

BLM AIR RESOURCES
TECHNICAL REPORT FOR OIL
AND GAS DEVELOPMENT IN
NEW MEXICO, OKLAHOMA,
TEXAS, AND KANSAS

2022

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1. INTRODUCTION

The purpose of this document is to present, discuss, and summarize technical information regarding air quality, air quality–related values, greenhouse gas (GHG) emissions and climate change relative to air resources with the Bureau of Land Management (BLM) New Mexico State Office (NMSO) Planning Areas (New Mexico, Oklahoma, Texas, and Kansas). Much of the information contained in this document is directly related to air quality in the context of oil and gas development; other information is generalized air quality data that can be applied to other development scenarios and assessments. This information can then be incorporated by reference into National Environmental Policy Act (NEPA) documents, such as leasing-level documents, and site-specific documents, such as Applications for Permit to Drill (APDs), as necessary.

Because the BLM manages extensive land holdings in New Mexico, far more of its activities are centered there than in other areas. The BLM has jurisdiction over mineral rights on federal lands managed by other agencies and on split estate lands in Kansas, Texas, and Oklahoma. Wherever possible, information for those states is included.

1.1 UPDATES, ADDITIONS, AND CHANGES FROM THE PREVIOUS REPORT

This section provides a list of updates, additions, and changes to the air resource technical report since the previous report.

- Fixed/edited minor grammar, spelling, formatting, and typographical errors.
- Added to regulatory discussion applicable to oil and gas operations to include the Federal Land Policy and Management Act (FLPMA) and NEPA.
- Added federal and state regulatory discussion.
- Added trend data for all criteria pollutants and hazardous air pollutants (HAPs).
- Added discussion of national pollutant trends.
- Expanded upon the health effects of certain pollutants.
- Updated to 2020 National Emissions Inventory (NEI) data and added a table with these data.
- Added an NEI data HAP section.
- Expanded on the HAP section to include the reference exposure levels (RELs), reference concentrations (RfCs), and a discussion of the HAP modeling study.
- Updated the Air Toxics Screening Assessment (AirToxScreen) section to reflect 2019 data and include 2017 and 2018 data as well.
- Removed discussion on the 2014 Western States Air Resources Council–Western Regional Air Partnership (WESTAR–WRAP).
- Removed discussion on the WRAP 2008 ozone study.
- Added discussion of the New Mexico Ozone Attainment Initiative (OAI) Photochemical Modeling Study.

- Added discussion of Colorado Air Resources Management Modeling Study (CARMMS) 2.0 northern New Mexico modeling study.
- Updated air emission calculators to single-well emission factors.
- The GHG section has been modified, incorporating the *2022 BLM Specialist Report on Annual Greenhouse Gas Emissions and Climate Trends* (<https://www.blm.gov/content/ghg/2022/>) (BLM Specialist Report) (BLM 2023a) and removing any outdated information.
- Added a discussion of the monetized impacts from GHG emissions.

1.2 AIR RESOURCES

Air quality, GHGs, and climate are components of air resources that may be affected by BLM applications, activities, and resource management. Therefore, the BLM must consider and analyze the potential effects of BLM and BLM-authorized activities on air resources as part of the planning and decision-making process. In particular, the activities surrounding oil and gas development are likely to have impacts related to air resources.

2 AIR QUALITY REGULATORY ANALYSIS

The Clean Air Act (CAA), as amended, is the primary authority for regulation and protection of air quality in the United States. The Federal Land Policy and Management Act (FLPMA) also charges the BLM with the responsibility to protect air and atmospheric values. Additionally, each state, tribal, or local government holds additional authority for regulating air quality within their unique jurisdiction.

2.1 CLASS I, II, AND III AREAS AND THE CLEAN AIR ACT

All areas of the United States not specifically classified as Class I by the CAA are considered Class II for air quality. Class I areas are afforded the highest level of protection by the CAA and include all international parks, national wilderness areas and national memorial parks greater than 5,000 acres, and national parks greater than 6,000 acres that were in existence on August 7, 1977. Moderate amounts of air quality degradation are allowed in Class II areas. Although the CAA allows for designation of Class III areas where greater amounts of degradation would be allowed, no areas have been designated as such by the U.S. Environmental Protection Agency (EPA). Air quality in a given area is determined by comparing monitored air pollution levels using air monitoring equipment operated in accordance with federal regulatory standards with National Ambient Air Quality Standards (NAAQS) for six regulated air pollutants defined in the CAA. In some cases, states have set their own ambient air quality standards in accordance with provisions of the CAA.

2.2 FEDERAL LAND POLICY AND MANAGEMENT ACT

The FLPMA of 1976 [43 United States Code [U.S.C.] §§ 1701-1785], often referred to as the BLM “Organic Act,” provides most of the BLM legislated authority, direction policy, and basic management guidance. This Act outlines the BLM 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 Organic 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” (Section 102 [43 U.S.C. § 1701] (a) (8)). To fulfill this responsibility, BLM land use plans ensure

“compliance with applicable pollution control laws, including state and federal air, water, noise, or other pollution standards or implementation plans” (Section 202 [43 U.S.C. § 1712] (a)(8)). Accordingly, BLM leases and operating permits for fossil fuels require compliance with all state and federal air pollution standards. FLPMA also gives the BLM authority to revoke or suspend any BLM-authorized activity that is found to be in violation of regulations applicable to public lands and/or in noncompliance with applicable state or federal air quality standards or implementation plans, thus ensuring that the BLM can provide for compliance with applicable air quality standards, regulations, and implementation plans (Section 302(c) [43 U.S.C. § 1732]). When authorizing activities, the BLM assumes full compliance with applicable state and federal air quality requirements and emissions standards, and related equipment and performance standards in effect at the time.

2.3 NATIONAL ENVIRONMENTAL POLICY ACT

The NEPA of 1969 (42 U.S.C. § 4321 et seq.) 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 NEPA is to “promote efforts which will prevent or eliminate damage to the environment and biosphere” and to promote human health and welfare. NEPA 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) [42 U.S.C. § 4321]). 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) [43 U.S.C. § 4321]).

2.4 ADDITIONAL GUIDANCE

Other guidance and policies are useful for the BLM in managing air resources. Although this guidance is not required by law, it can be useful for managing and analyzing air resources. Such guidance includes:

- Council on Environmental Quality (CEQ) guidance on NEPA analysis,
- CEQ NEPA guidance on consideration of GHG emissions and climate change from January 2023,
- The Federal Land Managers Air Quality Related Values Work Group (FLAG),
- 2022 BLM Specialist Report (BLM 2023a),
- The Mineral Leasing Act (MLA) of 1920 (30 U.S.C. § 181 et seq.),
- Executive Orders (EOs) 13990 and 14008,
- The Global Change Research Act of 1990 (Public Law 101–606; 104 Statute 3096–3104),
- BLM guidance for conducting air quality general conformity determinations (Instruction Memorandum No. 2013-025 – *Guidance for Conducting Air Quality General Conformity Determinations* [BLM 2012] and BLM Information Bulletin 2014-084 – *Issuance of the Bureau of Land Management Fact Sheet on the Air Quality General Conformity Rule* [BLM 2014a]).

For detailed information on many of these laws and policies and their relationship to mitigation of climate change, refer to Section 2.0 of the BLM Specialist Report (BLM 2023a).

2.5 FEDERAL RULES

The EPA has the primary responsibility for regulating atmospheric emissions, including six nationally regulated air pollutants defined in the CAA. These pollutants, referred to as “criteria pollutants,” are carbon monoxide (CO), nitrogen dioxide (NO₂) (and nitrogen oxides¹ [NO_x]), ozone (O₃), particulate matter smaller than 2.5 micrometers in diameter (PM_{2.5}), particulate matter smaller than 10 micrometers in diameter (PM₁₀), sulfur dioxide (SO) (and sulfur oxides [SO_x]), and lead (Pb).

The EPA New Source Performance Standards (NSPS) rules (under 40 Code of Federal Regulations [C.F.R.] § 60) are designed to regulate criteria air pollutant and O₃ precursor emissions. The EPA NSPS regulations that are most likely to have applicability to oil and gas operations are as follows:

- Subpart JJJJ – Standards of Performance for Stationary Spark Ignition Internal Combustion Engines
- Subpart Kb – Standards of Performance for Volatile Organic Liquid Storage Vessels (including Petroleum Liquid Storage Vessels) for which Construction, Reconstruction, or Modification Commenced After July 23, 1984
- Subpart OOOO (amended) – Standards of Performance for Crude Oil and Natural Gas Production, Transmission and Distribution
- Subpart OOOOa – Standards of Performance for Crude Oil and Natural Gas Facilities for which Construction, Modification, or Reconstruction Commenced after September 18, 2015: NSPS – Originally this rule and its draft was promulgated to regulate volatile organic compounds (VOCs) and GHG emissions (methane [CH₄]) from specific sources within the oil and natural gas industry which would have included new, modified, and reconstructed compressors, pneumatic controllers, pneumatic pumps, storage vessels, well completions, fugitive emissions from well sites and compressor stations, and equipment leaks at natural gas processing plants. In September 2018 and August 2019, the EPA proposed changes to the rule to modify, amend and/or rescind requirements for the 2012 and 2016 NSPS for the Oil and Gas Industry, which have been incorporated into the final rule as of September 14, 2020.

Other relevant NSPS requirements under 40 C.F.R. § 60 include:

- Subpart GG – Standards of Performance for Stationary Gas Turbines
- Subpart IIII – Standards of Performance for Stationary Compression Ignition Internal Combustion Engines
- Subpart K – Standards of Performance for Storage Vessels for Petroleum Liquids for which Construction, Reconstruction, or Modification Commenced after June 11, 1973, and prior to May 19, 1978
- Subpart Ka – Standards of Performance for Storage Vessels for Petroleum Liquids for which Construction, Reconstruction, or Modification Commenced after May 18, 1978, and prior to July 23, 1984

¹ The nitrogen oxide family of compounds includes nitric oxide (NO), NO₂, nitrous acid (HNO₂), and nitric acid (HNO₃).

- Subpart KKK – Standards of Performance for Equipment Leaks of VOCs from Onshore Natural Gas Processing Plants for Which Construction, Reconstruction, or Modification Commenced after January 20, 1984, and on or before August 23, 2011
- Subpart KKKK – Standards of Performance for Stationary Combustion Turbines
- Subpart TTTT – Standards of Performance for Greenhouse Gas Emissions for Electric Generating Units

2.6 STATE RULES

Regulation and enforcement of the NAAQS has been delegated to the states by the EPA. Both the NAAQS and the New Mexico Ambient Air Quality Standards (NMAAQs) are shown in Table 1. Texas has state property line standards for SO₂ and certain non-criteria pollutants. Other than the addition of a 30-minute SO₂ state property line standard, which varies based on which county a project is in, there are no other differences between state standards and NAAQS in Texas. Oklahoma and Kansas do not have state standards that differ from the NAAQS.

The regulatory authority for air quality in New Mexico is the New Mexico Environment Department (NMED) Air Quality Bureau (NMED 2023a), except in Bernalillo County and on tribal lands. The City of Albuquerque/Bernalillo Air Quality Division has authority over air quality in Bernalillo County. The regulatory authority for air quality in Kansas is the Kansas Department of Health and Environment, Bureau of Air (Kansas Department of Health and Environment 2023). The regulatory authority for air quality in Oklahoma is the Oklahoma Department of Environmental Quality (ODEQ), Air Quality Division (AQD) (ODEQ 2023). The regulatory authority for air quality in Texas is the Texas Commission on Environmental Quality (TCEQ), Air Division (TCEQ 2023a).

Table 1. NAAQS and NMAAQs

Pollutant	NAAQS Primary Standards		NAAQS Secondary Standards		NMAAQs Level (Averaging Time)
	Level	Averaging Time	Level	Averaging Time	
CO	9 ppm (10 mg/m ³)	8-hour ⁽¹⁾	None	(n/a)	8.7 ppm (n/a)
	35 ppm (40 mg/m ³)	1-hour ⁽¹⁾	None	(n/a)	13.1 ppm (n/a)
Pb	0.15 µg/m ³	Rolling 3-month average ⁽²⁾	0.15 µg/m ³	Rolling 3-month average ⁽²⁾	None (n/a)
NO ₂ (or NO _x)	53 ppb (100 µg/m ³)	Annual (arithmetic average)	53 ppb (100 µg/m ³)	Annual (arithmetic average)	50 ppb (n/a)
	100 ppb (188 µg/m ³)	1-hour ⁽³⁾	None	n/a	100 ppb (24-hour)
PM ₁₀	150 µg/m ³	24-hour ⁽⁴⁾	150 µg/m ³	24-hour ⁽⁴⁾	*

Pollutant	NAAQS Primary Standards		NAAQS Secondary Standards		NMAAQS Level (Averaging Time)
	Level	Averaging Time	Level	Averaging Time	
PM _{2.5}	12.0 µg/m ³	Annual ⁽⁵⁾ (arithmetic average)	15.0 ug/m ³	Annual ⁽⁵⁾ (arithmetic average)	*
	35 µg/m ³	24-hour ⁽⁶⁾	35 µg/m ³	24-hour ⁽⁶⁾	*
O ₃	0.070 ppm (137 µg/m ³)	8-hour ⁽⁷⁾	0.070 ppm (137 µg/m ³)	8-hour ⁽⁷⁾	None (n/a)
SO ₂ (or SO _x)	75 ppb (196 µg/m ³)	1-hour ⁽⁸⁾	0.5 ppm ⁽¹⁾ (1,300 µg/m ³)	3-hour	0.02 ppm (annual)** 0.10 ppm (24-hour)**

Source: EPA (2023a); N.M.A.C. 20.2.3.

Notes:

n/a = not applicable.

µg/m³ = micrograms/ cubic meter.

mg/m³ = milligrams/cubic meter.

ppb = parts per billion.

ppm = parts per million.

*The New Mexico Environmental Improvement Board repealed the total suspended particle NMAAQS in N.M.A.C. 20.2.3, Ambient Air Quality Standards effective November 30, 2018, and therefore, total suspended particles will no longer be reported. A determination was made that the current state and federal air quality standards for PM₁₀ and PM_{2.5} are sufficiently protective of public health and that that the repeal of the total suspended particles standard will not result in deterioration of air quality.

** For additional standards of air quality related to sulfur compounds in specific areas such as Chino Mines Company smelter furnace stack at Hurley and the Pecos-Permian basin intrastate air quality control region, see N.M.A.C. 20.2.3 and Table 28 of this report.

⁽¹⁾ Not to be exceeded more than once per year.

⁽²⁾ Not to be exceeded.

⁽³⁾ To attain this standard, the 3-year average of the 98th percentile of the daily maximum 1-hour average at each monitor within an area must not exceed 100 ppb (effective January 22, 2010).

⁽⁴⁾ Not to be exceeded more than once per year on average over 3 years.

⁽⁵⁾ To attain this standard, the 3-year average of the weighted annual mean PM_{2.5} concentrations from single or multiple community-oriented monitors must not be exceeded.

⁽⁶⁾ To attain this standard, the 3-year average of the 98th percentile of 24-hour concentrations at each population-oriented monitor within an area must not exceed 35 µg/m³ (effective December 17, 2006).

⁽⁷⁾ To attain this standard, the 3-year average of the fourth-highest daily maximum 8-hour average O₃ concentrations measured at each monitor within an area over each year must not exceed 0.070 ppm.

⁽⁸⁾ To attain this standard, the 3-year average of the 99th percentile of the daily maximum 1-hour average at each monitor within an area must not exceed 75 ppb.

On May 25, 2021, in accordance with Governor Michelle Lujan Grisham’s EO 2019-003 (January 29, 2019), the New Mexico Energy, Minerals and Natural Resources Department (EMNRD) announced the release of the New Mexico Oil Conservation Division (NMOCD) Statewide Natural Gas Capture Requirements (Waste Prevention Rule), New Mexico Administrative Code (N.M.A.C.) 19.15.27.9, as part of the New Mexico statewide enforceable regulatory framework to secure reductions in oil and gas sector emissions and to prevent natural gas waste from new and existing sources.

Key provisions include prohibition of unnecessary venting and flaring of waste natural gas where it is technically feasible to route the gas to pipeline or to use this gas for some other beneficial purpose (such as on-site fuel consumption). In all cases, operators must flare rather than vent natural gas except where this is technically infeasible or would pose a safety risk. These provisions will reduce VOC emissions due to stringent limitations on natural gas venting which results in un-combusted VOC emissions. Additionally, it proposes that natural gas be recovered and reused rather than flared, which would result in reductions of VOCs, NO_x, CO, SO₂, GHGs, and PM emissions.

The NMED has developed the "Oil and Natural Gas Regulation for Ozone Precursors" (N.M.A.C. 20.2.50.1), which was published on July 26, 2022, with an effective date of August 5, 2022. Approximately 50,000 wells and associated equipment will be subject to this regulation. It is anticipated that the regulation will annually reduce VOC emissions by 106,420 tons, nitrogen oxide (NO) emissions by 23,148 tons, and CH₄ emissions by 200,000 to 425,000 tons. The regulation includes emissions reduction requirements for compressors, engines and turbines, liquids unloading, dehydrators, heaters, pneumatics, storage tanks, and pipeline inspection gauge launching and receiving. The regulation also encourages operators to stop venting and flaring and use fuel cells technology to convert CH₄ to electricity at the well site and incentivizes new technology for leak detection and repair.

3 CRITERIA AIR POLLUTANTS

The EPA has the primary responsibility for regulating criteria air pollutants (CO, NO₂ (or NO_x), O₃, PM_{2.5}, PM₁₀, SO₂ (or SO_x), and Pb). The CAA charges the EPA with establishing and periodically reviewing NAAQS for each criteria pollutant. Table 1 shows the current primary and secondary NAAQS and averaging time for each pollutant, as well as the New Mexico–specific NMAAQs for select pollutants. Primary standards are set to protect the public health with a margin of safety, and secondary standards are meant to protect environmental concerns such as air quality related values (AQRVs) (visibility, vegetation injury, etc.).

3.1 MONITORING DATA AND DESIGN VALUES

Criteria pollutants are monitored throughout various parts of the country. Monitors measure concentrations of pollutant in the atmosphere, and the results are often presented in parts per million (ppm) or micrograms per cubic meter (µg/m³). EPA and states periodically analyze and review monitor locations, discontinuing monitoring at locations where pollutant concentrations have been well below the standards and adding monitors in areas where pollutant concentrations may be approaching air quality standards. *Instantaneous on-demand* monitored outdoor air quality data collected from state, local, and tribal monitoring agencies can be obtained from the EPA Air Data webpage and interactive tool (EPA 2023b). Most air monitors are situated to measure air quality in both neighborhoods and industrial areas. A few stations are situated in rural areas by various federal agencies to monitor air quality conditions and trends at national parks and other public lands and to identify background concentrations away from major emission sources.

Another type of monitoring data is *annual average concentration(s)* measured at air monitors, which is then translated to annual design values to be consistent with the individual NAAQS (as shown in Table 1). A design value is a statistic representing the monitored concentration of a given pollutant in a given location, expressed in the manner of its standard, which can be compared with the NAAQS. Design values are normally updated annually and posted to the EPA Air Quality Design Value website. These

design values are intended for informational use only and does not constitute a regulatory determination by EPA as to whether an area has attained an NAAQS.

3.2 OZONE AND VOLATILE ORGANIC COMPOUNDS

Ground-level O_3 is not emitted directly into the air but is created by chemical reactions between precursors— NO_x and VOCs—in the presence of sunlight (Figure 1). Whereas O_3 and NO_2 are criteria air pollutants, VOCs are not. Figure 1 uses a graphical representation to show how O_3 is created in the atmosphere.

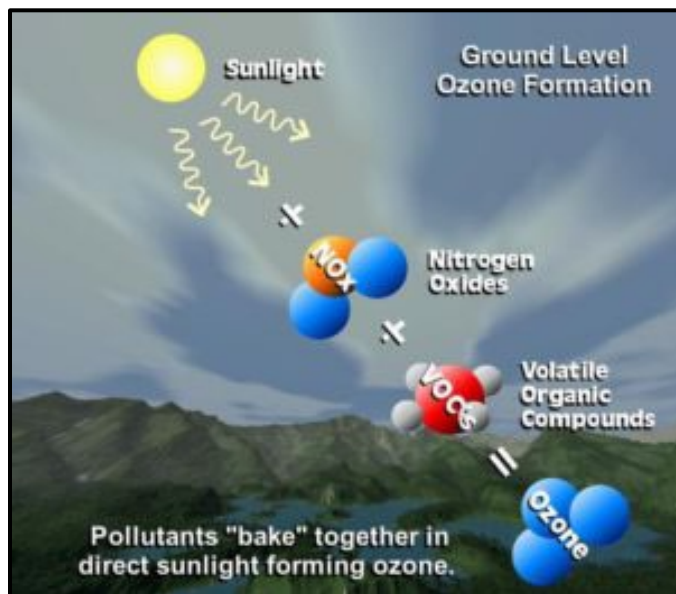


Figure 1. O_3 formation, courtesy of NASA.

VOCs are organic chemical compounds whose composition makes it possible for them to evaporate under normal atmospheric conditions of temperature and pressure (EPA 2023c). Although there is no NAAQS for VOCs, these are regulated by the EPA to prevent the formation of O_3 , a constituent of photochemical smog. Many VOCs are also HAPs. Inhalation of VOCs can cause difficulty breathing, nausea, and damage to the central nervous system and other organs. Some VOCs are also air toxins that can be carcinogenic. VOCs are components of natural gas and may be emitted from well drilling, operations, and equipment leaks, valves, pipes, and pneumatic devices. Additionally, VOCs are emitted from a variety of sources, such as refineries, oil and gas production equipment, consumer products, and natural (biogenic) sources, such as trees and plants.

Specifically, VOCs are emitted during well drilling and operations as exhaust from internal combustion engines. VOCs may be emitted from hydraulically fractured oil and gas wells during fracturing and refracturing of the wells. In the hydraulic fracturing process, a mixture of water, chemicals, and proppant is pumped into a well at extremely high pressures to fracture rock and allow oil and gas to flow from the geological formation. During one stage of well completion, fracturing fluids, water, and reservoir gas come to the surface at high velocity and volume (flowback). This flowback mixture contains VOCs, CH_4 , benzene, ethylbenzene, and n-hexane; some or all the flowback mixture may be vented, flared, or captured. The typical flowback process lasts from 3 to 10 days, so there is potential for

significant VOC emissions from this stage of the well completion process. Most new oil and gas wells drilled today use the hydraulic fracturing process.

O₃ is most likely to reach unhealthy levels on hot, sunny days but can still reach high levels during colder months. O₃ can also be transported long distances by wind (EPA 2023d).

People most at risk from breathing air containing O₃ include people with asthma, children, older adults, and people who are active outdoors, especially outdoor workers. In addition, people with certain genetic characteristics, and people with reduced intake of certain nutrients, such as vitamins C and E, are at greater risk from O₃ exposure (EPA 2023e). Deficiencies of vitamin E, a fat-soluble nutrient, is uncommon in developed countries but do occur in those individuals with conditions that prevent the body from adequately absorbing fats (e.g., chronic pancreatitis, cholestasis, cystic fibrosis, primary biliary, cirrhosis, Crohn's disease, or short bowel syndrome). Vitamin C deficiency and scurvy are rare in developed countries, as overt deficiency symptoms occur only if vitamin C intake falls below approximately 10 milligrams /day for many weeks; however, vitamin C deficiency can still occur in people with limited food variety or those with intestinal problems such as ulcerative colitis or Crohn's disease. Children are at greatest risk from exposure to O₃ because their lungs are still developing and they are more likely to be active outdoors when O₃ levels are high, which increases their exposure. Children are also more likely than adults to have asthma (EPA 2023e).

Depending on the level of exposure, breathing O₃ can trigger a variety of health problems. Effects of O₃ inhalation can include coughing and sore or scratchy throat; difficulty breathing deeply and vigorously and pain when taking deep breaths; inflammation and damage the airways; increased susceptibility to lung infections; aggravation of lung diseases such as asthma, emphysema, and chronic bronchitis; and an increase in the frequency of asthma attacks. Some of these effects have been found even in healthy people, but effects are more serious in people with lung diseases such as asthma. O₃ exposure may lead to increased school absences, medication use, visits to doctors and emergency rooms, and hospital admissions. Long-term exposure to O₃ is linked to aggravation of asthma and is likely to be one of many causes of asthma development. Studies in locations with elevated concentrations also report associations of O₃ with deaths from respiratory causes (EPA 2023e). Asthma often starts during childhood when the immune system is still developing. Multiple factors may work together to cause asthma, such as allergens in the environment that affect babies or young children, including cigarette smoke and certain germs; viral infections that affect breathing; and family history, such as a parent (in particular, a mother) who has asthma. Common triggers for asthma include indoor allergens, such as dust mites, mold, and pet dander or fur; outdoor allergens, such as pollens and mold; emotional stress; physical activity (although with treatment, most individuals can still be active); infections, such as colds, influenza (flu), or COVID-19; certain medicines, such as aspirin, which may cause serious breathing problems in people with severe asthma; poor air quality (such as high levels of O₃); or very cold air (National Heart, Lung, and Blood Institute 2022).

The environmental effects of O₃ include damaging sensitive vegetation and ecosystems. In particular, O₃ harms sensitive vegetation during the growing season (EPA 2023d). Plant species that are sensitive to the O₃ in terms of growth effects include trees found in many areas of the United States, such as black cherry (*Prunus serotina*), quaking aspen (*Populus tremuloides*), tulip poplar (*Liriodendron tulipifera*), white pine (*Pinus strobus*), ponderosa pine (*Pinus ponderosa*) and red alder (*Alnus rubra*). When sufficient O₃ enters the leaves of a sensitive plant, it can reduce photosynthesis, which is the process by which plants convert sunlight to energy to live and grow. O₃ can also slow a plant's growth and increase its risk of disease, damage from insects, effects of other pollutants, and damage from severe weather.

The effects of O₃ on individual plants can then have negative impacts on ecosystems, including loss of species diversity, changes to the specific assortment of plants present in a forest, changes to habitat quality, and changes to water and nutrient cycles (EPA 2023f).

3.2.1 OZONE TRENDS

Nationally, O₃ concentrations at urban and rural sites have decreased 29% from 1980 to 2022 (EPA 2023g). The increase of O₃-depleting substance (ODS) concentrations caused the large O₃ decline observed from 1980 to the mid-1990s. Since the late 1990s, concentrations of ODS have been declining due to the successful implementation of the Montreal Protocol on Substances that Deplete the Ozone Layer. The long-term decrease is also likely driven by reductions in global emissions of substances that lead to the formation of O₃, such as O₃ precursors VOCs and NO_x. In correlation over the same period, emissions of VOCs and NO_x have decreased by 61% and 72%, respectively (EPA 2023h). Nevertheless, some areas still experience O₃ exceedances as discussed in Section 2.6. Weather conditions have a significant role in the formation of O₃, which is most readily formed on warm summer days when there is stagnation. Conversely, O₃ production is more limited when it is cloudy, cool, rainy, or windy. EPA uses a statistical model to adjust for the variability in seasonal O₃ concentrations due to weather to provide a more accurate assessment of the underlying trend in O₃ caused by emissions, however often long periods are required to distinguish between weather effects and the effect of changes in pollutant emissions. Table 2 shows the O₃ trends for the counties in the major oil and gas basins of New Mexico (Eddy, Lea, Rio Arriba, Sandoval, San Juan, McKinley, Chaves, and Roosevelt Counties) and specific cities within the BLM NMSO area of operations (New Mexico, Oklahoma, Kansas, and Texas).

Table 2. Local O₃ Trends – 8 hour

State/County/City	2011–2013 Design Value (ppm)	2012–2014 Design Value (ppm)	2013–2015 Design Value (ppm)	2014–2016 Design Value (ppm)	2015–2017 Design Value (ppm)	2016–2018 Design Value (ppm)	2017–2019 Design Value (ppm)	2018–2020 Design Value (ppm)	2019–2021 Design Value (ppm)	2020–2022 Design Value (ppm)
New Mexico										
Eddy	0.071	0.071	0.069	0.067	0.068	0.074	0.079	0.078	0.077	0.077
Lea	0.066	0.065	0.067	0.066	0.067	0.070	0.071	0.068	0.066	0.066
Rio Arriba	n/a	n/a	n/a	0.064	0.065	0.067	0.067	0.065	0.064	0.064
Sandoval	0.063	0.063	0.065	0.064	0.065	0.068	0.068	0.070	0.068	0.070
San Juan	0.071	0.068	0.067	0.066	0.068	0.070	0.069	0.069	0.068	0.070
McKinley	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Chaves	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Roosevelt	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
<i>Carlsbad-Artesia, NM</i>	0.071	0.071	0.069	0.067	0.068	0.074	0.079	0.078	0.077	0.077
<i>Farmington, NM</i>	0.071	0.068	0.067	0.066	0.068	0.070	0.069	0.067	0.068	0.068
Oklahoma										
<i>Tulsa, OK</i>	0.076	0.073	0.068	0.065	0.063	0.065	0.066	0.065	0.064	0.066
<i>Oklahoma City, OK</i>	0.079	0.074	0.069	0.068	0.069	0.070	0.069	0.069	0.068	0.070
Kansas										
<i>Wichita, KS</i>	0.076	0.073	0.068	0.065	0.063	0.063	0.063	0.061	0.060	0.064
Texas										
<i>El Paso-Las Cruces, TX</i>	0.069	0.068	0.068	0.067	0.069	0.071	0.074	0.074	0.071	0.069
<i>Longview, TX</i>	0.077	0.071	0.068	0.066	0.065	0.065	0.065	0.063	0.062	0.061
<i>Dallas-Fort Worth-Arlington, TX</i>	0.87	0.081	0.083	0.080	0.079	0.076	0.077	0.076	0.076	0.077
<i>Austin-Round Rock, TX</i>	0.073	0.069	0.068	0.066	0.067	0.066	0.066	0.065	0.063	0.064

Source: EPA (2023g).

Note: n/a = Data not available due to lack of monitoring data.

3.3 NITROGEN DIOXIDE

NO₂ is both a criteria pollutant and an indicator for the NO_x family of NO compounds that are ground-level O₃ precursors. The NO family of compounds, a group of highly reactive gases, includes NO, NO₂, nitrous acid (HNO₂), and nitric acid (HNO₃). The primary sources of NO_x nationally are from the burning of fuel. The excess air required for complete combustion of fuels introduces atmospheric nitrogen into the combustion reactions at high temperatures and produces NO_x. Breathing air with a high concentration of NO₂ can cause adverse respiratory impacts in both healthy people and those with asthma (EPA 2023i). High concentration of NO₂ can irritate airways in the human respiratory system. Such exposures over short periods can aggravate respiratory diseases, particularly asthma, leading to respiratory symptoms. Longer exposures to elevated concentrations of NO₂ may contribute to the development of asthma and potentially increase susceptibility to respiratory infections. People with asthma and lung cancer, as well as children and the elderly are generally at greater risk for the health effects of NO₂. NO₂ exposure has also been strongly associated with heart and lung harm, affected pregnancy and birth outcomes, and were likely associated with increased risk of kidney and neurological harm, autoimmune issues, and cancer (American Lung Association 2023). NO₂ and other NO_x interact with water, oxygen, and other chemicals in the atmosphere to produce acid rain. High levels of NO₂ are also harmful to vegetation, damaging foliage, decreasing growth, and reducing crop yields (Rowland et al. 1985).

3.3.1 NITROGEN DIOXIDE TRENDS

Nationally, NO₂ concentrations have decreased substantially (65% reduction) from 1980 to 2022 due to improvements in motor vehicle emissions controls. In the southwest (Arizona, New Mexico, Colorado, and Utah), NO₂ concentrations have decreased 38% between 2000 and 2022; in the south (Texas, Oklahoma, Kansas, Arkansas, Louisiana, and Mississippi), NO₂ concentrations have decreased 29% between 2000 and 2022. EPA expects NO₂ concentrations will continue to decrease (EPA 2023j). Table 3 and Table 4 show the NO₂ trends for New Mexico, Kansas, Texas, and Oklahoma, as well as the counties in the major oil and gas basins of New Mexico and specific cities within the BLM NMSO area of operations.

Table 3. Local NO₂ Trends – Annual

State/County/City	2013 Design Value (ppm)	2014 Design Value (ppm)	2015 Design Value (ppm)	2016 Design Value (ppm)	2017 Design Value (ppm)	2018 Design Value (ppm)	2019 Design Value (ppm)	2020 Design Value (ppm)	2021 Design Value (ppm)	2022 Design Value (ppm)
New Mexico										
Eddy	2	3	2	2	3	5	5	5	5	5
Lea	4	n/a	5	4	4	5	5	5	4	4
Rio Arriba	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Sandoval	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
San Juan	12	11	11	10	10	10	10	10	9	9
McKinley	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Chaves	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Roosevelt	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
<i>Carlsbad-Artesia, NM</i>	2	3	2	2	3	5	5	5	5	5
<i>Farmington, NM</i>	8	7	6	6	6	6	5	6	6	6
Oklahoma										
<i>Tulsa, OK</i>	8	7	8	7	7	7	7	6	7	7
<i>Oklahoma City, OK</i>	6	5	n/a	n/a	n/a	n/a	n/a	5	5	5
Kansas										
<i>Wichita, KS</i>	9	8	7	7	7	8	6	6	7	6
Texas										
<i>El Paso-Las Cruces, TX</i>	14	14	14	15	n/a	n/a	14	13	n/a	11
<i>Longview, TX</i>	5	4	4	4	3	4	3	3	3	3
<i>Dallas-Fort Worth-Arlington, TX</i>	3	3	3	2	3	3	4	3	3	4
<i>Austin-Round Rock, TX</i>	5	5	4	4	5	5	5	n/a	3	3

Source: EPA (2023j).

n/a – Data not available due to lack of monitoring data.

Table 4. Local NO₂ Trends – 1 hour

State/County/City	2011-2013 Design Value (ppm)	2012-2014 Design Value (ppm)	2013-2015 Design Value (ppm)	2014-2016 Design Value (ppm)	2015-2017 Design Value (ppm)	2016-2018 Design Value (ppm)	2017-2019 Design Value (ppm)	2018-2020 Design Value (ppm)	2019-2021 Design Value (ppm)	2020-2022 Design Value (ppm)
New Mexico										
Eddy	n/a	18	19	19	20	23	27	29	29	31
Lea	36	n/a	n/a	n/a	n/a	34	35	35	32	31
Rio Arriba	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Sandoval	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
San Juan	41	37	36	35	35	34	34	33	32	31
McKinley	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Chaves	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Roosevelt	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
<i>Carlsbad-Artesia, NM</i>	21	18	19	19	20	23	27	29	29	31
<i>Farmington, NM</i>	39	35	33	28	n/a	n/a	n/a	23	23	24
Oklahoma										
<i>Tulsa, OK</i>	41	39	39	39	38	37	37	n/a	n/a	n/a
<i>Oklahoma City, OK</i>	54	51	45	45	44	43	n/a	n/a	n/a	n/a
Kansas										
<i>Wichita, KS</i>	65	55	39	38	n/a	n/a	n/a	36	36	36
Texas										
<i>El Paso-Las Cruces, TX</i>	n/a	53	55	58	59	60	56	56	n/a	n/a
<i>Longview, TX</i>	28	24	23	23	21	20	18	18	16	16
<i>Dallas-Fort Worth-Arlington, TX</i>	53	49	46	44	44	43	44	44	46	48
<i>Austin-Round Rock, TX</i>	n/a	n/a	32	31	30	30	31	n/a	n/a	n/a

Source: EPA (2023j).

n/a – Data not available due to lack of monitoring data.

3.4 CARBON MONOXIDE

CO, a colorless and odorless gas, is produced from the incomplete burning of carbon-containing compounds such as fossil fuels; it forms when there is not enough oxygen to produce carbon dioxide (CO₂). The greatest sources of CO to outdoor air are cars, trucks and other vehicles or machinery that burn fossil fuels.

Breathing air with a high concentration of CO reduces the amount of oxygen that can be transported in the blood stream to critical organs like the heart and brain. At very high levels, which are possible indoors or in other enclosed environments, CO can cause dizziness, confusion, unconsciousness, and death. Very high levels of CO are not likely to occur outdoors. However, when CO levels are elevated outdoors, they can be of particular concern for people with some types of heart disease (EPA 2023k).

3.4.1 CARBON MONOXIDE TRENDS

Nationally, CO concentrations have decreased 88% from 1980 to 2022 due to improvements in motor vehicle emissions controls. Monitored CO concentrations in the southwest region (New Mexico, Arizona, Colorado, and Utah) have decreased 70% between 2000 and 2022. Monitored CO concentrations in the south region (Texas, Oklahoma, Kansas, Arkansas, Louisiana, and Mississippi) have decreased 73% between 2000 and 2022 (EPA 2023l). Table 5 and Table 6 show the CO trends for New Mexico, Kansas, Texas, and Oklahoma as well as the counties in the major oil and gas basins of New Mexico and specific cities within the BLM NMSO area of operations.

Table 5. Local CO Trends – 8 hour

State/County/City	2012-2013 Design Value (ppm)	2013-2014 Design Value (ppm)	2014-2015 Design Value (ppm)	2015-2016 Design Value (ppm)	2016-2017 Design Value (ppm)	2017-2018 Design Value (ppm)	2018-2019 Design Value (ppm)	2019-2020 Design Value (ppm)	2020-2021 Design Value (ppm)	2021-2022 Design Value (ppm)
New Mexico										
Eddy	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Lea	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Rio Arriba	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Sandoval	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
San Juan	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
McKinley	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Chaves	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Roosevelt	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
<i>Carlsbad-Artesia, NM</i>	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
<i>Farmington, NM</i>	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Oklahoma										
<i>Tulsa, OK</i>	1.2	1.0	1.1	1.6	1.6	1.0	1.0	0.9	0.9	0.8
<i>Oklahoma City, OK</i>	0.8	0.8	0.9	0.9	0.9	0.8	0.8	1.4	1.4	1.1
Kansas										
<i>Wichita, KS</i>	1.4	1.3	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
<i>Kansas City, KS</i>	1.9	1.7	1.2	1.2	1.4	1.4	1.1	1.1	1.1	1.1
Texas										
<i>El Paso-Las Cruces, TX</i>	2.8	2.4	2.4	2.4	2.6	2.6	2.4	2.4	2.6	2.6
<i>Longview, TX</i>	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
<i>Dallas-Fort Worth-Arlington, TX</i>	1.5	1.5	1.5	1.5	1.1	1.2	1.3	1.3	1.1	1.3
<i>Austin-Round Rock, TX</i>	n/a	n/a	n/a	n/a	0.6	1.3	1.3	1.8	1.8	1.6

Source: EPA (2023I).

n/a – Data not available due to lack of monitoring data.

Table 6. Local CO Trends – 1 hour

State/County/City	2012-2013 Design Value (ppm)	2013-2014 Design Value (ppm)	2014-2015 Design Value (ppm)	2015-2016 Design Value (ppm)	2016-2017 Design Value (ppm)	2017-2018 Design Value (ppm)	2018-2019 Design Value (ppm)	2019-2020 Design Value (ppm)	2020-2021 Design Value (ppm)	2021-2022 Design Value (ppm)
New Mexico										
Eddy	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Lea	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Rio Arriba	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Sandoval	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
San Juan	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
McKinley	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Chaves	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Roosevelt	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
<i>Carlsbad-Artesia, NM</i>	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
<i>Farmington, NM</i>	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Oklahoma										
<i>Tulsa, OK</i>	1.9	1.6	1.6	2.4	2.4	1.4	1.4	1.4	1.4	1.2
<i>Oklahoma City, OK</i>	1.2	1.0	2.9	2.9	1.3	1.0	1.0	2.6	2.6	1.2
Kansas										
<i>Wichita, KS</i>	2.0	1.9	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
<i>Kansas City, KS</i>	2.6	2.2	1.8	1.8	1.9	1.9	1.8	1.5	1.7	1.7
Texas										
<i>El Paso-Las Cruces, TX</i>	4.9	4.0	4.4	4.4	4.2	5.0	5.0	3.8	4.1	4.1
<i>Longview, TX</i>	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
<i>Dallas-Fort Worth-Arlington, TX</i>	2.0	2.0	1.8	1.8	1.7	1.7	1.8	1.8	1.5	1.7
<i>Austin-Round Rock, TX</i>	0.7	0.6	0.5	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Source: EPA (2023I).

n/a – Data not available due to lack of monitoring data.

3.5 PARTICULATE MATTER

PM, also known as particle pollution, is a complex mixture of extremely small particles and liquid droplets. PM is made up of a number of components, including acids (such as nitrates and sulfates), organic chemicals, metals, and soil or dust particles. PM is measured and regulated according to particle size. PM₁₀ particles derive primarily from crushing, grinding, or abrasion of surfaces. PM_{2.5} particles derive primarily from the incomplete combustion of fuel sources and secondarily formed aerosols. Smaller particles are associated with more negative health effects, including respiratory and cardiovascular problems, because they can become more deeply embedded in the lungs and some may even get into the bloodstream (EPA 2023m). 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, nonfatal heart attacks, irregular heartbeat, and premature death. In adults, long-term particle pollution is linked to worsening of heart disease/atherosclerosis/COPD, higher risk of developing diabetes, higher risk of developing fatal lung cancer, impaired cognitive functioning, and increased risk of Parkinson's disease/Alzheimer's disease/other dementias (American Lung Association 2023). 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 2023n). Airborne dust can also deposit on snow. This dust deposition accelerates snowmelt by reducing albedo through surface darkening and enhanced snow grain growth (Skiles and Painter 2016). The degree of advanced snowmelt during each water year has a linear relationship to the amount of dust loading on the snowpack, which can affect the availability of late season water in areas dependent on snowmelt to fill their watersheds.

3.5.1 PARTICULATE MATTER TRENDS

Nationally, PM_{2.5} concentrations have decreased 42% from 2000 to 2022. In that same period, PM₁₀ concentrations decreased 34% nationally. In the southwest (New Mexico, Arizona, Colorado, and Utah), PM_{2.5} concentrations have decreased 25% from 2000 to 2022, and PM₁₀ concentrations have increased 23% during the same period. For the southern region encompassing Texas, Oklahoma, Kansas, Arkansas, Louisiana, and Mississippi, PM_{2.5} concentrations have decreased 30% and PM₁₀ concentrations have increased 15% between 2000 and 2022 (EPA 2023o, 2023p). Table 7 and Table 8 show the annual and 24-hour PM_{2.5} trends for New Mexico, Kansas, Texas, and Oklahoma, as well as the counties in the major oil and gas basins of New Mexico and specific cities within the BLM NMSO area of operations. PM₁₀ design values are only available and presented as average estimated exceedances value for each county. The only New Mexico county with data is San Juan County, which shows three maximum average estimated exceedances for the 1987 24-hour PM₁₀ NAAQS. Although exceedances are presented, the information listed in this PM₁₀ design value report is intended for informational use only and does not constitute a regulatory determination by EPA as to whether an area has attained an NAAQS. PM₁₀ monitored outdoor air quality data can be obtained from the EPA Air Data webpage and interactive tool (EPA 2023b).

Table 7. Local PM_{2.5} Trends – Annual

State/County/City	2011-2013 Design Value (ppm)	2012-2014 Design Value (ppm)	2013-2015 Design Value (ppm)	2014-2016 Design Value (ppm)	2015-2017 Design Value (ppm)	2016-2018 Design Value (ppm)	2017-2019 Design Value (ppm)	2018-2020 Design Value (ppm)	2019-2021 Design Value (ppm)	2020-2022 Design Value (ppm)
New Mexico										
Eddy	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Lea	8.4	7.8	7.8	7.1	7.5	7.6	8.1	7.0	6.5	6.3
Rio Arriba	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Sandoval	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
San Juan	4.7	4.5	4.1	n/a	n/a	n/a	n/a	n/a	n/a	n/a
McKinley	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Chaves	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Roosevelt	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
<i>Hobbs, NM</i>	8.4	7.8	7.8	7.1	7.5	7.6	8.1	7.0	6.5	6.3
<i>Farmington, NM</i>	4.7	4.5	4.1	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Oklahoma										
<i>Tulsa, OK</i>	10.1	9.3	8.8	8.7	8.8	9.6	9.5	9.1	8.9	9.0
<i>Oklahoma City, OK</i>	9.5	9.2	8.6	8.1	8.1	8.6	9.3	9.7	10.1	10.0
Kansas										
<i>Wichita, KS</i>	8.8	8.8	8.7	8.1	n/a	n/a	n/a	n/a	n/a	n/a
Texas										
<i>El Paso-Las Cruces, TX</i>	11.3	11.0	9.9	9.4	8.9	9.1	8.8	8.8	8.9	9.2
<i>Longview, TX</i>	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
<i>Dallas-Fort Worth-Arlington, TX</i>	10.0	9.7	9.4	8.8	8.6	8.9	9.2	8.9	8.4	8.2
<i>Austin-Round Rock, TX</i>	9.6	9.4	9.2	9.6	9.6	9.8	9.8	9.6	9.5	9.2

Source: EPA (2023o).

n/a – Data not available due to lack of monitoring data.

