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Bureau of Land Management - Farmington Field Office
Bureau of Indian Affairs - Navajo Regional Office

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Farmington Mancos-Gallup 2020 Environmental Consequences Supplemental Report

MISSION STATEMENTS

BLM

It is the mission of the Bureau of Land Management to sustain the health, diversity, and productivity of the public lands for the use and enjoyment of present and future generations.

BIA

The Bureau of Indian Affairs' mission is to enhance the quality of life, to promote economic opportunity, and to carry out the responsibility to protect and improve the trust assets of American Indians, Indian tribes, and Alaska Natives.

Cover Photo: View of Angel Peak Scenic Area. Photo taken by EMPSi.

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Farmington Mancos-Gallup 2020 Environmental Consequences Supplemental Report

EC.1 INTRODUCTION

This supplemental report presents the analysis methodology and nature of impacts that were develop to analyze the likely direct, indirect, and cumulative impacts, as presented in Chapter 3 of the Farmington Mancos-Gallup (FMG) Resource Management Plan Amendment/Environmental Impact Statement (RMPA/EIS) (the FMG RMPA/EIS).

This report is organized by resource topic. Unless otherwise noted, all references to chapters and appendices are referring to chapters in the FMG RMPA/EIS.

EC.1.1 Analytical Assumptions

Several assumptions were made to facilitate the analysis of the projected impacts. These assumptions set guidelines and provide reasonably foreseeable projected levels of development that would occur in the Farmington Mancos-Gallup planning area during the planning period. These assumptions should not be interpreted as constraining or redefining the management objectives and actions proposed for each alternative, as described in **Chapter 2** of the FMG RMPA/EIS.

The following general assumptions apply to all resource categories. Any specific resource assumptions are provided in the methods of analysis section for that resource.

- Implementing actions from any of the FMG RMPA/EIS alternatives will be in compliance with all valid existing rights, federal regulations, BLM policies, BIA policies, and other requirements.
- Implementation-level actions necessary to execute the land use plan-level decisions in the FMG RMPA/EIS will be subject to further environmental review, including the National Environmental Policy Act of 1969 (NEPA), as appropriate. The FMG RMPA/EIS may support future implementation decisions, such as issuing leases for fluid minerals (oil and gas).
- Restrictions on land use authorizations are identified for right-of-way (ROW) avoidance or ROW exclusion areas. Because the BLM does not have jurisdiction over non-BLM surface for land use authorizations, ROW avoidance and ROW exclusion restrictions apply only to the 1,290,400 acres of BLM-administered surface in the decision area.
- Administrative access includes motorized wheeled cross-country travel for lessees and permittees that is limited to the administration of a federal lease or permit. Persons or corporations having such a permit or lease could perform administrative functions on public lands in the scope of the permit or lease; however, this would not preclude modifying permits or leases to limit motorized wheeled cross-country travel during further site-specific analysis to meet resource management objectives or standards and guidelines, as outlined in the 2003 RMP (BLM 2003).
- Oil and gas drilling techniques could include vertical and horizontal drilling and the use of hydraulic fracturing.
- Direct impacts of implementing the FMG RMPA/EIS will primarily occur on the surface lands and minerals administered by the BLM and BIA; however, indirect impacts may occur at a broader scale due to the scattered landownership in the planning area.
- In the future, as tools for predicting climate change in a management area improve and climate change affects resources and necessitates changes in how resources are managed, the BLM and BIA

may reevaluate decisions made as part of this planning process and may adjust management accordingly.

