrose, located in the center of the field office.

5.8.1 Uncompahgre Field Office Oil and Gas Development and Production

As in the previous six years, there were no federal spuds in the UFO during 2022 (Table 38). Accordingly, construction emissions have been far less than modeled in the CARMMS high scenario. Active well counts have also been far below the high scenario and there has been very little oil production. Gas production has consistently been near or below the low scenario. There has been almost zero federal development in the TRFO over the monitoring period. Therefore, emissions continue to track below the CARMMS low scenario as described in the 2020 BLM Colorado Air Annual Report (BLM, 2021). In general, air resource values are meeting the objectives of the governing RMP and BLM's adaptive management strategy.

Table 38. 2022 UFO Oil and Gas Statistics.

Description	Federal	% Federal	% CARMMS-High	% CARMMS-Low
New Wells (Spuds)	0	-	-	-
Active Wells	46	69.7%	16.0%	119.2%
Oil Production (bbl)	171	49.0%	0.3%	7.6%
Gas Production (mcf)	3,206,287	67.7%	15.1%	119.4%

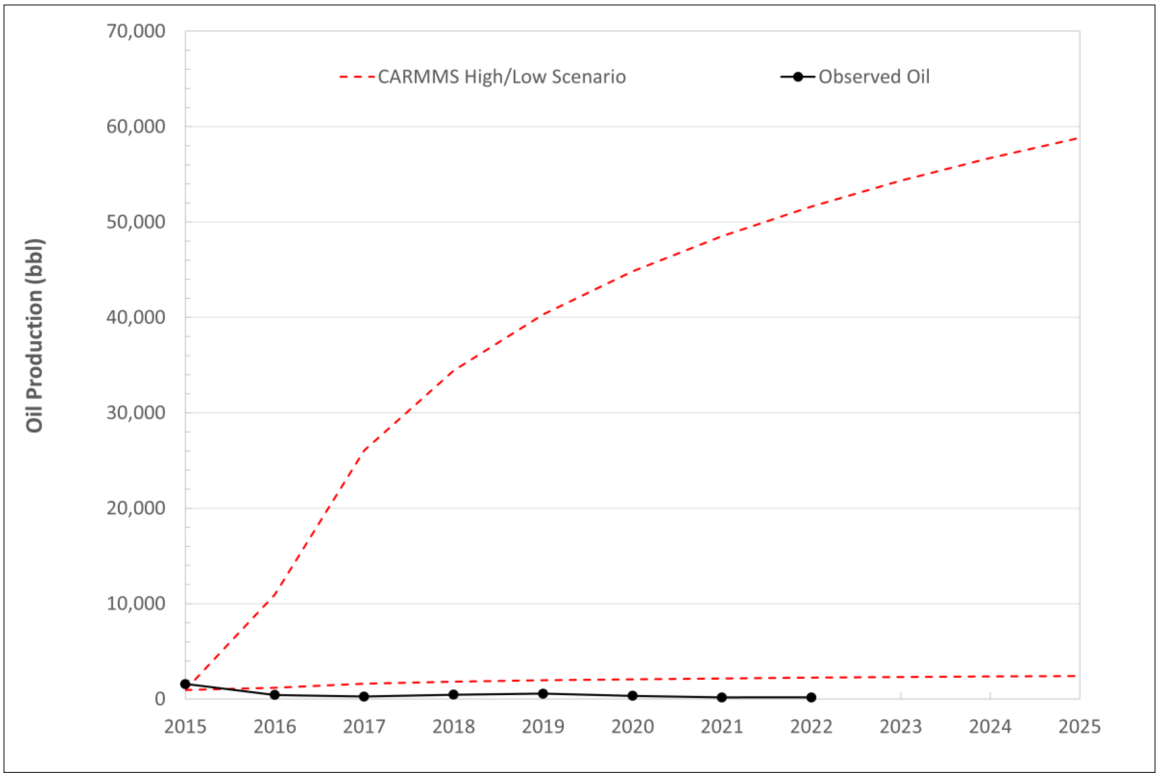

Figure 25. UFO Oil Production vs. CARMMS Scenarios.