Table 8. Local PM_{2.5} Trends – 24 hour

State/County/City	2011-2013 Design Value (ppm)	2012-2014 Design Value (ppm)	2013-2015 Design Value (ppm)	2014-2016 Design Value (ppm)	2015-2017 Design Value (ppm)	2016-2018 Design Value (ppm)	2017-2019 Design Value (ppm)	2018-2020 Design Value (ppm)	2019-2021 Design Value (ppm)	2020-2022 Design Value (ppm)
New Mexico										
Eddy	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Lea	22	21	n/a	17	15	16	16	17	17	19
Rio Arriba	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Sandoval	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
San Juan	13	12	11	n/a	n/a	n/a	n/a	n/a	n/a	n/a
McKinley	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Chaves	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Roosevelt	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
<i>Hobbs, NM</i>	22	21		17	15	16	16	17	17	19
<i>Farmington, NM</i>	13	12	11	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Oklahoma										
<i>Tulsa, OK</i>	22	21	20	21	20	24	24	23	23	23
<i>Oklahoma City, OK</i>	21	21	21	19	18	19	20	22	23	23
Kansas										
<i>Wichita, KS</i>	21	22	23	22	n/a	n/a	n/a	n/a	n/a	n/a
Texas										
<i>El Paso-Las Cruces, TX</i>	30	31	29	25	23	24	24	24	24	22
<i>Longview, TX</i>	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
<i>Dallas-Fort Worth-Arlington, TX</i>	24	23	22	19	17	18	18	20	21	23
<i>Austin-Round Rock, TX</i>	24	24	22	19	20	22	23	22	22	22

Source: EPA (2023o).

n/a – Data not available due to lack of monitoring data.

3.6 SULFUR DIOXIDE

SO₂ is one of a group of highly reactive gases known as “oxides of sulfur,” commonly referred to as SO_x. The largest sources of SO₂ emissions nationwide are from fossil fuel combustion at power plants (73%) and other industrial facilities (20%). Smaller sources of SO₂ emissions include industrial processes, such as extracting metal from ore, and the burning of high sulfur-containing fuels by locomotives, large ships, and non-road equipment. SO₂ is linked with a number of adverse effects on the respiratory system, including wheezing, shortness of breath, chest tightness, and reduced lung function. People with asthma, particularly children, are sensitive to these effects of SO₂. At high concentrations, gaseous SO_x can harm trees and plants by damaging foliage and decreasing growth. SO₂ and other SO_x can contribute to acid rain, which can harm sensitive ecosystems (EPA 2023q).

3.6.1 SULFUR DIOXIDE TRENDS

Nationally, SO₂ concentrations have decreased 85% from 2000 to 2022, but substantial decreases (94% reduction) have occurred since 1980 due to implementation of federal rules requiring reductions in SO₂ emissions from power plants and other large sources of SO₂. In the southwest, SO₂ concentrations decreased 94% between 2000 and 2022. In the southern region of the United States (Texas, Oklahoma, Kansas, Arkansas, Louisiana, and Mississippi), SO₂ concentrations decreased 81% between 2000 and 2022 (EPA 2023r). Table 9 shows the SO₂ trends for New Mexico, Kansas, Texas, and Oklahoma, as well as the counties in the major oil and gas basins of New Mexico and specific cities within the BLM NMSO area of operations.

Table 9. Local SO₂ Trends – 1 hour

State/County/City	2011-2013 Design Value (ppm)	2012-2014 Design Value (ppm)	2013-2015 Design Value (ppm)	2014-2016 Design Value (ppm)	2015-2017 Design Value (ppm)	2016-2018 Design Value (ppm)	2017-2019 Design Value (ppm)	2018-2020 Design Value (ppm)	2019-2021 Design Value (ppm)	2020-2022 Design Value (ppm)
New Mexico										
Eddy	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Lea	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Rio Arriba	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Sandoval	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
San Juan	23	21	13	8	2	2	2	1	1	8
McKinley	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Chaves	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Roosevelt	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
<i>Carlsbad-Artesia, NM</i>	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
<i>Farmington, NM</i>	9	7	5	3	2	2	2	1	1	1
Oklahoma										
<i>Tulsa, OK</i>	20	14	12	6	6	4	3	3	2	3
<i>Oklahoma City, OK</i>	4	4	3	3	3	3	2	2	1	1
Kansas										
<i>Wichita, KS</i>	n/a	n/a	6	5	4	4	4	3	3	3
Texas										
<i>El Paso-Las Cruces, TX</i>	n/a	10	9	n/a	n/a	n/a	n/a	n/a	n/a	6
<i>Longview, TX</i>	52	50	46	35	30	37	41	49	45	35
<i>Dallas-Fort Worth-Arlington, TX</i>	14	13	9	6	5	6	6	6	6	n/a
<i>Austin-Round Rock, TX</i>	n/a	n/a	5	4	4	3	3	n/a	n/a	n/a

Source: EPA (2023r).

n/a – Data not available due to lack of monitoring data.

3.7 NATIONAL TRENDS

EPA estimates nationwide emissions of ambient air pollutants and the pollutants they are formed from (their precursors) based on actual monitored readings or engineering calculations of the amounts and types of pollutants emitted by vehicles, factories, and other sources. Table 10 shows that emissions of the common air pollutants and their precursors have been reduced substantially since 1980.

Table 10. National Percent Changes in Emissions

Pollutant	1980 vs. 2022	1990 vs. 2022	2000 vs. 2022	2010 vs. 2022
CO	-75	-70	-58	-27
Lead (Pb)	-99	-88	-78	-36
NO _x	-72	-71	-67	-52
VOC	-61	-48	-29	-10
Direct PM ₁₀	-65	-27	-24	-13
Direct PM _{2.5}	Not available	-27	-35	-11
SO ₂	-93	-92	-89	-74

Source: EPA (2023h).

*A negative percentage means that concentrations have decreased.

3.8 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 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 2023s). Depending on the level of exposure, lead can adversely affect the nervous system, kidney function, immune system, reproductive and developmental systems and the cardiovascular system. Lead exposure also affects the oxygen carrying capacity of the blood. Lead can accumulate in the body over time, where it is stored in bones along with calcium. The lead effects most likely to be encountered in current populations are neurological effects in children. Infants and young children are especially sensitive to lead exposures, which may contribute to behavioral problems, learning deficits, lowered IQ, and hyperactivity. Children are also at an increased risk of slowed growth, hearing problems, and anemia. Adults exposed to lead can suffer from cardiovascular effects, decreased kidney function, and both male and female reproductive issues.

3.9 NEW MEXICO DESIGN VALUES

The most recent 2022 design values for the measured criteria pollutants of the counties in the major oil and gas basins of New Mexico are provided in Table 11 through Table 16. The 2022 design values are compared with the NAAQS and NMAAQs for those New Mexico counties with available data. Rural

counties, such as McKinley County, may not have existing monitors and, therefore, no data are available; other counties, such as San Juan County, may have monitors that record only certain pollutants. Design values are typically used to designate and classify nonattainment areas, as well as to assess progress toward meeting the NAAQS. Therefore, when the design values exceed the NAAQS or NMAAQs, actions may be taken to reassess the designations of these areas.

Table 11. 2022 Design Values – 8-hour O₃

County/Site	Design Value (ppm) ¹	NAAQS	Exceed NAAQS?
Eddy	0.077	0.070 ppm	Yes
Lea	0.066	0.070 ppm	No
Rio Arriba	0.064	0.070 ppm	No
Sandoval	0.070	0.070 ppm	No
San Juan	0.070	0.070 ppm	No
Chaves	n/a	0.070 ppm	n/a
McKinley	n/a	0.070 ppm	n/a
Roosevelt	n/a	0.070 ppm	n/a
<i>Bloomfield</i>	0.064	0.070 ppm	No
<i>Navajo Dam</i>	0.070	0.070 ppm	No
<i>Chaco Culture</i>	0.068	0.070 ppm	No
<i>Shiprock</i>	0.067	0.070 ppm	No

Source: EPA (2023t).

n/a – Data not available due to lack of monitoring data.

⁽¹⁾ Annual fourth-highest daily maximum 8-hour concentration averaged over 3 years.

Table 12. 2022 Design Values – Annual NO₂

County/Site	Design Value (ppb) ¹	NAAQS	Exceed NAAQS?	NMAAQs	Exceed NMAAQs?
Eddy	5	53 ppb	No	50 ppb	No
Lea	4	53 ppb	No	50 ppb	No
Rio Arriba	n/a	53 ppb	n/a	50 ppb	n/a
Sandoval	n/a	53 ppb	n/a	50 ppb	n/a
San Juan	9	53 ppb	No	50 ppb	No
Chaves	n/a	53 ppb	n/a	50 ppb	n/a
McKinley	n/a	53 ppb	n/a	50 ppb	n/a
Roosevelt	n/a	53 ppb	n/a	50 ppb	n/a
<i>Bloomfield</i>	9	53 ppb	No	50 ppb	No

County/Site	Design Value (ppb) ¹	NAAQS	Exceed NAAQS?	NMAAQs	Exceed NMAAQs?
<i>Navajo Dam</i>	6	53 ppb	No	50 ppb	No
<i>Chaco Culture</i>	1	53 ppb	No	50 ppb	No
<i>Shiprock</i>	3	53 ppb	No	50 ppb	No

Source: EPA (2023t).

Notes:

n/a – Data not available due to lack of monitoring data.

⁽¹⁾ Not to be exceeded during the year.

Table 13. 2022 Design Values – 1-hour NO₂

County/Site	Design Value (ppb) ¹	NAAQS	Exceed NAAQS?
Eddy	31	100 ppb	No
Lea	31	100 ppb	No
Rio Arriba	n/a	100 ppb	n/a
Sandoval	n/a	100 ppb	n/a
San Juan	31	100 ppb	No
Chaves	n/a	100 ppb	n/a
McKinley	n/a	100 ppb	n/a
Roosevelt	n/a	100 ppb	n/a
<i>Bloomfield</i>	31	100 ppb	No
<i>Navajo Dam</i>	24	100 ppb	No
<i>Chaco Culture</i>	4	100 ppb	No
<i>Shiprock</i>	22	100 ppb	No

Source: EPA (2023t).

n/a – Data not available due to lack of monitoring data.

⁽¹⁾ 98th percentile, averaged over 3 years.

Table 14. 2022 Design Values – Annual PM_{2.5}

County/Site	Design Value (µg/m ³) ¹	NAAQS	Exceed NAAQS? ²
Eddy	n/a	12 µg/m ³	n/a
Lea	6.3	12 µg/m ³	No
Rio Arriba	n/a	12 µg/m ³	n/a
Sandoval	n/a	12 µg/m ³	n/a
San Juan	n/a	12 µg/m ³	n/a

County/Site	Design Value ($\mu\text{g}/\text{m}^3$) ¹	NAAQS	Exceed NAAQS? ²
Chaves	n/a	12 $\mu\text{g}/\text{m}^3$	n/a
McKinley	n/a	12 $\mu\text{g}/\text{m}^3$	n/a
Roosevelt	n/a	12 $\mu\text{g}/\text{m}^3$	n/a
<i>Bloomfield</i>	n/a	12 $\mu\text{g}/\text{m}^3$	n/a
<i>Navajo Dam</i>	n/a	12 $\mu\text{g}/\text{m}^3$	n/a
<i>Chaco Culture</i>	n/a	12 $\mu\text{g}/\text{m}^3$	n/a
<i>Shiprock</i>	n/a	12 $\mu\text{g}/\text{m}^3$	n/a

Source: EPA (2023t).

n/a – Data not available due to lack of monitoring data.

⁽¹⁾ Annual mean averaged over 3 years.

⁽²⁾ The NMAAQs for total suspended particulates, which was used as a comparison for PM₁₀ and PM_{2.5}, was repealed as of November 30, 2018. The NAAQS still apply.

Table 15. 2022 Design Values – 24-hour PM_{2.5}

County/Site	Design Value ($\mu\text{g}/\text{m}^3$) ¹	NAAQS	Exceed NAAQS? ²
Eddy	n/a	35 $\mu\text{g}/\text{m}^3$	n/a
Lea	19	35 $\mu\text{g}/\text{m}^3$	No
Rio Arriba	n/a	35 $\mu\text{g}/\text{m}^3$	n/a
Sandoval	n/a	35 $\mu\text{g}/\text{m}^3$	n/a
San Juan ⁴	n/a	35 $\mu\text{g}/\text{m}^3$	n/a
Chaves	n/a	35 $\mu\text{g}/\text{m}^3$	n/a
McKinley	n/a	35 $\mu\text{g}/\text{m}^3$	n/a
Roosevelt	n/a	35 $\mu\text{g}/\text{m}^3$	n/a
<i>Bloomfield</i>	n/a	35 $\mu\text{g}/\text{m}^3$	n/a
<i>Navajo Dam</i>	n/a	35 $\mu\text{g}/\text{m}^3$	n/a
<i>Chaco Culture</i>	n/a	35 $\mu\text{g}/\text{m}^3$	n/a
<i>Shiprock</i>	n/a	35 $\mu\text{g}/\text{m}^3$	n/a

Source: EPA (2023t).

n/a – Data not available due to lack of monitoring data.

⁽¹⁾ 98th percentile, averaged over 3 years.

⁽²⁾ The NMAAQs for total suspended particulates, which was used as a comparison for PM₁₀ and PM_{2.5}, was repealed as of November 30, 2018. The NAAQS still apply.

⁽³⁾ Many rural counties have no monitoring data and are assumed under the CAA to be in attainment.

⁽⁴⁾ PM_{2.5} monitor stations currently show installed locations in the planning area (San Juan County); however, the monitor status of these stations shows invalid data and cannot be used to represent design values.

Table 16. 2022 Design Values – 1-hour SO₂

County/Site	Design Value (ppb) ¹	NAAQS	Exceed NAAQS?
Eddy	n/a	75 ppb	n/a
Lea	n/a	75 ppb	n/a
Rio Arriba	n/a	75 ppb	n/a
Sandoval	n/a	75 ppb	n/a
San Juan	8	75 ppb	No
Chaves	n/a	75 ppb	n/a
McKinley	n/a	75 ppb	n/a
Roosevelt	n/a	75 ppb	n/a
<i>Bloomfield</i>	1	75 ppb	No
<i>Navajo Dam</i>	n/a	75 ppb	n/a
<i>Chaco Culture</i>	n/a	75 ppb	n/a
<i>Shiprock</i>	8	75 ppb	No

Source: EPA (2023t).

n/a = Data not available due to lack of monitoring data.

⁽¹⁾ 99th percentile of 1-hour daily maximum concentrations, averaged over 3 years.

Note: Although there are no NAAQS for hydrogen sulfide (H₂S), New Mexico has set a 1-hour standard for H₂S at 0.010 ppm for all areas of the state outside of the area within 5 miles of the Pecos-Permian Air Quality Control Region and a 0.5-hour standard for H₂S at 0.100 ppm within the Pecos-Permian Air Quality Control Region and 0.030 ppm for municipal boundaries and within 5 miles of municipalities with populations greater than 20,000 in areas of the state outside of the area within 5 miles of the Pecos-Permian Air Quality Control Region (see Table 28).

3.10 GENERAL CONFORMITY AND NONATTAINMENT

If the concentration of one or more criteria pollutants in a geographic area is found to violate the NAAQS, the area may be classified as a **nonattainment** area. Areas with concentrations of criteria pollutants that are below the levels established by the NAAQS are considered either **attainment** or unclassifiable areas. Areas for which available data are not sufficient to make an attainment status designation are listed as unclassifiable. When a state submits a request to the EPA to redesignate a nonattainment area as an attainment area, it must submit a maintenance plan that demonstrates that the area can maintain the air-quality standard for at least 10 years following the effective date of redesignation. An EPA approved maintenance plan will allow the EPA to redesignate the area as an attainment area and in the interim is classified as a maintenance area.

To eliminate or reduce the severity and number of NAAQS violations in nonattainment areas and to achieve expeditious attainment of the NAAQS, the EPA promulgated the Conformity Rule (40 C.F.R. § 93, Subpart B). The Conformity Rule applies to federal actions and environmental analyses in nonattainment and maintenance areas completed after March 15, 1994. This rule contains a variety of substantive and procedural requirements to show conformance with both the NAAQS and state implementation plans (SIPs).

Section 176(c) of the CAA prohibits federal agencies from taking actions in nonattainment and maintenance areas unless the emissions from the actions conform to the SIP or tribal implementation plan for the area. Federal actions must be evaluated for conformity to the local SIP if the project 1) is within an EPA-designated nonattainment or maintenance area, 2) would result in emissions above the de minimis threshold quantities of criteria pollutants listed in 40 C.F.R. § 93, 3) is not a listed exempt action, and 4) has not been accounted for in an EPA-approved SIP.

The Conformity Rule requires that all federal actions in a nonattainment area must demonstrate conformity with the SIP for the pollutant in question. If the agency can demonstrate that emissions for the action will fall below certain established levels, known as de minimis, then no further analysis is necessary. To establish a de minimis claim, an emissions inventory for the project is required. In the case of O₃, the emissions inventory would include NO_x and VOCs. If emissions are projected to be above de minimis levels, a formal Conformity Determination may be required.

Nonattainment designation is classified on six levels depending on the design value and pollutant, with the lowest level starting at marginal and increasing in severity: marginal, moderate, serious, severe-15, severe-17, and extreme. Nonattainment areas in New Mexico are as follows:

- **O₃ nonattainment area in Doña Ana County (Sunland Park, New Mexico, southwest of the Carlsbad Field Office [CFO] Planning Area, south of Las Cruces):** In 1995, the EPA declared a 42-square-mile region in the southeast corner of the county on the border of Texas and Mexico as a marginal nonattainment area for the 1-hour O₃ standard. The nonattainment area included the city of Sunland Park, Santa Teresa, and La Union, New Mexico. The 1-hour O₃ standard was revoked by EPA in 2004 with the adoption of the new 8-hour O₃ standard. Due to the revocation of the 1979 1-hour O₃ standard and based on monitoring data, Sunland Park was designated as attainment for the 1997 8-hour O₃ standard (0.080 ppm).

In October 2015, the EPA lowered the NAAQS for O₃ to 0.070 ppm. As a result, in 2016, NMED recommended that the EPA designate a portion of Doña Ana County near Sunland Park, New Mexico, as nonattainment. Based on 2014 through 2016 O₃ monitoring data, EPA designated the Sunland Park area in southern Doña Ana County as a marginal nonattainment area for 2015 O₃ NAAQS on June 18, 2018, with an attainment deadline of August 3, 2021 (Federal Register 83:25776) (NMED 2020). On November 30, 2021 (Federal Register 86:67864), the EPA expanded the marginal nonattainment area that previously covered only the Sunland Park area in Doña Ana County to include El Paso County, Texas, and renamed the marginal nonattainment designated area as the El Paso-Las Cruces, TX-NM nonattainment area.

On December 6, 2018 (Federal Register 83:6299), the EPA published the Nonattainment Area SIP Requirements rule that establishes the minimum elements that must be included in all nonattainment SIPs, including the requirements for New Mexico Nonattainment New Source Review (NNSR) permitting. On August 10, 2021, the NMED submitted a SIP to the New Mexico NNSR permitting program to address the requirements of the 2015 8-hour O₃ NAAQS.

On November 16, 2022, the EPA approved this SIP, which updated the NNSR permitting program for the 2015 8-hour O₃ NAAQS (Federal Register 87:51041 and 86:57388).

- **O₃ Design Value Exceedance in Eddy County (Carlsbad, New Mexico):** In May 2023, new design values for NAAQS were published by the EPA for various counties throughout the United States. The monitor at 2811 Holland Street in Eddy County showed an 8-hour O₃ exceedance of 77 parts per billion (ppb) (EPA 2023t). This area has not been formally declared nonattainment by the

EPA through the State's recommendation, but it may be designated as nonattainment in the future.

New Mexico Statutes Annotated (N.M.S.A.) 1978, § 74-2-5, directs NMED to develop plans that may include regulations more stringent than federal rules for areas of the state in which ambient monitoring shows O₃ levels at or above 95% of the NAAQS to control NO_x and VOC emissions to provide for attainment and maintenance of the standard. The NMOCD Statewide Natural Gas Capture Requirements (Waste Prevention Rule) (N.M.A.C. 19.15.27.9) and NMED Oil and Natural Gas Regulation for Ozone Precursors (N.M.A.C.20.2.50.1) are recent regulations reducing NO_x, VOC, and CH₄ emissions. The 2015 8-hour primary NAAQS for O₃ is 0.070 ppm (70 ppb); 95% of the O₃ NAAQS is 0.067 ppm (67 ppb). This form of the standard requires averaging of 3 years of monitoring data for the fourth highest 8-hour average, using the most recent year's data to determine the "design value." For New Mexico, five counties show 3-year averages (2020–2022) of O₃ levels at or above 95% of the NAAQS or exceeding the NAAQS (EPA 2023t):

- Doña Ana County (81 ppb)
- Eddy County (77 ppb)
- Sandoval County (70 ppb)
- San Juan County (70 ppb)
- Santa Fe County (67 ppb)

The NMED participates in the Ozone Advance Program for the entirety of San Juan (northwestern New Mexico), Lea (southeastern New Mexico), and Eddy (southeastern New Mexico) Counties and for the portion of Doña Ana County that excludes the Sunland Park nonattainment area (south-central New Mexico). Since the acceptance into the Ozone Advance Program in April 2019, O₃ levels in Rio Arriba, Sandoval, Santa Fe, and Valencia Counties either currently or recently have exceeded 95% of the 2015 8-hour O₃ NAAQS (67 ppb) and could soon violate this standard. In total, the Ozone Advance Path Forward and outreach efforts includes the following nine counties: Chaves, Doña Ana, Eddy, Lea, Rio Arriba, San Juan, Santa Fe, Sandoval, and Valencia. Although Chaves County does not have O₃ monitors, the NMED includes it in the Ozone Advance Program planning effort as it is part of the Permian Basin with oil and gas emissions that contribute to high O₃ levels in Lea and Eddy Counties. The efforts under the Ozone Advance Program may benefit these areas by potentially 1) reducing air pollution in terms of O₃, as well as other air pollutants, 2) ensuring continued healthy O₃ levels, 3) maintaining the O₃ NAAQS and helping the Sunland Park nonattainment area attain the 2015 Ozone NAAQS, 4) avoiding violations of the NAAQS that could lead to a future nonattainment designation, 5) increasing public awareness about O₃ as an indirect air pollutant, and 6) targeting limited resources toward actions to address O₃ problems quickly. The NMED goal is to implement measures and programs to reduce O₃ in the near term and, ultimately, to effect changes that will protect community well-being into the future. NMED will work together and in coordination with stakeholders and the public to proactively pursue this goal (NMED 2022a).

- **PM₁₀ nonattainment area in Anthony, New Mexico (west of the CFO Planning Area, south of Las Cruces):** The State of New Mexico submitted the Anthony PM₁₀ SIP to the regional EPA headquarters on November 8, 1991. This area was designated nonattainment for PM₁₀ by the EPA in 1991. The nonattainment area is bounded by Anthony quadrangle, Anthony, New Mexico – Texas. SE/4 La Mesa 15-minute quadrangle, N32 00 – W106 30/7.5, Sections 35 and 36, Township 26 South, Range 3 East as limited by the New Mexico–Texas state line on the

south. The site is in Doña Ana County, which submitted a Natural Events Action Plan for PM₁₀ exceedances to the EPA in December 2000. However, Anthony, New Mexico, still exceeds the NAAQS for PM₁₀. Therefore, the EPA has not redesignated the state PM₁₀ nonattainment area at this time. The EPA has not indicated its plans to do so (NMED 2023b).

- The NMED Air Quality Bureau developed a Fugitive Dust Control Rule in conjunction with the mitigation plan to abate certain controllable sources in Doña Ana and Luna Counties. Mitigation plans are required by the EPA in areas where recurring natural events (in this case, high winds resulting in blowing dust) cause exceedances of the health-based national standards for PM. In 2020, NMED developed a single mitigation plan for Doña Ana and Luna Counties and recently updated this plan on March 10, 2021 (NMED 2021a). The Dust Mitigation Plan and the associated Fugitive Dust Control Rule (N.M.A.C. 20.2.23) enhance existing local dust control ordinances and provide coverage where there are gaps. The NMED Air Quality Bureau Fugitive Dust Control Rule was published in conjunction with the original Dust Mitigation Plan and became effective on January 1, 2019. The rule applies to sources of fugitive dust that are not required to obtain a construction permit from the Air Quality Bureau, including disturbed areas greater than 1.0 acre from construction/demolition activities and earthmoving. Control measures are required to stabilize surfaces to ensure emissions are not crossing the property line or exceeding opacity limits. Control measures listed in the rule include:
 - watering and/or applying dust suppressant unpaved surfaces,
 - limiting on-site vehicles speeds,
 - prohibiting activities during high winds,
 - watering exposed area before high winds,
 - planting trees or shrubs as a windbreak, and
 - revegetating disturbed area with native plants (NMED 2021a).
- **SO₂ Maintenance Area in Grant County (west of the CFO Planning Area, at the Arizona border):** This maintenance area is at the Phelps Dodge Chino Copper Smelter in Grant County. The maintenance area is defined as a 3.5-mile-radius region around the smelter. The maintenance area also includes high-elevation areas within an 8-mile radius. The State submitted a SIP to the regional EPA headquarters in August 1978. The New Mexico Air Quality Bureau submitted a redesignation plan to the EPA in February 2003 seeking to redesignate the portion of Grant County, New Mexico, from nonattainment to attainment for the SO₂ NAAQS. In this plan, it was reported that air monitoring data for this area revealed values better than NAAQS for SO₂. The February 2003 submittal also included a contingency measures plan that consists of monitoring measures and a maintenance plan for this area to ensure that attainment of the SO₂ NAAQS will be maintained through permitting and the applicable SIP rules. The redesignation plan was approved by the EPA in September 2003. The Grant County SO₂ Limited Maintenance Plan was submitted to the EPA in November 2013 to fulfill the second 10-year maintenance plan requirement under Section 175A(b) of the CAA to ensure maintenance of the 1971 SO₂ NAAQS through 2025 and was approved by the EPA on July 18, 2014 (NMED 2023b).

Texas Nonattainment Areas: There are currently 10 key nonattainment areas in Texas: one for PM₁₀ (city of El Paso); three for O₃ (Houston-Galveston-Brazoria area [eight counties], Dallas-Fort Worth area [10 counties], and Bexar County in San Antonio); and several areas not meeting the SO₂ 2010 standard

and therefore designated in part as nonattainment (Freestone and Anderson Counties, Howard County, Hutchinson County, Navarro County, Rusk and Panola Counties, and Titus County) (EPA 2023u).

The Houston-Galveston-Brazoria area has several counties in nonattainment status. The following counties are currently not meeting the 8-hour 2015 O₃ standard of 0.070 ppm (70 ppb): Brazoria, Chambers, Fort Bend, Galveston, Harris, and Montgomery. Each of these counties has been designated as marginal nonattainment for the 2015 O₃ nonattainment. Additionally, the six counties listed for nonattainment with the 2015 O₃ standard are also in nonattainment with the 8-hour 2008 O₃ standard along with Liberty County and Waller County. Each of these counties has been designated as serious nonattainment for the 2008 O₃ nonattainment (serious nonattainment for 2008 O₃ is an area with a design value of 0.100 up to but not including 0.113 ppm). De minimis values for areas designated as serious for both NO_x and VOCs are 50 tons per year (tpy) (EPA 2023u). The Dallas-Fort Worth area also has several counties in nonattainment status. The following counties are currently not meeting the 8-hour 2015 O₃ standard of 0.070 ppm (70 ppb): Collin, Dallas, Denton, Ellis, Johnson, Kaufman, Parker, Tarrant, and Wise Counties. The severity of the 2015 O₃ nonattainment for these counties is classified as marginal (an area with a design value of 0.071 up to but not including 0.081 ppm). Additionally, the following counties are designated nonattainment with respect to the 2008 8-hour O₃ standard: Collin, Dallas, Denton, Ellis, Johnson, Parker, Rockwall, Tarrant, and Wise Counties. These counties are designated as serious nonattainment areas. De minimis values for a serious designation in this area are 50 tpy for NO_x and VOCs (EPA 2023u).

3.10.1 KANSAS AND OKLAHOMA

There are currently no nonattainment areas for any criteria pollutant in the states of Kansas and Oklahoma.

4 NATIONAL EMISSIONS INVENTORY DATA

The NEI data present the emissions of each criteria pollutant by national, state, county, and tribal areas for major source sectors. National emissions trends are reported in the *2020 National Emissions Inventory and Trends Report (2020 NEI Report)* (EPA 2023v). The NEI data are updated every 3 years, with new emission inventory data incurring a 2- to 3-year data gathering period for final use. The most recent NEI is for 2020 and was released in March 2023. Emissions data are expressed in tpy or total volume of pollutant released to the atmosphere. Emissions data are useful in comparing source categories to determine which industries or practices are contributing the most to the general level of pollution in an area.

Details of the anthropogenic sectors mentioned in the report are:

- (1) Electricity generation is fuel combustion from electric utilities.
- (2) Fossil fuel combustion is fuel combustion from industrial boilers, internal combustion engines, and commercial/institutional or residential use.
- (3) Industrial processes include manufacturing of chemicals, metals, and electronics; storage and transfer operations; pulp and paper production; cement manufacturing; petroleum refineries; and oil and gas production.
- (4) On-road vehicles category includes both gasoline- and diesel-powered vehicles for on-road use.

- (5) Non-road equipment includes gasoline- and diesel-powered equipment for non-road use, as well as planes, trains, and ships.
- (6) Road dust includes dust from both paved and unpaved roads. Presentation of emissions data by source sector provides a better understanding of the activities that contribute to criteria pollutant emissions.

NEI data by pollutant (CO, NO_x, PM₁₀ and PM_{2.5}, SO₂, and VOCs) for the major sources within New Mexico, Kansas, Oklahoma, and Texas can be found in Appendix D.

The 2020 NEI data are broken down into the following emission source categories:

- Solvents – consumer and commercial solvent use, degreasing, dry cleaning, graphic arts, industrial surface coating and solvent use, and non-industrial surface coating.
- Mobile sources – aircraft, commercial marine vessels, locomotives, non-road equipment, and on-road vehicles.
- Industrial processes – cement manufacturing, chemical manufacturing, ferrous metals, mining, NEC, nonferrous metals, oil and gas production, petroleum refineries, pulp and paper, and storage and transfer.
- Fires – agricultural field burning, prescribed burning, and wildfires.
- Biogenic sources – vegetation and soil.
- Fuel combustion – institutional, electric generation, industrial boilers, internal combustion engines (ICEs), and residential (for biomass, coal, natural gas, oil).
- Agriculture – crops and livestock dust, fertilizer application, and livestock waste.
- Dust – construction dust, paved road dust, and unpaved road dust.

The figures below show the 2020 NEI VOC, NO_x, CO, PM₁₀, PM_{2.5}, and SO₂ emissions for the states of New Mexico, Texas, Oklahoma, and Kansas, showing the estimated percentage of total emissions from each of the applicable emission source categories above.

4.1 2020 NATIONAL EMISSIONS INVENTORY DATA

Total emissions within the United States and BLM NMSO area of operations are reported in Table 17, based on 2020 NEI data in tpy (EPA 2023v).

Table 17. 2020 NEI Air Pollutant Emissions in Tons per Year

State/County	NO _x	CO	VOC	PM ₁₀	PM _{2.5}	SO ₂	HAPs
U.S.	8,814,608	66,065,689	46,140,059	16,761,114	5,815,036	1,838,518	5,964,882
New Mexico	199,462	615,513	712,639	129,132	42,623	87,828	105,524
All NM Counties Below	119,806	218,232	394,181	44,803	12,312	85,822	45,785
<i>Chaves</i>	5,008	13,034	17,379	4,038	975	1,202	3,234

State/County	NO _x	CO	VOC	PM ₁₀	PM _{2.5}	SO ₂	HAPs
<i>Eddy</i>	26,808	45,159	101,008	7,325	2,305	35,502	11,764
<i>Lea</i>	32,702	46,128	126,317	6,245	2,295	46,579	13,507
<i>Roosevelt</i>	1,580	5,156	7,683	2,977	695	238	2,003
<i>Sandoval</i>	4,106	20,065	16,604	8,413	1,885	140	2,618
<i>San Juan</i>	30,160	49,095	51,662	7,033	2,059	1,656	4,272
<i>Rio Arriba</i>	12,423	26,303	53,474	3,632	919	61	4,829
<i>McKinley</i>	7,019	13,292	20,054	5,140	1,179	444	3,558
Kansas	199,314	927,620	698,701	500,208	146,908	14,794	128,527
<i>Cheyenne</i>	826	1,581	3,635	3,135	525	1	599
Texas	963,226	4,070,107	4,355,399	1,549,000	362,101	248,177	461,215
Oklahoma	239,316	1,236,732	1,190,095	503,476	142,324	34,886	131,286

Source: EPA (2023v).

Note: Reports both biogenic and human-caused emissions in the table above. Values may not always sum correctly if queried on demand as the NEI database updates its emissions periodically with newer emission information. Values include summaries for each county, including combustion, industrial, on-road/nonroad, and miscellaneous sectors.

The largest NEI anthropogenic sources of criteria air pollutants in New Mexico is oil and gas sources for CO, NO_x, SO₂, and VOCs (Table 18). The Area Sources category includes all area sources except biogenic (natural) sources, forest wildfires, and prescribed fires. From the period of 2008 to 2020, criteria air pollutant emissions have fluctuated. NO_x increased from 197,830 tons in 2008 to 199,462 tons in 2020, and SO₂ increased from 24,669 tons to 87,828 tons. However, PM₁₀ decreased from 821,631 tons to 129,132 tons, PM_{2.5} decreased from 101,998 tons to 42,623 tons, CO emissions decreased from 813,515 tons in 2008 to 615,513 tons in 2020, and VOCs decreased from 1,315,442 tons to 712,639 tons. Emissions from natural sources (biogenics) decreased from 1,499,241 tons in 2008 to 416,849 tons in 2020, while criteria air pollutant emissions from oil and gas production increased from 15,451 to 513,566 tons (EPA 2023v).

Table 18. 2020 Air Pollutant Emissions in Tons per Year by Source – New Mexico

Source	CO	NH ₃	NO _x	PM ₁₀	PM _{2.5}	SO ₂	VOC
Area sources	10,322	83,628	2,218	97,936	15,646	434	32,364
Oil and gas sources	100,695	4	67,956	2,171	2,005	83,175	257,560
Non-road mobile	64,346	15	20,430	969	925	72	5,730
On-road mobile	139,109	794	39,531	2,195	1,115	77	10,074
Point sources	79,958	1,128	50,508	9,741	9,273	2,824	28,385
VOC refueling	5	0	2	0	0	0	5,745
Natural sources (biogenics)	64,591	0	16,459	0	0	0	335,799

Source	CO	NH ₃	NO _x	PM ₁₀	PM _{2.5}	SO ₂	VOC
Forest wildfires	146,933	2,417	2,196	15,120	12,811	1,164	34,718
Prescribed fires	9,554	158	162	1,000	848	82	2,264
Total for New Mexico	615,513	88,144	199,462	129,132	42,623	87,828	712,639

Source: EPA (2023v).

The largest NEI anthropogenic sources of criteria air pollutants in Texas is oil and gas sources for NO_x and VOCs (Table 19). From the period of 2008 to 2020, criteria air pollutant emissions have fluctuated. NO_x decreased from 1,717,979 tons in 2008 to 933,997 tons in 2020, SO₂ decreased from 619,281 tons to 247,247 tons, PM₁₀ decreased from 2,514,908 tons to 1,548,279 tons, PM_{2.5} decreased from 462,178 tons to 361,420 tons, CO emissions decreased from 5,601,235 tons in 2008 to 4,066,407 tons in 2020, and VOC decreased from 6,028,204 tons to 4,354,204 tons. Emissions from natural sources (biogenics) decreased from 4,687,170 tons in 2008 to 2,777,116 tons in 2020, and criteria air pollutant emissions from oil and gas production decreased from 1,789,026 to 1,686,327 tons (EPA 2023v).

Table 19. 2020 Air Pollutant Emissions Tons per Year by Source – Texas

Source	CO	NH ₃	NO _x	PM ₁₀	PM _{2.5}	SO ₂	VOC
Area sources	256,981	518,847	66,505	1,391,488	233,612	46,988	336,696
Oil and gas sources	188,033	31	236,288	3,237	3,220	47,556	1,207,962
Non-road mobile	905,234	106	101,950	7,584	7,162	981	67,042
On-road mobile	1,172,835	7,595	210,029	15,969	6,575	805	66,713
Point sources	183,664	7,054	199,302	23,251	20,378	142,378	53,842
VOC refueling	65	1	84	8	7	11	39,449
Natural sources (biogenics)	334,168	0	103,142	0	0	0	2,339,806
Forest wildfires	80,902	1,330	1,572	8,654	7,337	745	19,224
Prescribed fires	944,525	15,545	15,125	98,088	83,129	7,783	223,470
Total for Texas	4,066,407	550,509	933,997	1,548,279	361,420	247,247	4,354,204

Source: EPA (2023v).

The largest NEI anthropogenic sources of criteria air pollutants in Kansas is oil and gas sources for VOCs (Table 20). From the period of 2008 to 2020, criteria air pollutant emissions have fluctuated. NO_x increased from 357,510 tons in 2008 to 199,312 tons in 2020, SO₂ decreased from 118,860 tons to 14,794 tons, PM₁₀ decreased from 866,070 tons to 500,208 tons, PM_{2.5} decreased from 193,662 tons to 146,908 tons, CO emissions decreased from 1,355,031 tons in 2008 to 927,620 tons in 2020, and VOCs decreased from 771,768 tons to 698,701 tons. Emissions from natural sources (biogenics) decreased from 688,504 tons in 2008 to 513,882 tons in 2020, while criteria air pollutant emissions from oil and gas production increased from 854 to 113,371 tons (EPA 2023v).

Table 20. 2020 Air Pollutant Emissions Tons per Year by Source – Kansas

Source	CO	NH ₃	NO _x	PM ₁₀	PM _{2.5}	SO ₂	VOC
Area sources	52,710	202,047	7,664	418,547	71,697	3,568	71,332
Oil and gas sources	33,055	22	22,337	603	603	124	56,627
Non-road mobile	116,899	12	38,572	2,257	2,150	164	9,495
On-road mobile	177,881	890	34,667	1,918	966	68	11,847
Point sources	47,909	1,049	41,931	6,672	6,115	4,424	7,846
VOC refueling	14	0	7	0	0	0	9,090
Natural sources (biogenics)	70,723	0	37,290	0	0	0	405,869
Forest wildfires	9,605	155	232	1,095	934	101	2,323
Prescribed fires	418,824	6,318	16,612	69,116	64,443	6,345	124,272
Total for Kansas	927,620	210,493	199,312	500,208	146,908	14,794	698,701

Source: EPA (2023v).

The largest NEI anthropogenic sources of criteria air pollutants in Oklahoma is oil and gas sources for VOCs (Table 21). From the period of 2008 to 2020, criteria air pollutant emissions have fluctuated. NO_x decreased from 463,786 tons in 2008 to 239,248 tons in 2020, SO₂ decreased from 148,620 tons to 34,886 tons, PM₁₀ decreased from 809,138 tons to 503,474 tons, PM_{2.5} decreased from 168,525 tons to 142,322 tons, CO emissions decreased from 1,736,048 tons in 2008 to 1,236,722 tons in 2020, and VOCs decreased from 1,356,316 tons to 1,190,093 tons. Emissions from natural sources (biogenics) decreased from 1,045,049 tons in 2008 to 822,989 tons in 2020, and criteria air pollutant emissions from oil and gas production decreased from 322,241 to 276,709 tons (EPA 2023v).

Table 21. 2020 Air Pollutant Emissions Tons per Year by Source – Oklahoma

Source	CO	NH ₃	NO _x	PM ₁₀	PM _{2.5}	SO ₂	VOC
Area sources	58,170	184,623	14,030	420,628	71,617	19,298	72,465
Oil and gas sources	45,423	0	46,040	1,134	1,106	958	182,048
Non-road mobile	176,121	15	26,395	1,699	1,612	287	15,394
On-road mobile	252,943	1,355	50,832	3,026	1,423	131	17,525
Point sources	70,607	1,553	64,174	13,467	12,045	8,498	24,813
VOC refueling	28	0	3	1	1	0	15,235
Natural sources (biogenics)	71,737	0	25,174	0	0	0	726,078
Forest wildfires	62,451	1,034	1,309	6,756	5,724	606	14,861

Source	CO	NH ₃	NO _x	PM ₁₀	PM _{2.5}	SO ₂	VOC
Prescribed fires	499,242	8,186	11,291	56,763	48,794	5,108	121,674
Total for Oklahoma	1,236,722	196,766	239,248	503,474	142,322	34,886	1,190,093

Source: EPA (2023v).

The largest NEI anthropogenic sources of criteria air pollutants in the San Juan Basin (McKinley, Sandoval, San Juan, and Rio Arriba Counties) is oil and gas sources for CO, NO_x, and VOCs (Table 22). From the period of 2008 to 2020, criteria air pollutant emissions have fluctuated. NO_x decreased from 57,085 tons in 2008 to 53,708 tons in 2020, SO₂ decreased from 13,146 tons to 2,301 tons, PM₁₀ decreased from 221,003 tons to 24,218 tons, PM_{2.5} decreased from 25,868 tons to 6,042 tons, CO emissions decreased from 147,491 tons in 2008 to 108,755 tons in 2020, and VOCs decreased from 209,861 tons to 141,794 tons. Emissions from natural sources (biogenics) decreased from 229,692 tons in 2008 to 81,279 tons in 2020, while criteria air pollutant emissions from oil and gas production increased from 2,309 to 116,232 tons (EPA 2023v). The NEI data by source for each county in the San Juan Basin are presented in Appendix A.

Table 22. 2020 Air Pollutant Emissions Tons per Year by Source – San Juan Basin

Source	CO	NH ₃	NO _x	PM ₁₀	PM _{2.5}	SO ₂	VOCs
Area sources	2,064	5,605	322	20,805	2,989	34	4,571
Oil and gas sources	33,662	0	22,582	287	283	289	59,129
Non-road mobile	7,469	2	2,978	128	124	4	737
On-road mobile	25,162	146	6,826	362	193	14	1,763
Point sources	25,670	200	18,591	2,264	2,139	1,926	6,216
VOC refueling	0	0	0	0	0	0	924
Natural sources (biogenics)	11,304	0	2,336	0	0	0	67,639
Forest wildfires	3,039	51	64	330	279	30	723
Prescribed fires	385	6	9	42	35	4	92
Total for San Juan Basin	108,755	6,010	53,708	24,218	6,042	2,301	141,794

Source: EPA (2023v).

The largest NEI anthropogenic sources of criteria air pollutants in the Permian Basin (Eddy, Chaves, Lea, and Roosevelt Counties) is oil and gas sources for CO, NO_x, PM₁₀, PM_{2.5}, SO₂, and VOCs (Table 23). From the period of 2008 to 2020, criteria air pollutant emissions have fluctuated. NO_x increased from 31,514 tons in 2008 to 66,098 tons in 2020, SO₂ increased from 9,995 tons to 83,521 tons, CO emissions increased from 98,963 tons in 2008 to 109,477 tons in 2020, and VOCs increased from 165,371 tons to 252,387 tons. However, PM₁₀ decreased from 100,800 tons to 20,585 tons, and PM_{2.5} decreased from 13,332 tons to 6,270 tons. Emissions from natural sources (biogenics) decreased from 198,891 tons in

2008 to 38,958 tons in 2020, while criteria air pollutant emissions from oil and gas production increased from 12,974 to 389,973 tons (EPA 2023v). The NEI data by source for each county in the Permian Basin are presented in Appendix A.

Table 23. 2020 Air Pollutant Emissions Tons per Year by Source – Permian Basin

Source	CO	NH ₃	NO _x	PM ₁₀	PM _{2.5}	SO ₂	VOCs
Area sources	1,731	26,246	503	16,733	2,786	162	7,755
Oil and gas sources	63,937	3	43,049	1,838	1,689	82,882	196,575
Non-road mobile	5,131	0	1,257	78	72	10	498
On-road mobile	15,136	88	3,422	213	100	7	999
Point sources	14,521	161	15,632	1,560	1,485	444	15,366
VOC refueling	0	0	0	0	0	0	1,635
Natural sources (biogenics)	7,549	0	2,201	0	0	0	29,208
Forest wildfires	906	14	19	99	83	9	215
Prescribed fires	566	9	15	64	55	7	136
Total for Permian Basin	109,477	26,521	66,098	20,585	6,270	83,521	252,387

Source: EPA (2023v).