- The discussion of impacts is based on the best available data. Where data are limited, the BLM and BIA used knowledge of the planning area and professional judgment, based on observation and analysis of conditions and responses in similar areas.
- Best management practices (BMPs) or mitigation measures (**Appendix B**) will apply, where appropriate, to all authorized surface-disturbing activities and occupancy associated with land use authorizations, permits, and leases issued on BLM-administered lands. The BLM administers approximately 1,290,400 surface acres in the decision area. Stipulations (**Appendix D**) also apply to fluid minerals leasing on lands overlying federal mineral estate, which includes that underlying BLM-administered lands, privately owned lands, and state-owned lands. There are 1,982,100 acres of federal mineral estate in the BLM minerals decision area.
- Data from geographic information systems (GIS) have been used in developing acreage calculations and for generating many of the figures. Calculations depend on the quality and availability of data; most calculations in the FMG RMPA/EIS are rounded to the nearest 100 acres. Given the scale of the analysis, the compatibility constraints between datasets, and the lack of data for some resources, all calculations are approximate and serve for comparison and analytic purposes only. The BLM and BIA may receive additional GIS data; therefore, acreages may be later recalculated and revised. Occasionally, due to multiple datasets manipulation (GIS intersects), data may not sum correctly within 1,000 acres of the decision areas' totals.
- In instances where varying management levels overlap, the stricter management prescriptions would apply by default. If the BLM Authorized Officer makes an exception, modification, or waiver to the stricter prescription, then the less strict management would still apply. The overlap is preserved to allow this layering of management in the cases where the stricter management prescription is excepted, modified, or waived. For example, if an area were subject to both no surface occupancy (NSO) and controlled surface use (CSU) stipulations, the NSO stipulation would apply by default. If the NSO stipulation were waived based on the waiver criteria for the stipulation, the CSU stipulation would still be applied. The area would not revert to having no stipulations unless both the NSO and CSU stipulations were waived.
- Some impacts could not be quantified, given the proposed management actions. Where this gap occurred, impacts were projected in qualitative terms or, in some instances, were described as unknown. Subsequent project-level analyses will provide the opportunity to collect and examine site-specific inventory data required to determine appropriate application of RMPA/EIS-level guidance. In addition, the BLM, BIA, and other agencies in the planning area continue to update and refine information used to implement this plan.

Oil and Gas Reasonable Foreseeable Development Scenario

The reasonably foreseeable development scenario (RFD), presented in **Appendix I**, **Table 4-1**, Estimated Number of Wells and Associated Disturbance, lists projected future oil and gas exploratory and development activity and associated disturbance through 2037. It is based on the management actions (constraints) for the alternatives (**Appendix I**).

Note that the RFD projections are possible or are likely to happen and should not be considered to be worst-case scenarios; they are reasonable and science-based projections of the anticipated oil and gas activity (**Appendix I**).

EC.1.2 Types of Impacts to Be Addressed

Potential impacts, described in terms of type, context, duration, and intensity, are generally defined as follows:

- *Type of Impact*—Because types of impacts can be interpreted differently by different people, this report does not differentiate between beneficial and adverse impacts (except in cases where such characterization is required by law, regulation, or policy). The presentation of impacts for key planning issues is intended to provide the BLM and BIA decision-makers and reader with an understanding of the multiple-use tradeoffs associated with each alternative.
- *Context*—This describes the area or location (site-specific, local, planning area-wide, or regional) in which the impact would occur. Site-specific impacts would occur at the location of the action, local impacts would occur in the general vicinity of the action area, planning area-wide impacts would affect a greater portion of the BLM field office and BIA region, and regional impacts would extend beyond the planning area boundaries.
- *Duration*—This describes the length of time an effect would occur, either short term or long term. Short term is defined as anticipated to begin and end in the first 5 years after the action is implemented; long term is defined as lasting beyond 5 years to the end of, or beyond, the 20-year planning time frame addressed in the RMPA/EIS.
- *Intensity*—Rather than categorizing impacts by intensity (e.g., major, moderate, and minor), this analysis discusses impacts using quantitative data wherever possible to illustrate intensity.
- *Direct and Indirect Impacts*—Direct impacts are caused by an action or implementation of an alternative and occur at the same time and place. Indirect impacts result from implementing an action or alternative but usually occur later in time or are removed in distance and are reasonably certain to occur.
- *Cumulative Impacts*—Cumulative impacts are described in the *Cumulative Impacts* sections of this report. Cumulative impacts are the direct and indirect impacts of a proposed project alternative's incremental impacts when they are added to other past, present, and reasonably foreseeable actions, regardless of who carries out the action (40 Code of Federal Regulations [CFR] 1508.7). The list of actions used for cumulative impact analysis is provided in **Section EC.3.2**, Past, Present, and Reasonably Foreseeable Future Actions.