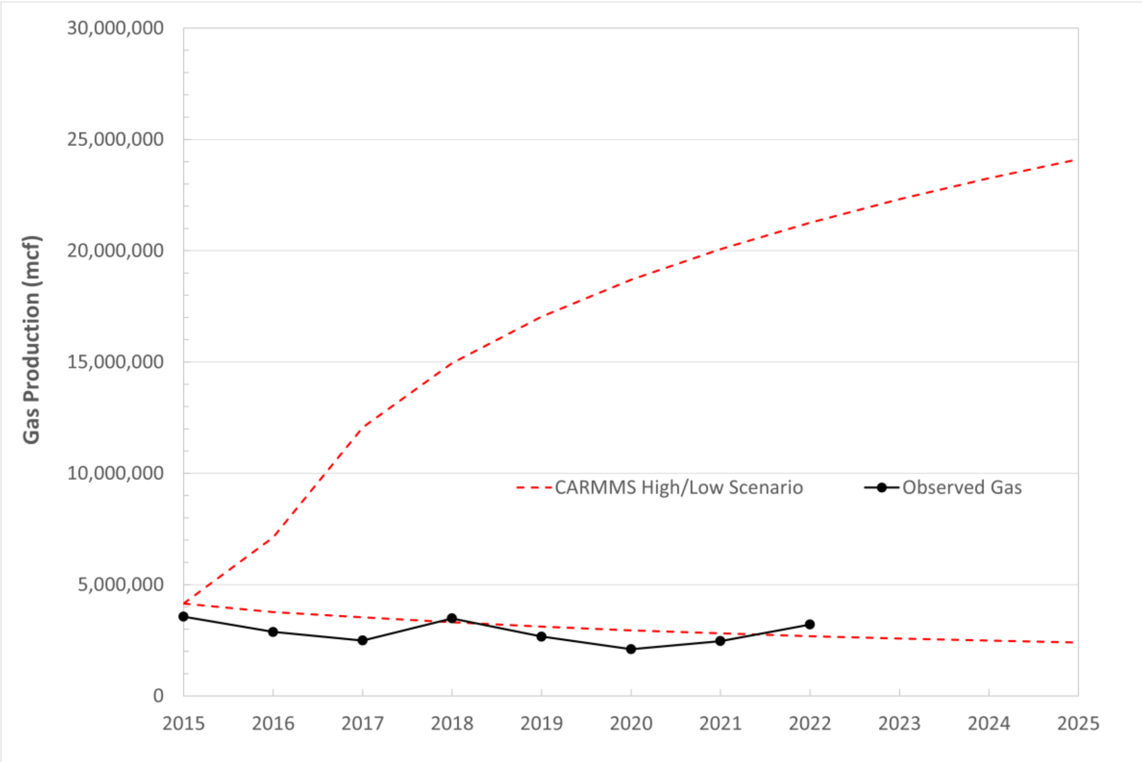

Figure 26. UFO Gas Production vs. CARMMS Scenarios.

5.8.2 Uncompahgre Field Office Air Trends

The UFO is mostly contained within the CDPHE's Western Slope air quality region with a small portion in the adjacent Central Mountain region. Air quality within the UFO is in attainment and is in full compliance with the NAAQS for the report year. The field office does not have any maintenance areas. Air quality monitoring is limited to just a few locations in the UFO. Telluride has a PM_{10} monitor. Ozone monitoring is conducted at Norwood in the southern part of the field office and in the northeastern portion at McClure Pass. There is also ozone monitoring just west of the field office at the base of Grand Mesa and to the east at Gothic. The Paonia monitor collected data through 2021 and has been relocated to North Park in the KFO.