The 2020 NEI VOC emissions for the states of New Mexico, Texas, Oklahoma, and Kansas are presented in Figure 2, which shows the estimated percentage of total VOC emissions from the largest source categories: biogenic sources, fires, industrial processes, mobile sources, and solvents (EPA 2023v).

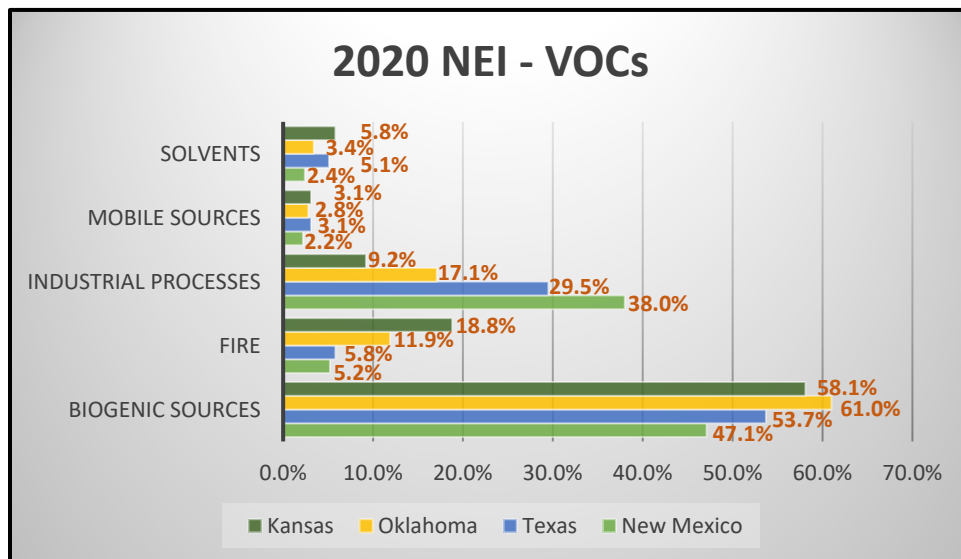


Figure 2. 2020 NEI – VOCs.

The 2020 NEI data for the BLM New Mexico portion of the San Juan Basin (San Juan, Rio Arriba, Sandoval, and McKinley Counties) indicate that biogenic sources and fuel combustion account for 47.7% and 3.0% of total VOC emissions, respectively, in the area (EPA 2023v). Industrial processes account for 43.7%, of which approximately 95.3% is from oil and gas production.

The 2020 NEI data for the BLM New Mexico portion of the Permian Basin (Eddy, Lea, Chaves, and Roosevelt Counties) indicate that biogenic sources and fuel combustion account for 11.6% and 2.7% of total VOC emissions, respectively, in the area (EPA 2023v). Industrial processes account for 81.5%, of which approximately 95.5% is from oil and gas production.

4.1.1 NITROGEN OXIDES EMISSIONS

The 2020 NEI NO_x emissions for the states of New Mexico, Texas, Oklahoma, and Kansas are presented in Figure 3, which shows the estimated percentage of total NO_x emissions from the largest source categories: fuel combustion, biogenic sources, fires, industrial processes, and mobile sources (EPA 2023v).

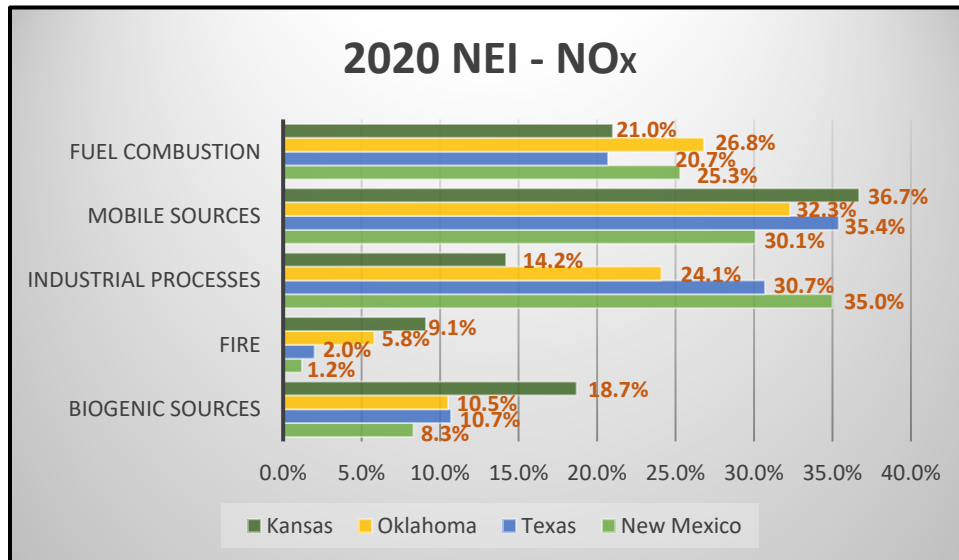


Figure 3. 2020 NEI – NO_x.

The 2020 NEI data for the BLM New Mexico portion of the San Juan Basin (San Juan, Rio Arriba, Sandoval, and McKinley Counties) indicate that fuel combustion and mobile sources account for 34.6% and 18.3% of total NO_x emissions, respectively, in the area (EPA 2023v). Industrial processes account for 42.5%, of which approximately 98.9% is from oil and gas production.

The 2020 NEI data for the BLM New Mexico portion of the Permian Basin (Eddy, Lea, Chaves, and Roosevelt Counties) indicate that fuel combustion and mobile sources account for 23.6% and 7.1% of total NO_x emissions, respectively, in the area (EPA 2023v). Industrial processes account for 65.8%, of which approximately 98.9% is from oil and gas production.

4.1.2 CARBON MONOXIDE EMISSIONS

The 2020 NEI CO emissions for the states of New Mexico, Texas, Oklahoma, and Kansas are presented in Figure 4, which shows the estimated percentage of total CO emissions from the largest source categories: fuel combustion, biogenic sources, fires, industrial processes, and mobile sources (EPA 2023v).

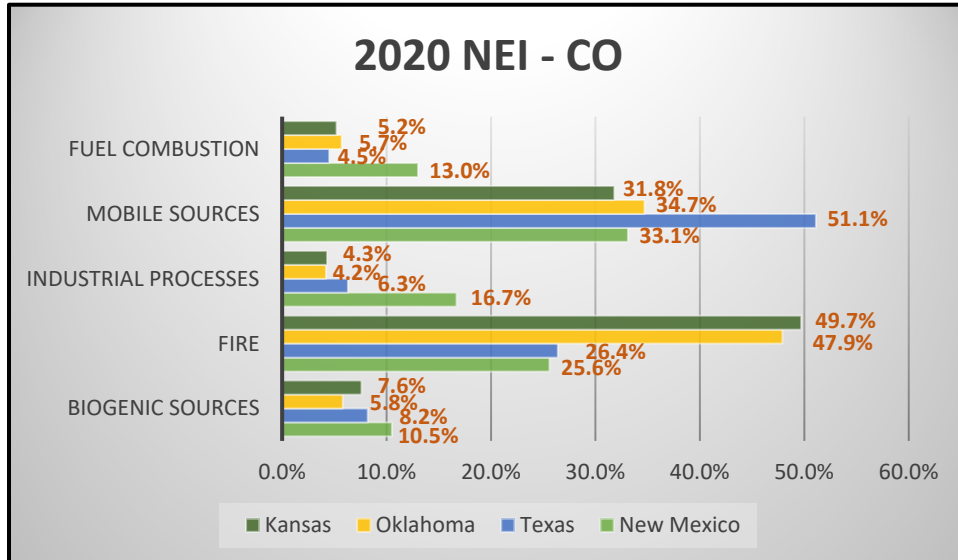


Figure 4. 2020 NEI – CO.

The 2020 NEI data for the BLM New Mexico portion of the San Juan Basin (San Juan, Rio Arriba, Sandoval, and McKinley Counties) indicate that fuel combustion and mobile sources account for 23.6% and 30.0% of total CO emissions, respectively, in the area (EPA 2023v). Industrial processes account for 31.2%, of which approximately 99.2% is from oil and gas production.

The 2020 NEI data for the BLM New Mexico portion of the Permian Basin (Eddy, Lea, Chaves, and Roosevelt Counties) indicate that fuel combustion and mobile sources account for 13.3% and 18.5% of total CO emissions, respectively, in the area (EPA 2023v). Industrial processes account for 59.2%, of which approximately 98.7% is from oil and gas production.

4.1.3 PARTICULATE MATTER

The 2020 NEI PM₁₀ and PM_{2.5} emissions for the states of New Mexico, Texas, Oklahoma, and Kansas are presented in Figure 5 and Figure 6, which show the estimated percentage of total VOC emissions from the largest source categories: dust sources, fuel combustion, agriculture, fires, industrial processes, and mobile sources (EPA 2023v).

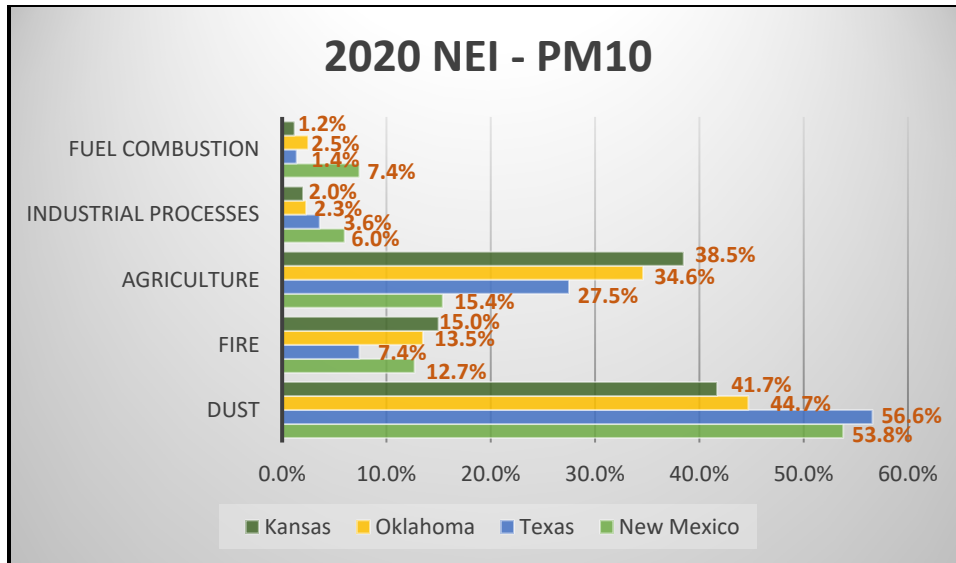


Figure 5. 2020 NEI - PM₁₀.

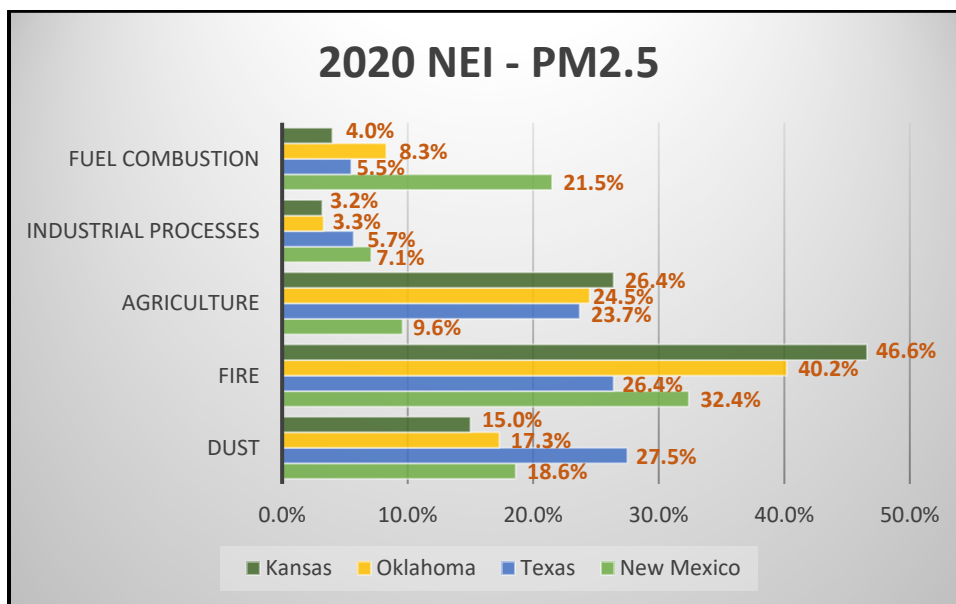


Figure 6. 2020 NEI - PM_{2.5}.

The 2020 NEI data for the BLM New Mexico portion of the San Juan Basin (San Juan, Rio Arriba, Sandoval, and McKinley Counties) indicate that dust, fires, and fuel combustion account for 66.8%, 1.6%, and 9.2% of total PM₁₀ emissions, respectively, in the area (EPA 2023v). Industrial processes account for 11.7%, of which approximately 10.1% is from oil and gas production. Dust, fires, and fuel combustion account for 30.3%, 5.4%, and 35.3%, respectively, of total PM_{2.5} emissions. Industrial processes account for 10.5%, of which approximately 44.6% is from oil and gas production.

The 2020 NEI data for the BLM New Mexico portion of the Permian Basin (Eddy, Lea, Chaves, and Roosevelt Counties) indicate that dust and agriculture account for 47.6% and 27.1% of total PM₁₀ emissions, respectively, in the area (EPA 2023v). Industrial processes account for 14.0%, of which

approximately 63.6% is from oil and gas production. Dust and agriculture account for 17.4% and 18.3%, respectively, of total PM_{2.5} emissions. Industrial processes account for 31.5%, of which approximately 85.6% is from oil and gas production.

4.1.4 SULFUR DIOXIDE EMISSIONS

The 2020 NEI SO₂ emissions for the states of New Mexico, Texas, Oklahoma, and Kansas are presented in Figure 7, showing the estimated percentage of total SO₂ emissions from the largest source categories: fuel combustion, fires, industrial processes, and mobile sources (EPA 2023v).

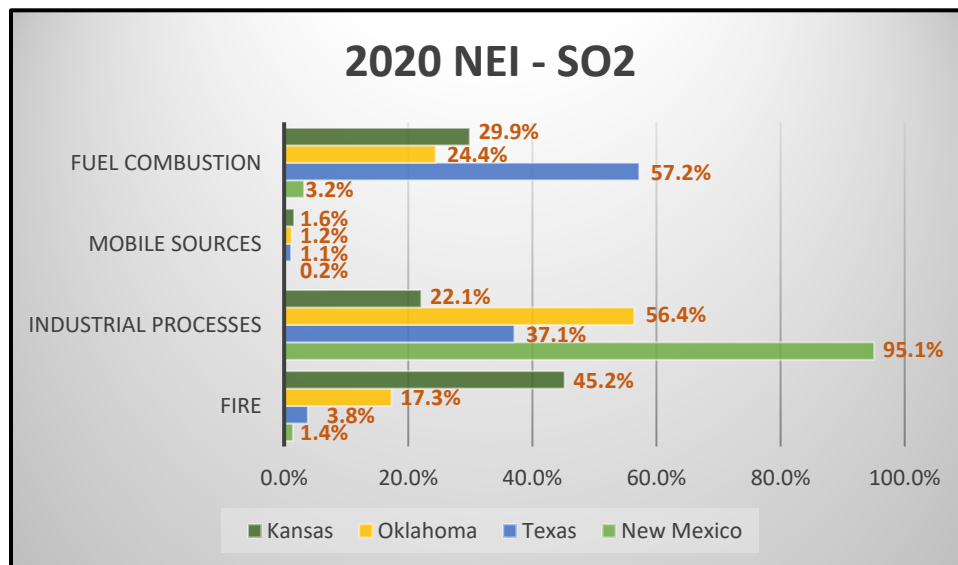


Figure 7. 2020 NEI - SO₂.

The 2020 NEI data for the BLM New Mexico portion of the San Juan Basin (San Juan, Rio Arriba, Sandoval, and McKinley Counties) indicate that fuel combustion and fires account 83.7% and 1.5% of total SO₂ emissions, respectively, in the area (EPA 2023v). Industrial processes account for 13.3%, of which approximately 94.8% come from oil and gas production.

The 2020 NEI data for the BLM New Mexico portion of the Permian Basin (Eddy, Lea, Chaves, and Roosevelt Counties) indicate that fuel combustion accounts for 0.5% of total SO₂ emissions in the area (EPA 2023v). Industrial processes account for 99.4%, of which approximately 99.8% is from oil and gas production.

4.1.5 HAZARDOUS AIR POLLUTANTS

The 2020 NEI HAPs emissions for the states of New Mexico, Texas, Oklahoma, and Kansas are presented in Figure 8, showing the estimated percentage of total HAPs emissions from the largest source categories: biogenics, fuel combustion, fires, industrial processes, and mobile sources (EPA 2023v). The NEI HAP emissions by state and county are summarized in Table 24.

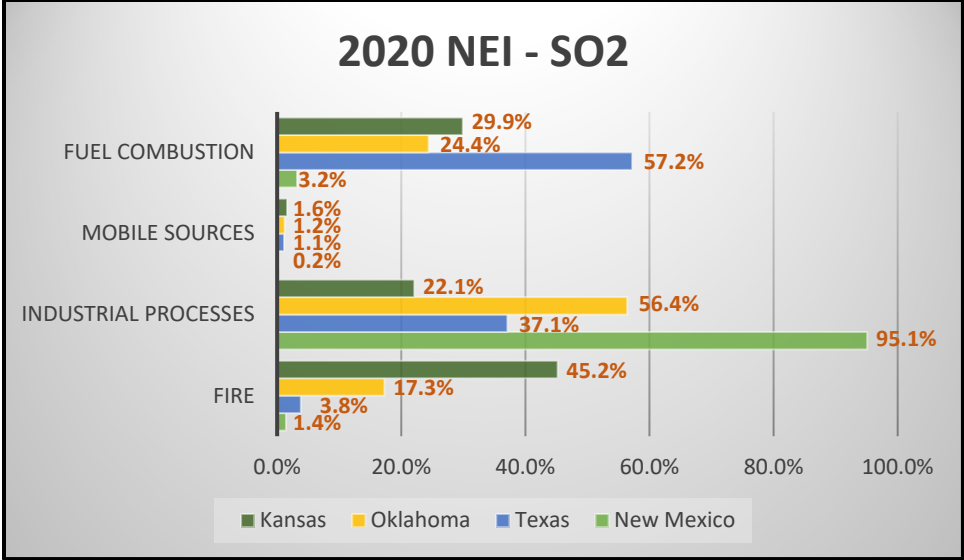


Figure 8. 2020 NEI - HAPs.

Table 24. Hazardous Air Pollutants for State and Field Offices

State/County	Acetaldehyde	Benzene	Ethylbenzene	Formaldehyde	Hexane	Methanol	Naphthalene	Toluene	Xylenes	Total HAPs
Kansas	20,514.8	2,737.0	613.8	22,799.9	1,390.9	57,983.9	820.8	4,523.7	2,542.3	128,527
Texas	47,402.9	17,442.7	3,896.1	73,173.0	9,553.9	219,649.1	3,188.4	29,293.3	16,091.2	461,215
Oklahoma	15,708.8	3,300.0	915.8	25,065.9	1,824.7	58,314.7	1,642.0	6,977.3	4,849.3	131,286
New Mexico	11,803.3	4,170.1	489.9	26,168.2	1,221.9	47,572.0	593.7	4,486.8	1,926.0	105,524
Chaves	346.2	40.6	18.0	583.0	21.9	1,798.6	7.0	90.7	32.9	3,234
Eddy	905.6	1,389.9	56.6	5,485.7	242.2	1,668.7	27.4	810.00	219.8	11,764
Lea	1,038.2	1,663.1	77.5	5,888.2	377.9	2,124.0	27.9	997.8	255.4	13,507
McKinley	428.2	27.4	11.1	637.8	18.0	2,169.5	11.7	73.7	37.0	3,558
Rio Arriba	604.0	40.1	12.1	1,075.1	34.9	2,783.1	8.5	80.6	46.9	4,829
Roosevelt	218.1	12.8	3.4	285.6	5.4	1,276.8	4.0	26.8	11.8	2,003
San Juan	470.5	151.9	26.1	1,020.6	98.0	1,815.3	19.7	260.0	105.1	4,272
Sandoval	325.0	44.8	21.3	461.0	30.3	1,261.8	18.7	147.0	68.7	2,618

Source: EPA (2023v).

5 HAZARDOUS AIR POLLUTANTS

Currently there are 187 specific pollutants and chemical groups known as HAPs. The list has been modified over time. HAPs are chemicals or compounds that are known or suspected to cause cancer or other serious health effects, such as compromises to immune and reproductive systems, birth defects, developmental disorders, or adverse environmental effects and may result from either chronic (long-term) and/or acute (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 the 187 HAPs. The U.S. Congress amended the federal CAA in 1990 to address a number of air pollutants that are known to cause or may reasonably be anticipated to cause adverse effects on human health or adverse environmental effects.

Ambient air quality standards do not exist for HAPs; however, the CAA requires control measures for HAPs. Mass-based emissions limits and risk-based exposure thresholds have been 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. NESHAPs are issued by the EPA to limit the release of specified HAPs from specific industrial sectors. These standards are technology based, meaning that they represent the MACT that are economically feasible for an industrial sector.

NESHAPs for Oil and Natural Gas Production and Natural Gas Transmission and Storage were published by the EPA on June 17, 1999. These NESHAPs were directed toward major sources and intended to control benzene, toluene, ethylbenzene and mixed xylenes (BTEX) and n-hexane. An additional NESHAP for Oil and Natural Gas Production Facilities directed toward area sources was published on January 3, 2007, and specifically addresses benzene emissions from triethylene glycol dehydrations units. The EPA issued a final rule revising the NESHAP rule effective October 15, 2012. The final rule includes revisions to the existing leak detection and repair requirements and established emission limits reflecting MACT for currently uncontrolled emission sources in oil and gas production and natural gas transmission and storage (Federal Register 77(159):49490–49600).

The EPA NESHAPs that are most likely to have applicability to oil and gas operations are as follows (in addition to the NESHAPs common/general provisions):

- 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

Note that several of the NSPSs that are potentially applicable to oil and gas operations (listed in Section 2) also regulate emissions of VOCs, a component of which includes HAP emissions. Although the NSPS rules are not designed to directly regulate HAP emissions, control of VOCs results in the co-benefit of HAP reductions.

The CAA defines a major source for HAPs to be one emitting 10 tpy of any single HAP or 25 tpy of any combination of HAPs. Under state regulations, a construction or operating permit may be required for any major source, though some exceptions apply. In New Mexico, these regulations are N.M.A.C. 20.2.70 and 20.2.73; in Texas, the regulation is 30 Texas Administrative Code (T.A.C.) § 122; in Kansas, the regulation is Kansas Administrative Regulations (K.A.R.) 28-19-500; and in Oklahoma, the regulation

is Oklahoma Register 252-100-7. Within its definition of a major source in the above-referenced regulations, the State of New Mexico includes the following language:

...hazardous emissions from any oil or gas exploration or production well (with its associated equipment) and hazardous emissions from any pipeline compressor or pump station shall not be aggregated with hazardous emissions from other similar units, whether or not such units are in a contiguous area or under common control, to determine whether such units or stations are major sources...

In other words, in determining a major source, each oil and gas exploration and production well must be considered singularly. Kansas, Texas, and Oklahoma regulations include similar language.

The State of New Mexico incorporates federal NESHAPs for pollutants through updates to N.M.A.C. 20.2.78, which adopts 40 C.F.R. § 61, and federal NESHAPs for source categories through updates to N.M.A.C. 20.2.82, which adopts 40 C.F.R. § 63. Similarly, Texas incorporates federal NESHAPs for both 40 C.F.R. § 61 and 40 C.F.R. § 63 through updates to 30 T.A.C. § 113. Kansas incorporates federal NESHAPs by adopting 40 C.F.R. § 61 through updates to K.A.R. 28-19-735 and incorporates NESHAP source categories at 40 C.F.R. § 63 through updates to K.A.R. 28-19-750. Oklahoma incorporates both 40 C.F.R. § 61 and 40 C.F.R. § 63 through Oklahoma Register 252-100-41-2 and the Oklahoma Administrative Code Appendix Q.

Although HAPs do not have federal air quality standards some states have established “thresholds” to evaluate human exposure for potential chronic inhalation illness and cancer risks. There are no applicable federal or state ambient air quality standards for assessing potential HAP impacts to human health and monitored background concentrations are rarely available. Therefore, RfCs for chronic inhalation exposures and RELs for acute inhalation exposures can be applied as evaluation criteria. Table 25 below provides the RfCs and RELs. Both the RfC and REL guideline values are for noncancer effects.

Table 25. HAP RELs and RfCs

HAPs	Acute RELs ¹	Noncancer Chronic RfC ²	Inhalation Unit Risk (IUR) ²
Benzene	27	30	7.8E-06
Toluene	5,000	5,000	Not applicable (n/a)
Ethylbenzene	22,000	1,000	2.5E-06
Xylenes	8,700	100	n/a
n-Hexane	180,000	700	n/a
Formaldehyde	55	9.8 ³	1.3E-05

¹Values referenced from EPA (2021a).

²Values referenced from EPA (2023w).

³There is no RfC for formaldehyde. The Agency for Toxic Substances and Disease Registry (ATSDR) chronic minimal risk level (MRL) of 0.008 ppm was used and converted to µg/m³.

5.1 CSU HAPS MODELING STUDY

Potential health risks associated with HAPs released into the air from oil and gas operations have been evaluated by review of existing emissions data, air quality monitoring, and modeling studies assessed. For example, a 2019 health assessment study was completed, the Final Report: Human Health Risk Assessment for Oil and Gas Operations in Colorado (ICF and Colorado State University [CSU] 2019), for which scientists from CSU conducted on-site air monitoring for 47 VOCs (including HAPs) during various stages of well development and production at oil and gas extraction facilities in Colorado. The study used tracer gas controlled-release sampling to develop calculated emission rates during various stages of well development and production for well pads of various sizes and at various locations in Colorado. Acetylene was released at a controlled, constant rate while samples were collected in canisters downwind of the well pads. The samples collected were analyzed in a lab for acetylene and 47 other VOC species, including a number of HAPs such as acetaldehyde and BTEX, to determine the concentration of each species. The ratio of the known acetylene release rate to the measured downwind sample concentration was then used to calculate emission rates of each VOC species for each sample. Dispersion modeling with the American Meteorological Society/Environmental Protection Agency Regulatory Model (AERMOD) was then performed in which rings of receptors were established at various distances from 300 to 2,000 feet from the center of the well pads to estimate short- and long-term chemical air concentrations. (ICF and CSU 2019). The maximum results of the dispersion modeling for each distance were then used in EPA Air Pollutants Exposure Model (APEX) to compare the calculated exposure levels from each scenario and each distance against acute, subchronic, and chronic exposure standards for each VOC species.

Results of the study indicate that acute (1-hour) exposures were below guideline levels (hazard index under 1, indicating short-term health impacts are unlikely to occur) for most chemicals. At the 500-foot distance, for a small number of chemicals (including benzene, toluene, and ethyltoluenes), the highest estimated acute exposures exceeded guideline levels at the most exposed (downwind) locations, in isolated cases by a factor of 10 or more, particularly during flowback activities at smaller well pads. Flowback is defined in the study as the period after the entire well is fracked and the plugs are drilled out to enable the flow of fracking fluid, water, oil, and natural gas to the surface (ICF and CSU 2019).

For a relatively small number of development scenarios, those highest predicted acute exposures decreased rapidly with distance, but remained above guideline levels out to 2,000 feet (ICF and CSU 2019). Flowback occurs during well completion when fracturing fluids, water, and reservoir gas come to the surface at high velocity and volume and contain a mixture of VOCs, CH₄, benzene, ethylbenzene, and n-hexane. As noted by the study, the identification of these estimated exceedances of acute health guidelines (hazard index above 1) is highly conservative, and the highest exposures occur rarely (ICF and CSU 2019). Subchronic modeled hazard indexes were generally lower than acute modeled hazard indexes. Most subchronic (multi-day/lasting less than 1 year) exposures were below subchronic guideline levels (all exposures at the 500-foot distance and beyond) during development activities, although subchronic exposures slightly above guideline levels for combined exposures to multiple chemicals were noted during fracking at distances out to 800 feet. As with acute exposure estimates, the study noted that the subchronic exposure estimates are also conservative (ICF and CSU 2019).

Chronic exposure was estimated for production operations, development and operations, and long flowback operations. Exposures at the 500-foot distance for the flowback periods were far below guideline levels for individual chemicals and only slightly above guideline levels for combined exposures

to multiple chemicals (ISF and CSU 2019). The chronic exposures during production operations were generally the lowest, relative to guideline levels, from all modeled scenarios. At the 500-foot distance from the facility, all chronic exposures during production activities were below guideline levels, and the average incremental lifetime cancer risk from chronic benzene exposure was 5 in 1 million or less (dropping below 1 in 1 million before the 2,000-foot distance). When estimates of chronic exposure include exposure to development activities occurring sequentially with exposure to production activities, exposures were only slightly higher than those estimated during the production activities alone.

The hazard index for chronic health impacts was 1 or less, often by more than an order of magnitude, at receptors that are 2,000 feet from the modeled well pad scenarios (ICF and CSU 2019). Table 26 summarizes cancer risks over a lifetime of exposure during oil and gas production operations (ICF and CSU 2019).

Table 26. Cancer Risks Over a Lifetime of Exposure During Production Operations of Oil and Gas Activities

Distance (feet)	Average Incremental Lifetime Cancer Risk	Maximum Exposed Individual Cancer Risk
300	10 in 1 million	benzene
400	–	10 in 1 million
500	4 in 1 million	7 in 1 million
1,400	1 in 1 million	benzene
2,000	benzene	1 in 1 million

Source: ICF and CSU (2019).

In summary, simulated cancer risks to average individuals were below 1 in 1 million at distances of 1,400 feet from the well pads, 4 in 1 million at 500 feet from the well pads, and 10 in 1 million at 300 feet from the well pads. Risk to maximum exposed individuals were below 1 in 1 million at distances of 2,000 feet from the well pads, 7 in 1 million at 500 feet from the well pads, and 10 in 1 million at 400 feet from the well pads (ICF and CSU 2019).

5.2 AIR TOXICS SCREENING ASSESSMENT

The AirToxScreen is the EPA ongoing review of air toxics in the United States. The EPA developed AirToxScreen as a screening tool for state, local, and tribal air agencies. AirToxScreen results help the EPA and other agencies identify which pollutants, emission sources, and places they may wish to study further to better understand any possible risks to public health from air toxics. AirToxScreen is the successor to the National Air Toxics Assessment, or NATA. In December 2022, EPA released the results of its 2019 AirToxScreen.

AirToxScreen calculates concentration and risk estimates from a single year of emissions data using meteorological data for that same year. The risk estimates assume a person breathes these emissions each year over a lifetime (or approximately 70 years). AirToxScreen then provides quantitative estimates of potential cancer risk and five classes of noncancer hazards (grouped by organ/system: immunological,

kidney, liver, neurological, and respiratory) associated with chronic inhalation exposure to real-world toxics. The 2019 AirToxScreen assessment includes emissions, ambient concentrations, and exposure estimates for about 181 of the 188 CAA air toxics plus diesel particulate matter (diesel PM). For about 140 of these air toxics (those with health data based on long-term exposure), the assessment estimates cancer risks, noncancer health effects, or both. The assessment includes noncancer health effects for diesel PM.

AirToxScreen potential cancer risk values represent statistical probabilities of developing cancer over a lifetime. AirToxScreen noncancer hazards are expressed as a ratio of an exposure concentration to an RfC associated with observable adverse health effects (i.e., a hazard quotient). “For a given air toxic, exposures at or below the RfC (i.e., hazard quotients are 1 or less) are *not* likely to be associated with adverse health effects. As exposures increase above the RfC (i.e., hazard quotients are greater than 1), the potential for adverse effects also increases” (EPA 2022a).

RfCs are indicators defined by the EPA as the daily inhalation concentrations at which no long-term adverse health impacts are expected. Short-term (1-hour) HAP concentrations will be compared with acute RELs. RELs are defined as concentrations at or below which no adverse health effects are expected (California Office of Environmental Health Hazard Assessment 2019). The primary air toxics of concern for oil and gas operations are BTEX, formaldehyde, and n-hexane.

It is important to note that AirToxScreen focuses solely on exposures from inhalation of outdoor ambient air. The AirToxScreen framework does not address inhalation from indoor ambient air, estimate human exposure to chemicals via ingestion or through dermal contact, or account for exposures that may take place via other mechanisms.

In addition, although AirToxScreen reports results at the census tract level, average risk estimates are far more uncertain at this level of spatial resolution than at the county or state level. To analyze air toxics in smaller areas, such as census blocks or in suspected “hotspots,” other tools such as site-specific monitoring and local-scale assessments should be used (EPA 2022a). AirToxScreen results are best used to focus on patterns and ranges of risks across the country. Additional AirToxScreen limitations can be reviewed at <https://www.epa.gov/AirToxScreen/airtoxscreen-limitations>.

In accordance with the AirToxScreen Technical Support Document (EPA 2022a), AirToxScreen is consistent with the EPA definition of a cumulative risk assessment, as stated in the EPA Framework for Cumulative Risk Assessment (EPA 2003:6), as “an analysis, characterization, and possible quantification of the combined risks to health or the environment from multiple agents or stressors.” (EPA 2003, 2022a). Table 27 shows the cancer risk (per million) and noncancer risk (hazard index) for Texas, Oklahoma, Kansas, and New Mexico, as well as eight counties in New Mexico from 2017 through 2019 (EPA 2023x). The EPA has determined that for the four counties in the BLM Farmington Field Office (FFO) (San Juan, Sandoval, Rio Arriba, and McKinley), the total cancer risk is a maximum of 18.72 in 1 million. The maximum contribution of the oil and gas industry to the cancer risk in the BLM FFO is 2.06 in 1 million. The EPA has determined that for Eddy and Lea Counties, the total cancer risk is a maximum of 22.25 in 1 million. The maximum contribution of the oil and gas industry to the cancer risk in Eddy and Lea Counties is 3.91 in 1 million. The total cancer risk is within the acceptable range of risk published by the EPA of 100 in 1 million as discussed in the National Contingency Plan, 40 C.F.R. § 300.430.

Table 27. Total Cancer Risk and Noncancer Respiratory Hazard from Existing HAP Emissions

United States and New Mexico	Respiratory Hazard Index			Total Cancer Risk (per million)			Oil and Gas Cancer Risk (per million)		
	2017	2018	2019	2017	2018	2019	2017	2018	2019
United States	0.36	0.32	0.31	28.68	25.00	25.50	0.15	0.19	0.12
Field Office									
Kansas	0.33	0.30	0.28	24.76	21.61	21.70	0.13	0.15	0.10
Oklahoma	0.39	0.34	0.30	28.96	24.70	24.85	0.55	0.64	0.34
Texas	0.35	0.29	0.30	31.33	25.81	28.13	0.27	0.32	0.30
New Mexico	0.24	0.21	0.22	20.27	17.57	19.10	0.24	0.33	0.34
County*									
Chaves	0.23	0.21	0.24	19.49	17.37	19.16	0.14	0.20	0.15
Eddy	0.24	0.22	0.23	21.41	20.09	22.25	2.25	3.38	3.91
Lea	0.23	0.20	0.21	20.27	18.30	20.16	2.15	2.86	3.05
McKinley	0.13	0.12	0.12	12.12	10.50	11.12	0.01	0.01	0.01
Rio Arriba	0.15	0.13	0.13	13.55	11.67	12.28	0.03	0.06	0.04
Sandoval	0.24	0.21	0.22	20.29	17.37	18.72	0.01	0.01	0.01
San Juan	0.29	0.30	0.28	17.57	17.10	17.56	1.73	2.21	2.06
Roosevelt	0.17	0.15	0.15	15.46	13.71	14.63	0.02	0.04	0.03

Source: EPA (2023x).

*These eight counties are where parcels are regularly nominated for BLM New Mexico Quarterly Oil and Gas Lease Sales.

The total risk for noncancer respiratory hazard index is estimated from a variety of factors from inhalation of air toxics nationwide, in both urban and rural areas. Background concentrations include pollutants that exist in the air that do not come from specific sources and may be derived from a natural source (biogenic) or from distance sources or pollutants that persist in the environment due to a long half-life. Background concentrations can explain pollutant concentrations found even without recent human-caused emissions. Oil and gas cancer risks are estimated from emissions from oil and gas operations such as emissions from individual well locations and production equipment such as pumps, dehydrators, tanks, and engines. Total cancer risk for the state of New Mexico (19.1 cases per million) was less than that of the United States (25.5 cases per million) (see Table 27). In addition, the respiratory noncancer hazard quotient values were consistently lower in the state of New Mexico (respiratory: 0.22) than national values (respiratory: 0.31).

At the county level, all eight counties (Chaves, Eddy, Lea, McKinley, Rio Arriba, Sandoval, San Juan, and Roosevelt) had cancer risk values and total hazard quotients less than those of the United States, with all total hazard quotients reported being less than 1 (<1.0).

5.3 HYDROGEN SULFIDE

Hydrogen sulfide (H₂S) is a colorless flammable gas with a rotten egg smell that is a naturally occurring by-product of oil and gas development in some areas, including the New Mexico portion of the Permian Basin. H₂S is both an irritant and a chemical asphyxiant with effects on both oxygen utilization and the central nervous system. Its health effects can vary depending on the level and duration of exposure. Effects may range from eye, nose, and throat irritation to dizziness, headaches, and nausea. High concentrations can cause shock, convulsions, inability to breathe, extremely rapid unconsciousness, coma, and death. Effects can occur within a few breaths and possibly a single breath.

H₂S was originally included in the list of Toxic Air Pollutants defined by Congress in the 1990 amendments to the CAA. It was later determined that H₂S was included through a clerical error, and it was removed by Congress from the list. H₂S was addressed under the accidental release provisions of the CAA. Congress also tasked the EPA with assessing the hazards to public health and the environment from H₂S emissions associated with oil and gas extraction. That report was published in October 1993 (EPA 1993).

H₂S was added to the Emergency Planning and Community Right-to-Know Act list of toxic chemicals in 1993. In 1994, the EPA issued an administrative stay of reporting requirements for H₂S while further analysis was conducted. The administrative stay was lifted and Toxic Release Inventory reporting due in July 2013 for calendar year 2012 emissions required reporting of H₂S.

Although there are no NAAQS for H₂S, a number of states, especially those with significant oil and gas production, have set standards at the state level. Table 28 summarizes these standards for states under BLM NMSO area of operation.

Table 28. State Ambient Air Quality Standards for H₂S

State	Standard	Averaging time	Remarks
Kansas	None	Not applicable (N/A)	N/A

State	Standard	Averaging time	Remarks
Oklahoma	200 ppb (0.2 ppm)	24 hour	N/A
New Mexico	0.010 ppm (10 ppb)	1 hour ⁽¹⁾	Statewide except Pecos-Permian Basin Intrastate Air Quality Control Region*
	0.100 ppm (100 ppb)	0.5 hour ⁽²⁾	Pecos-Permian Basin Intrastate Air Quality Control Region
	0.030 ppm (30 ppb)	0.5 hour	Within municipal boundaries and within 5 miles of municipalities with population >20,000 in Pecos-Permian Basin Air Quality Control Region
Texas	0.08ppm (80 ppb)	0.5 hour	If downwind concentration affects a property used for residential business or commercial purposes
	0.12 ppm (120 ppb)	0.5 hour	If downwind concentration affects only property not normally occupied by people

Source: Skrtic (2006).

* The Pecos-Permian Basin Intrastate Air Quality Control Region is composed of Quay, Curry, De Baca, Roosevelt, Chaves, Lea, and Eddy Counties in New Mexico.

⁽¹⁾ Pecos-Permian Basin intrastate air quality control region has a 0.5-hour standard of 0.10 ppm.

⁽²⁾ Not to be exceeded more than once per year.

NMED has no routine monitors for H₂S. However, a one-time study in 2002 sheds some light on the levels that can be expected near oil and gas facilities (Skrtic 2006). These readings are averaged over 3-minute periods so are not comparable with the standard, which has longer averaging periods. The New Mexico data indicate that ambient concentrations of H₂S at the sampling locations, which included both oil and gas facilities and sites without oil and gas facilities, are at least an order of magnitude greater than 0.11 to 0.33 ppb, which are the ambient levels of H₂S that can be expected in urban areas. The ambient levels recorded at the two sites without expected sources of H₂S—Indian Basin Hilltop, no facility, and Carlsbad City Limits, Tracy-A—both averaged 7 ppb, indicating that H₂S concentrations in this part of New Mexico are higher than normal urban background levels (Skrtic 2006) (Table 29).

H₂S levels measured at flaring, tank storage, and well drilling sites, averaging from approximately 100 to 200 ppb, are significantly elevated compared with normal background levels usual background H₂S concentrations in this area of New Mexico (Skrtic 2006). Although these concentrations generally produce a nuisance due to odors that may translate into headaches, nausea, and sleep disturbances if exposure is constant, one study found central nervous system, respiratory system, and ear, nose, and throat symptoms associated with annual average H₂S levels ranging from 7 to 27 ppb (Skrtic 2006). Overall, the data show that concentrations of H₂S vary widely, even at similar facilities: at one compressor/dehydrator, the average concentration over the course of monitoring was 4 ppb, whereas at another, the average was 1,372 ppb. The data further demonstrate that H₂S is present, often at elevated levels, at oil and gas facilities (Skrtic 2006).

Table 29. Summary of Monitoring Data from New Mexico Study

Facility Type	H ₂ S Concentration Measured at Monitoring Site (ppb)	
	Range	Average
Indian Basin hilltop, no facility	5–8	7
Indian Basin compressor station	3–9	6
Indian Basin active well drilling site	7–190	114
Indian Basin flaring, production, and tank storage site	4–1,200	203
Marathon Indian Basin refining and tank storage site	2–370	16
Carlsbad city limits, near 8 to 10 wells and tank storage sites	5–7	6
Carlsbad city limits, Tracy-A	5–8	7
Compressor station, dehydrators – Location A	4–5	4
Compressor station, dehydrators – Location B	2–15,000	1,372
Huber flare/dehydrating facility	4–12	77
Snyder oil well field	2–5	4
Empire Abo gas processing plant	1–1,600	300
Navajo oil refinery	3–14	7–8

Source: Skrtic (2006).

In Oklahoma, routine monitoring downwind of two refineries in Tulsa showed H₂S levels that were within State standards but above normal background levels. The levels of H₂S in both neighborhoods, although not very high, are nevertheless above the EPA RfC of 1.4 ppb and are elevated well above normal background levels of 0.11 to 0.33 ppb. It is possible that continuous exposure to these levels poses health risks. Although the Oklahoma DEQ is monitoring H₂S levels, there is no concurrent community health or exposure study investigating the health effects of chronic exposure to these levels of H₂S (Skrtic 2006). In Texas, which has 12 routine monitors, H₂S levels generally ranged from 0.1 to 5 ppb. One monitor at a compressor station, however, showed frequent levels exceeding the State standard of 0.8 ppm (Skrtic 2006). In December 2005, the last month for which the data have been validated by the TCEQ, 20% of the hourly readings exceeded the State standard of 0.8 ppm. Chronic exposure to such levels, generally considered a nuisance due to odor, has also been shown to adversely affect human health (Skrtic 2006).

6 AIR QUALITY MODELING

Traditional air quality modeling generally falls into three categories: 1) near-field dispersion modeling is applied to criteria pollutants, HAPs, and AQRVs, where a small to medium number of sources are involved to cover an area within 50 kilometers (km) of a proposed project; 2) far-field or transport modeling is used to provide regional assessments of cumulative and incremental impacts at distances greater than 50 km; and 3) photochemical modeling may be used for large-scale projects with a large number of sources or with complex issues including O₃ and secondary particulate impacts.

6.1 NEW MEXICO OZONE ATTAINMENT INITIATIVE (OAI) PHOTOCHEMICAL MODELING STUDY

The State of New Mexico initiated the New Mexico Ozone Attainment Initiative (OAI) Photochemical Modeling Study (New Mexico OAI Study) in the spring of 2018 to address the high O₃ concentrations in the state, protect the O₃ attainment status of the state, and ensure health and welfare of the residents of the state for future generations (NMED 2021b). Based on the WRAP, Western Air Quality Study (WAQS) CAMx 2014 36/12-km modeling platform, a CAMx 2014 36/12/4-km O₃ modeling platform was developed with the 4-km domain focused on New Mexico and adjacent states. The New Mexico OAI Study also looked at 2028 future year base case modeling and oil and gas control sources. The 2028 oil and gas control strategy reduced oil and gas NO_x emissions by approximately 21,000 tpy (or by 64% compared to the 2028 base case) and oil and gas VOC emissions by approximately 53,000 tpy (or by 46% compared to the 2028 base case) (NMED 2021b). This study has been incorporated by reference.