For ease of reading, impacts presented are direct and long term and occur in the larger planning area, unless they are noted as indirect, short-term and temporary, or localized. Analysis shown under the BLM or BIA No Action Alternative may be referenced in the other alternatives with such statements as "impacts would be the same as the No Action Alternative" or "impacts would be similar to the No Action Alternative, except for . . . ," as applicable.

Cumulative Impacts

Cumulative impacts on the environment result from implementing any one of the RMPA alternatives in combination with other reasonably foreseeable actions outside the scope of this plan, either in the planning area or next to it. Cumulative impact analysis is required by the Council on Environmental Quality (CEQ) regulations because environmental conditions result from many different factors acting together. The total effect of any single action cannot be determined by considering it in isolation but must be determined by considering the likely result of that action in conjunction with many others. together. The total effect of any single action cannot be determined by considering it in isolation but must be determined by considering the likely result of that action in conjunction with many others.

Evaluating potential impacts considers incremental impacts that could occur from the proposed project, as well as impacts from past, present, and reasonably foreseeable future actions. Management actions could be influenced by activities and conditions on adjacent public and non-public lands beyond the planning area boundary; therefore, assessment data and information could span multiple scales, landownerships, and jurisdictions. These assessments involve determinations that often are complex and, to some degree, subjective.

Cumulative Analysis Method

The cumulative impacts discussion that follows considers the alternatives in the context of the broader human environment—specifically, actions that occur outside the scope and geographic area covered by the RMPA. The cumulative impact analysis is limited to important issues of national, regional, or local significance; therefore, not all resources identified for the direct and indirect impact analysis in this EIS are analyzed for cumulative impacts.

Because of the programmatic nature of an RMPA and cumulative impacts assessment, the analysis tends to be broad and generalized. This is in order to address the impacts that could occur from a reasonably foreseeable management scenario, combined with other reasonably foreseeable activities or projects. Consequently, this assessment is primarily qualitative for most resources because of a lack of detailed information that would result from project-level decisions and other activities or projects.

Quantitative information is used whenever available and as appropriate to portray the magnitude of an impact. The analysis assesses the magnitude of cumulative impacts by comparing the environment in its baseline condition with the expected impacts of the alternatives and other actions in the same geographic area. The magnitude of an impact is determined through a comparison of anticipated conditions against the naturally occurring baseline, as depicted in the affected environment (Farmington Mancos-Gallup 2018 Affected Environment Technical Report), or the long-term sustainability of a resource or social system. The following factors were considered in this cumulative impact assessment:

- Federal, nonfederal, and private actions
- Potential for combined impacts or combined interaction between impacts
- Potential for impacts on cross political and administrative boundaries
- Other spatial and temporal characteristics of each affected resource
- Comparative scale of cumulative impacts across alternatives

Temporal and spatial boundaries used in the cumulative analysis are developed on the basis of resources of concern and actions that might contribute to an impact. The baseline year for the cumulative impacts analysis is 2018. The time frame of this analysis is the life of the RMPA, which encompasses a 20-year planning period.

Spatial boundaries vary and are larger for resources that are mobile or that migrate (e.g., elk, compared with stationary resources. Occasionally, spatial boundaries could be contained in the planning area. Spatial boundaries were developed to facilitate the analysis and are included under the appropriate resource section heading. Spatial boundaries were developed to facilitate the analysis and are included under the appropriate resource section heading.