The AQI information for the UFO (Table 11) shows that good air quality conditions prevailed on 86% and 82% of the days over the previous three years in Delta and Gunnison counties, respectively. The primary pollutant of concern for each county is ozone. While NO_2 observations in the UFO ceased with the relocation of the Paonia monitor, the previously recorded data show that typical values were about 25% of the 1-hour standard and about 10% of the annual NO_2 standard. During 2022, there were no NAAQS exceedances of PM_{10} recorded at the Telluride site and the highest 24-hour value was 89 µg m^{-3}. There is no apparent trend in PM_{10} concentration in Telluride as shown in Figure 4-40 of the [2022 CDPHE Air Quality Data Report](). There is no $PM_{2.5}$ monitoring in the UFO, but area monitors typically record values less than 50% of the NAAQS. Ozone design values are elevated at 0.065 ppm, or 93% of the NAAQS, which is slightly lower than observed a few years ago (Table 16).

There are no IMPROVE sites in the UFO, but the White River NF (WHRI1) and Weminuche Wilderness (WEMI1) sites are proximate to the field office and provide representative visibility information. There has been a statistically significant improvement in visibility on the clearest and most impaired days at both IMPROVE monitors (Table 18), demonstrating progress towards 2064 RHR goals.

The most representative nitrogen deposition monitor for the UFO is in Gothic (CO10) where total nitrogen deposition has averaged 1.29 kg ha^{-1} over the past five years, ranging from 1.04 kg ha^{-1} to 1.51 kg ha^{-1}. While this is a relatively low amount of nitrogen deposition that is generally less than critical loads for various ecosystem components, it is slightly higher than the NPS benchmark standard of 1 kg ha^{-1}. There is no long-term trend apparent at the Gothic NTN site.

With oil and gas development and production tracking at or below the CARMMS low scenario and generally good prevailing air quality conditions, UFO air resources is meeting the objectives of the governing RMP and BLM's adaptive management strategy.

5.9 White River Field Office

The WRFO is part of the BLM Colorado Northwest District and provides administration for more than one million surface acres of public land in Rio Blanco, Moffat, and Garfield counties. The federal mineral estate in the WRFO in nearly twice that amount. The major urban areas in the WRFO include the towns of Rangely and Meeker. The RMP providing direction for the WRFO management actions was amended and finalized in 2016. The RMP contains provisions to protect air quality and AQRVs by complying with applicable federal, state, and local air quality laws, regulations, standards, and implementation plans.

5.9.1 White River Field Office Oil and Gas Development and Production

In 2022, there were 47 federal spuds, which is just under 8% of the CARMMS high scenario and much less than the low scenario (Table 39). Since tracking began in 2016, there have been about 25 spuds per year on average, which is approximately one-third of the low scenario and only 4% of the high scenario. Active well counts are also much less than either the high or low scenario. Total federal oil production in the WRFO has been slightly higher than the low scenario (Figure 27) while federal gas production has consistently been less than the low scenario (Figure 28). Federal development in the WRFO has been exceptionally low over the monitoring period, such that field office emissions are tracking well below the low CARMMS scenario levels.

Table 39. 2022 WRFO Oil and Gas Statistics.

Description	Federal	% Federal	% CARMMS-High	% CARMMS-Low
New Wells (Spuds)	47	87.0%	7.8%	62.7%
Active Wells	2,643	91.4%	34.0%	64.5%
Oil Production (bbl)	1,578,333	50.8%	61.4%	111.6%
Gas Production (mcf)	51,784,418	44.7%	14.2%	57.2%