6.1.1 2028 OZONE MODELING RESULTS

The 2028 base case and 2028 oil and gas control strategy modeling results followed EPA guidance, which recommended using a current year design value based on an average of three O₃ design values centered on the base modeling year (2014 in the New Mexico OAI Study). As a result, this part of the New Mexico OAI Study used a current year design value from 2012 through 2016.

To develop the 2028 O₃ future year design values for the specific scenarios, the current year design value (2012–2016, average of three design values over 5 years) was scaled by relative response factors (RRFs), which are model-derived scaling factors. In the New Mexico OAI Study, the RRFs are the ratio of the 2028 future scenario (base case or oil and gas control strategy scenario) over the 2014v2 base case CAMx O₃ results ($RRF = \Sigma \text{Model}_{2028} / \Sigma \text{Model}_{2014}$). This method allowed for the development of a projected 2028 O₃ future year design value for the respective scenarios (base case or oil and gas control strategy). The current 2012–2016 O₃ design values for sites in the counties in the major oil and gas basins of New Mexico (Eddy, Lea, Rio Arriba, Sandoval, San Juan, McKinley, Chaves and Roosevelt) range from 61.0 to 71.0 ppb. The 2028 base case saw future O₃ design value reductions ranging from –2.0 to –5.6 ppb in the oil and gas New Mexico counties, including reductions of –2.3 ppb at Carlsbad in Eddy County, –2.0 ppb at Hobbs in Lea County, –5.6 ppb at Bernalillo in Sandoval County, and –2.2 ppb and –3.3 ppb at Bloomfield and Navajo Lake, respectively, in San Juan County. The 2028 base case future O₃ design values in the oil and gas New Mexico counties ranged from 58.4 to 66.7 ppb. The 2028 oil and gas control strategy saw future O₃ design value reductions ranging from –0.3 to –0.8 ppb, including reductions of –0.3 ppb at Carlsbad, –0.7 ppb at Hobbs, –1.5 ppb and –0.8 ppb at Navajo Lake and Bloomfield, respectively, and –0.3 ppb at Bernalillo from the 2028 base case. The 2028 projected oil and gas control strategy O₃ design values in the oil and gas New Mexico counties ranged from 58.1 to 66.4 ppb. Using this method and following EPA guidance, all 2028 projected O₃ future design values at monitoring sites in New Mexico were below the 2015 NAAQS for O₃ of 70 ppb using the 2012–2016 design value (NMED 2021b).

With the recent upward trend in O₃ values in southeastern New Mexico, the New Mexico OAI study also looked at more recent design values (2015–2019 and 2017–2019). A similar method to that described above was used to determine the future 2015–2019 and 2017–2019 design values; however, it should be noted that because the New Mexico OAI Study used the CAMx 2014v2 base case results as the denominator in the RRF equation ($RRF = \Sigma \text{Model}_{2028} / \Sigma \text{Model}_{2014}$) to develop 2028 O₃ future design value projections, any emission changes (increase or decreases) between 2014 and the end of the 2010 decade will not be accounted for (e.g., increases in oil and gas source emissions and decreases in mobile

source emissions). This will result in uncertainties and will likely overstate the 2028 O₃ future design values in the Permian Basin emissions, as emissions from oil and gas sources are higher at the end of the 2010 decade than in 2014 (NMED 2021b).

The current 2015–2019 O₃ design values at the sites in the oil and gas New Mexico counties selected for this sensitivity test ranged from 62.0 to 79 ppb and included Carlsbad (79 ppb), Hobbs (71 ppb), Bernalillo (69 ppb), Bloomfield (69 ppb), and Navajo (70 ppb). The 2028 base case saw future O₃ design value reductions ranging from –2.1 to –5.8 ppb, including reductions of –2.5 ppb at Carlsbad, –2.1 ppb at Hobbs, –2.3 ppb at Navajo Lake, –5.8 ppb at Bernalillo, and –3.4 ppb at Bloomfield. 2028 projected base case O₃ design values at all sites in the oil and gas New Mexico counties selected for this sensitivity test ranged from 61.2 to 71.2 ppb. Note that the 2015–2019 future O₃ design value had one monitoring site (Carlsbad) that exceeded the 2015 NAAQS for O₃ at 71.2 ppb. The 2028 oil and gas control strategy saw future O₃ design value reductions ranging from 0.3 to –1.5 ppb, including reductions of –0.3 ppb at Carlsbad, –0.7 at Hobbs, –0.8 at Coyote Ranger District, –0.3 at Bernalillo, –0.8 at Bloomfield, and –1.5 at Navajo Lake, from the 2028 base case. 2028 projected oil and gas control strategy O₃ design values at all New Mexico sites selected for this sensitivity test ranged from 60.9 to 70.9 ppb. Emission controls in the 2028 oil and gas control strategy were sufficient to reduce the 2028 future O₃ value at Carlsbad (70.9 ppb) to below the NAAQS for O₃ (NMED 2021b).

The current 2017–2019 O₃ design values at all sites in the oil and gas New Mexico counties selected for this sensitivity test ranged from 67.0 to 79.0 ppb and included Carlsbad (79.0 ppb), Hobbs (71.0 ppb), Coyote Ranger District (67.0 ppb), Bloomfield (68.0 ppb), Navajo Lake (69.0 ppb) and Bernalillo (68.0 ppb) (with values above the 2015 O₃ NAAQS). The 2028 base case saw future O₃ design value reductions ranging from –0.3 to –2.6 ppb, including reductions of –2.6 ppb at Carlsbad, –0.8 ppb at Hobbs, –1.5 ppb at Navajo Lake, –0.3 ppb at Bernalillo, –0.9 ppb at Bloomfield, and –0.8 ppb Coyote Ranch District. The 2028 projected base case O₃ design values at all sites in the oil and gas New Mexico counties selected for this sensitivity test ranged from 62.1 to 76.4 ppb. Note that the 2017–2019 future O₃ design value had one monitoring site in the oil and gas New Mexico counties (Carlsbad – 76.4) that exceeded the 2015 NAAQS for O₃. The 2028 oil and gas control strategy saw future O₃ design value reductions ranging from –0.3 to –1.5 ppb, including reductions of –0.4 ppb at Carlsbad, –0.8 ppb at Hobbs, –1.5 ppb at Navajo Lake, –0.3 ppb at Bernalillo, –0.9 ppb at Bloomfield, and –0.8 ppb Coyote Ranch District, from the 2028 base case. The 2028 projected oil and gas control strategy O₃ design values at all sites in the oil and gas New Mexico counties selected for this sensitivity test ranged from 61.8 to 76.0 ppb. The 2028 future design value at Carlsbad of 76.0 ppb (with the oil and gas control strategy) exceeds the 2008 and 2015 NAAQS for O₃. However, as mentioned above, the design of this sensitivity study will result in uncertainties and will likely overstate the 2028 O₃ future design values in the Permian Basin, as emissions from oil and gas sources are higher at the end of the 2010 decade than in 2014 (NMED 2021b).

The final part of the New Mexico OAI Study investigated source apportionment and was conducted to determine the contributions of source sectors to 2028 future year O₃ design values under the oil and gas control strategy scenario. One investigation involved international emissions. The speciated modeled attainment test (SMAT) O₃ projection tool was run without the contributions of international anthropogenic emissions for current design values 2012–2016, 2015–2019, and 2017–2019. In New Mexico, international anthropogenic emissions contributed from 11 to 26 ppb to the projected 2028 future design values. The Carlsbad site had reductions of 20.3 ppb, 21.7 ppb, and 23.2 ppb, respectively. Carlsbad, which had produced a projected 2028 exceedance for both the 2008 and 2015 NAAQS for O₃ under the current design value 2017–2019 scenario, was below 55 ppb for a future design value under

all three design value scenarios (2012–2016, 2015–2019, and 2017–2019) (NMED 2021b). The Bloomfield site, in the northern part of the state, had reductions of 13.8 ppb, 14.5 ppb, and 14.6 ppb, respectively. Bloomfield, which had not produced a projected 2028 O₃ exceedance for either the 2008 and 2015 NAAQS for O₃ under the current design value 2017–2019 scenario (68 ppb), was below 50 ppb for a future design value under all three design value scenarios (2012–2016, 2015–2019, and 2017–2019) (NMED 2021b).

6.2 CARMMS 2.0 NORTHERN NEW MEXICO MODELING STUDY

The Comprehensive Air Quality Model with Extensions (CAMx) photochemical grid model (PGM) is used in the CARMMS 2.0 to assess the air quality and AQRV impacts associated with BLM-authorized mineral development on federal lands within BLM Colorado and the BLM FFO Planning Areas. CARMMS 2.0 uses data from the modeling platform of Western Air Quality Study (WAQS) from the Intermountain West Data Warehouse (IWDW) for the 2011 base year and 2025 future year air quality modeling and has adopted a two-way nested 12/4-km horizontal resolution domain. Three 2025 future year oil and gas levels were developed for a range of potential outcomes: a high-development scenario, a low-development scenario, and a medium-development scenario (which is a mitigated version of the high-development scenario where additional emission controls were applied). Additional information on CARMMS 2.0 methodology can be found in the *CARMMS 2.0 Air Impact Assessment for BLM Farmington Field Office Oil and Gas Development Report* (BLM and Ramboll 2018), incorporated by reference. The estimated emissions, air quality, and AQRV impacts from oil and gas development from the Mancos Shale modeled in CARMMS 2.0 (BLM and Ramboll 2018) are used to estimate impacts from development by the BLM FFO in the *Air Impact Assessment for BLM Farmington Field Office Oil and Gas Development Report* (BLM and Ramboll 2018), incorporated by reference. The Mancos Shale was treated as a separate source group in the CARMMS 2.0 modeling, and air quality and AQRV impacts from the Mancos Shale were separately quantified, enabling this analysis for the BLM FFO. As stated above (with consideration of both the Mancos-Gallup and Rio Puerco Field Office (RPFO) reasonably foreseeable development [RFD] scenarios), there would be an estimated 3,400 (federal and nonfederal) wells drilled within the New Mexico portion of the San Juan Basin by 2039. In contrast, CARMMS 2.0 modeling estimates that by 2025 there will be 2,756 new oil and gas wells for the high scenario and 1,378 new oil and gas wells for the low scenario in the Mancos Shale in New Mexico. Compared to the Mancos-Gallup RFD, CARMMS 2.0 predicts that 749 more federal wells under the low scenario and 2,127 more federal wells under the high scenario would be developed by 2025 than predicted by the RFD. CARMMS 2.0 also predicts that 567 more total wells under the low scenario and 1,866 more wells under the high scenario would be developed in the planning area as a whole (federal and nonfederal development). Note that the additional 200 wells from the RPFO RFD added into the comparison to the CARMMS 2.0 modeling would still result in more wells developed by 2025 in the CARMMS 2.0 modeling than predicted by the RFD. The low- and high-development scenarios of CARMMS 2.0 well development estimates are conservatively high relative to the RFD baseline scenario and current development (Section 2.1.1.1 in BLM and Ramboll 2018). As a result, the low-development scenario can be used to represent a conservative estimate of federal and planning area-wide impacts through 2025.

The NAAQS for O₃ is defined as the 3-year average of the fourth highest daily maximum 8-hour (DMAX8) O₃ concentration. Because CARMMS 2.0 only uses 1 year of meteorology (2011), the 2025 fourth highest DMAX8 O₃ concentration is used as a pseudo-NAAQS comparison metric. For the 2011 base case, there are vast regions where the modeled fourth highest DMAX8 O₃ level exceeds the NAAQS (all source groups). In the 2025 high-, low-, and medium-development scenarios, the areas of O₃ exceedances decrease from the 2011 base case, with the 2025 to 2011 O₃ differences showing decreases in almost all

areas. The large contribution of natural emissions (natural wildfires) to the modeled fourth highest DMAX8 O₃ concentrations was noted in the analysis. Maximum O₃ contributions to the 2025 fourth highest DMAX8 O₃ due to the BLM FFO are 1.7 ppb, 0.9 ppb, and 1.0 ppb for the 2025 high, low, and medium-development scenarios, respectively. Maximum contributions of the BLM FFO O₃ to the fourth highest DMAX8 O₃ level above the current O₃ NAAQS for O₃ (71.0 ppb and higher) for the 2025 high, low, and medium-development scenarios were 2.01%, 0.84%, and 0.90%, respectively (BLM and Ramboll 2017).

There are two NAAQS for PM_{2.5}, one for a 24-hour averaging time that is expressed as a 3-year average of the 98th percentile value in a year with a threshold of 35 µg/m³ and an annual average over three years with a threshold of 12 µg/m³. With a complete year of modeling results, the 98th percentile corresponds to the eight highest daily PM_{2.5} concentration in a year. The modeling of the differences between the 2025 Scenarios and 2011 base case (all sources) shows decreases of PM_{2.5} concentrations in most of the domain, but also increases in a number of regions, including Denver, eastern Utah, and central and northwest New Mexico. Maximum PM_{2.5} contributions to the eighth highest daily PM_{2.5} concentrations are 0.8, 0.4, and 0.4 µg/m³ in the 2025 high-, low-, and medium-development scenarios, respectively. Compared to 2011, 2025 annual PM_{2.5} concentrations for all sources are reduced in most of the domain but increase in a number of regions, including near Denver. Maximum contributions to the annual average PM_{2.5} concentrations for the BLM FFO are 0.3, 0.1, and 0.1 µg/m³ in the 2025 high-, low-, and medium-development scenarios, respectively. Maximum contributions to the second highest daily average PM₁₀ for the BLM FFO are 2.7, 1.3, and 1.1 µg/m³ in the 2025 high-, low-, and medium-development scenarios, respectively (BLM and Ramboll 2017).

The differences in 1-hour NO₂ concentrations between the 2011 and 2025 emission scenarios (all sources) indicate increases at various regions throughout the domain, including large increases in northern and eastern Arizona and New Mexico. Maximum contributions to the 1-hour NO₂ concentrations for the BLM FFO are 5.8, 3.0, and 3.2 µg/m³ in the 2025 high-, low-, and medium-development scenarios, respectively. Maximum contributions to the annual average NO₂ concentrations for the BLM FFO are 1.5, 0.8, and 0.9 µg/m³ in the 2025 high-, low-, and medium-development scenarios, respectively (BLM and Ramboll 2017).

Contributions of the CAA Prevention of Significant Deterioration (PSD) pollutant concentrations across all PSD Class I and sensitive Class II areas due to emissions from the BLM FFO for each development scenario were also developed. Contributions of BLM FFO emissions to PSD pollutant concentrations at Class I and Sensitive Class II areas for the 2025 high-, low-, and medium-development scenarios can be found in the *Air Impact Assessment for BLM Farmington Field Office Oil and Gas Development Report* (BLM and Ramboll 2017) and have been incorporated by reference. All BLM FFO contributions are below the PSD Class I and Sensitive Class II pollutant increments at the high-, low-, and medium-development scenarios.

In summary, the CARMMS 2.0 low-development scenario, which represents a conservative estimate of federal impacts through 2025, does not exceed the indicator thresholds for any of the NAAQS, PSD Class I or Class II increment thresholds, the sulfur deposition threshold, the change in visibility threshold at any Class I area, or the thresholds for acid-neutralizing capacity at sensitive lakes. The low-development scenario would exceed the indicator threshold for change in visibility at one Class II area, the Aztec Ruins National Monument, and the nitrogen deposition threshold at Mesa Verde National Park, San Pedro Parks Wilderness, Weminuche Wilderness, Aztec Ruins National Monument, Chama River Canyon Wilderness, South San Juan Wilderness, and Cruces Basin Wilderness. The CARMMS 2.0

high-development scenario would not exceed any of the PSD Class I or Class II increment thresholds, the change in visibility threshold at Class I areas, the sulfur deposition threshold, or the thresholds for acid-neutralizing capacity at sensitive lakes. It would exceed the NAAQS indicator thresholds for O₃, annual average PM_{2.5}, and annual average NO₂; the change in visibility threshold at one Class II area, Aztec Ruins National Monument; and the nitrogen deposition threshold at Bandelier Wilderness, Mesa Verde National Park, San Pedro Parks Wilderness, Weminuche Wilderness, Aztec Ruins National Monument, Chama River Canyon Wilderness, Cruces Basin Wilderness, Dome Wilderness, Monte Vista National Wildlife Refuge, South San Juan Wilderness, and Sandia Mountain Wilderness.

6.3 PECOS DISTRICT OFFICE ATMOSPHERIC AND PHOTOCHEMICAL GRID MODELING

On July 10, 2023, BLM released the RFD scenario for oil and gas activities to provide BLM CFO a projection of the potential future oil and gas development activity for the next 20 years (starting in 2023) to assist the BLM in updating the CFO's resource management plan (RMP). Included are projections for vertical and horizontal wells drilled, future surface disturbance accompanying this development, water production and use, and oil and gas production volumes. The RFD establishes a baseline scenario that can then be used to compare the RMP with its alternatives and to analyze the long-term effects that could result from oil and gas activities.

For BLM planning purposes, projections of future oil and gas production were created by analyzing historical production data and constructing decline curves that forecast future volumes for the next 20 years. Future annual oil and gas production was generated using decline curves from historical production data and then extrapolated into future years to acquire remaining production for existing wells and future production from new well development.

In the short term the trend of increasing oil production is anticipated to continue until 2025. This year (2025) was selected based on current 2022 U.S. Energy Information Administration (EIA) Annual Energy Outlook (AEO) reference case projections for oil price peaking in 2025 and then remaining at a relatively stable but lower value afterwards (EIA 2023). In the long term the expectation is for new well production to reduce as the resources become less prolific, resulting in a decrease in well development. The average wells spudded on federally managed lands from 2011 through 2021 was 617 new spuds per year, thus a short-term prediction of 770 new spuds allow for the continued upward trend in development over the short term. In total, 12,500 wells are predicted to be drilled and completed on federal lands managed by the BLM CFO. Most (approximately 90%) of this development will be horizontal completions.

The federal portion represents 60% of the total activity in the area of interest (i.e., the New Mexico portion of the Permian Basin), thus the total (federal and nonfederal) well development is projected to be 19,600, of which 90% is horizontal. The total (federal and nonfederal) historical spuds from 2011 through 2021 average 1,031 per year. In comparison, the total new well spud count is projected to be 1,208 in the beginning of the forecast period, declining to 769 wells at the end of the 20-year period.

The BLM CFO RFD also discussed water production as it is important to assess and predict the associated water production and the corresponding use of water in oil and gas development. Water production is estimated to be 30 billion barrels of water over the life of the plan or 1.5 billion barrels per year. Water production has averaged approximately 1 billion barrels of water per year over the last twelve years, thus a 50% increase in water production is projected for the RFD period, capturing the increasing trend observed the last several years.

The previous RFD scenario for oil and gas in the Pecos District Office (PDO) (Engler et al. 2012; Engler and Cather 2014) projects that 800 oil and gas wells would be completed within the PDO each year for the 20-year scenario (2015–2035), for a total of approximately 16,000 new wells (federal and nonfederal), most of which are expected to be horizontally drilled. The Comprehensive Air Resources Technical Support Document (ARTSD) by URS Corporation (URS) was prepared to report the potential air quality impacts resulting from this RFD scenario (URS 2013). This effort included atmospheric dispersion and PGM to predict concentrations of specific pollutants in and around the BLM CFO (in which most of the PDO oil and gas activity occurs). Updated modeling for the current 2023 BLM CFO RFD is in progress. Therefore, the ARTSD modeling study from 2013 is the most up to date information to estimate air impacts.

The results of ARTSD analysis, which are discussed in more detail below, indicate that air quality impacts from the RFD scenario, although noticeable, are generally acceptable. Most predicted criteria pollutant concentrations are well below the NAAQS throughout the extensive modeling domains included in this analysis. Although no exceedances of NAAQS were predicted from the modeling of federal wells associated with the RFD scenario (6,400 wells), consideration of the entire RFD scenario (16,000 wells) and other reasonably foreseeable future actions (i.e., cumulative impacts) in the ARTSD included predictions of pollutant concentrations approaching or exceeding the NAAQS (for O₃, PM_{2.5} and potentially SO₂) and indicate the need for additional ambient monitoring data, refined modeling, and consideration of additional mitigation measures. Most of the areas where NAAQS would be exceeded are in the BLM CFO (URS 2013). The in-progress modeling being completed based on the 2023 CFO RFD will provide updated results and conclusions.

Visibility—Visibility modeling was performed using the BLM CFO RFD potential oil and gas well development scenario and with mitigation using EPA on-the-books emission controls and additional management controls. This analysis tiers to the modeling that was performed in the ARTSD (URS 2013) for the BLM CFO for results of visibility impairment indicating that, for the Carlsbad region, visibility impacts to Carlsbad Caverns National Park (CCNP) at the project level are minimal and not expected to be of concern for the CCNP (Engler et al. 2012; URS 2013). The visibility screening analysis followed the recommendations in the FLAG Phase I Report – Revised Guidelines (U.S. Forest Service [USFS] et al. 2010). The analysis relies on a 0.5 and 1.0 delta-deciview (change in visibility) threshold, calculated for base year 2008, base case 2017, and future RFD years. Non-project cumulative emissions are driving the overall visibility impacts. A refinement of the cumulative emissions would reduce the number of days of total visibility impacts and would likely be closer to baseline and future visibility impacts. Any refinement down to a smaller scope of development or project-specific level would likely reduce the number of days of total visibility impacts that would be likely closer to matching actual base and future visibility impacts/baseline conditions (URS 2013). The URS 2013 visibility modeled results were further refined to show relative impacts. The results indicate that there are no days in which the threshold is exceeded at the project level for the CCNP. An additional study of air pollutant emissions and cumulative air impacts done for the BLM CFO indicates that pollutants contributing to reductions in visibility are largely coming from outside the region (Applied EnviroSolutions 2011). Visibility is further discussed in Section 8.

Deposition—Deposition modeling was performed using the BLM CFO RFD potential oil and gas well development scenario and with mitigation using EPA on-the-books emission controls and additional management controls. This analysis tiers to the modeling that was performed in the ARTSD for results of nitrogen and sulfur deposition impairment (Engler et al. 2012; URS 2013).

To assess potential nitrogen and sulfur deposition impacts in the planning area, deposition impacts were compared with the National Park Service (NPS) Air Resources Division screening deposition analysis

thresholds (DATs), which are defined as 0.005 kilogram per hectare per year (kg/ha/year) in the western United States for both nitrogen and sulfur. A DAT is the additional amount of nitrogen or sulfur deposition within a Class I area below which estimated impacts from a proposed new or modified source are considered to be insignificant. The DAT is a screening threshold that was developed primarily to assess impacts from a single stationary source (USFS et al. 2000, 2010). Modeling results showing deposition greater than a DAT do not strictly indicate the need for mitigation. If a DAT is exceeded, cumulative modeling may be required to demonstrate that cumulative deposition is below the level of concern (LOC). The LOC for the nitrogen and sulfur deposition values, defined by the NPS and USFS, are 3 kg/ha/year for nitrogen and 5 kg/ha/year for sulfur (Fox et al. 1989).

Results of analysis showed that the maximum annual nitrogen DAT at the project level was exceeded for CCNP but may be below the LOC at specific receptors (Table 30). The BLM CFO RFD modeling results showed that the predicted nitrogen deposition was expected to be below the LOC value of 3 kg/ha/year for CCNP (URS 2013). The maximum annual sulfur DAT at the project level (BLM CFO RFD) was below the DAT and LOC thresholds for CCNP. Deposition rates that are below the LOC are believed to cause no adverse impacts. Appendix R and Appendix S of the ARTSD provide detailed nitrogen deposition results for project level and cumulative impacts, respectively (URS 2013). Deposition is further discussed in Section 8.

Table 30. Maximum Annual Nitrogen Deposition

Area with Greatest Predicted Impact	Maximum Modeled Project Deposition (kg/ha/year)	DAT* (kg/ha/year)	Background Deposition (kg/ha/year)	Total Project Deposition (kg/ha/year)	LOC† (kg/ha/year %)
Class I	-	<i>0.005</i>	-	-	<i>3.0</i>
Salt Creek Wilderness	0.29	5,800%	2.59	2.88	93%
Carlsbad Caverns National Park	0.19	3,800%	2.59	2.77	92%
Sensitive Class II	-	<i>0.005</i>	-	-	<i>3.0</i>
Bitter Lake National Wildlife Refuge	0.29	5,800%	2.59	2.88	93%
Gruña National Wildlife Refuge	0.11	2,200%	2.59	2.70	90%

Source: URS (2013).

* The DAT is shown in italics, while the maximum modeled deposition is provided as a percentage of the DAT.

† The LOC is shown in italics, while the maximum total deposition is shown as a percentage of the LOC.

To assess potential cumulative effects to AQRVs, the air quality assessment considers emissions and potential impacts of expected growth oil and gas development for nearby oil and gas basins, as well as the Permian Basin, the Raton Basin, San Juan Basin, Denver-Julesburg Basin, White River Field Office, Colorado River Valley Field Office, Utah Vernal Field Office, and Oklahoma, Kansas, and Texas Oil and Gas Basins (URS 2013). Cumulative scenario results were above the nitrogen and sulfur LOC for CCNP. It should be noted that it is typical for large aggregate projects that include thousands of sources (such as oil and gas development in the BLM CFO) to have deposition values greater than the DATs and LOCs based on the uncertainty in the model parameters, and more refined modeling studies are often

required to better understand potential effects. Future potential development in the region as a whole could result in degradation of air quality related to nitrogen deposition, depending on the number of sources present during development and any mitigation applied. Appropriate mitigation would be determined following further analysis at the site-specific APD stage of a project that allows for refined modeling analysis (as appropriate), which incorporates project-specific information.

In 2016, Chevron developed a master development plan for the Permian Basin (also known as Hayhurst Development Area covering southeastern New Mexico and the northern panhandle of Texas). In which 436 oil and gas wells were projected to be developed across 106 well pads. Although it is not anticipated that all wells will be developed concurrently during this project, similar results of AQRVs can be expected for large well development projects. The Chevron analysis extends the URS (2013) modeling that was performed and updates NO_x emissions in the planning area. The results of acid deposition monitoring showed incremental exceedances of the nitrogen DAT of 0.005 kg/ha/year in the CCNP during drilling operations but would be well below the DAT once drilling is completed (BLM 2016).

It is expected that a refined analysis may be required at the time of proposed lease development for well development that could potentially impact nitrogen deposition at the CCNP. A refined analysis of acid deposition must address the following criteria:

- Is the affected area sensitive to deposition?
- Is the affected area currently impacted by deposition?
- Have critical loads or target loads been developed for the affected area?
- Does current deposition exceed the critical load or target load?

This refined analysis should be in consultation with the NPS as prescribed in FLAG guidance (USFS et al. 2011). Federal land managers will do their best to manage and protect resources at every area that they administer. Federal land managers believe that the need to minimize potential impacts to a Class I area should be a major consideration in the best available control technology determination for a project proposed near such an area. Therefore, if a source proposes to locate near a Class I area, additional costs to minimize impacts to sensitive Class I resources may be warranted, even though such costs may be considered economically unjustified under other circumstances (USFS et al. 2010).

6.4 FOUR CORNERS AIR QUALITY TASK FORCE

In 2002, NMED and local governments convened to sign an Early Action Compact for O₃ under an EPA program that required commitment for state and local action to resolving O₃ issues prior to a nonattainment designation. In 2005, the States of Colorado and New Mexico convened a group of stakeholders, then known as the Four Corners Air Quality Task Force (FCAQTF), to address air quality issues in the Four Corners region in light of continued energy development and growth in the region and consider options for mitigating air pollution. A report detailing a wide range of mitigation options was published in November 2007 (FCAQTF 2007).

In 2008, its task complete, the group became known as the Four Corners Air Quality Group (FCAQG) and continued as a forum for discussion of existing air quality issues and potential solutions. The FCAQG is currently composed of more than 100 members and 150 interested parties representing a wide range of perspectives on air quality in the Four Corners region. Members include private citizens, representatives from public interest groups, universities, industry, state, tribal, and local governments, and federal

agencies. The BLM has been an active participant from the beginning and maintains a representative on the steering committee. The last FCAQG met in person and virtually on September 21 and 22, 2023. For more information visit the FCAQG at the NMED website at <https://www.env.nm.gov/air-quality/four-corners-air-quality-group/>.

6.4.1 PREVIOUS STUDIES

Previous emissions inventories were conducted for New Mexico in 2007 and 2009, and a photochemical modeling analysis was completed for the FCAQTF in 2009. These inventories and modeling are discussed in more detail in the *Air Resources Technical Report for Oil and Gas Development in New Mexico, Oklahoma, Texas, and Kansas: 2020* (BLM 2021a).

6.5 AIR QUALITY MODELING FOR TEXAS

Numerous reports on air quality modeling projects done by and for the TCEQ, including modeling done for the several Texas county nonattainment areas, can be accessed on the Air Division website (TCEQ 2023a). The TCEQ has convened advisory groups in southeast Texas and Dallas-Fort Worth to assist the agency in addressing photochemical modeling issues.

6.6 PLANNED MODELING STUDIES

The following modeling studies are in progress and, when released, will be incorporated into this report:

- BLM Western Regional Air Quality Modeling Study (criteria pollutants),
- BLM Western Regional HAPs Modeling Study, and
- BLM Carlsbad Air Modeling Modification (HAPS and criteria pollutants).

7 OIL AND GAS SINGLE-WELL EMISSIONS

The per-well emissions factors (GHGs and non-GHGs) by phase (well development and production operations) on an annual basis. An emissions factor is a value that relates the quantity of a pollutant released into the atmosphere with an activity that generates the pollutant. They are typically expressed in units of weight or mass (e.g. pounds, kg, tons) per activity (e.g. duration of equipment operation, construction of an oil or gas well). Emissions factors are the basis for developing emissions inventories that are used for air quality management decisions. The BLM uses emissions inventories to evaluate the change to county-level emissions, comparison between NEPA alternatives, and as inputs for air quality models if modeling is warranted. Over time emissions factors may change due to new emissions regulations, development of control technologies, or data and information improvements for emissions.

Air pollutant emissions from oil and gas activities occur during construction and operations of a well. Construction related emissions occur from the use of heavy machinery during pad construction, drilling, testing and completion, venting and flaring, interim reclamation, and vehicles. Construction emissions are typically a onetime occurrence. Operation-related emissions occur from well workovers, pump engines, heaters, tanks, truck loading, fugitive leaks, pneumatics, dehydrators, compressor engines, reclamation, and vehicle traffic. Emissions from operational activities occur throughout the life of a well. Several factors may influence actual emissions including location, geological formation, well depth, equipment used, supporting infrastructure, and other factors.

7.1 FIELD OFFICE

7.1.1 FARMINGTON FIELD OFFICE

The BLM FFO emission estimates were developed from the BLM Single Oil and Gas Well Emission Inventory Tool. The BLM Single Oil and Gas Well Emission Inventory Tool uses the EPA Compilation of Air Pollutant Emissions Factors (AP-42), EPA Motor Vehicle Emission Simulator (MOVES), EPA Exhaust and Crankcase Emission Factors for Nonroad Engine Modeling – Compression-Ignition, and other sources. The tool has also been modified to account for San Juan Basin gas profiles, typical project details, and recent EMNRD and NMED rules and regulations (Waste Prevention Rule and Ozone Precursor Rule). Production data from the IHS Markit Enerdeq database (commercial source), including an estimate of the total potential mineral yield, or estimated ultimate recovery (EUR), and the associated decline rates were included in the BLM Single Oil and Gas Well Emission Inventory Tool. Single-well estimates and associated production data were based on horizontal drilling (Max Emissions from Oil and Gas Scenarios–Single Well Emissions in the San Juan Basin). The horizontal oil emissions were based on the deep oil with high gas scenario. The horizontally drilled single-well emissions could be used in cases when well types are unknown, such as during leasing, providing a conservative estimate for vertically drilled wells. Whereas this information provides an estimate of emissions based on typical development occurring in New Mexico, actual emissions from the development of any given well may differ. Table 31 summarizes horizontally drilled single-well emissions for the BLM FFO. The FFO is calculating project-specific emissions on a project-specific basis. A weighted average single well emission estimate based on project specific data is currently being developed to be used for future lease sales.

Table 31. BLM FFO Horizontal Single-Well Emissions

Well Type	Total Emissions (tons per year)						
	CO	NO _x	PM ₁₀	PM _{2.5}	SO ₂	VOCs	HAPs
Single-well construction/ development phase	3.69	14.50	9.45	1.48	0.0008	1.07	0.02
Single-well operation phase	5.75	2.54	4.35	0.56	0.0013	12.19	0.49
Single well total	9.44	17.04	13.80	2.04	0.0021	13.26	0.51

Source: BLM Single Oil and Gas Well Emission Inventory Tool.

Max Emissions from Oil and Gas Scenarios - Single Well Emissions in the San Juan Basin

7.1.2 CARLSBAD FIELD OFFICE

The BLM CFO emission estimates were developed from the BLM Single Oil and Gas Well Emission Inventory Tool. The BLM Single Oil and Gas Well Emission Inventory Tool uses the EPA Compilation of Air Pollutant Emissions Factors (AP-42), EPA MOVES, EPA Exhaust and Crankcase Emission Factors for Nonroad Engine Modeling – Compression-Ignition, and other sources. The tool has also been modified to account for Permian Basin gas profiles, typical project details, and recent EMNRD and NMED rules and regulations (Waste Prevention Rule and Ozone Precursor Rule). Production data from the IHS Markit Enerdeq database (commercial source), including an estimate of the total potential mineral yield, or EUR, and the associated decline rates were included in the BLM Single Oil and Gas Well Emission Inventory Tool. Single-well estimates and associated production data were based on horizontal drilling.

The horizontally drilled single-well emissions could be used in cases when well types are unknown, such as during leasing, providing a conservative estimate for vertically drilled wells. Whereas this information provides an estimate of emissions based on typical development occurring in New Mexico, actual emissions from the development of any given well may differ. Table 32 summarizes horizontally drilled single-well emissions for the BLM CFO.

Table 32. BLM CFO Horizontally Drilled Single-Well Emissions

Phase	Total Emissions (tons per year)						
	CO	NO _x	PM ₁₀	PM _{2.5}	SO ₂	VOCs	HAPs
Single-well construction/ development phase	3.45	13.62	10.28	1.53	0.01	0.71	0.02
Single-well operation phase	1.34	1.11	4.92	0.88	4.61E-03	10.54	0.93
Single well total	4.79	14.73	15.20	2.41	0.02	11.25	0.95

Source: BLM Single Oil and Gas Well Emission Inventory Tool.

7.1.3 OKLAHOMA FIELD OFFICE

Table 33 presents the current single-well emissions estimates for the Oklahoma Field Office (OFO) from the Reasonably Foreseeable Development Scenario – Kansas, Oklahoma, & Texas and Oklahoma, Kansas and Texas BLM Record of Decision and Approved Resource Management Plan (BLM 2016, 2020).

Table 33. BLM OFO Single-Well Emissions

Factor Type	Total Emissions (tons per year)						
	CO	NO _x	PM ₁₀	PM _{2.5}	SO ₂	VOCs	HAPs
Single-well oil emission factors	2.06	4.53	0.58	0.27	0.12	4.46	0.31
Single-well gas emission factors	1.87	5.53	0.67	0.33	0.11	0.77	0.06

Source: BLM (2016, 2020).

Notes:

* The representative well used to calculate emissions is a horizontal oil well. Emissions for vertical wells were not used from this analysis due to current predominance in horizontal technological drilling methods and because presenting horizontal oil wells emissions estimates represents a more conservative summary of emissions compared with emissions from a vertical well, with the exception of SO₂, which could be four to five times greater in a vertical well scenario. However, SO₂ emissions are still estimated to be within the same magnitude and less than 1 ton per year of SO₂ emissions per well. Estimated emissions from a typical horizontal gas well are higher for the criteria pollutants PM₁₀, PM_{2.5}, and NO_x. However, estimated emissions from horizontal oil wells are higher for CO, VOC, and HAP emissions. Because the overall magnitude of emissions from oil wells is estimated to be higher in terms of total criteria pollutant emissions, an oil well is evaluated for the purpose of this analysis.

† VOC emissions at the operational phase represent uncontrolled emissions and estimate potential emissions representing the contribution for “one oil well” from the emissions at storage tanks, gathering facilities, etc. However, federally enforceable regulations, such as NSPS Subparts OOOO and OOOOa, require emission reduction of VOCs from well completions following hydraulic fracturing or refracturing and storage tanks with emissions greater than 6 tpy after federally enforceable controls. Therefore, actual emissions from the one-well scenario are likely be lower than represented.

7.1.4 ADDITIONAL INFORMATION REGARDING SINGLE-WELL EMISSION FACTORS

The single-well emissions in this document can be used to estimate emissions for all project types. Over time, calculators may be developed, or single-well emission may be modified to capture new or more regionally specific oil and gas development parameters (through ongoing modeling efforts associated with RMP revisions), or new project-specific calculators may emerge (such as those related to oil and gas leasing, e.g., the lease sale emissions tool). As new or more refined tools become available, they may be used to make emissions projections as warranted.

7.2 WELL COUNTS

The number of active wells can vary greatly from year to year; in addition, counts are not static or logarithmic by nature. Well count data can be obtained from many sources, such as state oil and gas commission databases, university and research databases, and proprietary databases, as well as public federal databases. The sources reporting well counts may also differ in reporting methods. Reporting of well counts may include various types of wells such as active, new, temporarily abandoned, and inactive (shut in or temporarily abandoned). For the purposes of this report, the BLM uses the Petroleum Recovery Research Center, Automated Fluid Minerals Support System (AFMSS) and state oil and gas well count reporting. Table 34 show the active wells within each field office (NMOCD 2023).

Table 34. Active Wells

Field Office	Total (Federal and Nonfederal)	Federal
Pecos Development Office (PDO)	45,579	24,990
Farmington Field Office (FFO)	22,014	15,697
Roswell Field Office RFO	2,929	838
Carlsbad Field Office (CFO)	42,650	24,152

Source: NMOCD (2023).

Increased GHG emissions can be connected to well development. The most substantial GHGs emitted by oil and gas development and production are CO₂ and CH₄. To facilitate quantification, most project-level analyses tend to assume that all wells would be developed concurrently and in the same year, though it is more likely that future potential development would not occur in this manner. Table 35 provides past well completion data based on APD activity from the BLM AFMSS I system (BLM 2021b) and BLM AFMSS II system (BLM 2021c, 2023b).

Table 35. Past and Present BLM Well Completions Based on APD Activity

Number of BLM Well Completions*							BLM RFD ⁽³⁾	No. of Wells Developed ⁽⁴⁾
2016	2017	2018	2019	2020	2021	2022		
Farmington Mancos-Gallup Analysis Area (FMGAA)⁽¹⁾								
19	8	61	22	317	67	161	1,980	83
Pecos District Office (PDO)⁽²⁾								
150	199	261	284	1,160	587	852	6,400	1163
Oklahoma Field Office								
–	–	–	–	–	–	29	–	–
Texas								
–	–	–	–	–	–	4	–	–
Kansas								
–	–	–	–	–	–	0	–	–

Sources: BLM (2021b, 2021c, 2023b)

Notes:

– = Not available.

* Wells completed from 2016 through 2019 are reported from BLM AFMSS I with run date April 2021 (BLM 2021b). Wells completed from 2020 through 2021 are reported from BLM AFMSS II with run date August 2022 (BLM 2021c). Wells completed in 2022 are reported from BLM AFMSS II with run date May 2023 (BLM 2023b). Counts for AFMSS I and AFMSS II used different methods, hence a marked increase in 2019. AFMSS II counts each single-well completion separately. These values include re-completions.

⁽¹⁾ BLM FMGAA number of BLM federal and nonfederal wells in BLM PDO RFD (2016–2037) is 3,400. BLM FMGAA wells include completions from BLM FFO and RPFO.

⁽²⁾ BLM PDO number of BLM federal and nonfederal wells in BLM PDO RFD (2016–2037) is 16,000. BLM PDO wells include completions from BLM CFO, Hobbs Field Office, and RFO.

⁽³⁾ BLM RFD for FMGAA (2018–2037) and BLM PDO, OFO, Texas, and Kansas (2016–2035).

⁽³⁾ The number of wells developed after the start of the RFD for each respective field office (2018 for BLM FFO and 2016 for BLM PDO, OFO, Texas, and Kansas) are presented to disclose the current levels of development toward the total RFD projections.

8 AIR QUALITY–RELATED VALUES

AQRVs are resources sensitive to air quality and can include a wide variety of atmospheric chemistry–related indicators. AQRVs include visibility and specific scenic, cultural, physical, biological, ecological, and recreational resources identified for a particular area. The NAAQS secondary standards are promulgated to ensure non-health related air quality impacts, such as AQRVs, are protected. The BLM can reasonably rely on compliance with the secondary NAAQS to prevent adverse impacts to these resources. Monitoring and modeling of AQRVs help to provide a level of protection to sensitive areas such as Class I parks and wilderness areas. Congress established certain national parks and wilderness areas as mandatory Class I areas where only a small amount of air quality degradation is allowed. Defined by the CAA, Class I areas include national parks greater than 6,000 acres, wilderness areas and national memorial parks greater than 5,000 acres, and international parks. These areas must have been in existence at the time the CAA was passed by Congress in August 1977.

The goal of Class I management is to protect natural conditions, rather than the conditions when first monitored. That is, if initial monitoring in a Class I area identifies human-caused changes, appropriate actions should be taken to remedy them to move toward a more natural condition. The goal of Class I management is to protect not only resources with immediate aesthetic appeal (i.e., sparkling clean streams) but also unseen ecological processes (such as natural biodiversity and gene pools) (U.S. Forest Service [USFS] et al. 2000). The FLAG issued a revised Phase 1 report in 2010 (USFS et al. 2010). This report was developed as a tool to provide consistent approaches to the analysis of the effects of air pollution on AQRVs. The FLAG report focuses on three areas of potential impact: visibility, aquatic and terrestrial effects of wet and dry pollutant deposition, and terrestrial effects of O₃. This report is structured to address these same three areas of potential impact. The requirement to assess impacts to AQRVs is established in the PSD rules. PSD is a permitting program for new and modified major sources of air pollution that are in attainment areas. The majority of facilities that the BLM analyzes are below a major source of emissions.

The BLM goals include managing jurisdictional field office activities and development to protect and improve air quality and, within the scope of the BLM authority, minimize emissions that cause or contribute to violations of air quality standards or that negatively impact AQRVs (e.g., acid deposition, visibility).

8.1 PREVENTION OF SIGNIFICANT DETERIORATION

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 likely 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, whereas 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 the state agency with jurisdiction 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 respective air district. Any subsequent

analysis performed for NEPA purposes will be used for informational purposes only. PSD increments for Class I and Class II areas are listed in Table 36.

Table 36. PSD Increments

Pollutant	Period	Maximum Allowable Increase (micrograms per cubic meter)	
		Class I	Class II
SO ₂	3-hour	25	512
	24-hour	5	91
	Annual	2	20
NO ₂	Annual	2.5	25
PM ₁₀	24-hour	8	30
	Annual	4	17
PM _{2.5}	24-hour	2	9
	Annual	1	4

Source: 40 C.F.R. § 52 Subpart C, Chapter 1.

8.2 VISIBILITY

Pollution in the atmosphere can impair scenic views by degrading the contrast, colors, and distance an observer is able to see. Visibility can be assessed in terms of the distance that a person can distinguish a large dark object on the horizon and is measured as the standard visual range in miles. Visibility is of greatest concern in Class I areas, which are afforded the highest level of air quality protection by the CAA. Average natural visual range conditions for Class I areas can be found in FLAG (USFS et al. 2010). Visibility impairment is a result of regional haze, which is caused by the accumulation of pollutants from multiple sources in a region. Emissions from industrial and natural sources may undergo chemical changes in the atmosphere to form particles of a size that scatter or absorb light and result in reductions in visibility.

The EPA and other agencies have been monitoring visibility in national parks and wilderness areas since 1988. In 1999, the EPA announced a major effort to improve air quality in national parks and wilderness areas. The Regional Haze Rule (40 C.F.R. § 51, Subpart P, Protection of Visibility) calls for state and federal agencies to work together to improve visibility in 156 national parks and wilderness areas.

The rule requires the states, in coordination with the EPA, NPS, U.S. Fish and Wildlife Service (USFWS), USFS, and other interested parties, to develop and implement air quality protection plans to reduce the pollution that causes visibility impairment. The first state plans for regional haze were due in December 2007. States, tribes, and five multijurisdictional regional planning organizations worked together to develop the technical basis for these plans. Comprehensive periodic revisions to these initial plans were due July 31, 2021, again in 2028, and every 10 years thereafter (EPA 2023y). As of August 25, 2022, 15 states failed to submit 2021 regional haze plans to the EPA by both the first and second deadlines, July 31, 2021, and August 15, 2022. Therefore, New Mexico and 14 other states are included in the

Findings of Failure to Submit (EPA 2023z). States implement the Regional Haze Program through SIPs in accordance with the Regional Haze Rule.