EC.2 Supplemental Resources

EC.2.1 Air Resources

This section discusses impacts on air quality, air quality related values (AQRVs), and GHGs from proposed management actions of other resources and resource uses. Existing conditions concerning air resources are described in **Section 3.3.1**, Air Resources, of the FMG RMPA/EIS and **Section AE.2.1**, Air Resources, of the Affected Environment Supplemental Report.

Air resources were evaluated within the planning area to determine how they could be affected by future federal actions implemented under the FMG RMPA/EIS. Actions that initiate or increase emissions of air pollutants can result in negative effects on air resources, including increased concentrations of air pollutants, decreased visibility, increased atmospheric deposition on soils and vegetation, and acidification of sensitive water bodies. This RMPA includes BLM management actions related to fluid minerals (oil and gas), lands and realty, vegetation treatments, and lands with wilderness characteristics, described in **Table 2-3**. It also includes BIA actions related to oil and gas leasing, described in **Table 2-4**. Because only fluid minerals-related actions have the potential for measurable impacts on air resources, this section focuses on these actions. Impacts from BLM management actions for lands and realty, vegetation treatments, and lands with wilderness characteristics would have limited direct and indirect impacts on regional air quality conditions in the planning area. This is because these actions would not result in long-term changes in air quality, compared with the current conditions; therefore, these topics are not discussed in detail.

The FMG RMPA/EIS analyzes impacts on air quality and AQRVs at a regional (planning area-wide) and cumulative scale. Site-specific (localized) impacts resulting from individual oil and gas development projects within the planning area will be evaluated in project-specific NEPA analyses during lease sales and applications for permits to drill.

GHG emissions from oil and gas development are discussed at the end of this section, along with indirect emissions from downstream uses of oil and gas based on production estimates contained in the RFD prepared for the FMG RMPA/EIS (**Appendix I**).

Methods and Assumptions

The analysis of fluid minerals-related impacts is based on the Colorado Air Resources Management Modeling Study (CARMMS) with Updated Mancos Shale Modeling, as applicable to oil and gas leasing in the Farmington Field Office (FFO) (CARMMS 1.5; Vijayaraghavan et al. 2016), as updated in 2017 (CARMMS 2.0; Vijayaraghavan et al. 2017). The BLM undertook the CARMMS methodology and analysis to estimate the regional and cumulative impacts on air quality and AQRVs from BLM-authorized oil and gas and mining development in BLM Colorado Field Offices and in the BLM New Mexico FFO. CARMMS allows field offices to better understand regional air quality for permitting activities at the time of project proposal by tracking the level of development that has occurred in a field office against the modeled impacts under low and high development scenarios. The CARMMS modeling is used in this document to help understand potential impacts on regional air quality at the planning and pre-decisional levels. The future year emissions and air quality and AQRV impacts from oil and gas development in the Mancos Shale modeled in CARMMS are used in this EIS as an estimate of impacts from oil and gas development authorized by the BLM under this RMPA. Specifically, this analysis presents:

- Estimated 2025 emissions of criteria pollutants, volatile organic compounds (VOCs), hazardous air pollutants (HAPs), and GHGs for each development scenario, as presented in the CARMMS 2.0 report (Vijayaraghavan et al. 2017);
- Direct and indirect impacts on air quality and AQRVs from oil and gas development in the Mancos Shale portion of the Farmington Field Office that would be authorized under this RMPA, as presented in the air impact assessment report prepared for this RMPA/EIS (Vijayaraghavan et al. 2018; **Appendix J**); and
- Cumulative impacts from BLM-authorized oil and gas development in the Mancos Shale portion of the Farmington Field Office in combination with other federal and nonfederal emissions sources, including BLM-authorized oil and gas development in the non-Mancos Shale portion of the Farmington Field Office (as presented in Vijayaraghavan et al. 2018; **Appendix J**).

Impacts associated with each alternative are being analyzed based on the low and high development scenarios analyzed in CARMMS. They are impacts from a range of developments that could occur over the life of this RMPA through continued updates to the CARMMS modeling study. Also analyzed was a medium scenario, where additional emissions controls were applied to the high scenario.