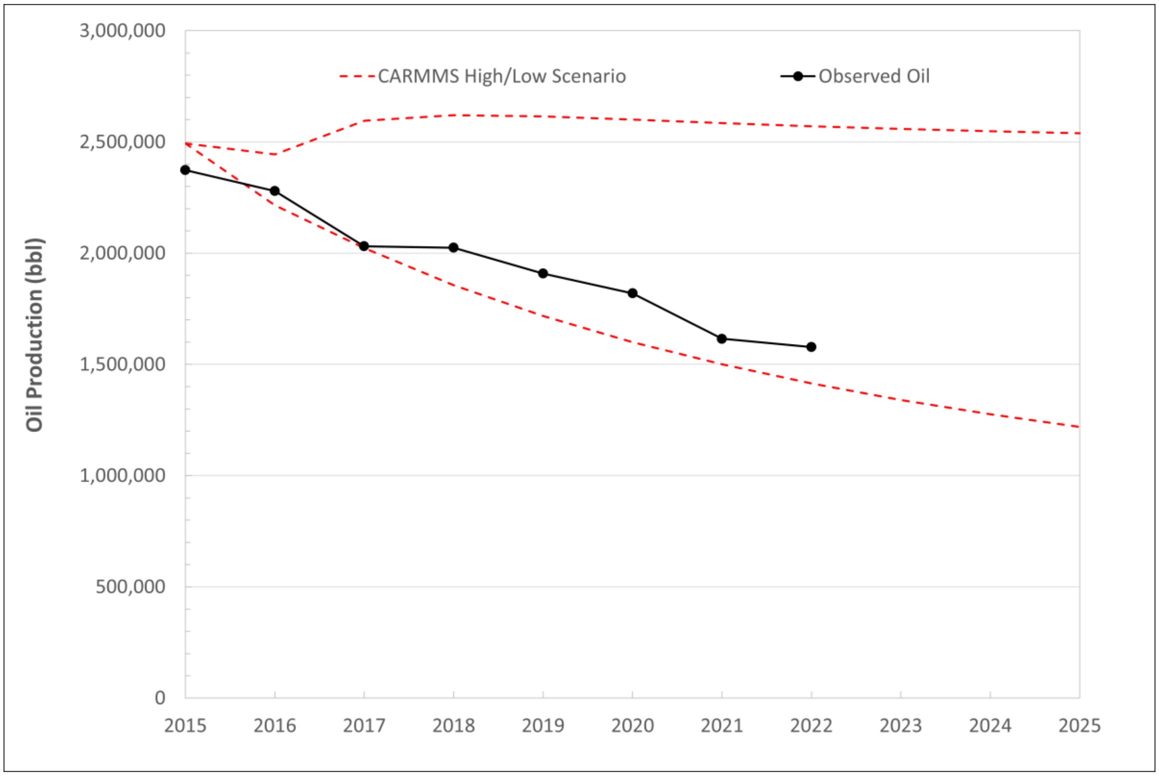

Figure 27. WRFO Oil Production vs. CARMMS Scenarios.