Texas proposed a 2021 regional haze SIP revision that is designed to address regional haze in Big Bend and Guadalupe Mountains National Parks in Texas and Class I areas outside Texas that may be affected by emissions from within the state. On June 30, 2021, the commission adopted the 2021 regional haze SIP revision (Project No. 2019-112-SIP-NR). The SIP revision demonstrates compliance with the regional haze requirements of Section 169A of the CAA and the Regional Haze Rule for the second planning period (TCEQ 2023b).

As part of the process of developing Oklahoma 2021 regional haze SIP, the ODEQ AQD identified 12 facilities that are reasonably anticipated to impact visibility conditions at the Wichita Mountains Wilderness Area and identified 21 sources in neighboring states that are reasonably anticipated to impact visibility conditions at the Wichita Mountains Wilderness Area (including sources in Texas) and have asked these states to consider the potential impact of the sources identified within their states for further analysis as part of the process for developing their 2021 regional haze SIP. The SIP was submitted to EPA Region 6 on August 9, 2022 (ODEQ AQD 2022).

In 1985, the EPA initiated a network of monitoring stations to measure impacts to visibility in Class I Wilderness Areas. These monitors are known as the Interagency Monitoring for the Protection of Visual Environments (IMPROVE) monitors and exist in some but not all Class I wilderness areas. Table 37 shows the Class I areas in the BLM NMSO area of operations and whether they have an IMPROVE monitor and, if not, which monitor is considered representative for that area. There are no Class I areas in Kansas.

Table 37. Class I Areas and IMPROVE Monitors

State	Class I Area	Agency	IMPROVE
New Mexico	Bandelier	National Park Service (NPS)	Yes
	Bosque del Apache	U.S. Fish and Wildlife Service (USFWS)	Yes
	Carlsbad Caverns	NPS	Guadalupe Mountains
	Gila	U.S. Forest Service (USFS)	Yes
	Pecos	USFS	Wheeler Peak
	Salt Creek	USFWS	Yes
	San Pedro Parks	USFS	Yes
	Wheeler Peak	USFS	Yes
	White Mountain	USFS	Yes
Texas	Big Bend	NPS	Yes
	Guadalupe Mountains	NPS	Yes

Visibility is monitored using methodologies established by the IMPROVE Program. The particulates that contribute to haze are collected on filters at each IMPROVE site. Samples are then measured to determine how visibility is impacted over time and by which pollutants.

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 1-dv change is roughly the smallest perceptible change in visibility. Because visibility at any one location is highly variable throughout the year, it is characterized by three groupings: the clearest 20% days, average 20% days, and haziest 20% days. Visibility degradation is primarily due to sulfate, nitrate, and PM in the atmosphere, with contributions from both anthropogenic and natural sources. Measuring progress in air pollution control can be challenging because natural sources largely beyond human control such as dust storms and wildfires can produce significant visibility impairment over large areas for days to weeks at a time. Under the auspices of the 2017 Regional Haze Rule revisions, the EPA proposed a new visibility tracking—most impaired days—to better characterize visibility conditions and trends. The most impaired days are those with the most impairment from anthropogenic sources, whereas the haziest grouping now better represents days with haze from natural sources. Total haze on the most impaired days is used to track progress toward Regional Haze Rule goals. Comparing trends in the 20% haziest days with the 20% most impaired days provides a method to assess impacts from episodic events, like wildfires, which have greatly affected visibility throughout the western United States in recent years (Burke et al. 2021). More information about the EPA impairment framework can be found at: <http://vista.cira.colostate.edu/Improve/impairment/>.

Visibility information can be found at the Federal Land Managers Environmental Database (FED) (FED 2019). Figure 9 through Figure 20 illustrate visibility trends based on air monitoring data for the IMPROVE sites in the BLM NMSO area of operation for the clearest, haziest, and most impaired categories. Note that peaks such as those seen for Bandelier National Monument in 2000 may be accounted for by the occurrence of large wildfires. A downward sloping line means less reduction of visibility and therefore an improvement. In most cases, visibility trends have been flat or improving. Implementation of best available retrofit technology (BART) strategies as required under the Regional Haze Rule over the next few years should result in further improvements.

Trends for Class I areas affected by sources in northwestern New Mexico (see Figure 19 and Figure 20) are similar to trends for Class I areas in southern New Mexico. Although visibility on worst days at Guadalupe Mountains National Park may have diminished, a careful analysis of fire activity in the area would be necessary to draw conclusions about the cause of some peaks in recent years (CSU 2020).

A qualitative discussion of visibility impacts from oil and gas development in the *Farmington Resource Management Plan with Record of Decision* concludes that for the scenario modeled, which projected greater development than has occurred, there could potentially be significant impacts to visibility at Mesa Verde National Park, a Class I area in southwest Colorado (BLM 2003). Occasional impacts to San Pedro Parks (north New Mexico) and Weminuche (southern Colorado) Wilderness Areas were also thought possible. However, visibility trends shown for San Pedro Parks, Mesa Verde, and Weminuche indicate that visibility on the best days has been flat to improving and visibility on worst days has shown little change over the period of record.

Visibility modeling performed for the BLM CFO area is discussed further in Section 6.3.

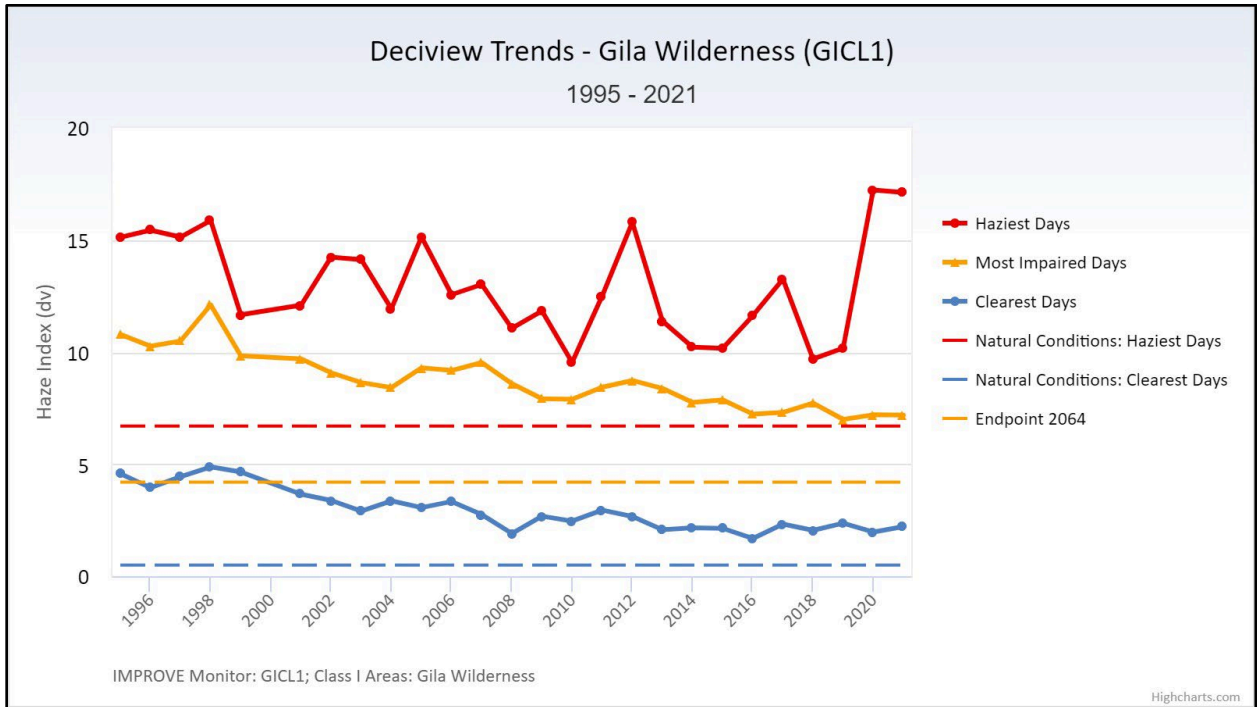


Figure 9. Visibility extinction trends for the Gila Wilderness Area, New Mexico (FED CIRA 2023).

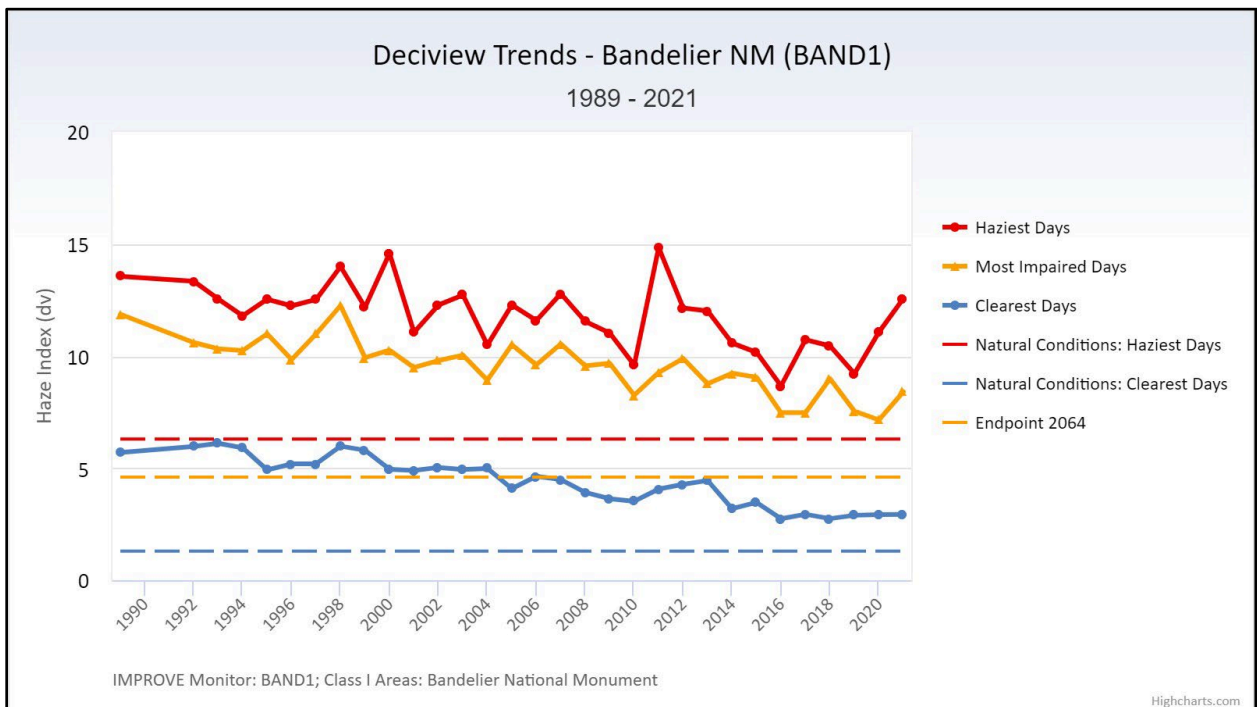


Figure 10. Visibility extinction trends for the Bandelier National Monument, New Mexico (FED CIRA 2023).

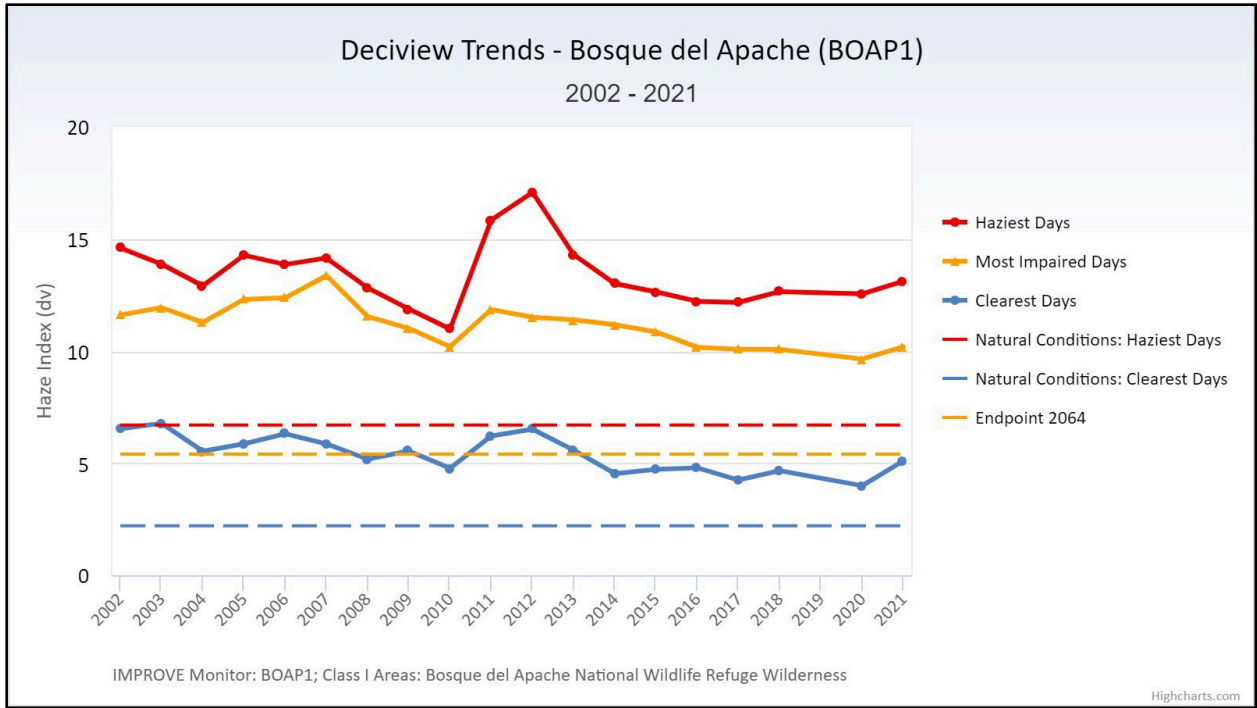


Figure 11. Visibility extinction trends for the Bosque del Apache, New Mexico (FED CIRA 2023).

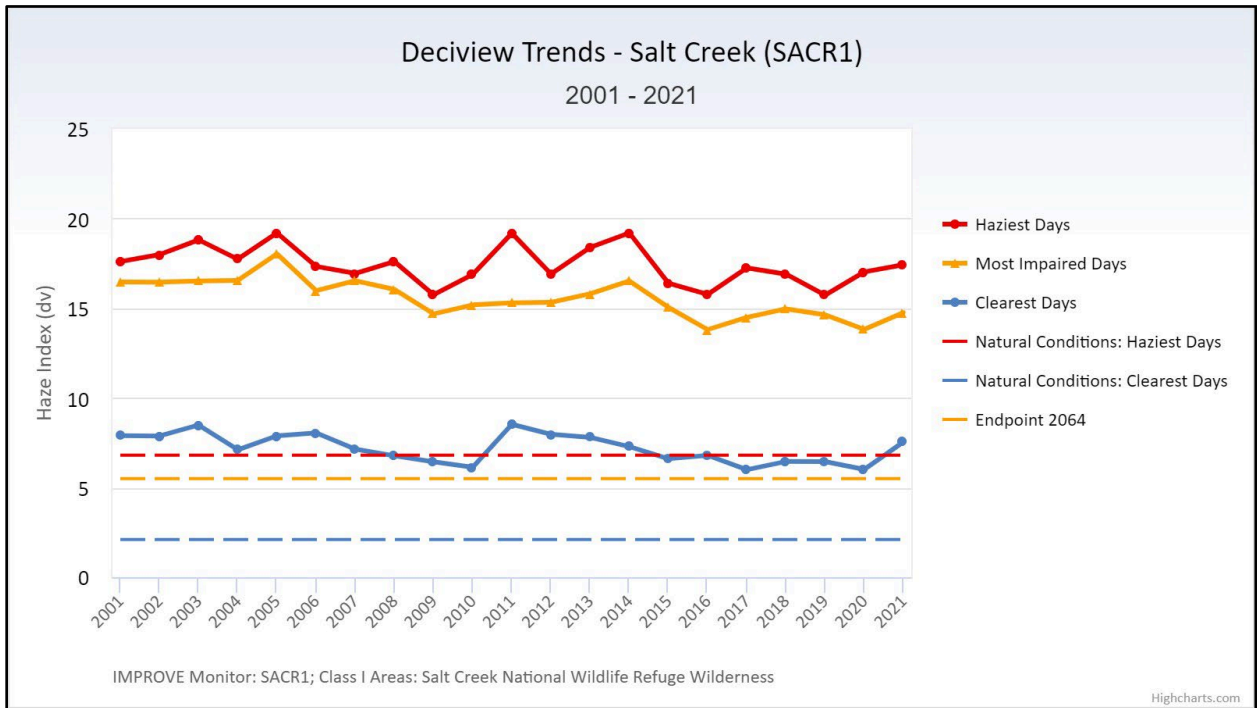


Figure 12. Visibility extinction trends for the Salt Creek, New Mexico (FED CIRA 2023).

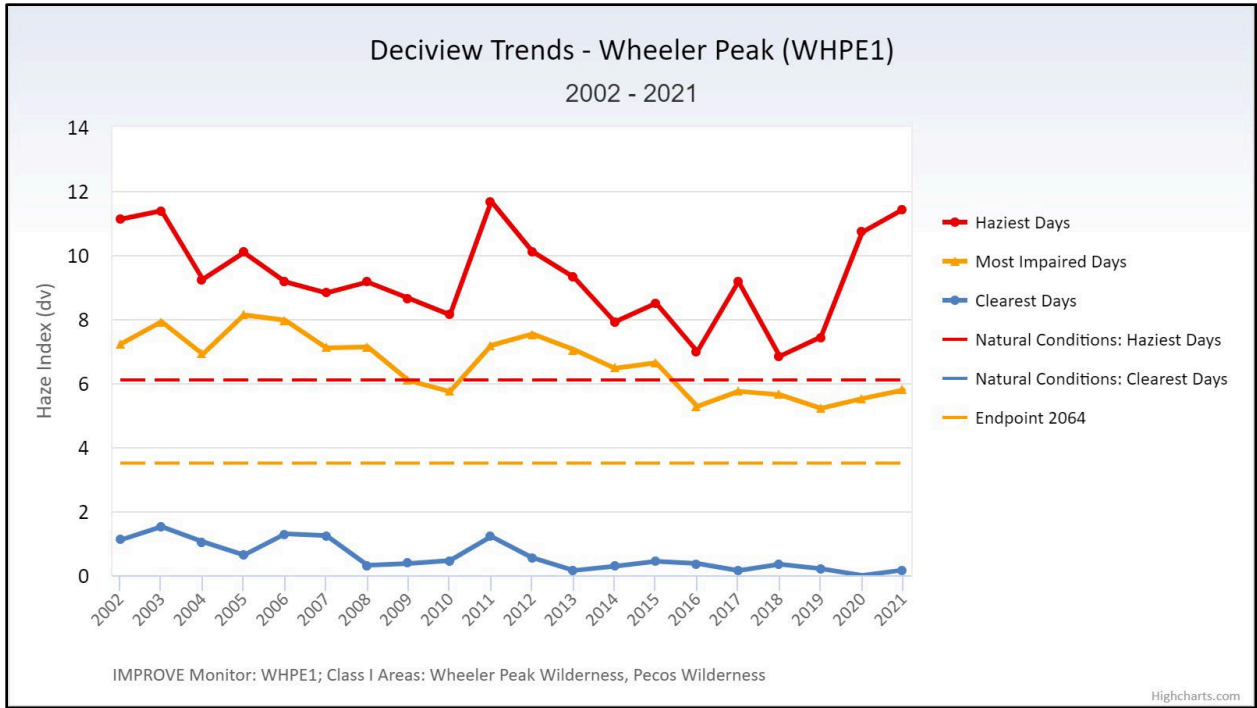


Figure 13. Visibility extinction trends for the Wheeler, New Mexico (FED CIRA 2023).

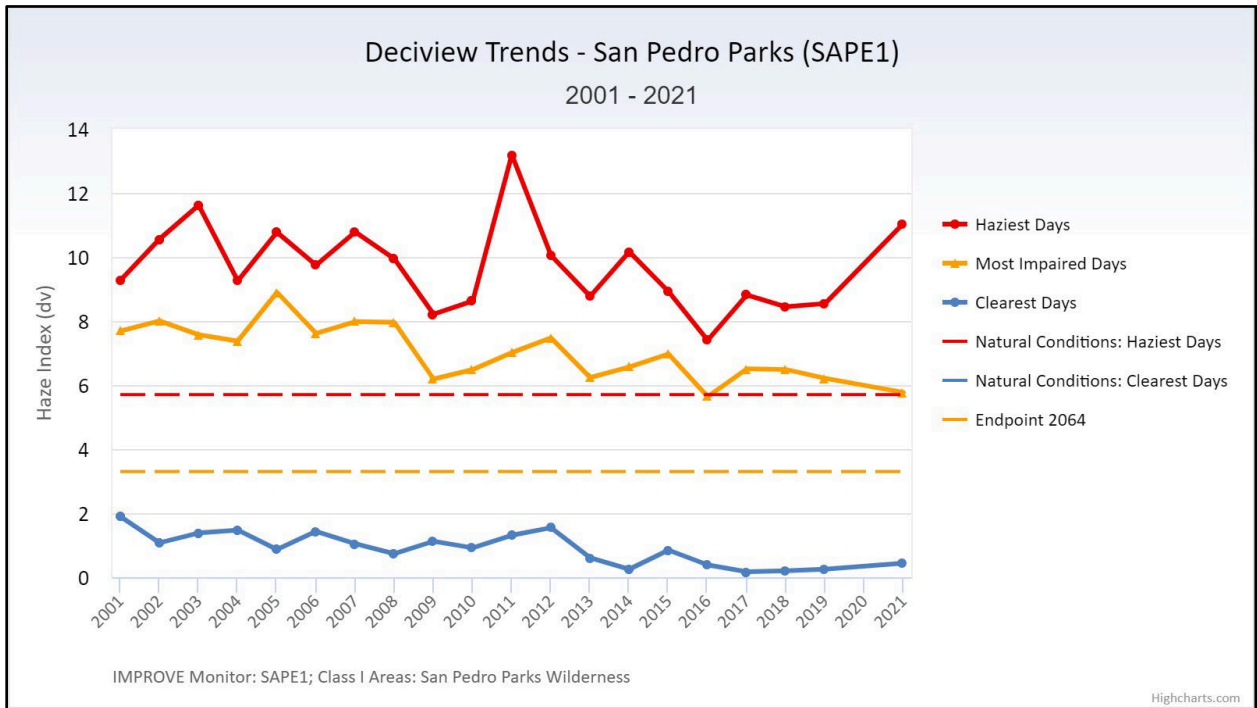


Figure 14. Visibility extinction trends for San Pedro Parks, New Mexico (FED CIRA 2023).

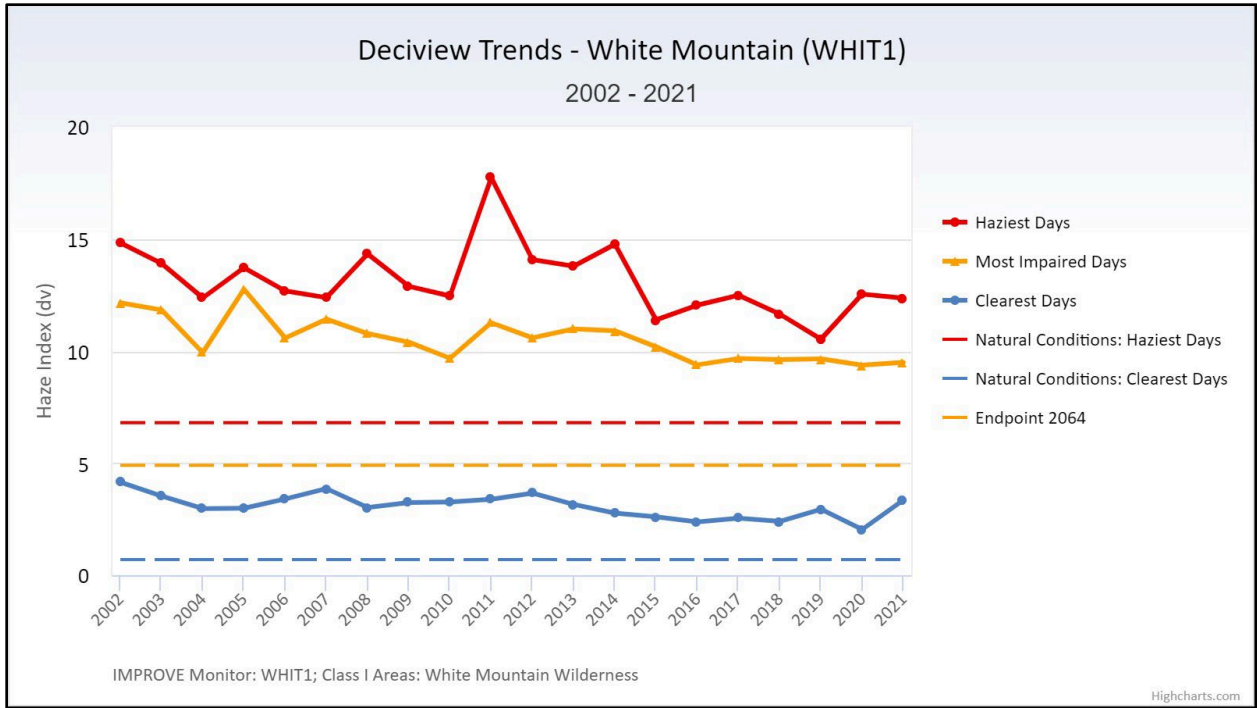


Figure 15. Visibility extinction trends for White Mountain, New Mexico (FED CIRA 2023).

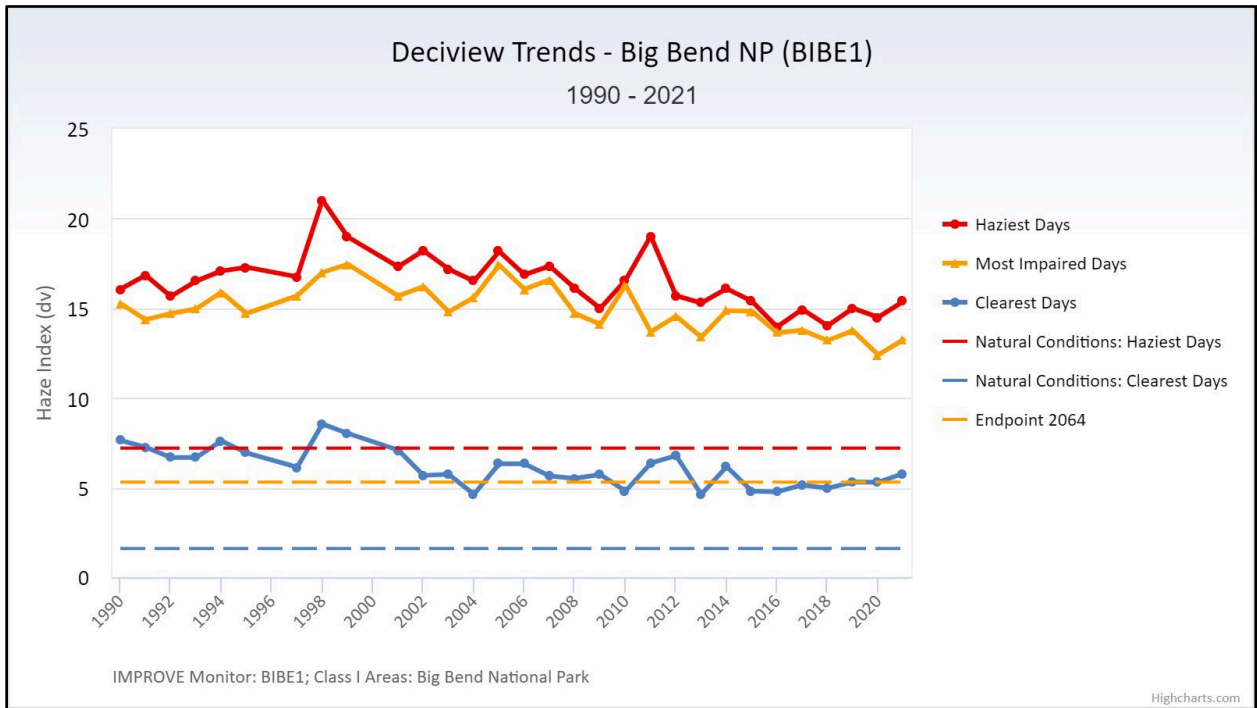


Figure 16. Visibility extinction trends for Big Bend, Texas (FED CIRA 2023).

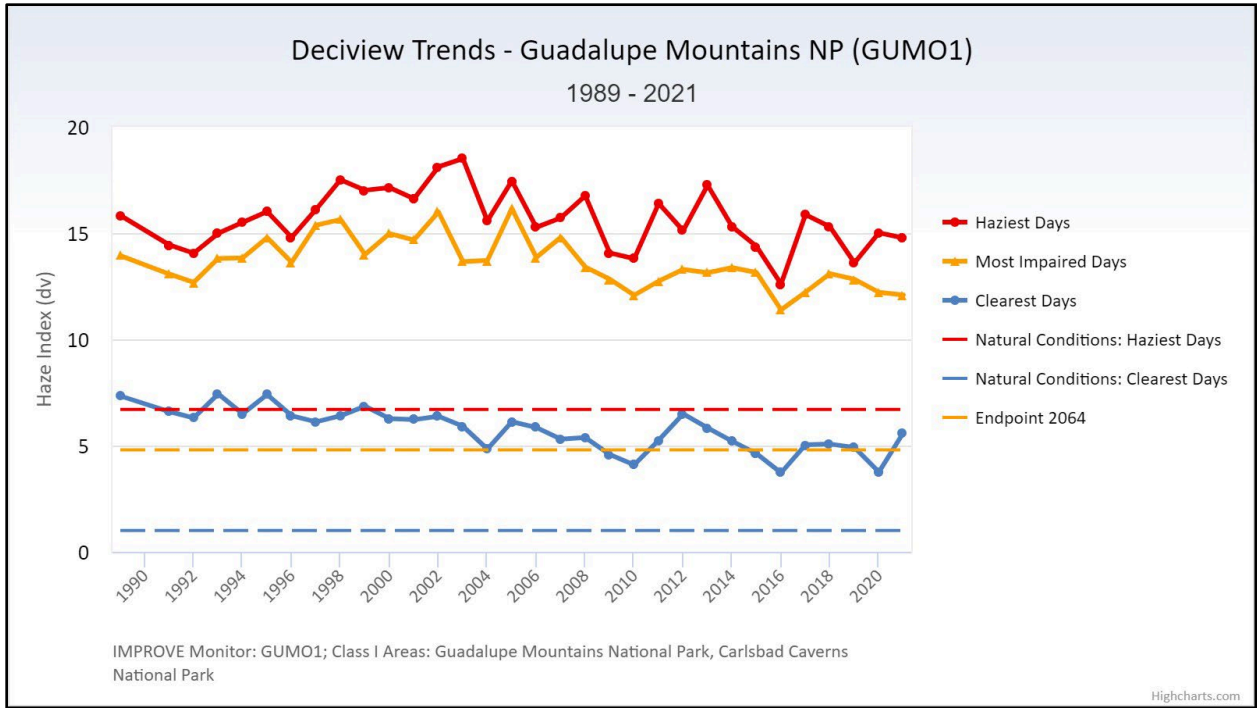


Figure 17. Visibility extinction trends for Guadalupe Mountains National Park, Texas (FED CIRA 2023).

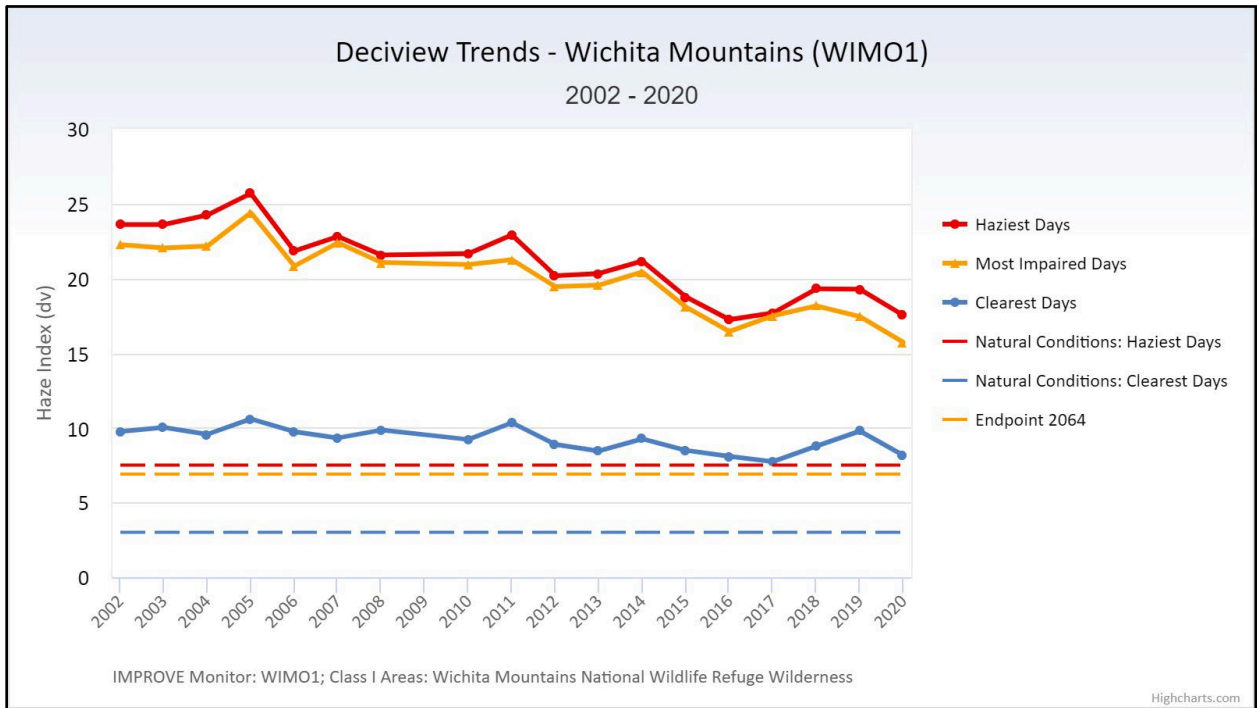


Figure 18. Visibility extinction trends for Wichita Mountains, Oklahoma (FED CIRA 2023).

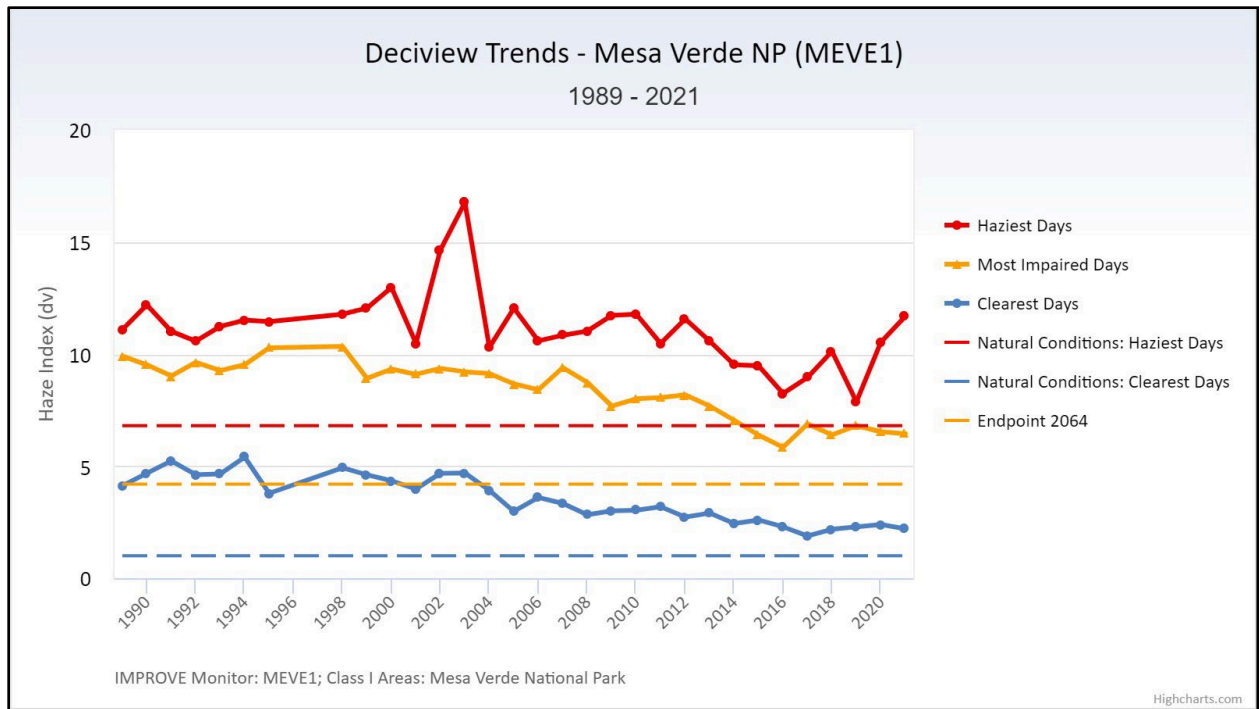


Figure 19. Visibility trends at Class I areas affected by sources in northwestern New Mexico – Mesa Verde National Park, Colorado (FED CIRA 2023).

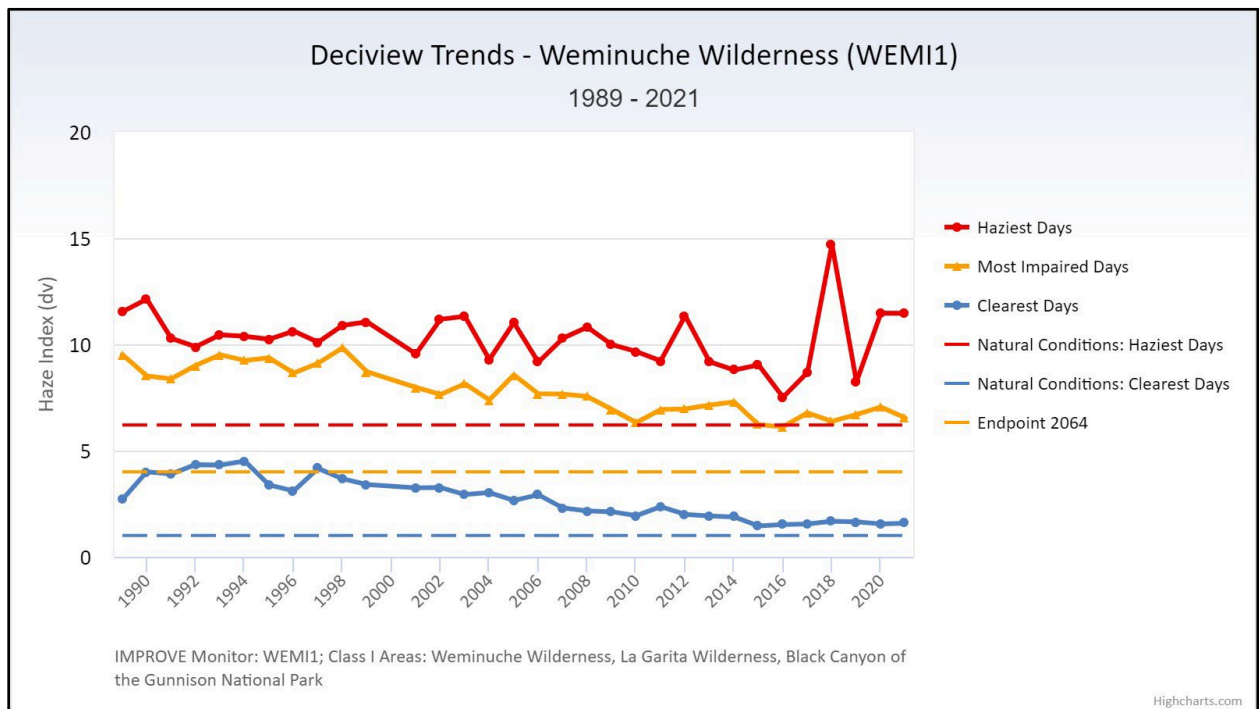


Figure 20. Visibility trends at Class I areas affected by sources in northwestern New Mexico – Weminuche Wilderness, Colorado (FED CIRA 2023).

8.3 WET AND DRY POLLUTANT DEPOSITION

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.

In general, the soils in New Mexico have a high acid neutralizing capacity and surface water is scarce, resulting in minimal impacts in this area. Also, the EPA Acid Rain Program has resulted in greatly reduced levels of the most damaging pollutants. There are currently two active wet deposition monitors in New Mexico: Mayhill and Bandelier National Monument. In addition, monitors near the border at Mesa Verde and Guadalupe Mountains National Parks may shed some light on conditions in New Mexico. Data can be accessed through the National Atmospheric Deposition Program (NADP) at <https://nadp.slh.wisc.edu/networks/national-trends-network/>. Wet deposition data are also available for monitoring sites in Kansas, Oklahoma, and Texas at this site (NADP 2019).

The EPA has operated the EPA 2021 Clean Air Status and Trends Network (CASTNET) since 1991 to provide data to assess trends in air quality, deposition, and ecological effects due to changes in air emissions. Sites are in areas where urban influences are minimal. There are currently two CASTNET observation sites in New Mexico, three in Texas, two in Kansas, and one in Oklahoma. There is also a CASTNET site at Mesa Verde National Park in the Four Corners region. National maps of pollutant concentrations can be found at <https://www3.epa.gov/castnet/airconc.html>. These maps show that New Mexico and most of the western states have much lower concentrations of all monitored pollutants than the eastern states and Southern California. Nitrates are somewhat elevated in eastern Kansas and eastern Oklahoma, but this is likely associated with agricultural activities rather than oil and gas development. The maps also show that the trend over the past 30 years has been for decreases in all pollutants in most areas of the country. As an example, Figure 21 and Figure 22 show particulate nitrate and sulfate levels for 1990 and 2021 (EPA 2023aa). Total nitrogen deposition decreased by 51% from 1990 through 2016 in the eastern United States and decreased by 27% in the western United States between 1996 through 2014; however, total nitrate concentrations measured at the eastern sites were generally two to three times higher than concentrations measured at western reference sites. In recent years, total nitrogen deposition in the eastern United States continues to decrease and stays steady at the low levels reached in 2014 in the western United States. Total dry and wet sulfur deposition decreased by 89% from 1990 through 2016 in the eastern United States and decreased by 45% from 1996 through 2016 in the West, over 3-year mean periods. In recent years, total dry and wet sulfur deposition in the eastern United States continues to decrease and stays steady at the low levels reached in 2016 in the western United States. Figure 23 through Figure 26 show the total nitrate and total dry and wet sulfur deposition trends through 2021. These trends in deposition levels are discussed in depth in the *CASTNET 2020 Annual Report* (EPA 2020) and 2021 CASTNET annual network plan (EPA 2021b).

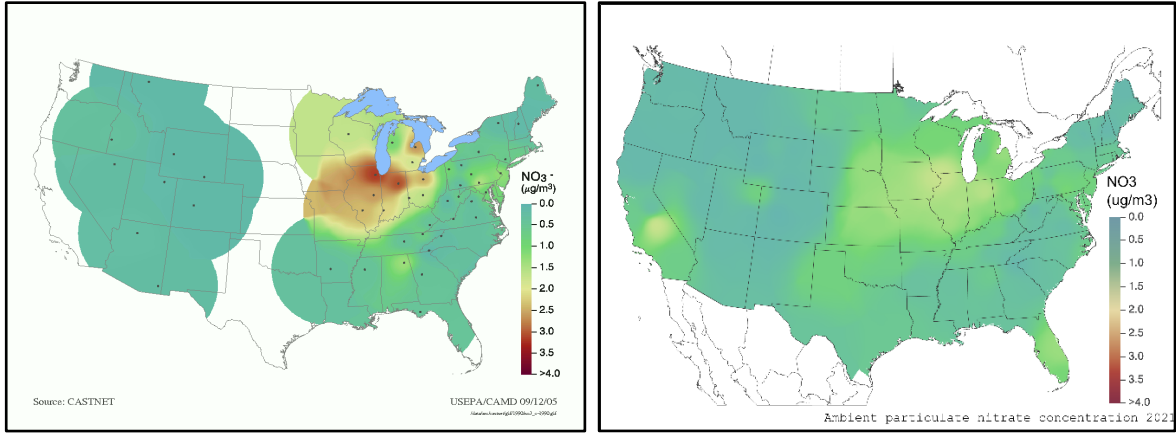


Figure 21. Particulate nitrate in 1990 (left) and 2021 (right).