Because the BLM authorizes permits to drill on Navajo lands for which the BIA issues leases, impacts from oil and gas development on Navajo lands are included in both the BLM analysis of impacts and the BIA analysis of impacts to be responsive to the responsibilities of each agency for considering the effects of their actions on air resources.

Indicators

Indicators of impacts are as follows:

- Predicted contributions of criteria air pollutants concentrations in parts per million (ppm), parts per billion (ppb), or micrograms per cubic meter (μg/m^3) as compared with significant impact levels (SILs) for national ambient air quality standards (NAAQS)
- Predicted contributions of criteria air pollutant concentrations in μg/m^3 compared with prevention of significant deterioration (PSD) increments
- Predicted changes in visibility in deciviews in Class I and sensitive Class II areas
- Predicted contribution to sulfur and nitrogen deposition in kilograms nitrogen per ha in Class I and sensitive Class II areas
- Predicted changes in lake chemistry in μg//L based on acid neutralizing capacity
- Potential GHG emissions in metric tons resulting from BLM-authorized oil and gas development

Assumptions

The analysis includes the following assumptions:

- Air pollutant emissions and resultant concentrations and deposition rates presented in this analysis are useful for determining the scale of potential increases in emissions but may not represent actual future emissions.
- While a portion of the Mancos Shale extends into Colorado, emissions from oil and gas development in the Mancos Shale would occur primarily in the Farmington Field Office (100 percent of oil wells and 74 percent of gas wells). New Mexico-specific information is used in this analysis where available. Otherwise, information from the entire Mancos Shale area is used, presenting a conservative estimate of impacts.
- Mineral resource development and operation would be subject to federal and state emissions control regulations in place at the time development occurs.
- Mineral resource development and operation would be subject to BMPs, conditions of approval (COAs), and stipulations contained in Appendices B, C, and D, respectively.
- There is a correlation between global concentrations of GHGs and climate change; however, it is not currently possible to link projected GHG emissions associated with any particular activity to specific environmental impacts at a specific site or location. While there are difficulties in attributing specific climate change impacts to any given project or activity and quantifying those impacts, estimated GHG emissions can serve as a proxy for a proposed action's climate change impacts.

Nature and Type of Effects

Air pollution impacts from oil and gas development are limited by state and federal regulations, standards, and implementation plans established under the Clean Air Act and administered by the New Mexico Environment Department. Under the Clean Air Act, the BLM and BIA provide for compliance with all applicable federal, Tribal, state, and local air quality laws, statutes, regulations, standards, and implementation plans.

Oil and gas leasing has no direct impact on air resources but would have indirect impacts from subsequent oil and gas development, reclamation, and end use combustion. Air pollutant emissions occur as part of field construction and well production activities. Sources of emissions during construction include vehicle traffic, well pad and road construction, pipeline construction, and well drilling and completion. The primary air pollutants emitted during construction would be criteria air pollutants (CO_2, nitrogen oxide, sulfur dioxide (SO_2), particulate matter less than 10 microns in diameter (PM_{10}), and particulate matter less than 2.5 microns in diameter ($PM_{2.5}$)), VOCs, and HAPs (benzene, toluene, ethyl benzene, xylene, n-hexane, and formaldehyde). These activities elevate air pollutant levels, but impacts of a construction activity (e.g., development of a well pad) are localized and short term.

Fugitive dust (PM_{10} and $PM_{2.5}$) emissions result from work crews commuting to and from work sites and from transporting and operating equipment during construction. Windblown fugitive dust emissions also occur from open and disturbed land during construction. Travel on unpaved roadways to access oil and gas operations are a primary source of fugitive dust in the planning area. These emissions are localized and long term.

During field production, air pollutant emissions occur from compressor station operation, well site pumping unit engines, water transfer pump engines, well site heaters, valves/flanges, vehicle traffic on roads during routine field operations and maintenance, and work-over activities. The pollutants emitted are the same as those described for construction but occur over the life of the activity. The pollutants emitted are the same as those described for construction but occur over the life of the activity. These emissions are long term.