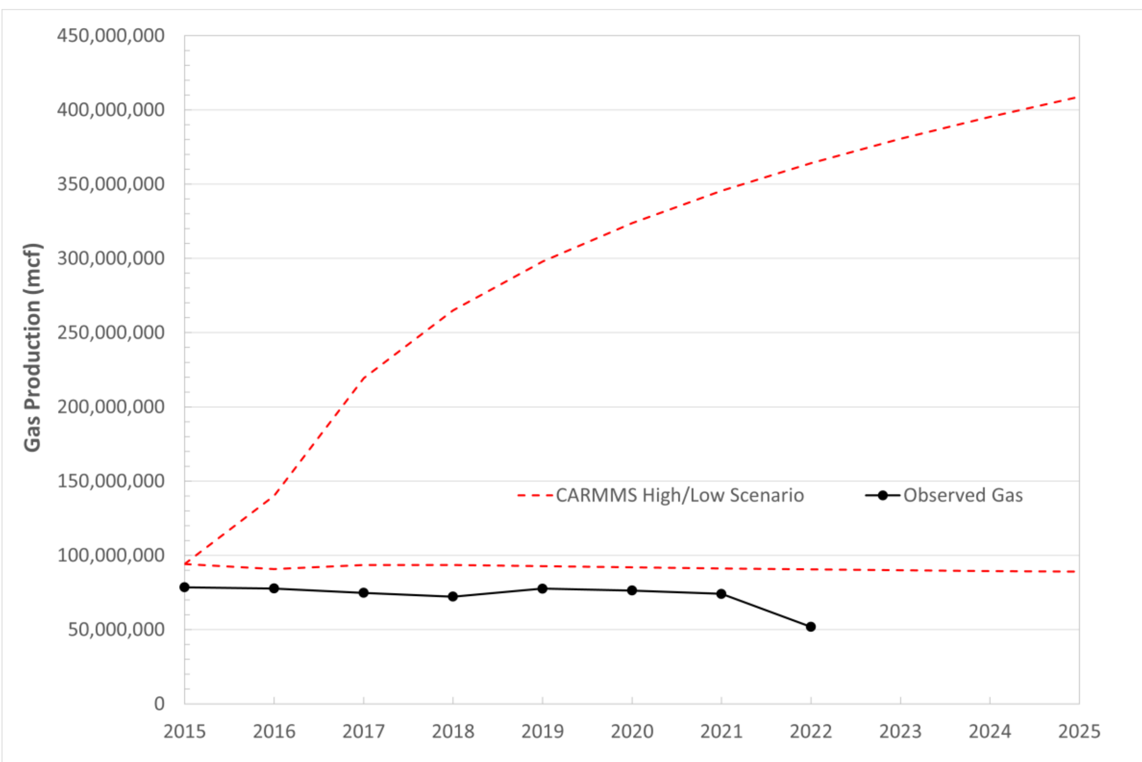

Figure 28. WRFO Gas Production vs. CARMMS Scenarios.

5.9.2 White River Field Office Air Trends

The WRFO is entirely contained within the CDPHE's Western Slope air quality region. The region is designated as in attainment and is in full compliance with the NAAQS for the report year. The field office is also free from any maintenance areas. The WRFO has two BLM-sponsored air quality monitors located in Rangely and the Piceance Basin that collect meteorological data and monitor for ozone, $PM_{2.5}$, and NO_2. There is also ozone monitoring in the far eastern portion of the field office at Ripple Creek Pass.

Air quality was considered good on 73% of days over the past three years in Rio Blanco County with ozone the primary pollutant of concern on most days (Table 11). The $PM_{2.5}$ data show that levels are approximately 70% of the annual NAAQS and 60% of the 24-hour NAAQS. The annual NO_2 design value is 20% of the NAAQS while the 1-hour value is less than 2%. Ozone is the primary concern in the field office with the most recent design value of 0.065 ppm, or 93% of the NAAQS.

The Flattops (FLTO1) IMPROVE monitor within the field office is no longer active but observed conditions for the nine years (2012 – 2020) of monitoring indicate that visibility on the clearest days was only slightly above natural conditions and prevailing visibility in the absence of wildfire smoke was very good (Figure 3). The nearest two active IMPROVE sites – Mount Zirkel (MOZO1) and White River NF (WHRI1) – have observed statistically significant improvement in visibility (Table 18) on the most impaired and clearest days and have the lowest haze indices observed in Colorado.

There are no NTN or CASTNET sites in the WRFO thus the two nearest locations – Four Mile Park (CO08) and Sand Spring (CO15) – are likely the most representative of conditions in the field office. While nitrogen deposition at the Four Mile Park location is relatively low, it has increased from about 1 kg ha^{-1} to 1.5 kg ha^{-1} since monitoring began in 1988. At Sand Spring, there is no long-term trend and typical values range from 0.8 kg ha^{-1} to 1.4 kg ha^{-1}, with the five most recent annual data showing 1.23 kg ha^{-1}. The level of nitrogen deposition is low compared to other sites in Colorado (Table 19) and generally lower than critical loads thresholds. However, deposition is slightly above the NPS benchmark standard of 1 kg ha^{-1} indicating some ecosystem components could be degraded.

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