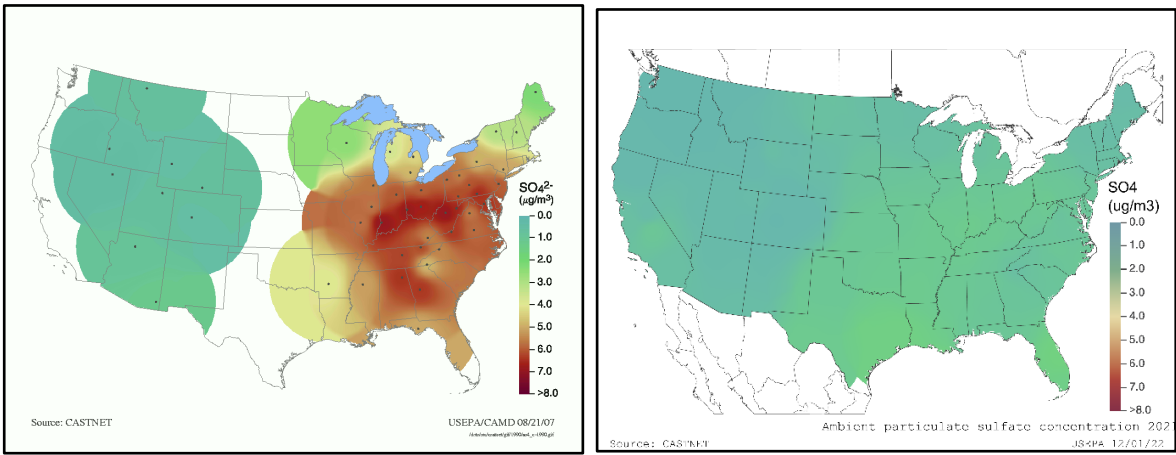


Figure 22. Particulate sulfate in 1990 (left) and 2019 (right).

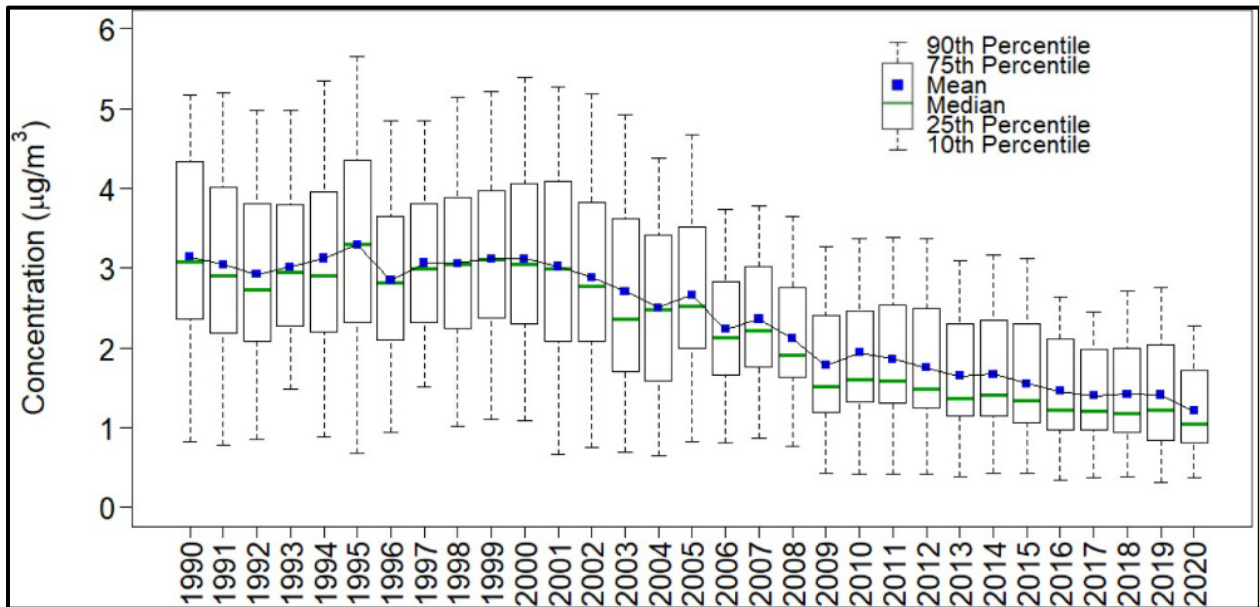


Figure 23. Trends in annual mean total nitrate concentrations – eastern reference sites.

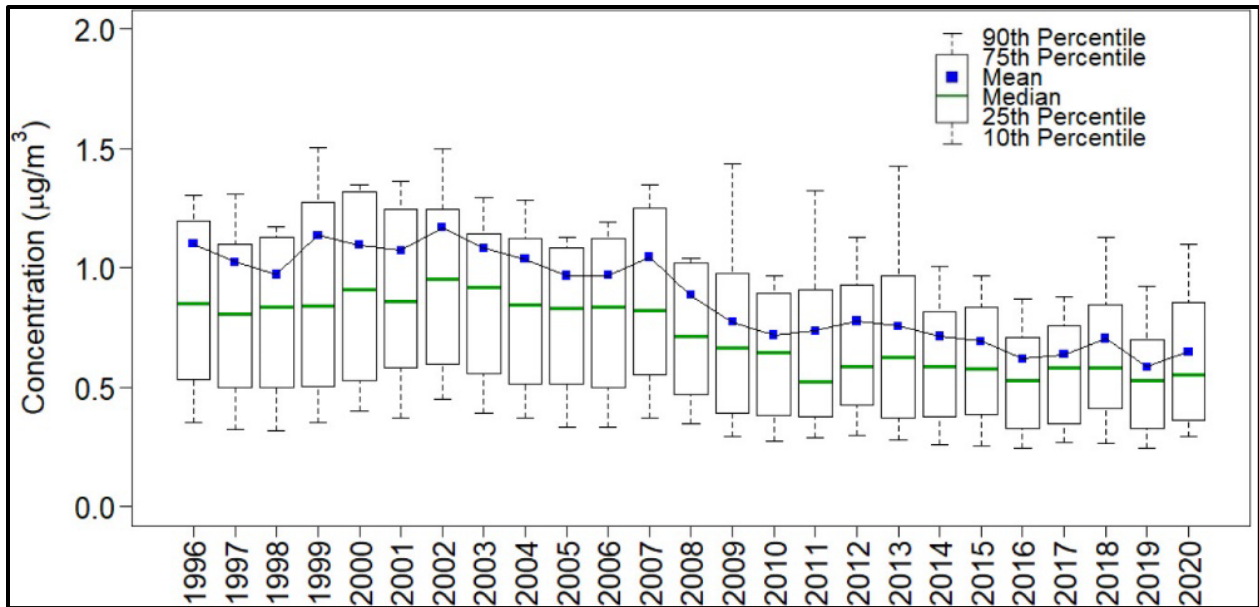


Figure 24. Trends in annual mean total nitrate concentrations – western reference sites.

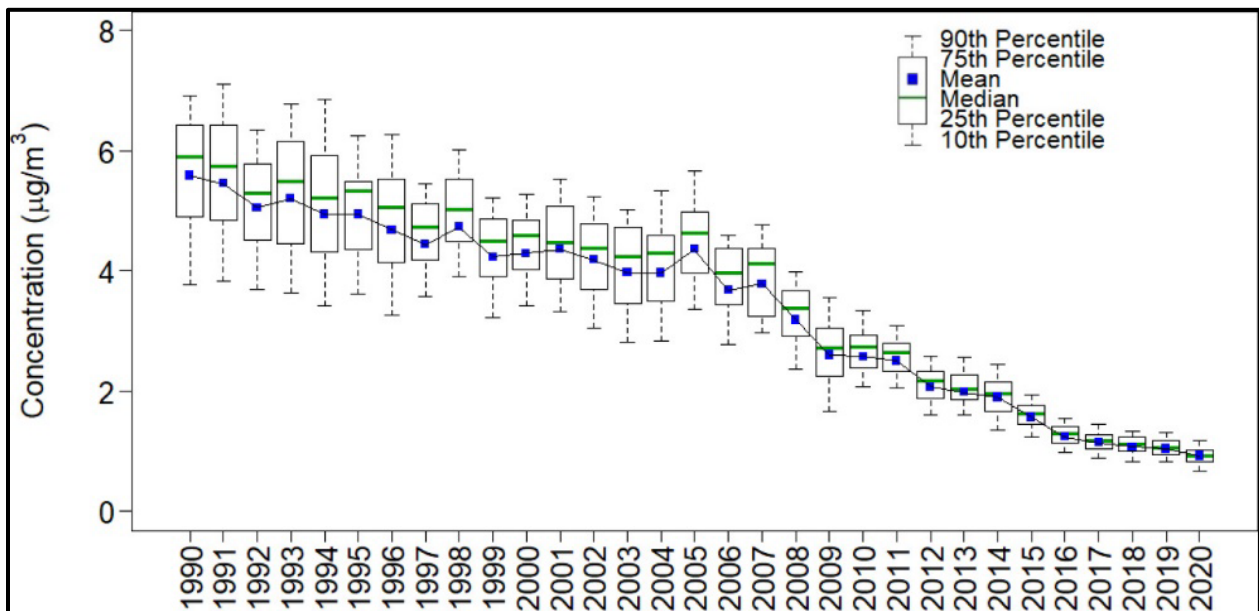


Figure 25. Trends in annual mean SO_2 concentrations – eastern reference sites.

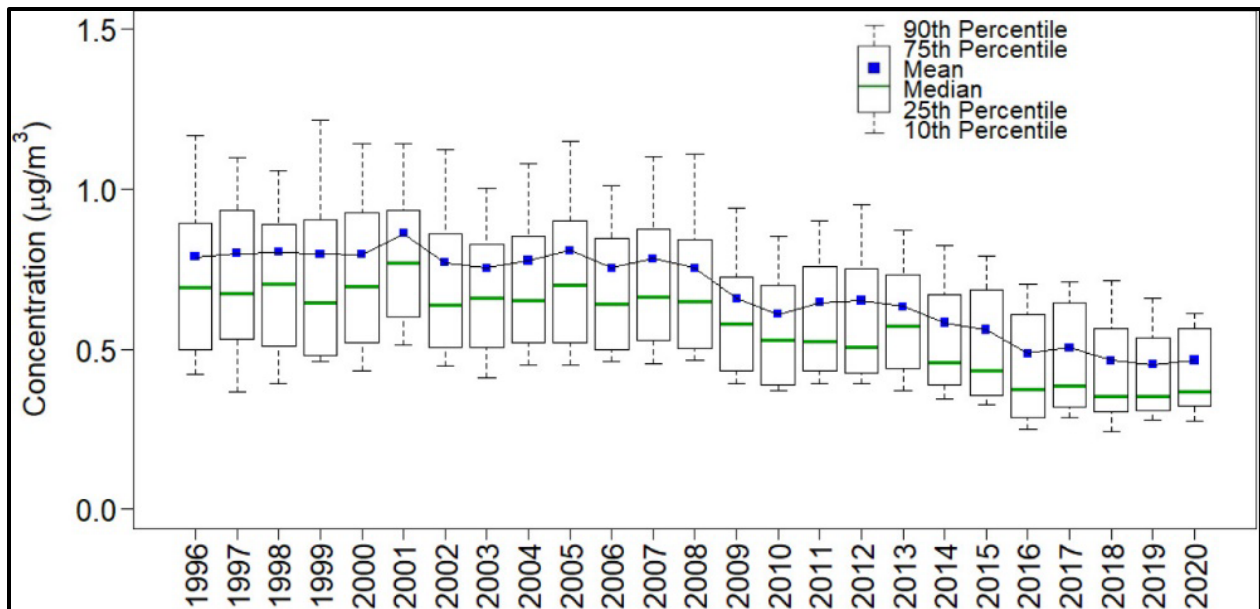


Figure 26. Trends in annual mean SO₂ concentrations – western reference sites.

The NPS also monitors and evaluates deposition to determine parks most at risk and where conditions are declining or improving (NPS 2021). Nitrogen deposition conditions, which are 5-year averages from 2017 through 2021, are fair to poor with an improving trends observed at Bandelier, though trend data are unavailable for many locations (Table 38). Sulfur deposition conditions are good to poor with trend data also unavailable for most locations. Visibility and deposition modeling for the BLM CFO area are discussed in Section 6.3.

Table 38. Nitrogen and Sulfur Deposition Conditions at Class I Areas

State	Class I Area	Nitrogen (Conditions/Trend)	Sulfur (Conditions/Trend)
New Mexico	Bandelier	Fair / Trend Not Available	Good / Improving
	Bosque del Apache	n/a	n/a
	Carlsbad Caverns	Poor / Trend Not Available	Poor / Trend Not Available
	Gila	Poor / Trend Not Available	Good / Trend Not Available
	Pecos	Poor / Trend Not Available	Good / Trend Not Available
	Salt Creek	n/a	n/a
	San Pedro Parks	n/a	n/a
	Wheeler Peak	n/a	n/a
	White Mountain	n/a	n/a
Texas	Big Bend	Poor / Trend Not Available	Fair / Relatively Unchanging Trend
	Guadalupe Mountains	Poor / Trend Not Available	Fair / Relatively Unchanging Trend

State	Class I Area	Nitrogen (Conditions/Trend)	Sulfur (Conditions/Trend)
Oklahoma	Wichita Mountains	n/a	n/a

Source: NPS (2021).

n/a = Deposition condition data not available due to lack of monitoring data.

9 CUMULATIVE EFFECTS

More specific information about sources in New Mexico oil and gas producing regions that have the greatest impacts on air quality and GHGs is included below. The CEQ regulations define cumulative effects as “the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or nonfederal) or person undertakes such actions” (40 C.F.R. § 1508.7).

9.1 CURRENT AND REASONABLY FORESEEABLE CONTRIBUTIONS TO CUMULATIVE EFFECTS

A list of major sources (sources emitting more than 100 tpy of CO, VOC, NO_x, SO₂, PM_{2.5}, or PM₁₀) in New Mexico, Kansas, Oklahoma, and Texas can be found in Appendix D. Any of these sources may contribute to cumulative effects within a local or regional context. All major sources represent emissions from the 2020 NEI Report (EPA 2023v).

9.2 MODELING

Proposed and in-progress modeling, some of which will have cumulative implication, are discussed in Section 6.6. The most up-to-date modeling is discussed in Sections 6.1 through 6.5.

10 CLIMATE, CLIMATE CHANGE, AND GREENHOUSE GASES

The BLM Specialist Report (BLM 2023a) presents the estimated emissions of GHGs attributable to fossil fuels produced on land and mineral estate managed by the BLM and will be reference throughout this report. The report is focused on estimating GHG emissions from coal, oil, and gas development that is occurring and is projected to occur on the federal onshore mineral estate. The report includes a summary of emissions estimates from reasonably foreseeable federal fossil fuel development and production over the next 12 months, as well as longer-term assessments of potential federal fossil fuel GHG emissions and the anticipated climate change impacts resulting from the cumulative global GHG burden. The report can provide context by disclosing cumulative impacts of GHG emissions from fossil fuel energy leasing and development authorizations on the federal onshore mineral estate relative to several emission scopes and base years. A detailed discussion of climate change science and predicted impacts (Section 4.0), including past and present climate impacts (Section 4.2) and climate change impacts in select states with BLM-authorized fossil fuels (Section 4.3), as well as the existing and reasonably foreseeable GHG emissions associated with BLM actions (Section 7.0), are included in the BLM Specialist Report.

10.1 CLIMATE AND CLIMATE CHANGE

Climate refers to atmospheric conditions (e.g., temperature, humidity, pressure, precipitation, solar radiation, wind) at a particular location averaged over a long period of time. The American

Meteorological Society (AMS) defines climate change as “any systematic fluctuation in the long-term statistics of climate elements (e.g., temperature, pressure, or wind) that is sustained over several decades or longer” (AMS 2012). Climatologists commonly use 30-year averages of variables, such as temperature and precipitation, as benchmarks for historical comparison and climate change assessment. National Oceanic and Atmospheric Administration (NOAA), National Centers for Environmental Information (NCEI) climate normals are three-decade averages of climatological variables including temperature and precipitation, updated every 10 years, with the 1991–2020 U.S. climate normals dataset serving as the latest release. It contains average daily and monthly temperature, precipitation, snowfall, heating and cooling degree days, frost/freeze dates, and growing degree days calculated from observations at approximately 15,000 stations (NCEI 2023a). Climate normals representative for each field office are found in the climate normal section of Appendix C. Prevailing wind information is also presented in wind roses in Appendix C but are only available for airports with continuous measurements. Wind roses are a polar plot to visually present wind speed and direction.

Trend analysis is a technique used to estimate future conditions based on historical trends. The main assumption behind trend analysis is that what happened in the past is expected to happen in the future. Average temperature and precipitation and trend information for each New Mexico, Kansas, Oklahoma, and Texas climate division is compiled from the Climate at a Glance Website (NCEI 2023b). The averages for the most recent climate normal period (1991–2020) are also presented for comparison to the average of all data from 1895 to 2020. Graphical representation of historical annual total precipitation (1895–2020) and trends and historical annual average temperature (1895–2020) and trends are provided in Appendix C.

The driver for the buildup of heat within the climate system is best described in terms of radiative forcing (RF). The term describes the energy balance (i.e., equilibrium), or the difference between solar radiation absorbed by Earth and the energy radiated back to space that will occur given the heliophysics of the sun-earth system and the basic laws of thermodynamics.

On longer time scales, GHG concentrations exert a larger influence on Earth’s climate than the higher frequency oscillations that produce natural interannual to multiyear variability. Because GHG emissions dominate other sources of climate variability on the multidecade to century time scale, climate change models can project future states of Earth’s climate based on GHG emissions scenarios.

Earth's climate system is complex and interwoven in ways that are not yet fully understood. There are several known climate feedback mechanisms that add uncertainty in terms of timing (fast and slow feedbacks) and overall sensitivity within the evaluation of the climate system. Sensitivity refers to the amount of positive or negative feedback that occurs in response to a given forcing. The feedbacks and processes connecting RF to a climate response can operate on a wide range of time scales. Reaching temperature equilibrium in response to anthropogenic activities (emissions and land use changes) takes decades or longer because some of the climate components—in particular the oceans and—are slow to respond due to their large thermal masses and the long-time scale of circulation between the ocean surface and the deep ocean. Some of the latest available climate feedback research indicates that relatively small changes in RF can initiate stronger responses in some feedback components. This suggests that some of these mechanisms, and the climate in general, may have a higher sensitivity than is currently understood. As with the forcing components, there are also positive and negative feedback mechanisms, and there is a relatively wide range of uncertainty concerning estimates of the climate sensitivity that leaves the subject open to further investigation. To quote directly from Chapter 8 of the Working Group I contribution to the *Climate Change 2014: Synthesis Report (AR5)* (Intergovernmental

Panel on Climate Change Climate Change [IPCC] 2014), "In a complex and interconnected system, feedbacks can become increasingly complex, and uncertainty of the magnitude and even direction of feedback increases the further one departs from the primary perturbation, resulting in a trade-off between completeness and robustness, and hence utility for decision-making" (IPCC 2018). Section 4.1 of the BLM Specialist Report provides additional information on climate forcing and feedback.

10.2 GREENHOUSE GASES

Anthropogenic GHGs are commonly emitted air pollutants that include CO₂, CH₄, nitrous oxide (N₂O), and several fluorinated species of gases such as hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF₆). CO₂ is by far the most abundant, and more than two-thirds of human-made CO₂ emissions in the United States come primarily from the transportation and electricity production sectors. CH₄ from human activities accounts for approximately 10% of total U.S. GHG emissions and results from primarily agriculture and natural gas and petroleum systems. N₂O emissions from agriculture, fuel combustion, and industrial sources account for approximately 7% of the U.S. total GHG emissions. The BLM Specialist Report Sections 3.1–3.3 provide more details on these three GHG pollutants.

Atmospheric concentrations of naturally emitted GHGs have varied for millennia, and Earth's climate fluctuated accordingly. However, since the beginning of the industrial revolution around 1750, human activities have significantly increased GHG concentrations and introduced human-made compounds that act as GHGs in the atmosphere. Several types of activities contribute to the phenomenon of climate change, including emissions of GHGs from fossil fuels used as a primary energy source, large wildfires, changes to the natural carbon cycle, and changes to radiative forces and reflectivity (albedo). Concentrations of CO₂, CH₄, and N₂O are now substantially higher than concentrations found in various ice cores dating back to the past 800,000 years. From preindustrial times until today, the global average concentrations of CO₂, CH₄, and N₂O in the atmosphere have increased by around 49%, 165%, and 24%, respectively. Table 39 shows the average global concentrations of CO₂, CH₄, and N₂O in 1750, 2011, and 2022. Atmospheric concentrations of GHGs are reported in ppm and ppb. Section 4.1 of the BLM Specialist Report provides additional information on historical GHG estimates and the NOAA published Annual Greenhouse Gas Index (AGGI). The AGGI was developed to provide an easily understood standard for expressing the climate-warming influence of long-lived GHGs. Specifically, the AGGI is the ratio of the total direct climate forcing from measured long-lived GHG concentrations compared to the 1990 baseline year (chosen because it is the baseline year for the Kyoto Protocol and the publication year of the first IPCC Scientific Assessment of Climate Change). This represents a 49% increase to climate forcing since 1990 and a 1.8% increase over 2021 levels. Whereas the AGGI does not predict the amount Earth's climate has warmed, it does provide a measure of the effect of GHG emissions on the climate system.

Table 39. Average Global Concentrations of GHGs in Select Years

Greenhouse Gas	Preindustrial 1750	2011	2022	Increase 1750–2022
Carbon dioxide (CO ₂)	278 ppm	390.5 ppm	417 ppm ⁽¹⁾	49%
Methane (CH ₄)	722 ppb	1,803 ppb	1,912 ppb ⁽²⁾	165%

Greenhouse Gas	Preindustrial 1750	2011	2022	Increase 1750–2022
Nitrous oxide (N ₂ O)	270 ppb	324 ppb	336 ppb ⁽²⁾	24%

Notes: ppm = parts per million; ppb = parts per billion.

⁽¹⁾ The atmospheric CO₂ concentration is the 2022 annual average at the Mauna Loa, Hawaii, station (NOAA 2022a). The global atmospheric CO₂ concentration, computed using an average of sampling sites across the world, was 415 ppm in 2021 (NOAA 2022a).

⁽²⁾ The values presented for CH₄ and N₂O are global 2022 annual average mole fractions (NOAA 2022a).

10.3 OTHER GASES, ATMOSPHERIC AEROSOLS, AND PARTICULATES

Several gases do not have a direct effect on climate change but indirectly affect the absorption of radiation by impacting the formation or destruction of GHGs. These gases include CO, NO_x, and non-CH₄ VOCs. Fossil fuel combustion and industrial processes account for most emissions of these indirect GHGs. Unlike other GHGs, these gases are short lived in the atmosphere.

Atmospheric aerosols (PM) also contribute to climate change. Aerosols directly affect climate by scattering and absorbing radiation (aerosol-radiation interactions) and indirectly affect climate by altering cloud properties (aerosol-cloud interactions). PM₁₀ typically originate from natural sources and settle out of the atmosphere in hours or days. PM_{2.5} often originate from human activities such as fossil fuel combustion. These so-called “fine” particles can exist in the atmosphere for several weeks and have local short-term impacts on climate. Aerosols can also act as cloud condensation nuclei, the particles upon which cloud droplets form.

Light-colored particles, such as sulfate aerosols, reflect and scatter incoming solar radiation, having a mild cooling effect, while dark-colored particles (often referred to as “soot” or “black carbon”) absorb radiation and have a warming effect. There is also the potential for black carbon to deposit on snow and ice, altering the surface albedo (or reflectivity), and enhancing melting. There is high confidence that aerosol effects resulted in negative RF, offsetting a substantial portion of the positive RF resulting from the increase in GHGs, but the magnitude of their effects contribute the largest uncertainty to our understanding of climate (IPCC 2022).

10.4 THE NATURAL GREENHOUSE EFFECT

The natural greenhouse effect is critical to the discussion of climate change. The greenhouse effect refers to the process by which GHGs in the atmosphere absorb heat energy radiated by Earth’s surface. Water vapor is the most abundant GHG, followed by CO₂, CH₄, N₂O, and several trace gases. Each of these GHGs exhibit a particular “heat trapping” effect, which causes additional heat retention in the atmosphere that would otherwise be radiated into space. The greenhouse effect is responsible for the earth’s warm atmosphere and temperatures suitable for life on Earth. Different GHGs can have different effects on the earth’s warming due to their ability to absorb energy (“radiative efficiency”) and how long they stay in the atmosphere (“lifetime”). Without the natural greenhouse effect, the average surface temperature of the earth would be about zero degrees Fahrenheit (°F). Water vapor is often excluded from the discussion of GHGs and climate change since its atmospheric concentration is largely dependent upon temperature rather than being emitted by specific sources.

11 GREENHOUSE GAS REGULATORY ANALYSIS

11.1 FEDERAL RULES

Originally, the NSPS OOOOa – Crude Oil and Natural Gas Facilities for which Construction, Modification, or Reconstruction Commenced after September 18, 2015, draft and rule were promulgated to regulate VOCs and GHG (CH₄) emissions from specific sources within the oil and natural gas industry, which would have included new, modified, and reconstructed compressors, pneumatic controllers, pneumatic pumps, storage vessels, well completions, fugitive emissions from well sites and compressor stations, and equipment leaks at natural gas processing plants. NSPS OOOO – Crude Oil and Natural Gas Facilities for which Construction, Modification, or Reconstruction Commenced after August 23, 2011, and on or before September 18, 2015, requires reduction of VOCs from well completion operations and storage tanks constructed after August 23, 2011. NSPS OOOOa requires reduction of VOCs from well completion operations from new or refractured hydraulically fractured wells and requires reduction of storage tank emissions by 95% for tanks constructed after September 18, 2015, with emissions greater than 6 tpy of VOCs (which has the co-benefit of reducing CH₄ emissions as well). NSPS OOOOa also imposes semiannual leak detection and repair requirements for the collection of fugitive emission components at well sites constructed after September 18, 2015, that produce more than 15 barrels of oil equivalent (boe) per day. NSPS OOOOa also requires scheduled maintenance and/or emission control devices for reciprocating and centrifugal compressor venting at compressor stations and includes provisions to limit emissions from natural gas pneumatic devices and pumps. In September 2018 and August 2019, the EPA proposed changes to the rule to modify, amend, and/or rescind requirements for the 2012 and 2016 NSPS for the oil and gas industry, which have been incorporated into the final rule as of September 14, 2020. Following the 2020 amendment to OOOO and OOOOa, fugitive emissions monitoring is required only for those wells producing greater than 15 boe per day. These provisions aim to reduce fugitive emissions of VOCs at oil and gas facilities.

11.2 GREENHOUSE GASES NEPA GUIDANCE

In 2020, the CEQ issued a final rule (2020 Rule) to update its regulations for federal agencies to implement the NEPA. This guidance became effective on September 14, 2020. U.S. Department of the Interior (DOI) Secretarial Order 3399, Department-Wide Approach to the Climate Crisis and Restoring Transparency and Integrity to the Decision-Making Process (April 16, 2021), directs Bureaus/Offices to not apply the 2020 Rule in a manner that would change the application or level of NEPA that would have been applied to a proposed action before the 2020 Rule went into effect on September 14, 2020. On April 20, 2022, CEQ issued a final rule to amend certain provisions of its regulations for implementing NEPA, addressing the purpose and need of a proposed action, agency NEPA procedures for implementing CEQ NEPA regulations, and the definition of “effects.” The amendments generally restore provisions that were in effect for decades before being modified in 2020. Bureaus/offices will continue to follow the DOI NEPA regulations at 43 C.F.R. § 46, Department Manual (DM) procedures (516 DM Ch. 1–15), and guidance and instruction from the Office of Environmental Policy and Compliance until updated direction is provided.

11.3 GUIDANCE ON ASSESSING GREENHOUSE GASES IN NEPA

CEQ issued guidance in early 2023 to assist federal agencies in their consideration of the effects of GHG emissions and climate change when evaluating proposed federal actions in accordance with NEPA and

CEQ regulations implementing the procedural provisions of NEPA. When addressing climate change, agencies should consider 1) the potential effects of a proposed action on climate change, including by assessing both GHG emissions and reductions from the proposed action and 2) the effects of climate change on a proposed action and its environmental impacts. Key points of the guidance include:

- Quantify a proposed actions and alternatives reasonably foreseeable GHG emissions (including direct and indirect emissions).
- Provide context for the GHG emissions associated with a proposed action and alternatives.
- Analyze reasonable alternatives, including those that would reduce GHG emissions relative to baseline conditions, and identify available mitigation measures to avoid, minimize, or compensate for climate effects.
- Considering the effects of climate change on a proposed action.

11.4 MONETIZED IMPACTS FROM GREENHOUSE GAS EMISSIONS

The “social cost of carbon dioxide (SC-CO₂),” “social cost of nitrous oxide (SC-N₂O),” and “social cost of methane (SC-CH₄)”—together, the “social cost of greenhouse gases” (SC-GHG)—are estimates of the monetized damages associated with incremental increases in GHG emissions in a given year. However, they do not constitute a complete cost-benefit analysis nor do the SC-GHG numbers present a direct comparison with other impacts analyzed in this document. SC-GHG is only useful as a measure of the benefits of GHG emissions reductions to inform agency decision-making.

For federal agencies, the best currently available estimates of the SC-GHG are the interim estimates of the SC-CO₂, SC-CH₄, and SC-N₂O developed by the Interagency Working Group on the SC-GHG (IWG). Select estimates are published in the Technical Support Document (IWG 2021), and the complete set of annual estimates are available on the Office of Management and Budget website (Office of Management and Budget 2021).

The SC-GHGs associated with estimated emissions from future potential development of lease parcels are calculated and reported on a lease-sale level. The SC-GHGs are also disclosed at the APD level. These estimates would represent the present value (from the perspective of the current year) of future market and nonmarket costs associated with CO₂, CH₄, and N₂O emissions from potential well development and operations and potential end use. These estimates are calculated based on IWG estimates of social cost per metric ton (t) of emissions for a given emissions year (for the life of the lease/project) and BLM estimates of emissions in each year.

11.5 PSD AND TITLE V

GHGs became regulated pollutants on January 2, 2011, under the PSD and Title V Operating Permit Programs because of their contribution to global climate change effects. These gases absorb energy emitted from Earth’s surface and re-emit a larger portion of the heat back to Earth, rather than allowing the heat to escape into space, than would be the case under more natural conditions. The EPA GHG Tailoring Rule (40 C.F.R. §§ 51, 52, 70, et al.) set initial emissions thresholds for PSD and Title V permitting based on carbon dioxide equivalent (CO₂e). These thresholds apply to stationary sources that emit greater than 100,000 tons CO₂e per year (e.g., power plant, or landfill, etc.) or modifications of major sources with resulting emissions increase greater than 75,000 tons CO₂e per year.

In addition to the Tailoring Rule, the EPA requires reporting of GHGs from facilities with stationary sources that emit 25,000 t CO₂e per year or more in the United States. The Mandatory Reporting Rule (40 C.F.R. § 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 CO₂ for geological sequestration must report net emissions regardless of quantity (40 C.F.R. § 98, Subpart RR). This provides a basis for future EPA policy decisions and regulatory initiatives regarding GHGs. Section 2 of the BLM Specialist Report provides additional regulations and policies for GHGs (BLM 2023a).

11.6 EXECUTIVE ORDERS

EOs and memoranda issued to address the climate crisis have focused on GHG emission reductions and increased renewable energy production. The following is a summary of two of the EOs.

EO 13990, issued on January 25, 2021, focuses on protecting public health and directs all executive departments and agencies to immediately commence work to confront the climate crisis with the goal to improve public health and the environment. Two key directives in this EO are 1) the establishment of an IWG tasked with developing and promulgating costs for agencies to apply during cost-benefit analysis and 2) the rescission of the CEQ draft guidance entitled "Draft National Environmental Policy Act Guidance on Consideration of Greenhouse Gas Emissions" (Federal Register 84:30097). The EO also directs the DOI Secretary to place a temporary moratorium on all oil and gas activities in the Arctic National Wildlife Refuge, revokes the permit for the Keystone XL pipeline, and requires all agency heads to review any agency activity under the prior administration to ensure compliance with the current administration's environmental policies.

EO 14008, issued on January 27, 2021, directs the executive branch to establish climate considerations as an element of U.S. foreign policy and national security and to take a government-side approach to the climate crisis. This EO reaffirms the decision to rejoin the Paris Agreement and commit to environmental justice and new clean infrastructure projects, establishes a National Climate Task Force and puts the United States on a path to achieve net-zero emissions by no later than 2050. Specific directives for the DOI and the BLM include increasing renewable energy production on public land and waters, performing a comprehensive review of potential climate and other impacts from oil and natural gas development on public land, establishing a civilian climate corps, and working with key stakeholders to achieve a goal of conserving at least 30% of the nation's lands and waters by 2030.

12 GREENHOUSE GAS EMISSIONS

Current ongoing global climate change is caused, in part, by the atmospheric buildup of GHGs, which may persist for decades or even centuries. The buildup of GHGs, such as CO₂, CH₄, N₂O, and fluorinated gases since the start of the industrial revolution has substantially increased atmospheric concentrations of these compounds compared to historical background levels. Because GHGs circulate freely throughout Earth's atmosphere, climate change is a cumulative global issue.

Common air emissions related to oil and gas activities include CO₂, CH₄, and N₂O. Other industries emit more potent GHGs, including several fluorinated species of gases, such as HFCs, PFCs, and SF₆. CO₂ is emitted from the combustion of fossil fuels (oil, natural gas, and coal), solid waste, and trees and wood products and as a result of other chemical reactions (e.g., manufacture of cement). The production and transport of coal, natural gas, and oil emit CH₄, which can also be emitted from coal-mining operations, naturally occurring coal CH₄ seepages, releases/leaks from the oil and gas industry, livestock and other

agricultural practices, and the decay of organic waste in municipal solid waste landfills. Agricultural and industrial activities emit N₂O, as well as combustion of fossil fuels and solid waste. Fluorinated gases are powerful GHGs that are emitted from a variety of industrial processes and are often used as substitutes for ODS (i.e., chlorofluorocarbons [CFCs], hydrochlorofluorocarbons [HCFCs], and halons), but typically not from oil and gas operations. SF₆ is the most potent (highest radiative efficiency) GHG known and is typically used as an insulator in circuit breakers, gas-insulated substations, and switchgear used in the transmission system to manage the high voltages carried between power-generating stations and customer load centers.

The impact of a given GHG on global warming depends both on its RF 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 CH₄, react in the atmosphere relatively quickly (on the order of 12 years); others, such as CO₂, typically last for hundreds of years or longer. Climate scientists have calculated a factor, known as the global warming potential (GWP), for each GHG that accounts for these effects.

The GWP is used as a conversion factor to convert a mixture of different GHG emissions into CO₂e. The larger its GWP, the more the specific gas warms the earth as compared to CO₂. 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 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 (BLM 2023a; UNFCCC 2021).

Updated GWPs were reported in the 2021 *IPCC Sixth Assessment Report Global Warming Potentials* (AR6) (IPCC 2021) as the level of scientific understanding increased and include the assessment reports of its three working groups, three special reports, a refinement to the methodology report, and the synthesis report. The synthesis report is the last of the AR6 products, released in March 2023. Section 8.3 of the BLM Specialist Report summarizes AR6 details.

GWP values account for changes in radiative properties, atmospheric lifetimes, and indirect contributions of the different gases. The atmospheric lifetimes and GWPs for the major GHGs over the 20-year and 100-year time horizons are listed below in Table 40. CO₂ has a GWP of 1, and for the purposes of analysis, a GHG GWP is generally standardized to O₂, or the equivalent amount of CO₂ mass the GHG would represent. Section 3.4 of the BLM Specialist Report provides additional details on GWPs.

Table 40. AR6 Global Warming Potentials

Greenhouse Gas	GWP Values for 20-Year Time Horizon	GWP Values for 100-Year Time Horizon
Carbon dioxide (CO ₂)	1	1
Methane (CH ₄)	Fossil origin – 82.5 Nonfossil origin – 79.7	Fossil origin – 29.8 Nonfossil origin – 27.0
Nitrous oxide (N ₂ O)	273	273
Select hydrofluorocarbons (HFCs)	–	HFC-32 – 771 HFC-134a – 4,144

Greenhouse Gas	GWP Values for 20-Year Time Horizon	GWP Values for 100-Year Time Horizon
Sulfur hexafluoride (SF ₆)	–	–

Sources: IPCC (2021).

12.1 NATIONAL GREENHOUSE GAS EMISSIONS BY SECTOR

It is useful to compare the relative and absolute contributions to climate change of different GHG emissions, as well as emissions from different regions/countries or sources/sectors. There are several different metrics that can be used for this comparison. A GHG emissions inventory is used to identify and quantify the anthropogenic GHG emissions from different regions/countries or sources/sectors. Using the GWP concept, GHG emissions are often reported in terms of CO₂e.

To meet the obligations of the UNFCCC, the EPA publishes a national inventory of U.S. GHG emissions and sinks on an annual basis (EPA Inventory) (EPA 2023bb). The lowest GHG emissions since reporting began, 6,026.0 million metric tons (or megatonnes) (Mt) of CO₂e, occurred in 2020, and the peak GHG emissions, 7,477.4 Mt CO₂e, occurred in 2005. The largest source of GHG emissions from human activities in the United States is from burning of fossil fuels for electricity, heat, and transportation. Total U.S. emissions have decreased by 2.3% from 1990 to 2021; 2005 emissions were 15.3% above 1990 levels. The latest national GHG emissions are for calendar year 2021, in which total gross U.S. GHG emissions were reported at 6,340.2 Mt CO₂e, represents an increase of approximately 6.4% from the previous year and a decrease of 16.6% from the peak emissions in 2005. Emissions increased from 2020 to 2021 by 314.2 Mt CO₂e. Net emissions (including sinks) were 5,586.0 Mt CO₂e. The lower GHG emissions in 2020 were largely due to the impacts of the coronavirus (COVID-19) pandemic on travel and economic activity. The decline also reflects the combined impacts of many long-term trends, including population, economic growth, energy market trends, technological changes (e.g., energy efficiency and the carbon intensity of energy fuel choices). Figure 5.4 in Section 5.3 of the BLM Specialist Report provides an illustration of U.S. GHG emissions (Mt/year) from fossil fuel combustion between 1990 through 2021 (BLM 2023a).

Section 5.3, Table 5-1 of the BLM Specialist Report further breaks down GHG emissions by major source category and shows GHG trends from 1990 to 2021. The pollutant categories reported in the annual inventory report include CO₂, CH₄, N₂O, HFCs, PFCs, SF₆, and nitrogen trifluoride (NF₃); source categories vary for each pollutant. The primary GHG emitted by human activities in the United States was CO₂, representing approximately 79.4% of total 2021 GHG emissions on a GWP-weighted basis. The largest source of CO₂ and of overall GHG emission in 2021 was fossil fuel combustion (4,639 Mt). CH₄ emissions from all sectors (793.4 Mt) accounted for 11.5% of U.S. emissions in 2021. The major sources of CH₄ include natural gas systems, enteric fermentation and manure management associated with domestic livestock, and decomposition of wastes in landfills. N₂O emissions accounted for 6.2% of total GHG emissions in 2021 (405.1 Mt). The agricultural sector including fertilizers and soil management and manure management was the largest source of N₂O emissions (BLM 2023a).

The energy sector includes three different subcategories—coal mining, natural gas and petroleum systems, and fossil fuel combustion. The emissions itemized under the coal mining and natural gas and petroleum systems subcategories include emissions for all U.S. sources in each of the categories and are not differentiated by mineral ownership (i.e., federal, state, or private minerals). In 2021, GHG emissions from coal mining subcategory were 300.7 Mt, a decrease of 6% from the previous year (BLM 2023a).

The coal mining sector includes emissions from underground and surface mining, as well as post-mining activities and abandoned underground mines. In 2021, GHG emissions from the natural gas and petroleum systems subcategory were 53.6 Mt, a decrease of 2.4% from the previous year. The natural gas and petroleum systems sector includes emissions from oil and gas exploration, production, and processing, as well as other sources. In 2021, the total GHG emissions from the fossil fuel combustion subcategory were 4,689.4 Mt, up 6.3% from the previous year. The fossil fuel combustion sector includes emissions from the use of fossil fuels in transportation, electricity generation, industry, and residential use. Approximately 82% (5,196.6 Mt) of the total emissions were from the energy sector, primarily fossil fuel combustion for transportation and electricity generation (BLM 2023a).

12.2 GLOBAL, NATIONAL, STATE, AND COUNTY GREENHOUSE GAS EMISSIONS

Global and national annual GHG emissions and projections, as well as state annual GHG emissions are discussed in the Section 5.0 of the BLM Specialist Report (BLM 2023a). The global, national, and state annual gross GHG emissions are presented in Table 41. Global emissions were obtained from the Emissions Database for Global Atmospheric Research (EDGAR) (EDGAR 2023). National emissions are from the EPA Inventory (EPA 2023w) and Section 5.3, Table 5-1, of the BLM Specialist Report. State emissions for 1990 through 2020 are from the EPA Inventory and Table 5-2, Section 5.5 of the BLM Specialist Report. State emissions for 2021 are from the EPA interactive tool, the Greenhouse Gas Inventory Data Explorer (EPA 2023cc). Note that national- and state-level data are not yet available for 2022.

Table 41. Annual Global, National, and State Gross GHG Emissions (CO₂e) in Megatonnes (Mt) per Year

Area	1990	2005	2017	2018	2019	2020	2021
Global	33,268	42,318	51,195	52,398	52,557	50,632	53,057
United States	6,487.3	7,477.4	6,561.8	6,754.8	6,617.9	6,026	6,340.2
U.S. Fossil CO ₂	4,728.2	5,747.3	4,852.5	4,989.8	4,855.9	4,344.9	4,639.1
New Mexico	77.9519	90.6474	77.1175	74.3114	79.6294	73.6055	75.839
Oklahoma	140.3499	151.6456	139.7246	145.1994	137.7015	128.4296	133.483
Kansas	120.1948	125.4311	108.9567	113.2366	110.9066	106.8618	109.013
Texas	765.1829	824.1614	848.3239	880.7928	888.2165	818.9269	873.11

Sources: Tables 5-1 and 5-2 in BLM (2023a); EDGAR (2023); EPA (2023bb, 2023cc).

County-level GHG emissions information for New Mexico is available in the 2020 NEI and from the EPA Facility Level Information on GHG Tool (FLIGHT) (EPA 2023v, 2023dd). The NEI includes emissions data for mobile sources, prescribed fires, and wildfires, whereas the FLIGHT tool includes emissions data for major industrial facilities. Although emissions data for FLIGHT are updated annually, the 2020 reporting year is shown here to match the 2020 NEI data. The combined county-level anthropogenic GHG emissions from the NEI and FLIGHT datasets are provided in Table 42. At the county level, emissions information is not readily available for residential, commercial, agriculture, and fugitive sources, but these sources account for the difference in state and county total emissions shown in Table 41 and Table 42. Detailed emissions from all source types for each county are also provided in Appendix A.

Table 42. County-Level GHG Emissions (CO₂e) for the 2020 Reporting Year

County	Data Source	CO ₂ (t)	CH ₄ (t)	N ₂ O (t)	20-year Total CO ₂ e (t)	100-year Total CO ₂ e (t)
Chaves	NEI	384,360	30	6	388,360	386,802
	FLIGHT	84,247	40	48	100,651	98,543
Total		468,607	30	54	613,868	610,774
Eddy	NEI	607,292	59	6	1,231,284	1,197,081
	FLIGHT	844,135	649	1,222	676,468	674,254
Total		607,292	708	1,228	4,985,031	4,855,493
Lea	NEI	671,095	42	7	951,197	947,621
	FLIGHT	4,162,410	1,940	2,327	1,801,179	1,703,262
Total		4,833,505	42	2,334	291,660	287,630
McKinley	NEI	942,776	68	10	25,325	24,797
	FLIGHT	760,371	1,858	3,251	1,086,609	1,082,134
Total		942,776	1,926	3,261	39,583	38,740
Rio Arriba	NEI	284,211	76	4	827,552	820,271
	FLIGHT	21,223	10	12	35,952,691	33,902,872
Total		305,434	76	16	172,499	170,204
Sandoval	NEI	1,076,013	85	13	35,320	34,582
	FLIGHT	32,530	16	21	388,360	386,802
Total		1,108,543	85	34	100,651	98,543
San Juan	NEI	812,711	138	13	613,868	610,774
	FLIGHT	14,220,175	38,896	67,852	1,231,284	1,197,081
Total		812,711	39,034	67,865	676,468	674,254
Roosevelt	NEI	168,213	44	3	4,985,031	4,855,493
	FLIGHT	29,251	14	18	951,197	947,621
Total		168,213	58	21	1,801,179	1,703,262

Sources: EPA (2023v, 2023dd)

12.3 NATIONAL GREENHOUSE GAS EMISSIONS GREENHOUSE GAS REPORTING PROGRAM (FLIGHT)

The Greenhouse Gas Reporting Program (GHGRP) is codified by regulation (40 C.F.R. § 98) and requires reporting of GHG data and other relevant information from large GHG emission sources, fuel and

industrial gas suppliers, and CO₂ injection sites in the United States. In total, 41 categories are covered by the program. Facilities are generally required to submit annual reports under 40 C.F.R. § 98 if:

- GHG emissions from covered sources exceed 25,000 t CO₂e per year.
- Supply of certain products would result in over 25,000 t CO₂e of GHG emissions if those products were released, combusted, or oxidized.
- The facility receives 25,000 t or more of CO₂ for underground injection.