Methane, carbon dioxide, and nitrous oxide are the primary GHGs associated with oil and gas production. During drilling and completion, natural gas may be flared or vented from conventional, coal bed methane, and shale wells. After completion, activities may include installing pipelines and facilities for gas processing, collection, and distribution. Methane, the main component of natural gas, can be released via controlled venting or through unintentional leaks during well development, production, and transmissions. Carbon dioxide can be inherently present in natural gas or it can be used in the production process to enhance oil recovery, in which case it is released through venting or leaks. At the drilling and production stage, carbon dioxide emissions are most commonly associated with controlled flaring and fossil fuel combustion used to power equipment used in drilling, pumping, compression, and transportation. In addition to the GHG emissions from development activities, the combustion of oil and gas in downstream uses is an indirect source of GHG emissions.

For this EIS, the BLM and BIA are each making planning-level decisions related to oil and gas leasing allocations and under what conditions leasing and subsequent development can occur. Specific oil and gas leasing decisions are not being made, and therefore air quality impacts for specific lease sales or development projects are not being analyzed. Rather, anticipated future impacts from oil and gas development on air quality are being assessed based on the level of development proposed under each alternative. The specific process for evaluating impacts on air resources at the lease sale and project-specific level is described near the end of this section under *Air Resources Protection Practices*.

Applicability of CARMMS 2.0 Model Scenarios

Because a new RFD for the FMG RMPA/EIS (**Appendix I**) was prepared after the CARMMS 2.0 modeling study was completed, a comparison of well development levels in CARMMS 2.0 and in the RFD was performed to determine how the projected development in the RFD correlated to the low and high development scenarios in CARMMS 2.0. **Table EC-1** shows the RFD projections under the baseline scenario and each alternative and the well counts used in CARMMS 2.0.

As shown in **Table EC-1**, the RFD estimated that 2,490 federal oil and gas wells could potentially be developed in the Mancos Shale area between 2018 and 2037 under baseline conditions, with 629 of these wells developed by 2025 (the end model year in CARMMS 2.0). By contrast, CARMMS 2.0 estimated that 1,378 wells for the low scenario and 2,756 wells for the high scenario would be developed by 2025. Thus, 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). Thus, the low scenario can be used to represent a conservative estimate of federal and planning area-wide impacts through 2025.

Table EC-1
FMG RMPA/EIS RFD Projections by Alternative

Well Counts	Baseline RFD[1]	Alternative A	Alternative B1	Alternative B2	Alternative C[6]	Alternative D	No Action
Total Wells (2018-2025)							
BLM	*500*	*353*	*354*	*283*	*468-471*	*475*	*473*
BIA[2]	*129*	*129*	*129*	*129*	*129*	*129*	*129*
All Federal[3]	629	482	499	412	597-600	604	602
Planning Area (federal and nonfederal)[4]	809	662	662	592	775-780	784	781
Total Wells (2018-2037)							
BLM	*1,980*	*1,399*	*1,402*	*1,125*	*1,848-1,865*	*1,881*	*1,873*
BIA[2]	*510*	*510*	*510*	*510*	*510*	*510*	*510*
All Federal[3]	2,490	1,909	1,912	1,635	2,358-2,375	2,391	2,383
Planning Area (federal and nonfederal)[4]	3,200	2,619	2,622	2,345	3,068-3,085	3,101	3,093
CARMMS 2.0 Total Wells (2016-2025) (Low Scenario)[5]						**1,378**	
CARMMS 2.0 Total Wells (2016-2025) (High Scenario)[5]						**2,756**	