The reported data are usually made available to the public in October of each year. It should be noted that the GHGRP does not represent total U.S. GHG emissions but provides facility-level data for large sources of direct emissions, thus representing most of U.S. GHG emissions. The GHGRP data collected from direct emitters represent about half of all U.S. emissions. When including GHG information reported to the GHGRP by suppliers, emissions coverage reaches approximately 85% to 90% (EPA 2023ee). The EPA Inventory contains information on all GHG emissions sources and sinks in the United States (EPA 2023bb). For more information, please visit <https://www.epa.gov/ghgreporting>.

12.3.1 COMPRESSOR ENGINES AND STATIONS (MIDSTREAM) REPORTED GREENHOUSE GAS EMISSIONS

Compressor engines link the natural gas pipeline infrastructure that transports natural gas from its source to points of consumption. Table 43 shows the GHG emissions from transmission compressor stations and gas plants for each state where BLM NMSO has mineral estate (from FLIGHT). Some gas plants and compressor stations emissions may not be reported to FLIGHT because emissions from the plant or station do not exceed EPA GHG reporting threshold. Additionally, there are gathering compression stations that are not considered “point sources” under the Mandatory Reporting Rule, which are instead reported under the oil and gas gathering and boosting industry segment.

Table 43. 2021 Midstream GHG from Gas Plants and Compressor Stations

State	Number of Reporting Transmission Compressor Stations	Total GHG Emissions from Reporting Compressor Stations (Mt CO ₂ e)	% U.S. Total Reported Compressor Station GHG Emissions	Number of Reporting Gas Plants	Total GHG Emissions from Reporting Gas Plants (Mt CO ₂ e)	% U.S. Total Reported Gas Plant GHG Emissions
New Mexico	18	0.52	1.58%	22	2.0	3.39%
Texas	105	4.9	14.85%	204	17	28.81%
Oklahoma	17	0.43	1.30%	48	2.0	3.39%
Kansas	22	0.34	1.03%	5	0.61	1.03%

Source: EPA (2023dd).

Emissions from oil and gas “point sources,” including natural gas processing, transmission and compression, transmission pipelines, and storage and distribution, in the United States totaled 107 Mt CO₂e in 2021, which was about 3.95% of the U.S. total. GHG emissions reported to EPA in 2021 (EPA 2023dd). Emissions from the onshore oil and gas gathering and boosting segment, which includes

compressor stations, meter stations, gathering pipelines, and other miscellaneous midstream oil and gas support facilities, totaled 86 Mt CO₂e in 2021 (EPA 2023dd).

12.3.2 REFINERIES (MIDSTREAM) REPORTED GREENHOUSE GAS EMISSIONS

Crude oil produced throughout the BLM NMSO area of operations is transported by pipeline and/or tanker truck to refineries where the oil is processed into various types of fuel. Table 44 shows the GHG emissions from refineries in each BLM NMSO state.

Table 44. 2021 Greenhouse Gas Emissions from Refineries

State	Number of Reporting Refineries	Total GHG Emissions from Reporting Refineries (Mt CO ₂ e)	% U.S. Total Reported Refinery GHG Emissions
New Mexico	3	0.79	0.48%
Texas	29	54.0	32.73%
Oklahoma	5	4.1	2.48%
Kansas	3	3.1	1.88%

Source: EPA (2023ee).

There are three refineries in New Mexico: one in Jamestown (Gallup Refinery), one in Artesia, and one in Lovington. Kansas has three refineries, Oklahoma has five refineries, and Texas has 29 refineries. Transportation and processing of crude oil and petroleum products result in emissions of various HAPs, criteria pollutants, and GHGs. In 2021, GHG emissions from refineries (total of 137 reporting) accounted for 165 Mt CO₂e emitted, which is 6.09% of the 2021 total GHG emissions reported to EPA (EPA 2023ee).

12.3.3 OTHER MAJOR INDUSTRIES GENERATING GREENHOUSE GAS EMISSIONS

Potash mining is another major industry in the BLM CFO area. There are two mining companies operating four potash processing plants in the BLM CFO area. Potash production produces emissions of various HAPs, criteria pollutants, and GHGs. In 2015, potash mines in southeastern New Mexico emitted 97,140 t of CO₂e collectively. This is 0.002% of total U.S. GHG emissions (EPA 2023v). In 2016, CO₂e emissions decreased significantly, as some facilities discontinued reporting GHG emissions for valid reasons: operations had ceased, operations were changed such that a process or operation no longer meets the “Definition of Source Category,” the entire facility or supplier was merged into another facility or supplier that already reports to the GHGRP, the facility reported emissions or quantity of GHG supplied of less than 15,000 t CO₂e for 3 consecutive years, or the facility reported emissions or quantity of GHG supplied of less than 25,000 t CO₂e for 5 consecutive years. Thus, in 2019 the emissions from Intrepid Potash reported only 8,109 t CO₂e, which is 0.0001% of total U.S. GHG emissions. As of 2021, 0 t of CO₂e were reported.

Coal mining and coal-fired power generation are major industries in San Juan County, New Mexico. Coal production produces emissions of various HAPs, criteria pollutants, and GHGs. In 2021, the San Juan Mine reported 0.73 Mt CO₂e, whereas data for the Navajo Mine were not available. In 2021, coal mining in the United States contributed 44.7 Mt CO₂e from CH₄, which is 6.1% of total U.S. CH₄ emissions and 0.71% of total U.S. GHG emissions (EPA 2023bb).

The 2020 NEI data for San Juan County include emissions from the San Juan Generating Station near Waterflow, New Mexico, and the Four Corners Power Plant on Navajo Nation land in Fruitland, New Mexico. Both were PSD major sources subject to BART requirements to comply with the Regional Haze Rule. Two electric generating units (EGUs) at the San Juan Generating Station were shut down in December 2017, and new selective catalytic reduction (SCR) technology was installed on the two remaining EGUs. The 2020 NEI data take into account the EGU shutdowns and the new SCR system technology; subsequently, the San Juan Generating Station was closed in September 2022, removing all EGUs associated with this facility. Two EGUs have been shut down at the Four Corners Power Plant, and the remaining two EGUs had SCR technology installed in 2018. The shutdown of San Juan Generating Station and two EGUs at the Four Corners Power Plant and the installation of SCR technology at the Four Corners Power Plant are expected to result in significant emissions reductions.

In Texas, EGUs in O₃ nonattainment areas (Beaumont-Port Arthur, Dallas-Fort Worth and Houston-Galveston-Brazoria) are required to limit NO_x emissions from utility boilers, auxiliary steam boilers, stationary gas turbines, and duct burners under 30 T.A.C. § 117(c). The Texas-proposed regional haze SIP did not require BART-eligible EGUs to install controls because the State of Texas determined the impact of each plant's emissions did not significantly degrade visibility in a Class I area or facilities had already reduced emissions or shut down units. On December 16, 2014, the EPA proposed to partially disapprove the Texas regional haze SIP and also proposed a Federal Implementation Plan to require SO₂ emissions reductions at 15 Texas BART-eligible sources.

In Oklahoma, Tulsa Public Service Company of Oklahoma retired one coal-fired EGU in Oologah, Oklahoma, and installed a dry sorbent injection system on a second coal-fired EGU in April 2016. A second EGU will be shut down by December 31, 2026, to meet the requirements of the Regional Haze Rule. In 2016, SO₂ emissions were reduced by 78%, and NO₂ emissions were reduced by 81%.

In 2011, EPA disapproved the Oklahoma SIP revision plan for controls at the Oklahoma Gas and Electric Sooner and Muskogee Units and the American Electric Power (AEP)–Public Service Company of Oklahoma (PSO) Northeastern Plant Units 3 and 4. The EPA determined that dry scrubber control technology was needed at these units to meet Regional Haze Rule requirements. The disapproval was challenged by the State of Oklahoma, upheld by the courts, and has been appealed to the Supreme Court by the State of Oklahoma. Oklahoma submitted a SIP revision in 2013 that was approved by EPA in March 2014, which revises the BART determination for AEP-PSO Units 3 and 4. The revised determination includes short-term compliance with emissions limits, shut down of one of the units by April 16, 2016, and shut down of the other unit by December 31, 2026.

In Kansas, emissions at four coal-fired EGUs were significantly reduced as a result of the Regional Haze Rule. At the Kansas City Power and Electric La Cygne Power Plant, an SCR system was installed on both units, and air scrubbers were installed. These actions resulted in an 83% reduction in NO_x emissions and an 82% reduction in SO₂ emissions. Installing low-NO_x burners and switching to natural gas combustion at the Westar Energy Jeffrey Energy Center coal-fired EGUs resulted in an 82% reduction in NO_x emissions and a 34% reduction in SO₂ emissions.

13 CLIMATE CHANGE PROJECTIONS

13.1 REPRESENTATIVE CONCENTRATION PATHWAYS

Section 8.0 of the BLM Specialist Report provides information on projected climate change. Climate scientists provide projection analyses by modeling changes to Earth's systems in response to a range of global emissions scenarios known as representative concentration pathways (RCPs) (Section 8.1 of the BLM Specialist Report). The RCPs are not fully integrated scenarios of climate feedback, policy, emissions limits, thresholds, or socioeconomic projections but rather a consistent set of cumulative emissions projections out to year 2100 of only the components of RF that are meant to serve as input for climate and atmospheric chemistry modeling. There are four scenarios that climate scientists have used for assessment are listed below and discussed in more detail in the BLM Specialist Report.

- RCP2.6 – A low-emissions pathway that is representative of scenarios that lead to very low atmospheric GHG concentrations.
- RCP4.5 – Stabilization scenario where total RF stabilizes before 2100 by employment of a range of technologies and strategies for reducing GHG emissions. This pathway forecasts global emissions increasing until about 2040 and then declining starting in 2050.
- RCP6.0 — Stabilization scenario where total RF stabilizes after 2100 by employment of a range of technologies and strategies for reducing GHG emissions. Emissions of CO₂ grow steadily until 2080 before declining.
- RCP8.5 - Pathway scenario with increasing emissions over time that leads to very high GHG-concentration levels. This pathway assumes emissions trajectories follow historical growth and assumes no climate policies are enacted to reduce emissions.

By 2050, the magnitude of projected climate change is substantially affected based on which of the four scenarios is considered. According to the IPCC, only emissions projections following the lowest concentration pathway (RCP2.6) result in an estimated mean increase in global average temperatures below 2°C. Equally important, IPCC scientists project warming will continue beyond 2100 under all RCP scenarios except for RCP2.6.

The projected increase of global mean surface temperature by the end of the twenty-first century (2081–2100) relative to 1986 through 2005 is likely to be 0.3°C to 1.7°C under RCP2.6, 1.1°C to 2.6°C under RCP4.5, 1.4°C to 3.1°C under RCP6.0, and 2.6°C to 4.8°C under RCP8.5. Oceans will continue to warm, with the greatest impacts occurring at the surface of tropical and northern hemisphere subtropical regions. Models also predict ocean acidification will increase for all RCP scenarios. Global mean sea level rise will very likely continue at a faster rate than observed from 1971 to 2010.

13.2 SHARED SOCIOECONOMIC PATHWAYS

In preparation for the AR6, the climate science research community, economists, and energy systems modelers developed a new range of “pathways” that examine how global society, demographics, and economics might influence future climate impacts, vulnerabilities, adaptation, and mitigation over the next century. The scenarios are collectively known as the Shared Socioeconomic Pathways (SSPs). These new scenarios were used to inform the latest round of climate modeling that was incorporated into AR6 and are discussed in more detail in Section 8.2 of the BLM Specialist Report. The RCPs and SSPs are

meant to complement each other. The RCPs set pathways for GHG concentrations and the potential amount of RF and warming the world may experience by the end of the century. The SSPs explore how reductions in emissions will, or will not, be achieved and can therefore be thought of as potential mitigation alternatives.

The five SSP scenarios provide a range of plausible trends that could shape future society and include the following:

- SSP1 – Low challenges to mitigation and adaptation and there is a shift towards sustainable practices and sustainable development.
- SSP2 – Medium challenges to mitigation and adaptation that follows historical development trends throughout the twenty-first century.
- SSP3 – High challenges to mitigation and adaptation and presents a less optimistic economic and social development scenario, with little investment in education or health in poorer countries coupled with a fast-growing population and increasing inequalities.
- SSP4 – Low challenges to mitigation, high challenges to adaptation and presents a less optimistic economic and social development scenario, with little investment in education or health in poorer countries coupled with a fast-growing population and increasing inequalities.
- SSP5 – High challenges to mitigation, low challenges to adaptation and assumes that development is driven by fossil fuel energy.

The SSPs can then be combined with various emission mitigation objectives to identify how each of the different RCPs can be achieved. To understand how the SSPs relate to different levels of warming under the RCP scenarios, six different integrated assessment models (IAMs) were used. The IAMs produce an estimate of the GHG emissions that would occur based on socioeconomic factors outlined in the SSPs. The resulting emissions were then used as inputs for the Model for the Assessment of Greenhouse Gas Induced Climate Change (MAGICC) to provide estimates of atmospheric GHG concentrations and future warming. This research shows that some mitigation and adaptation to climate change is much easier under some SSP scenarios than others and not all SSPs are compatible with RCPs that limit warming to 1.5°C or 2°C above preindustrial levels. However, even though not all IAMs find a viable solution for scenarios that limit warming below 1.5°C or 2°C, it does not necessarily mean that these scenarios are impossible. Models are imperfect and cannot foresee all changes that will happen over the next century.

13.3 GLOBAL CLIMATE CHANGE PREDICTIONS

According to preliminary data estimates provided by the Rhodium Group (an independent research provider), cumulative global net GHG emissions increased by approximately 4.6% in 2021, compared to a 5% reduction in 2020, primarily due to economic effects of the COVID-19 pandemic. The EIA provides long-term (2020–2050) world energy and emissions projections in its International Energy Outlook (IEO). As of September 2023, the most recent IEO that contains CO₂ emissions data is the IEO2021, released in October 2021. The IEO provides several different scenarios to forecast future energy needs and associated carbon emissions. The reference case reflects current trends and relationships among supply, demand, and prices in the future and is a reasonable baseline case to compare with cases that include alternative assumptions about the future energy system.

Similar to the EIA 2023 AEO report, the IEO provides a reference case that assumes global energy consumption will rise nearly 50% between 2020 and 2050. According to the reference case projections, the use of all fossil fuels increases through 2050, with much of the increased demand coming from Asia. Natural gas consumption is forecast to grow by 31% through the projection period, which is limited by the projected growth in renewable energy sources (27% share in 2050). Constant petroleum growth is forecast for the entire projection period, with almost the entire supply going toward meeting transportation demand and growth. Global energy-related CO₂ emissions are projected to increase by 0.6% per year from 2020 to 2050 from about 35 gigatonnes (Gt) of CO₂ to about 43 Gt. Although aggregate CO₂ emissions from the energy sector are projected to continue to rise, the carbon intensity of future energy sources (i.e., the amount of CO₂ emissions produced per unit of energy used) is projected to decrease, indicating that sources of energy that do not produce CO₂ emissions (e.g., renewables) will comprise a larger portion of meeting future energy demands. Figure 5-3 of the BLM Specialist Report, which are EIA IEO graphs, shows some of the historical and projected energy and emissions estimates derived from global fossil fuel use. Some of the data are displayed separately for countries that are a part of the Organization of Economic Cooperation and Development, of which the United States is a part, and those that are not.

13.4 REGIONAL CLIMATE CHANGE PREDICTIONS

The following climate change discussion summarizes information from the BLM Specialist Report regarding the fourth national climate assessment (NCA4) and NOAA state climate summaries for New Mexico, Kansas, Oklahoma, and Texas. Section 8.4 of the BLM Specialist Report provides more details on state climate summaries. Figure 8-3 in the BLM Specialist Report provides projected temperature changes for the presented states relative to a low- and high-emissions scenario (RCPs 4.5 and 8.5) analyzed by the NCA. Section 8.5 of the BLM Specialist Report discusses the effects of climate change on public health and safety.

Climate modeling suggests that average temperatures in the New Mexico region may rise by 4°F to as much as 12°F by the end of the twenty-first century, depending on the emissions scenario. Although projections of annual precipitation are uncertain, more precipitation falling as rain is very likely to occur as temperatures increase (BLM 2023a).

The U.S. Bureau of Reclamation (Reclamation) et al. (2013) made the following projections through the end of the twenty-first century for the Upper Rio Grande Basin (southern Colorado to south-central New Mexico) based on the current and predicted future warming:

- There will be decreases in overall water availability by one-quarter to one-third.
- The seasonality of stream and river flows will change with summertime flows decreasing.
- Stream and river flow variability will increase. The frequency, intensity, and duration of both droughts and floods will increase.

The Reclamation *West-Wide Climate Risk Assessment: Upper Rio Grande Impact Assessment* also noted that reduction in water is expected to make environmental flows in the Upper Rio Grande system more difficult to maintain and reduce the shallow groundwater available to riparian vegetation (Reclamation et al. 2013). Both effects have implications for the habitat of fish and wildlife in the Upper Rio Grande Basin riparian ecosystems. A USFS assessment of 117 species of birds, reptiles, amphibians, and mammals along the Middle Rio Grande in New Mexico (Friggens et al. 2013, as cited in

Reclamation et al. 2013) projected decreasing availability of riparian habitat and loss of mature trees due to fire and disease, which would directly and indirectly affect many species of birds and mammals. Most evaluated species were projected to experience negative effects from climate change; however, a few species that are considered generalists and highly adaptable, such as coyotes, jackrabbits, some lizards, and road runners, may benefit from conversion of the riparian area associated with the Rio Grande to a more sparsely vegetated and drier habitat (Friggens et al. 2013, as cited in Reclamation et al. 2013).

Observed temperatures are generally within the envelope of model simulations of the historical period (Figure 9-3 in Reclamation et al. 2013). Historically unprecedented warming is projected during the twenty-first century. Less warming is expected under a lower emissions future, where the average daily maximum temperature could rise by as much as 6°F, in contrast to the higher emissions scenario that could lead to average daily maximums that are 11°F warmer than the historical record.

Texas, Oklahoma, and Kansas are part of the Great Plains region, which will see increases in temperatures and more frequent drought in the future. Temperature increases and precipitation decreases will stress the region's primary water supply, the Ogallala Aquifer. Seventy percent of the land in this area is used for agriculture. Threats to the region associated with climate change include:

- pest migration as ecological zones shift northward,
- increases in weeds, and
- decreases in soil moisture and water availability (Reclamation et al. 2013).

13.4.1 STATE CLIMATE CHANGE TRENDS AND PREDICTIONS

NOAA National Centers for Environmental Information released its climate summaries by state in 2022. The key messages bulleted below in Sections 13.4.1.1 through 13.1.1.4 represent climate summary information for each state within the BLM NMSO area of operations. More detailed climate discussions for each state can be found through the State Climate Summaries webpage (NOAA 2022b). Section 4.3 of the BLM Specialist Report also discusses the climate change indicators, impacts, and trends, authorizations including NOAA precipitation and temperature data, specific to states where the BLM conducts most of its fossil fuel (BLM 2023a).

13.4.1.1 NEW MEXICO

- Average annual temperature has increased by almost 2°F since the beginning of the twentieth century, and the number of extremely hot days and warm nights has also increased. Historically unprecedented future warming is likely.
- The summer monsoon rainfall, which provides much needed water for agricultural and ecological systems, varies greatly from year to year and future trends in such precipitation are highly uncertain.
- Droughts are a serious threat in this water-scarce state. Drought intensity is projected to increase, and snowpack accumulation is projected to decrease, which will pose a major challenge to New Mexico environmental, agricultural, and human systems. Wildfire frequency and severity are projected to increase in New Mexico (Frankson, Kunkel, Stevens, and Easterling 2022).

13.4.1.2 OKLAHOMA

- Average annual temperature has increased by about 0.6°F since the beginning of the twentieth century. Winter warming has been characterized by the much below average occurrence of extremely cold days since 1990. Under a higher emissions pathway, historically unprecedented warming is projected during this century.
- Precipitation can vary greatly from year to year in this region of transition from humid to semi-arid conditions. Extreme precipitation events are projected to increase, which may increase the risk of flooding and associated increases in soil erosion and non-point-source runoff into streams and lakes.
- The agricultural economy of Oklahoma makes the state particularly vulnerable to droughts, several of which have occurred in recent years. Higher temperatures will increase the rate of soil moisture depletion, leading to an increase in the intensity of naturally occurring future droughts (Frankson, Kunkel, Stevens, Champion, Stewart, and Nielsen-Gammon 2022).

13.4.1.3 KANSAS

- Average annual temperature has increased about 1.5°F since the beginning of the twentieth century, with greater warming in the winter and spring than in the summer and fall. The number of very cold nights has been much below average since 1990. Under a higher emissions pathway, historically unprecedented warming is projected during this century.
- Precipitation has varied greatly from year to year in this region of transition from humid conditions in the east of the state to semi-arid conditions in the west. Projected increases in winter precipitation and decreases in summer precipitation may result in both beneficial and negative impacts.
- The agricultural economy of Kansas makes the state vulnerable to droughts and heat waves, several of which occurred in the 1930s, 1950s, and in recent years. Projected increases in temperatures may increase the intensity of future droughts. The frequency of wildfire occurrence and severity is also projected to increase in Kansas (Frankson, Kunkel, Stevens, Easterling, Lin, Shulski, Umphlett, and Stiles 2022).

13.4.1.4 TEXAS

- Mean annual temperature has increased by almost 1.5°F since the beginning of the twentieth century. Under a higher emissions pathway, historically unprecedented warming is projected during this century, with associated increases in extreme heat events.
- Although projected changes in annual precipitation are uncertain, increases in extreme precipitation events are projected. Higher temperatures will increase soil moisture loss during dry spells, increasing the intensity of naturally occurring droughts.
- Future changes in the number of landfalling hurricanes in Texas are difficult to project. As the climate warms, increases in hurricane rainfall rates, storm surge height due to sea level rise, and the intensity of the strongest hurricanes are projected (Runkle, Kunkel, Nielson-Gammon, Frankson, Champion, Stewart, Romolo, and Sweet 2022).

13.5 NEW MEXICO GREENHOUSE GAS TRENDS

Overall, total New Mexico statewide gross GHG emissions are expected to decrease (Energy and Environmental Economics, Inc. [E3] 2020). The *New Mexico Greenhouse Gas (GHG) Emissions Inventory and Forecast* (E3 2020) projects the following for year 2030 in New Mexico for emissions produced within the state (i.e., production-based emissions):

- Gross GHG emissions of 96.6 Mt CO₂e—an increase of 22% relative to 2005 and a decrease 15% relative to 2018. New Mexico emissions are more than twice the national average of GHG emissions per capita. High per-capita emissions for New Mexico are largely the result of a GHG-intensive oil and gas industry, which makes up a significant portion of overall GHG emissions profile.
- Top sources of GHG emissions: transportation fuel use (15.4 Mt CO₂e), electricity generation (12.9 Mt CO₂e), and oil and gas (fugitive and fuel emissions) (32.5 Mt CO₂e). Transportation fuel and electricity generation decreased over 2005 estimates, but oil and gas increased.
- Approximately 43 Mt of CO₂e are projected as a result of oil and natural gas production, processing, transmission, and distribution. This is 44.5% of the gross New Mexico emissions, a slight decrease compared with the relative contribution of oil and gas production in 2018, (53.0%), and an increase compared with the relative contribution of oil and gas production in 2005 (25.0%).

All scenarios see a significant rise in emissions from 2005 to 2018, as well as a significant drop from 2018 to 2023, driven primarily by the NSPS for the oil and gas sector (E3 2020).

13.6 CUMULATIVE CLIMATE CHANGE SUMMARY

Existing conditions of climate change in any given location are the result of numerous complex factors, both natural and human caused. Natural factors contributing to the current condition of air resources include existing climate resulting from long-term atmospheric weather patterns, soil types, and vegetation types. Anthropogenic factors contributing to the current condition of air resources include long-term human habitation, growing human populations, transportation methods and patterns, recreational activities, economic patterns, and the presence of power plants and other industrial sources. The presence of natural resource (primarily oil and natural gas) extraction and processing on some BLM lands also impacts air quality and GHG emissions.

The AR6 reaffirms with high confidence the AR5 finding that there is a near-linear relationship between cumulative anthropogenic CO₂ emissions and the global warming they cause. Each 1,000 gigatonnes of CO₂e (GtCO₂e) of cumulative CO₂ emissions is assessed to likely cause a 0.27°C to 0.63°C increase in global surface temperature with a best estimate of 0.45°C. This is a narrower range compared to AR5. GtCO₂e quantity is referred to as the transient climate response to cumulative CO₂ emissions (TCRE). This relationship implies that reaching net zero anthropogenic CO₂ emissions is a requirement to stabilize human-induced global temperature increase at any level, but that limiting global temperature increase to a specific level would imply limiting cumulative CO₂ emissions to within a carbon budget (IPCC 2022).

13.7 PARIS AGREEMENT AND GLOBAL CARBON BUDGET DISCUSSION

The United States has established an economy-wide target of reducing its net GHG emissions by 50% to 52% below 2005 levels in 2030 in its national determined contribution (NDC) under the Paris Agreement (UNFCCC 2021). This goal is also included in *The Long-Term Strategy of the United States, Pathways to Net-Zero Greenhouse Gas Emissions by 2050* (U.S. Department of State and the U.S. Executive Office of the President 2021). Net GHG emissions include both anthropogenic and natural emissions of GHGs, as well as removals by sinks (e.g., carbon uptake by forests). To develop the NDC, the National Climate Task Force performed an analysis of potential and measured impacts of various policies and measures (both potential and existing) at all levels of government and in all relevant sectors. This analysis was conducted using input from all federal government agencies, as well as other stakeholders, such as scientists, activists, local and state governments, and various local institutions. For the industrial sector, the NDC outlines that the U.S. government will support research and implementation of very low- and zero-carbon industrial processes and products, including introducing these products to market. The U.S. government will also incentivize carbon capture and the use of new sources of hydrogen for powering industrial facilities. The net emissions (including sinks) in 2005 were 6,635 Mt CO₂e (UNFCCC 2021); therefore, the 2030 net emissions are estimated to be between approximately 3,185 and 3,318 Mt CO₂e. So far, the United States is anticipated to have met and surpassed the 2020 target of 17% reduction in net economy-wide emissions below 2005 levels and is broadly on track to meet the 2025 goal of 26% to 28% emissions reductions below 2005 levels (UNFCCC 2021).

Carbon neutrality, or net zero emissions, is maintaining a balance between emitting and absorbing GHGs from the atmosphere. On a global scale, carbon neutrality would result in atmospheric concentrations of GHGs reaching an equilibrium, which could stabilize climate change and limit global warming. Under the 2015 Paris Agreement, countries agreed to cut GHG emissions with the goal of holding the increase in the global average temperature to well below 2 degrees Celsius (°C) above preindustrial levels and pursuing efforts to limit the temperature increase to 1.5°C above preindustrial levels to avoid some of the more dire consequences associated with climate change.

Annually, the United Nations Environment Programme (UNEP) publishes an emissions gap report, which provides an assessment of how actions and pledges of countries affect global GHG emissions trends and how these trends compare to emissions trajectories that are consistent with long-term goals for limiting global warming (UNEP 2022). Specifically, the emissions gap is the difference between GHG emissions levels consistent with limiting global warming to 1.5°C or 2.0°C and the emissions levels consistent with current reduction commitments by member nations. By 2030, the UNEP estimates that to limit warming to 2.0°C or 1.5°C, global annual emissions should be approximately 41 GtCO₂e and 32.7 GtCO₂e, respectively. Based on the most optimistic current emissions pledges, the global emissions gap in 2030 would be 11 GtCO₂e above the 2.0°C warming goal and 25 GtCO₂e above the 1.5°C warming goal. The UNEP emissions gap report does not account for the recent passage of the Inflation Reduction Act. The Inflation Reduction Act formalizes an economy-wide policy, while continuing federal oil and gas leasing over the next 10 years, which puts the United States within reach of meeting the 2030 emissions target (Rhodium Group 2022). Additionally, the U.S. Department of Energy (DOE) stated that, “While [Federal] oil and natural gas leasing provisions may lead to some increase in GHG pollution in 2030, those possible increases are dwarfed around 35-to-1 by the net estimated pollution reduction associated with the two laws [Inflation Reduction Act and Bipartisan Infrastructure Law]” (DOE 2022). Note that whereas the Inflation Reduction Act specifically mentions oil and gas leasing but not APDs, leasing is a commitment of resources and development is a foreseeable outcome of the lease. Carbon budgets have not yet been established on a national or subnational scale, primarily due to the lack of

consensus on how to allocate the global budget to each nation, and as such the global budgets that limit warming to 1.5°C or 2.0°C are not useful for BLM decision-making as it is unclear what portion of the budget applies to emissions occurring in the United States.

Table 9-1 of the BLM Specialist Report provides an estimate of the potential emissions associated with BLM fossil fuel authorizations in relation to IPCC carbon budgets. The BLM uses the long-term estimates of federal fossil fuel (oil, gas, and coal) emissions that were developed from the EIA 2023 AEO. The projected annual emissions are added over the remaining time frame until the global emissions budget is estimated to be exhausted to show the portion of the budget that is consumed by federal emissions. The BLM-estimated emissions include direct emissions as well as transport and downstream combustion emissions. It is important to note that this comparison of BLM-estimated emissions from fossil fuel authorizations to global carbon budgets does not portray the full picture of carbon flux (amount emitted vs. amount stored/sequestered/offset) on public lands. Section 9.1 of the BLM Specialist Report provides information on carbon neutrality and carbon budgets. In the BLM Specialist Report, results of the carbon budget analysis are presented as the percent of the budget consumed by federal fossil fuel emissions and the difference in time it takes to consume the budget with and without federal fossil fuel emissions. Table 9-1 of the BLM Specialist Report provides an estimate of the potential emissions associated with BLM fossil fuel authorizations in relation to IPCC carbon budgets, showing that the federal oil and gas is 0.57% of the carbon budget (under the 1.5°C scenario) and 0.59% of the carbon budget (under the 2.0°C scenario) and that the estimated global surface warming attributable to federal minerals was 0.0023°C (under the 1.5°C scenario) and 0.0065°C (under the 2.0°C scenario). The results reflect only the emissions side of the equation and may overestimate actual consumption of global carbon budgets resulting from BLM leases and authorizations. The U.S. Geological Survey (USGS) estimated that sequestration on federal land offset approximately 15% of CO₂ emissions resulting from the extraction and end-use combustion emissions of fossil fuels on federal lands (BLM 2023a). In future annual iterations of the BLM Specialist Report, the BLM may refine this carbon budget evaluation based on new or improved emissions and sequestration information on public lands, and on potential future U.S. policies establishing carbon neutral emissions pathways.

14 GREENHOUSE GAS ANALYSIS AND METHODOLOGIES

As stated, the BLM Specialist Report presents the estimated emissions of GHGs attributable to fossil fuels produced on land and mineral estate managed by the BLM. Fossil fuel extraction, construction, and operation (well development), and processing and end-use production activities all contribute to air pollutants and GHG emissions in the BLM FFO and CFO areas, especially San Juan, northwest Sandoval, Eddy, Lea, and Chaves Counties, as well as in parts of Oklahoma, Kansas, and Texas. This includes midstream sources from the natural gas compressor stations and pipelines, gas plants, and petroleum refining as well as final downstream end-use by the consumer. Coal mining is also occurring in the BLM FFO and OFO areas. Potash mining in the BLM CFO area also contributes to air contaminant and GHG emissions.

Although incremental contributions to global GHGs from a proposed land management action cannot currently be translated into effects on climate change globally or in the area of any site-specific action, GHG emission volumes can be used as a proxy in determining impacts. In this way, we can estimate emissions from a project or land management action and then compare those activities with the regional, national, or global level of GHGs or GHGs emitted by a certain industry within a region.

The BLM Specialist Report contains estimates of both direct and indirect (including downstream combustion) emissions from BLM-authorized fossil fuel development on the federal mineral estate for the three primary GHGs of concern (CO₂, CH₄, N₂O). In addition, the estimated emissions are aggregated at different scales for comparison with emissions reports and inventories completed by other entities at state, national, and global scales and for relevant industrial sectors.

14.1 DIRECT AND INDIRECT OIL AND GAS EMISSIONS

The term direct is used to describe emissions from fossil fuel mineral development and production-related activities authorized by the BLM that typically take place on leased acres of the federal mineral estate. Direct emissions could result from a variety of activities, such as lease exploration, access road construction, well pad or coal mine development, well drilling and completions, recurring maintenance and production equipment operations, and site reclamation.

Indirect emissions occur as a consequence of the authorized action and can include activities such as the processing, transportation, and any end-use combustion of the fossil fuel mineral products. They are a consequence of the produced fossil fuels but occur downstream from the point of production on federal lands and/or are outside of BLM approval authority. End use emissions make up most of GHG emissions related to federal energy resource development. The sum of the direct and indirect GHG emissions from fossil fuel mineral production is also known as a life cycle assessment (LCA).

The emissions estimates are also presented at two cumulative scales: geographic and temporal. The geographic cumulative scale is the entire onshore federal mineral estate managed by the BLM. The temporal cumulative scales include estimated emissions from total federal onshore mineral production projected for the next 12 months, the life-of-project emission estimates associated with the 12-month projections, and the long-term emissions from the portion of energy demand estimated to be met from the federal mineral estate out to year 2050 using data from the Energy Information Administration. The estimates provide a baseline to compare emissions from BLM-authorized development with those of the broader economy (national and global) and illustrate the degree to which federal fossil fuel mineral development contributes to projected GHG emissions and therefore to climate change.

To account for the full life-cycle assessment, estimates of projected emissions are included on both a short-term and long-term basis: in which the short-term estimates are based on RFD trends derived from leasing and production statistics, and the long-range estimates are based on the analysis of energy market dynamics developed by the EIA in its AEO report. Together, the estimates are designed to provide relevant, well-supported, and factual information that is intended to fully account for GHG emissions from BLM authorizations to develop the federal mineral estate (BLM 2023a).

Section 6.1 of the BLM Specialist Report contains emission factors and production data applying a combination of published LCA data, other studies and statistics, and assumptions for each fossil fuel type. In general, this means that the total federal GHG burden on the environment is best described by the end use, or downstream combustion portion of the disclosed accounting, plus any fugitive emissions that result from fossil mineral processes prior to end use. Some of the referenced LCA sources contain estimates for systemic losses of CH₄ (i.e., fugitive emissions), such that when these data are available the BLM back-calculates the fugitive losses from the direct emissions to more fully provide transparency for emissions resulting from BLM-authorized development.

The end-use phase emissions for coal, oil, and gas (assumed combustion) are estimated using EPA emissions factors from Tables C-1 and C-2 of 40 C.F.R. § 98, Subpart C, as shown in Tables 6-2, 4-7, and 4-9 of the BLM Specialist Report. The EPA factors were chosen to represent the downstream portion of these life-cycle emissions since they provide a relatively straightforward basis for estimating the consumption of each fuel for which the actual downstream transformation or use is relatively unknown compared to the assumptions and specificity used in the referenced LCA data.

Fossil fuel production is the primary input used in the LCA methodology and generally in this report. The BLM is using data and statistics from the EIA and the DOI Office of Natural Resources Revenue (ONRR), both of which provide production accounting services for domestic fossil fuel minerals to estimate report year emissions on a fiscal year basis (when such data exist). Details on the coal, oil, and gas emission factors are in Sections 6.2, 6.4, and 6.10 of the BLM Specialist Report. Table 45 presents emissions data from reasonably foreseeable projects involving federal fossil fuel production and authorizations.

Table 45. Emissions from Reasonably Foreseeable Projected 12-Month Projects Federal Fossil Fuel Production and Authorizations

BLM-Authorized	Direct Mt CO₂e/year	Indirect Mt CO₂e/year	Combustion Mt CO₂e/year	Total Mt CO₂e/year	Life-of-Project Mt CO₂e
Existing Federal Production					
Coal	0.19	0.01	1.50	1.71	1.71
Oil	15.21	11.01	82.95	109.17	734.60
Gas	5.92	15.03	56.92	77.87	707.07
Total	21.3	26.0	141.4	188.7	1,443.4
Permitted but Not Yet Developed Oil, Gas, and Coal Leases					
Coal	0.00	0.00	0.00	0.00	0.00
Oil	20.17	14.59	110.01	144.77	283.23
Gas	3.98	10.09	38.24	52.31	150.12
Total	24.1	24.7	148.3	197.1	433.4
Potential New Leases in the Next 12 Months					
Coal	0.00	0.00	0.00	0.00	0.00
Oil	3.00	2.17	16.38	21.55	42.16
Gas	0.59	1.50	5.69	7.78	22.34
Total	3.6	3.7	22.1	29.3	64.5
Total Projected Emissions By Mineral Type					
Coal	0.19	0.01	1.50	1.71	1.71
Oil	38.38	27.77	209.34	275.49	1059.99
Gas	10.49	26.62	100.85	137.96	879.53

BLM-Authorized	Direct Mt CO ₂ e/year	Indirect Mt CO ₂ e/year	Combustion Mt CO ₂ e/year	Total Mt CO ₂ e/year	Life-of-Project Mt CO ₂ e
Total	49.1	54.4	311.7	415.2	1,941.2

Sources: BLM (2023a).

14.2 COAL, OIL AND GAS PRODUCTION

Estimates of production (or downstream/end-use) GHG emissions are dependent on projected oil and gas production volumes. The BLM does not direct or regulate the end use of produced oil and/or gas. The challenge for estimating downstream emissions comes with understanding when and how oil and gas would be distributed and used for energy. It can be reasonably assumed that oil and gas produced on leases would be combusted primarily for electricity generation, transportation, industry, agriculture, commercial, and residential uses. From this assumption, the BLM provides potential GHG emissions estimates using currently available GHG emissions data. Tables 6-6, 6-9, and 6-11 of the BLM Specialist Report presents emissions for year 2022 from BLM coal, crude oil, and gas leasing authorizations, which are based on ONRR records of actual coal, oil, and gas production (BLM 2023a). Table 46 shows a summary of the ONRR production data from the BLM NMSO area of operation, total U.S. coal, oil, and gas production (federal and nonfederal) to illustrate the percentage of federal coal relative to the U.S. total (percent U.S. total) and the percentage of federal coal, oil, and gas that comes from the various federal producing states (percent federal). The percent total calculations are based on the 5-year average data column. The end-use phase emissions for coal, oil, and gas (assumed combustion) are estimated using EPA emissions factors from Tables C-1 and C-2 of 40 C.F.R. § 98, Subpart C, as shown in BLM Specialist Report Tables 6-2, 6-8, and 6-10 and ONRR production data.

Table 46. ONRR Production Data – Federal and State Coal, Oil, and Gas Production

Mineral (unit)	2018	2022	5-year Average	% Total	% Federal
Coal (tons)					
U.S. Total	756,167,095	594,585,532	633,985,504	100%	n/a
Federal Total	309,155,058	270,220,938	276,148,916	43.56%	100%
Kansas	0	0	0	0%	0%
New Mexico	1,792,186	2,217,007	2,184,749	0.34%	0.79%
Oklahoma	350,832	3,348	118,026	0.02%	0.04%
Texas	0	0	0	0%	0%
Oil (bbl)					
U.S. Total	3,997,971,000	4,337,716,000	4,216,108,800	100%	n/a
Federal Total	845,773,523	1,106,343,804	984,508,366	23.35%	100%
Onshore Total	224,937,918	478,226,183	343,818,145	8.15%	34.92%
Kansas	129,441	86,826	109,445	0%	0.01%
New Mexico	116,322,558	354,130,443	222,565,740	5.28%	22.61%
Oklahoma	624,315	706,947	645,043	0.02%	0.07%

Mineral (unit)	2018	2022	5-year Average	% Total	% Federal
Texas	463,508	165,295	323,383	0.01%	0.03%
Gas (Mcf)					
U.S. Total	37,325,539,000	43,378,280,000	40,752,782,800	100%	n/a
Federal Total	4,323,237,689	4,441,410,027	4,324,577,900	10.61%	100%
Onshore Total	3,331,459,200	3,626,318,224	3,407,905,419	8.36%	78.80%
Kansas	3,778,687	2,795,821	3,258,425	0.01%	0.08%
New Mexico	883,585,093	1,673,973,824	1,221,571,148	3.00%	28.20%
Oklahoma	15,472,528	11,312,381	14,062,407	0.03%	0.33%
Texas	27,643,840	43,173,374	31,324,792	0.08%	0.71%

Source: BLM (2023a).

Notes:

bbl = barrels.

Mcf = thousand cubic feet.

n/a = not available.

14.3 UNCERTAINTIES OF GREENHOUSE GAS CALCULATIONS

The BLM Specialist Report relies on life-cycle emissions estimates produced in part by the DOE National Energy Technology Laboratory (NETL). The life-cycle estimates produced by the BLM cover broad activities used to represent recovery and processing of federal minerals, including lease exploration, construction, well drilling and completion, production, processing, transportation, and end use. The BLM acknowledges that operational diversity, product variations, and broad geographic distribution of the federal mineral estate introduces some uncertainty into the simplifying assumptions and approximation methodologies used to estimate emissions for the BLM Specialist Report. For some of the current estimates, such as CO₂ emissions from energy-related combustion activities, the impact of uncertainties on overall emission estimates is believed to be relatively small. For some other limited categories of emissions, including the assumptions used to estimate production and project future emissions, the following uncertainties could have a larger impact on the estimates.

- The uncertainties inherent to the sourced LCA data, which are unavoidably propagated in the BLM estimates.
- Uncertainty in GWP factors, which may be up to ±40% and may change often due to updated scientific understanding.
- Unknowable factors about actual or future development localities, methodologies, and production rates.
- The exact nature of energy sources and amounts used in production, transportation, and processing systems.
- How the produced federal minerals are ultimately transformed and used.
- The overall energy density of the produced federal mineral estate (used in emissions calculations).

- The exact nature of any control technology that may be used at direct or indirect activity locations.

The best available data were used and presented for the emissions estimates in this report, and as new information becomes available, the BLM will continue to improve and revise its emission estimates, methodologies, and assumptions as appropriate. Ultimately, these estimates are subject to many influences that are largely beyond BLM practical control. Unforeseen changes in several factors such as geologic conditions, drilling technology, global and national economics, energy demand, geopolitical strife, and laws and policies enacted at the federal, state, and local level could result in different outcomes than those projected.

15 OIL AND GAS SINGLE-WELL GHG EMISSIONS

15.1 FIELD OFFICE

15.1.1 FARMINGTON FIELD OFFICE

The GHG single-well emission factors in Table 47 use the same methodology discussed in Section 7.1.1.

Table 47. BLM FFO Horizontal Single-Well GHG Emissions

Phase	Total Emissions (metric tons per year)			
	CO ₂	CH ₄	N ₂ O	CO ₂ e
Single-well construction/ development phase	1,607.50	0.66	0.013	1,630.72
Single-well operation phase	937.31	5.40	0.002	1,099.03
Single well total	2,544.81	6.06	0.015	2,729.75

Source: BLM Single Oil and Gas Well Emission Inventory Tool.

Max Emissions from Oil and Gas Scenarios - Single Well Emissions in the San Juan Basin

15.1.2 CARLSBAD FIELD OFFICE

The GHG single-well emission factors in Table 48 use the same methodology discussed in Section 7.1.2.

Table 48. BLM CFO Horizontal Single-Well GHG Emissions

Phase	Total Emissions (tons per year)			
	CO ₂	CH ₄	NH ₃	CO ₂ e
Single-well construction/ development phase	1,540.62	0.41	0.012	1,556.21
Single-well operation phase	329.04	1.28	0.002	367.66
Single well total	1,869.66	1.69	0.014	1,923.87

Source: BLM Single Oil and Gas Well Emission Inventory Tool.

15.1.3 OKLAHOMA FIELD OFFICE

The GHG single-well emission factors in Table 49 use the GHG Lease Sale Tool default emissions for a deep oil/high gas scenario.

Table 49. BLM OFO Horizontal Oil Single-Well GHG Emissions

Phase	Total Emissions (metric tons per year)			
	CO ₂	CH ₄	NH ₃	CO ₂ e
Single-well construction/ development phase	1,767.4	1.01	0.014	1,801.32
Single-well operation phase	1,113.7	16.86	0.003	1,616.95
Single well total	2,881.1	17.87	0.017	3,418.27

Source: BLM Single Oil and Gas Well Emission Inventory Tool.

16 GHG EMISSIONS AND PROJECTIONS FROM BLM-AUTHORIZED ACTIONS

The estimates presented here provides direct and indirect GHG emission estimates for the existing federal fossil fuel production. Existing emissions estimates show the GHGs emitted from the assumed consumption of each fossil fuel based on production statistics from the previous fiscal year for all producing wells and mines. The projected emissions include both short- and long-term estimates based on the methodologies discussed in Chapter 6 of the BLM Specialist Report.

16.1 SHORT TERM

Table 50 presents the emissions from coal production on the federal mineral estate in fiscal year (FY) 2022, which result from multiplying the representative emission factors from Tables 6-1, 6-3, and 6-4 in the BLM Specialist Report by the state-specific shipping and production data contained in Tables 6-5 and 6-6. The short-term emissions projections (12-month and life-of-project) from reasonably foreseeable coal production in the eight states where federal coal is presently being produced are also included in the BLM Specialist Report.

Table 51 shows the FY 2022 held-by-production emissions from oil production on the federal mineral estate. The emissions are calculated by multiplying the emission factors from Tables 6-8 of the BLM Specialist Report by the state-specific production amounts from emission factors Table 6-9 of the same report.

Table 52 shows the FY 2022 held-by-production emissions from gas production on the federal mineral estate. The emissions are calculated by multiplying the emission factors from Table 6-10 of the BLM Specialist Report by the state-specific production amounts from Table 6-11. The estimates presented here include emissions from the full oil and gas lifecycle, including emissions arising from activities outside of BLM jurisdiction (such as emissions associated with refining and processing).

Table 50. GHG Emissions from Coal Production on the Federal Mineral Estate in Fiscal Year 2022

Area	2022 Production (tons)	Extraction (Mt CO ₂ e)	Processing (Mt CO ₂ e)	Transport (Mt CO ₂ e)	Combustion (Mt CO ₂ e)	Total (Mt CO ₂ e)
U.S. Total	594,585,532	11.7728	N/A	21.4875	1,167.73	1,200.99
Federal Total (Onshore)	270,220,938	4.8034	1.3996	9.1646	475.79	491.15
Federal Total (Onshore and Offshore)	270,220,938	4.8034	1.3996	9.1646	475.79	491.15
New Mexico	2,217,007	0.5748	0.0814	0	5.2	5.85
Oklahoma	3,348	0.0009	0	0.0849	0.01	0.09
Kansas	N/A	N/A	N/A	N/A	N/A	N/A
Texas	N/A	N/A	N/A	N/A	N/A	N/A

Source: BLM (2023a), Chapter 7, Table 7-1.

Notes:

Mt CO₂e = metric tons carbon dioxide equivalent.

N/A – No data for these states.

Table 51. GHG Emissions from Oil Production on the Federal Mineral Estate in Fiscal Year 2022

Area	Production (bbl)	Extraction (Mt CO ₂ e)	Processing (Mt CO ₂ e)	Transport (Mt CO ₂ e)	Combustion (Mt CO ₂ e)	Total (Mt CO ₂ e)
U.S. Total	4,337,716,000	319.9808	220.3434	43.6504	1,880.41	2,464.38
Federal Total (Onshore)	478,226,183	35.2774	24.2925	4.8124	207.31	271.69
Federal Total (Onshore and Offshore)	1,106,343,804	55.7236	56.199	11.1331	479.6	602.66
New Mexico	354,130,443	26.1232	17.9888	3.5636	153.52	201.19
Oklahoma	706,947	0.0521	0.0359	0.0071	0.31	0.4
Kansas	86,826	0.0064	0.0044	0.0009	0.04	0.05
Texas	165,295	0.0122	0.0084	0.0017	0.07	0.09

Source: BLM (2023a), Chapter 7, Table 7-4.

Table 52. GHG Emissions from Gas Production on the Federal Mineral Estate in Fiscal Year 2022

Area	Production (Mcf)	Extraction (Mt CO ₂ e)	Processing (Mt CO ₂ e)	Transport (Mt CO ₂ e)	Combustion (Mt CO ₂ e)	Total (Mt CO ₂ e)
U.S. Total	43,378,280,000	245.8639	84.0267	540.195	2,364.04	3,234.12
Federal Total (Onshore)	3,626,318,224	20.5536	7.0244	45.159	197.63	270.36

Area	Production (Mcf)	Extraction (Mt CO ₂ e)	Processing (Mt CO ₂ e)	Transport (Mt CO ₂ e)	Combustion (Mt CO ₂ e)	Total (Mt CO ₂ e)
Federal Total (Onshore and Offshore)	4,441,410,027	25.2504	8.6033	55.3094	242.05	331.21
New Mexico	1,673,973,824	9.4879	3.2426	20.8462	91.23	124.81
Oklahoma	11,312,381	0.0641	0.0219	0.1409	0.62	0.84
Kansas	2,795,821	0.0158	0.0054	0.0348	0.15	0.21
Texas	43,173,374	0.2447	0.0836	0.5376	2.35	3.22

Source: BLM (2023a), Chapter 7, Table 7-11.

Notes:

Mcf = thousand cubic feet.

Mt CO₂e = metric tons carbon dioxide equivalent.

The emissions from oil and gas projected APD approvals and leasing within the next 12-months on both a maximum annual and life-of-project basis are also included in the BLM Specialist Report. Figure 27 through Figure 30 shows an annualized timeline of the projected short-term life-of-project CO₂e emissions from existing producing wells and projected wells from new APDs and Leasing (12-months)) for each state within the BLM NMSO area of operation. Figure 31 shows the same the cumulative sum of all the state series (i.e., the federal sum) is displayed in the BLM Specialist Report Table 7-18. The long-term emissions estimates presented in presented in the BLM Specialist Report Figure 7-2 and Table 7-18 are based on the EIA AEO reference case. The BLM Specialist 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 14.24% of total U.S. GHG emissions (reference case).

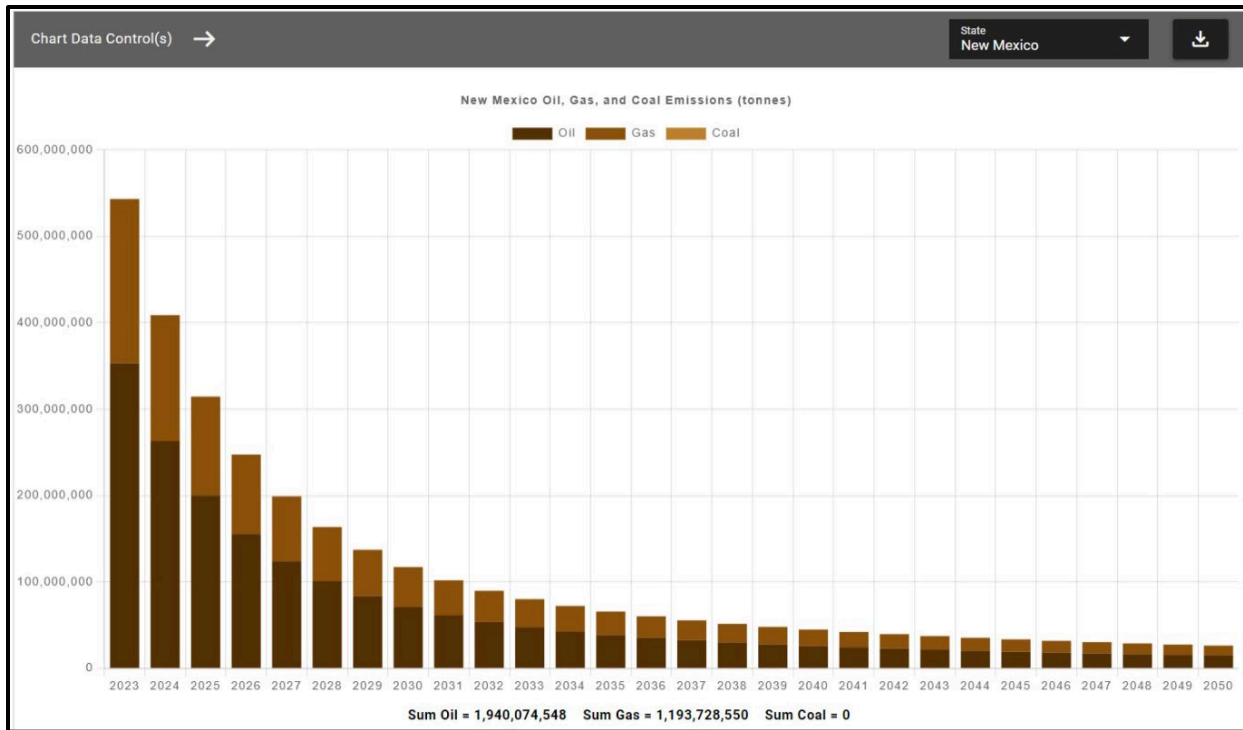


Figure 27. Projected New Mexico oil, gas, and coal CO₂e emissions (metric tons) (BLM 2023a).

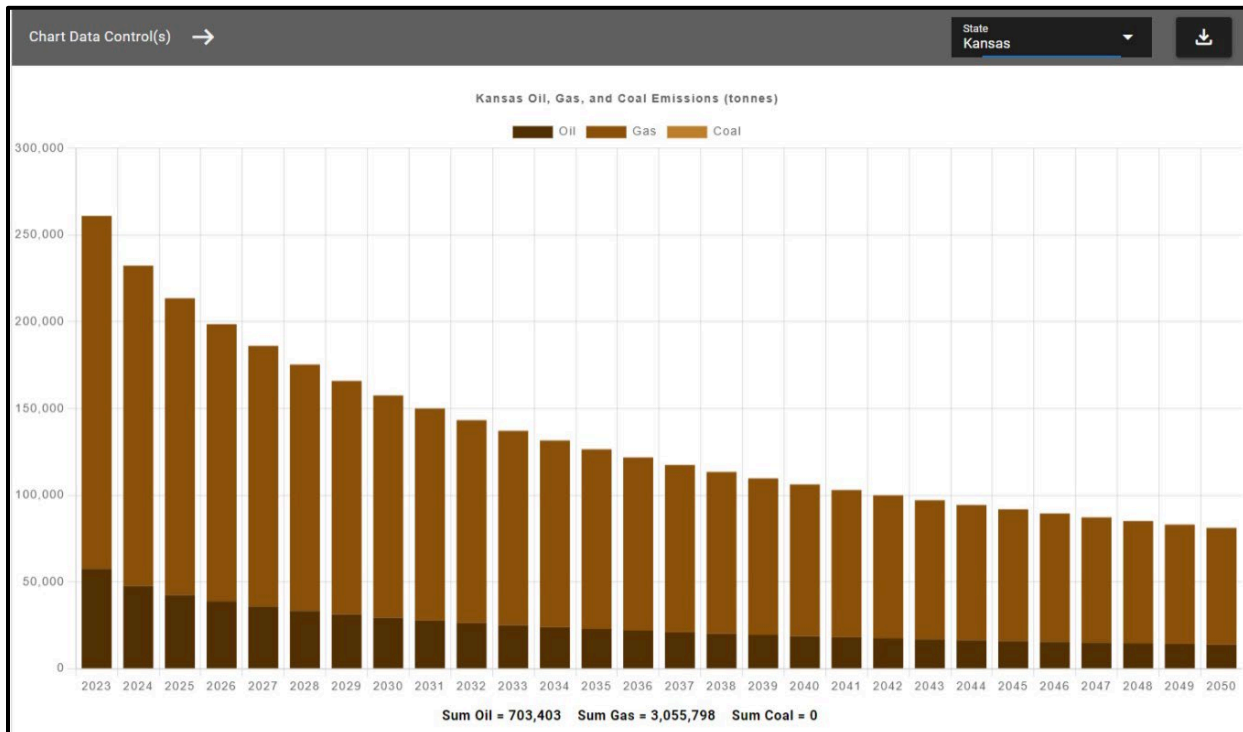


Figure 28. Projected Kansas oil, gas, and coal CO₂e emissions (metric tons) (BLM 2023a).

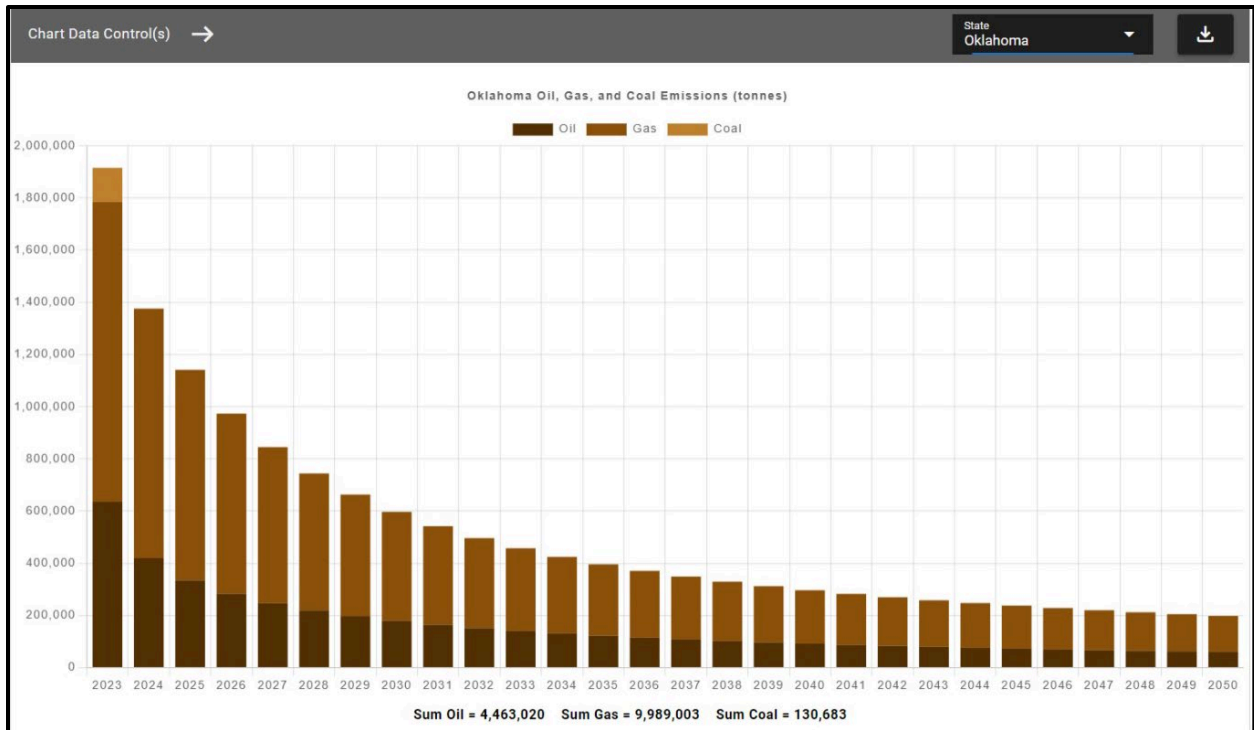


Figure 29. Projected Oklahoma oil, gas, and coal CO₂e emissions (metric tons) (BLM 2023a).

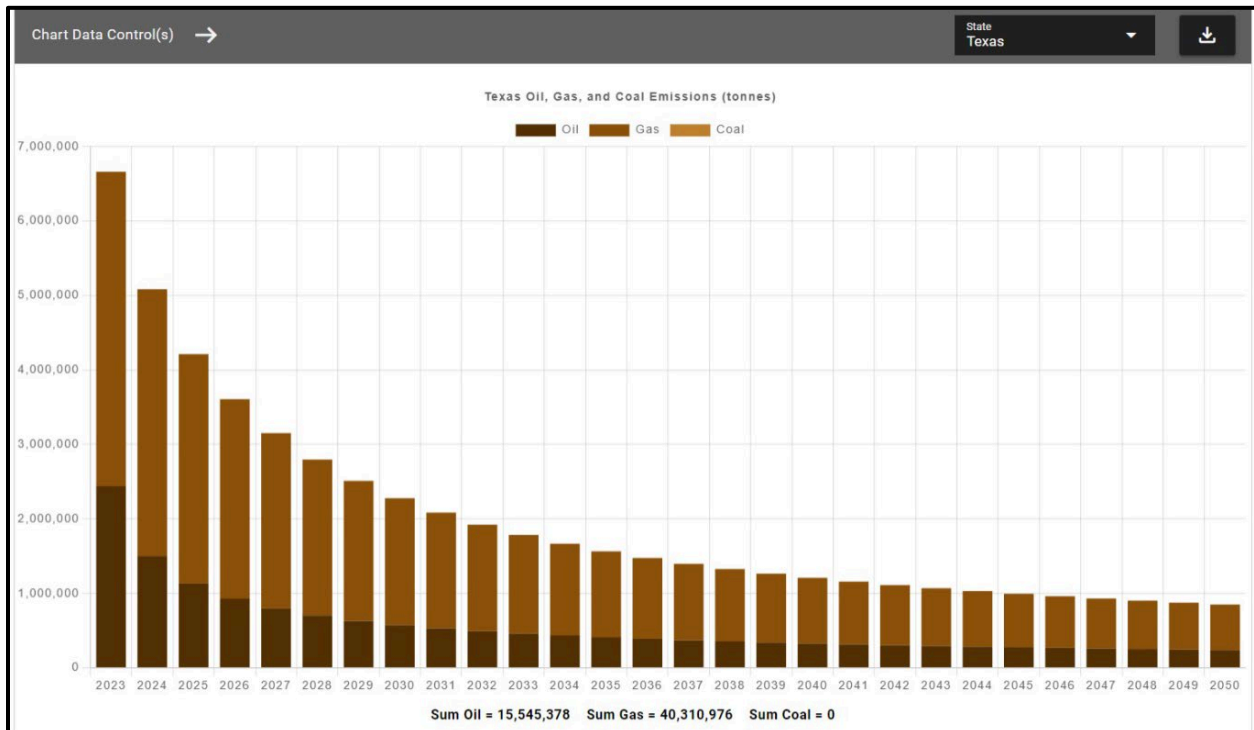


Figure 30. Projected Texas oil, gas, and coal CO₂e emissions (metric tons) (BLM 2023a).

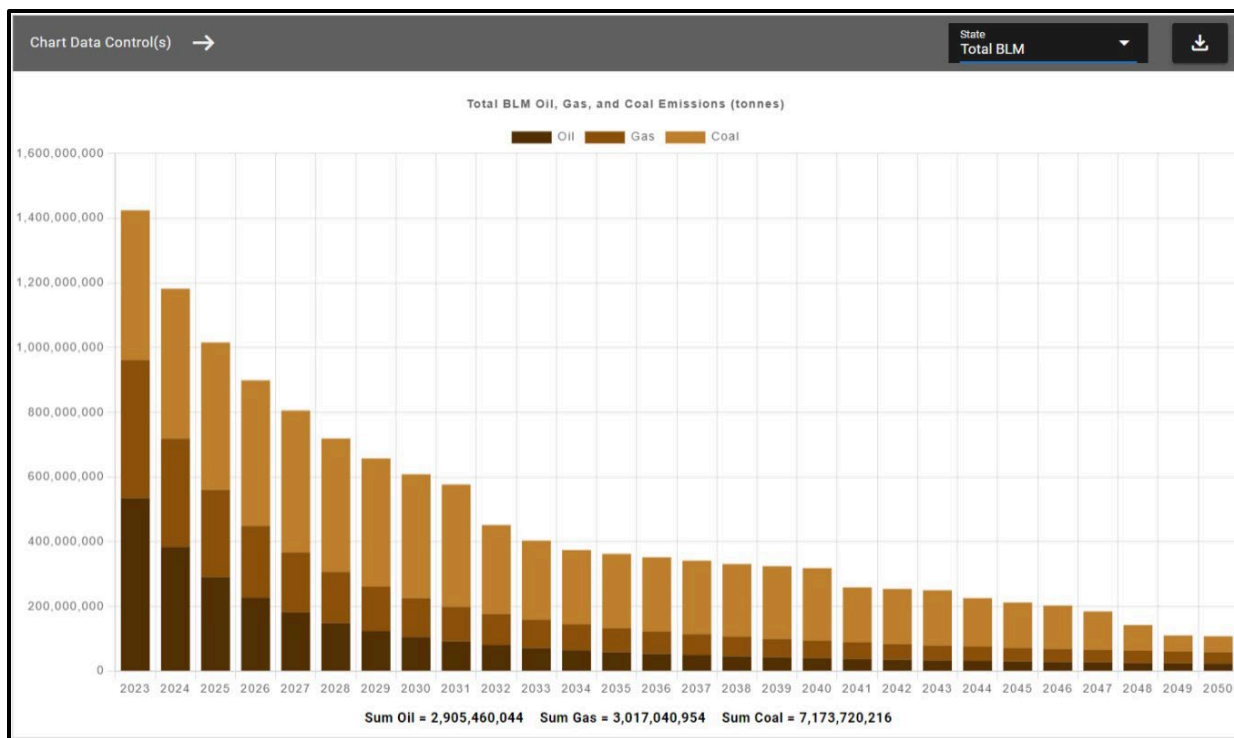


Figure 31. Projected total BLM oil, gas, and coal CO₂e emissions (metric tons) (BLM 2023a).

16.2 LONG-TERM PROJECTED TRENDS

The BLM Specialist Report also discusses long-term projected annual trends in federal fossil fuel production, energy values, and GHG emissions to year 2050 based on data obtained from the EIA AEO report (EIA 2021). The AEO does not delineate production on a federal and nonfederal basis (it only provides total U.S. production), and thus the BLM uses a 5-year average of actual federal production to provide a ratio from which to base the federal portion of future production forecasts. The projections are made by multiplying each year of data from the AEO report by the most current 5-year averages of federal production divided by the 5-year averages of total U.S. production for each fossil fuel mineral type. The long-term emissions estimates presented in Figure 7-2 and Table 7-19 of the BLM Specialist Report are based on EIA AEO 2023 data. For the 2023 AEO, the high oil price scenario produces the highest emissions. The low oil and gas supply case produces the lowest projected emissions, which is slightly counterintuitive considering that the low renewables cost case would be expected to produce fewer emissions overall (second lowest scenario). Areas with higher levels of coal production could see higher emissions in a low oil and gas supply scenario, as increased coal production takes up the energy slack from lower available oil and gas supplies. The BLM Specialist Report provides access to most of the AEO cases, as these explore a variety of market conditions including varying production, price, and overall economic growth rates and the AEO scenario selection controls in Figure 7-2 of the BLM Specialist Report can be used to view the projected emissions from federal fossil fuel production. Table 7-19 of the BLM Specialist Report provides the long-term cumulative sums of production, energy values, and GHG emissions projected out to year 2050 for the AEO reference case. At the national level, these long-term projections estimate that there will be emissions of 16,523 Mt CO₂e from federal oil and gas combined, and 24,508 Mt CO₂e from all federal fossil fuel minerals (oil, gas, and coal) (see Table

53). GHG emissions for future projections for all growth scenarios is available in the BLM Specialist Report (BLM 2023a).

Table 53. Estimated Projected or “Long-Term” Oil and Gas GHG Emissions from Federal Leases

Area	Oil (Mt CO ₂ e per year)	Gas (Mt CO ₂ e per year)	Coal (Mt CO ₂ e per year)	Total (Mt CO ₂ e per year)
BLM Total	8,371	8,152	7,985	24,508
New Mexico	6,199	3,763	95	10,057
Oklahoma	12	25	2	39
Kansas	2	6	-	8
Texas	3	97	-	100

Source: BLM (2023a), Chapter 5.

The projections made from the 2023 AEO data show that fossil fuel mineral development on federal land accounts for approximately 14.24% of total U.S. GHG emissions (reference case). The difference in federal emissions on an absolute basis between the high and low AEO projection scenarios is approximately 3,647.87 Mt CO₂e over the entirety of the projection period, or about 130.28 Mt CO₂e on an annual average basis. The difference (or delta) between the cumulative 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 production over the longer term. Similarly, if the short-term emissions exceed a longer-term scenario, then the delta can be thought of as the amount of reduction required to attain the outlook forecast. In all cases, the EIA clearly explains that the AEO scenario projections are not predictions of what will happen, but rather they are modeled projections of what may happen given certain assumptions (BLM 2023a).

17 GHG EMISSIONS ANALYSIS

17.1 CLIMATE IMPACT MODELING

Section 9.3 of the BLM Specialist Report discusses the BLM use of reduced complexity climate models (RCMs) for the purposes of obtaining potential gross scale (e.g., perturbations from global climatic means) earth system responses that could be attributable to the federal decision scope over which the BLM has purview. Currently, the IPCC uses coupled Earth System Models (ESMs), which are the state of the science in coupled Earth system modeling as the primary climate research tool. However, these classes of climate models are computationally intensive, making such models infeasible to assess hundreds to thousands of emissions scenarios. Therefore, RCMs could potentially be used to analyze such emissions to assess potential basic earth system responses that could be attributable to BLM-authorized GHG increases. Although this application is consistent with the policy analysis nature of this class of climate models, RCMs do not produce sufficiently resolved temporal or spatial information that would be necessary to project earth system responses for specific subannual temporal ranges and specific geographic areas for a given emissions scenario.

Section 9.1 of the BLM Specialist Report further discusses the MAGICC as a potential resource as it offers detailed documentation and baseline scenario emissions input files that are easily modified to suit BLM

needs. The BLM Specialist Report uses the projected emissions for each of the long term onshore federal mineral emissions for 12 AEO cases (Figure 7-2 of the BLM Specialist Report) and conducted MAGICC runs evaluating potential contributions to global climate change and related values for the SSP119 and SSP245 climate change projection scenarios. These two scenarios were chosen because they most closely approximate or frame the desired outcomes of the Paris Climate Accord and would also reflect the greatest contribution as a percent of BLM-authorized cumulative emissions relative to the global emissions levels contained in the SSP scenarios (should provide for a conservative contribution analysis). MAGICC modeling was completed for two federal mineral emissions source groups separately, oil and gas and oil, gas, and coal. Section 9.1 of the BLM Specialist Report provides additional information regarding the SSP119 and SSP245 base scenarios and other assumptions used for the MAGICC modeling.

The MAGICC results and baseline scenarios results are used to determine the overall federal contribution from each AEO scenario run. Section 9.1 of the BLM Specialist Report present in detail the "high oil price" and "low oil and gas supply" potential impacts.

In summary, for the SSP119 scenario, the projected federal minerals emissions under each AEO scenario would make up a larger portion of the SSP119 global levels by year 2050 as compared to early years (e.g., 2030) because they would not follow the same global trends of reductions towards net-zero. Under the AEO "high oil price" scenario, federal mineral (oil, gas, and coal) CO₂ emissions are projected to make up approximately 30% of the total global CO₂ levels in year 2050. Whereas in the SSP245 scenario, projected federal mineral (oil, gas and coal) CO₂ emissions under the AEO "high oil price" scenario are projected to make up around only 2% of the total global CO₂ emissions level in 2050. For the SSP245 scenario, projected federal minerals emissions under each AEO scenario would constitute a similar percentage of the global emissions levels for all future years through 2050. The AEO "low oil and gas supply" scenario has the lowest projected federal fossil fuel GHG emissions levels and under this scenario would constitute approximately 22% and 1.5% of the SSP119 and SSP245 year 2050 global CO₂ emissions levels, respectively. Tables 9-3 and 9-4 of the BLM Specialist Report present the MAGICC modeling results for each baseline scenario (SSP119 and SSP245 – no changes to the modeling inputs) and for the modified AEO "high oil price" case (scenario with the highest predicted federal mineral emissions and global climate change impacts), and the AEO "low oil and gas supply" case (scenario with lowest predicted federal fossil fuel emissions and global climate change impacts). The model results show that regardless of the global climate change projection scenario (SSP119 or SSP245) and the pathway that federal fossil fuels emissions follow, federal minerals emissions are predicted to have minimal impacts to future global climate change through the end of the century (BLM 2023a).

17.2 NATURAL GAS SYSTEMS AND PETROLEUM SYSTEMS

Within the fossil fuel combustion sector in 2021, the contribution by fuel type shows that petroleum represents 44.4% of the fuel type, natural gas 34.9%, and coal 20.6% as shown in Figure 5-4 of the BLM Specialist Report (BLM 2023a).

The EPA Inventory of U.S. Greenhouse Gas Emissions and Sinks (2023bb) describes "Natural Gas Systems" and "Petroleum Systems" as two of the major sources of U.S. GHG emissions. The inventory identifies the major contributions of natural gas and petroleum systems as total CO₂ and CH₄ emissions. Natural gas and petroleum systems do not produce noteworthy amounts of any other GHGs.

Within the category of "Natural Gas Systems," the EPA identifies emissions occurring during distinct stages of operation, including field production, processing, transmission and storage, and distribution.

“Petroleum Systems” sub-activities include production field operations, crude oil transportation and crude oil refining. Within Natural Gas Systems and Petroleum Systems, the BLM has authority to regulate those field production operations that are related to oil and gas measurement and prevention of waste (via leaks, spills, and unauthorized flaring and venting).

Total GHG emissions (CH₄, CO₂, and N₂O) from natural gas systems in 2021 were 217.5 Mt CO₂e, a decrease of 12% from 1990, primarily due to decreases in CH₄ emissions, and a decrease of 2% from 2020, both primarily due to decreases in CH₄ emissions. Of the overall GHG emissions (217.5 Mt CO₂e), 83% is CH₄ emissions as expressed as CO₂e (181.4 Mt CO₂e), 17% is CO₂ emissions (36.2 Mt), and less than 0.01% is N₂O emissions as expressed as CO₂e (0.01 Mt CO₂e) (BLM 2023a).

CH₄ and CO₂ emissions from natural gas systems include those resulting from normal operations, routine maintenance, and system upsets. Emissions from normal operations include natural gas engine and turbine uncombusted exhaust, flaring, and leak emissions from system components. Routine maintenance emissions originate from pipelines, equipment, and wells during repair and maintenance activities. Pressure surge relief systems and accidents can lead to system upset emissions. In the EPA reported data, emissions of N₂O from flaring activities are included, with most of the emissions occurring in the processing and production segments. Note that in the EPA reported data, CO₂ emissions exclude all combustion emissions (e.g., engine combustion) except for flaring CO₂ emissions.

Section 3.7 of the EPA Inventory of U.S. Greenhouse Gas Emissions and Sinks provides a characterization of the six emission subcategories of natural gas systems: exploration, production (including gathering and boosting), processing, transmission and storage, distribution, and post-meter (EPA 2023bb). Each of the segments is described, and the different factors affecting CH₄, CO₂, and N₂O emissions are discussed.

Total GHG emissions (CH₄, CO₂, and N₂O) from petroleum systems in 2021 were 74.9 Mt CO₂e, an increase of 23% from 1990, primarily due to increases in CO₂ emissions. Since 2020, total emissions from petroleum systems increased by 10%. Of the overall GHG emissions (74.9 Mt CO₂e), 24.7 Mt are CO₂ emissions, 50.2 Mt CO₂e are from CH₄ emissions, and 0.02 Mt CO₂e (0.08 kt N₂O) are from N₂O emissions from petroleum systems in 2021. U.S. oil production decreased by 1% from 2020 to 2021 (BLM 2023a).

CH₄ emissions from petroleum systems are primarily associated with onshore and offshore crude oil production, transportation, and refining operations. During these activities, CH₄ is released to the atmosphere as emissions from leaks, venting (including emissions from operational upsets), and flaring. CO₂ emissions from petroleum systems are primarily associated with crude oil production and refining operations. Note that in the EPA reported data, CO₂ in the petroleum systems emissions exclude all combustion emissions (e.g., engine combustion) except for flaring CO₂ emissions. All combustion CO₂ emissions (except for flaring) are accounted for in the fossil fuel combustion category. Emissions of N₂O from petroleum systems are primarily associated with flaring.

Section 3.6 of the GHG Annual Sinks provides a characterization of the four emission subcategories of petroleum systems: exploration, production (including well drilling, testing, and completion), production, crude oil transportation, and crude oil refining. Each of the segments is described and the different factors affecting CH₄, CO₂, and N₂O emissions are discussed.

Table 54 displays GHG emissions (CO₂, CH₄, and N₂O) related to natural gas systems, petroleum systems, and coal mining; CO₂ emissions listed represent CO₂ emissions that are not otherwise captured in the “fossil fuel combustion” category. The natural gas and petroleum subsectors are the stages of production outlined in the table below.

Table 54. 2021 GHG Emissions for Oil and Gas Subsectors and Coal Mining

Sector	Subsector	2021 GHG Emissions (Mt CO ₂ e)				% of U.S. Total GHGs
		CO ₂	CH ₄ ⁽¹⁾	N ₂ O	Total GHGs	
U.S. Total		5,032.3	727.4	393.3	5,586.0***	100%
Natural Gas Systems	Total	36.2	181.4	0.007	217.5	3.89%
	Exploration ⁽²⁾	**	0.2	0.00001	0.2	0.004%
	Production field operations	9.1	94.1	0.003	103.2	1.85%
	Onshore production	NE	50.0	NE	NE	NE
	Offshore production	NE	0.7	NE	NE	NE
	Gathering and boosting ⁽³⁾	NE	43.4	NE	NE	NE
	Processing	26.1	14.3	0.004	40.4	0.72%
	Transmission and storage	0.9	44.5	0.0004	45.4	0.81%
	Post-meter	**	13.0	NO	13.0	0.23%
	Distribution	**	15.3	NO	15.5	0.28%
Petroleum systems	Total	24.7	50.2	0.02	74.9	1.34%
	Exploration ⁽²⁾	0.5	0.2	0.0002	0.6	0.01%
	Production field operations	20.0	48.9	0.01	68.9	1.23%
	Crude oil transportation	**	0.2	NE	0.2	0.004%
	Crude refining	4.2	0.8	0.011	5.1	0.09%
Coal mining	–	2.5	51.1+	*	47.1	0.84%

Source: EPA (2023bb), Table 2-1.

* Indicates values less than 0.1 teragram (Tg) CO₂e.

** Indicates values that do not exceed 0.05 Tg CO₂e.

*** Indicates that the total U.S. GHG emissions value includes U.S. emissions of four additional minor classes of GHGs not listed here (HFC, PFCs, SF₆, and NF₃).

NE = Not estimated; NO = Not occurring.

+ Includes data from abandoned coal mines.

⁽¹⁾ These values represent CH₄ emitted to the atmosphere. CH₄ that is captured, flared, or otherwise controlled (and not emitted to the atmosphere) has been calculated and removed from emission totals.

⁽²⁾ Exploration includes well drilling, testing, and completions.

⁽³⁾ Gathering and boosting includes gathering and boosting station routine vented and leak sources, gathering pipeline leaks and blowdowns, and gathering and boosting station episodic events.

In summary, CO₂ is produced during the burning of fossil fuels to run internal combustion engines that may be used in drilling, transportation, pumping, and compression. CO₂ may be a significant component of natural gas, especially coal-bed CH₄, and is vented during field operations or processing. CO₂ is also used in enhanced oil production processes and may be released or escape to the atmosphere during those processes. CH₄ is the primary component of natural gas and is released to the atmosphere during

both oil and gas production either intentionally during production when it cannot be captured, or accidentally through leaks and fugitive emissions.

Emissions from production (including gathering and boosting) accounted for 52% of CH₄ emissions and 25% of CO₂ emissions from natural gas systems in 2021. Emissions from gathering and boosting and pneumatic controllers in onshore production accounted for most of the production segment CH₄ emissions in 2021. Within gathering and boosting, the largest sources of CH₄ are compressor exhaust slip, compressor venting and leaks, and tanks. Flaring emissions account for most of the CO₂ emissions from production, with the highest emissions coming from flare stacks at gathering stations, miscellaneous onshore production flaring, and tank flaring. CH₄ emissions from production increased by 45% from 1990 to 2021, due primarily to increases in emissions from pneumatic controllers (due to an increase in the number of controllers, particularly in the number of intermittent bleed controllers) and increases in emissions from compressor exhaust slip in gathering and boosting. CH₄ emissions decreased 3% from 2020 to 2021 due to decreases in emissions from pneumatic controllers and liquids unloading. CO₂ emissions from production increased by approximately a factor of 2.7 from 1990 to 2021 due to increases in emissions at flare stacks in gathering and boosting and miscellaneous onshore production flaring and increased 3% from 2020 to 2021 due primarily to increases in emissions from tanks and acid gas removal units at gathering and boosting stations. N₂O emissions decreased by 24% from 1990 to 2021 and decreased 12% from 2020 to 2021. The decrease in N₂O emissions from 1990 to 2021 and from 2020 to 2021 is primarily due to decreases in emissions from flaring at gathering and boosting stations (EPA 2023bb).

Production emissions account for 81% of the total CO₂ emissions (including leaks, vents, and flaring) from petroleum systems in 2021. The principal sources of CO₂ emissions are associated gas flaring, miscellaneous production flaring, and oil tanks with flares. In 2021, these three sources together accounted for 97% of the CO₂ emissions from production. In 2021, CO₂ emissions from production were 3.4 times higher than in 1990, due to increases in flaring emissions from associated gas flaring, miscellaneous production flaring, and tanks. Overall, in 2021, production segment CO₂ emissions decreased by 17% from 2020 levels primarily due to decreases in associated gas flaring and miscellaneous production flaring in the Permian and Williston Basins. Production emissions accounted for 48% of the total N₂O emissions from petroleum systems in 2021. The principal sources of N₂O emissions are associated gas flaring, oil tanks with flares, miscellaneous production flaring, and offshore flaring. In 2021, N₂O emissions from production were 115% higher than in 1990 and were 51% lower than in 2020 (EPA 2023bb).

Distribution system CH₄ emissions in 2021 were 70% lower than 1990 levels and 1% lower than 2020 emissions. Distribution system CO₂ emissions in 2021 were 70% lower than 1990 levels and 1% lower than 2020 emissions. Annual CO₂ emissions from this segment are less than 0.1 Mt CO₂e across the time series. CH₄ emissions from the post-meter segment accounted for approximately 7% of emissions from natural gas systems in 2021. Post-meter CH₄ emissions increased by 60% from 1990 to 2021 and increased by less than 1% from 2020 to 2021, due to increases in the number of residential houses using natural gas and increased natural gas consumption at industrial facilities and power plants. CO₂ emissions from post-meter account for less than 0.01% of total CO₂ emissions from natural gas systems.

18 MITIGATION

Section 10.0 of the BLM Specialist Report discusses various forms of mitigation, including controlling (best management practices [BMPs]), preventing emissions, and offsetting emissions. The reduction of

air pollutant and GHG emissions from oil and gas operations has been the subject of much study and discussion in recent years.

The BLM decision space for mitigating climate impacts from fossil fuel development is currently limited by authorization in statutes such as FLPMA and MLA. Therefore, the BLM has a limited ability to provide meaningful or measurable mitigation actions in the context of climate change resulting from cumulative global emissions. The direct emissions resulting from the development of the federal mineral estate represent a small percentage of the U.S. and global emissions, just 1.09% and 0.12% respectively (BLM 2023a). No single authorized project-level action can produce emissions with such significance that the action could be perceived as influencing the climate. The BLM has developed BMPs designed to reduce emissions from field production and operations for on-lease activities.

In addition to controlling or preventing emissions, strategies to offset emissions could be used to align BLM decision-making with the goal of achieving net-zero emissions by 2050. The following are potential offset strategies discussed in more detail in Section 10 of the BLM Specialist Report.

- Carbon Sequestration – In 2018, the USGS produced a report (Merrill et al. 2018) estimating GHG emissions and sequestration on federal lands from 2005 to 2014. The report provides net ecosystem productivity (NEP) factors for all federal lands in the United States. NEP is the amount of CO₂ converted to fixed carbon by the terrestrial ecosystem and is the product of CO₂ converted to carbon through photosynthesis minus the release of CO₂ back into the atmosphere from plant respiration and the decomposition of dead organic matter. The report also provided details on land use changes and land cover changes (LULC), which are typically brought on by wildfires, harvest, and general land development (BLM 2023a).
- Plugging Orphaned and Abandoned Wells – Plugging abandoned wells that are not expected to be used again could reduce the overall emissions from federal lands. The Infrastructure Investment and Jobs Act was signed into law on November 15, 2021, and established the Orphaned Well Site Plugging, Remediation, and Restoration Program (Public Law 117-58, Section 40601). The unplugged wells with the highest GHG emissions are found in the eastern U.S., with a mean emissions rate of 6.87 t CO₂e/year/well. Wells on federal land that are predominately in the western United States have a mean emissions rate of 0.42 t CO₂e/year/well, which is 6% of the emissions of an unplugged well in the eastern United States (BLM 2023a).
- Energy Substitution – Overall, GHG emissions could be reduced if production and consumption of energy from fossil fuels were displaced by lower emitting forms of energy. Energy markets are complex, and the net effects of production changes in one location or one sector are affected by multiple factors in the broader energy market. In general, reductions in oil and natural gas produced from federal leases may be partially offset by nonfederal production (state and private) in the United States, in which the indirect GHG emissions would be similar, or by overseas production, in which case the GHG emissions would likely be higher, as there are generally less regulatory requirements for production and the produced fuels would need to be physically transported into the United States. There may also be substitution of other energy resources to meet energy demand. These substitution patterns will be different for different fuel types. The effect of substitution between different fuel sources on indirect GHG emissions depends on the replacement energy source (BLM 2023a).
- Carbon Capture – The Carbon Storage Project was implemented to develop carbon sequestration methodologies for geological (i.e., underground) and biological (e.g., forests and

rangelands) carbon storage to enhance carbon storage in geologic formations and in plants and soils in an environmentally responsible manner. The BLM recently issued policy regarding geologic carbon storage on public lands, as part of a comprehensive strategy to combat climate change and reduce CO₂ levels in the atmosphere. Additionally, the BLM is presently processing a right-of-way grant (Standard Form [SF]-299) for a project in the BLM CFO with a design capacity to sequester approximately 409.5 Mt CO₂, and a plan of development (POD) submitted for two injection wells that would sequester up to 750,000 t of CO₂ per year at a rate of 39.4 million cubic feet per day (MMcfd). Other projects will likely follow. Another form of carbon capture includes recovering and using coal mine methane (CMM), which includes the recovery of CH₄ that would otherwise be released from a coal seam and leak into the atmosphere (BLM 2023a).

- **Compensatory Mitigation** – Compensatory mitigation is the process of offsetting adverse impacts by replacing or substituting the affected resource or environment through a proponent’s offsite actions, monetary payments, or in-kind contributions. Some examples of compensatory mitigation for GHG emissions include plugging orphaned and abandoned wells, purchasing carbon offsets, or supporting land improvement projects that maximize carbon sequestration (BLM 2023a).

Much of the current policy on mitigating emissions in the United States comes from individual states and municipalities, as well as market forcing that results when institutions move assets and future investments away from fossil fuel projects (BLM 2023a).

The EPA Natural Gas STAR Program established in 1993 has been a leader in developing and analyzing strategies to reduce CH₄ emissions (EPA 2022b). These reductions can help to control not only GHGs but also VOCs, which contribute to O₃ formation. Numerous opportunities for emissions reduction, including funds to assist with implementation, are documented on the EPA Natural Gas STAR website. Each year, partners submit annual reports documenting their previous year’s CH₄ emission reduction activities. Since the inception of the program cumulative through 2020, partners have eliminated 1.72 trillion cubic feet of CH₄ emissions by implementing 150 cost-effective technologies and practices.

In 2015, EPA Natural Gas STAR partner companies operated 51% of the active federal wells in the New Mexico portion of the San Juan Basin and 13% of the active federal wells in the New Mexico portion of the Permian Basin. In addition, Natural Gas STAR partner companies operated 5%, 11%, and 33% of the active federal wells in Kansas, Oklahoma, and Texas, respectively (BLM 2014b). The EPA has found Natural Gas STAR partner actions to result in measurable decreases in GHG emissions since the program’s implementation. In October 2012, the EPA promulgated air quality regulations controlling VOC emissions at hydraulically fractured gas wells. These rules require air pollution mitigation measures that reduce the emissions of VOCs. These same mitigation measures have a co-benefit of reducing CH₄ emissions.

The Natural Gas STAR Methane Challenge Program is a voluntary program founded by the EPA in collaboration with oil and natural gas companies. The program recognizes companies that make specific and transparent commitments to reduce CH₄ emissions. More than 60 companies from all segments of the industry—production, gathering and boosting, transmission and storage, and distribution—are now program partners.

The BLM has two infrared cameras that are being used to detect leaks and fugitive emissions. BLM inspectors carry these cameras into the field and have been able to alert operators of equipment

requiring repair or maintenance. At this time, the cameras are being used in an advisory rather than a regulatory role.

Cumulatively, it is expected that future levels of criteria pollutant, VOC, HAP, and GHG emissions related to oil and gas operations would be lower than current levels due to the aforementioned factors. However, there will be increases in emissions associated with reasonably foreseeable oil and gas development and future potential development of leases.

Although it is beyond the scope of this report to detail the wide range of mitigation strategies available, it must be noted that, for the most part, these strategies must be applied on a case-by-case basis at the project level.

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20 APPENDICES

20.1 APPENDIX A NATIONAL EMISSIONS INVENTORY (NEI)

20.2 APPENDIX B AIRTOXSCREEN RESULTS

20.3 APPENDIX C CLIMATE NORMALS, WIND ROSES, AND TRENDS

20.4 APPENDIX D MAJOR SOURCES (NEI)