Source: Appendix I
[1]The baseline RFD represents the maximum level of development that could occur before applying NSO stipulations under each alternative.
[2]For BIA, development would be the same regardless of alternative.
[3]Because the BLM approves applications for permits to drill, the BLM and BIA categories are combined for comparison to CARMMS.
[4]Planning area well counts include total estimated well development; thus, federal well counts are a subset of planning area well counts
[5]Well counts for the New Mexico portion of the Mancos Shale, which includes all oil wells and 74 percent of the gas wells.
[6]Range of BLM well projections in Alternative C based on the sub-alternative: (2018-2025) C1=471 wells; C2/C3=470 wells; C4=469 wells; and C5=468 wells and (2018-2037) C1=1,865 wells; C2=1,862 wells; C3=1,859; C4=1,856 wells; and C5=1,848 wells. Range of planning area well projections in Alternative C based on the sub-alternative: (2018-2025) C1=780 wells; C2=779; C3/C4=778 wells; and C5=775 wells and (2018-2037) C1=3,085 wells; C2=3,082 wells; C3=3,079; C4=3,076 wells; and C5=3,068 wells.

Because CARMMS 2.0 projections start in 2016 and the RFD starts in 2018, an additional comparison between well development levels was made. The CARMMS 2.0 well development levels for 2016 and 2017 were added to the RFD well development levels and then compared to the CARMMS 2.0 well counts. CARMMS 2.0 projects that 200 wells in the low scenario and 400 wells in the high scenario would be developed in these two years. Adding these wells to the RFD baseline scenario, either 829 or 1,029 federal wells would be developed by 2025. Thus, CARMMS 2.0 predicts that 549 more federal wells under the low scenario and 1,727 more federal wells under the high scenario would be developed by 2025 than predicted by the RFD. In addition, adding these wells to the planning area well counts, yielding 1,009 wells or 1,209 wells, would also result in well development levels below the CARMMS 2.0 low and high scenarios. Thus, the low scenario can be used to represent a conservative estimate of federal and planning area-wide impacts through 2025 when adjusted to account for a 2016 to 2025 timeframe.

Lastly, a comparison of well development over the life of the RMPA (2018-2037) to well development under CARMMS 2.0 (2016 to 2025) was made. The RFD baseline scenario estimated that 2,490 federal oil and gas wells and 3,200 total wells could potentially be developed in the planning area by 2037. CARMMS 2.0 predicts that 266 more federal wells would be developed in the planning area under the high scenario than under the RFD's baseline scenario. Thus, the high scenario can be used to represent a conservative estimate of federal impacts over the life of the RMPA, though with much less certainty. This is because it is speculative to accurately predict future air quality impacts past 2025 since there is no adequate US-wide emissions inventory beyond year 2025 for conducting the cumulative air quality analysis. As air pollutant monitoring data and new future year national emissions inventories become available, the BLM is committed to modeling air quality impacts over the life of the RMPA.

Emissions Inventory

Emissions estimates for oil and gas activities were calculated using oil and gas emissions calculators developed for and explained in the CARMMS 2.0 modeling report (Vijayaraghavan et al. 2017). Planning area emission estimates for criteria pollutants, GHG emissions, and HAPs for future year 2025 are shown in **Table EC-2**.

Table EC-2
2025 New Mexico Mancos Shale Emissions from Well Development (Construction and Operations)

Scenario	Criteria Pollutant Emissions (tons per year)						GHG Emissions (tons per year)			HAP Emissions (tons per year)
	VOC	CO	NOx	PM_{10}	$PM_{2.5}$	SO_2	CO_2	CH_4	N_2O	
Federal Emissions										
Low	3,198	1,878	1,450	917	156	2	338,733	8,159	5	360
Medium[1]	2,751	3,343	1,811	726	167	5	660,987	14,337	11	312
High	6,396	3,757	2,901	1,900	312	5	677,465	16,318	10	711
Non-Federal Emissions										
Low	1,371	805	622	393	67	1	145,171	3,497	2	149
Medium[1]	2,741	1,749	1,241	814	140	2	307,407	8,204	5	310
High	2,741	1,610	1,243	719	134	2	290,342	6,994	4	305
All Wells										
Low	4,569	2,683	2,072	1,310	223	4	483,904	11,656	7	508
Medium[1]	5,492	5,093	3,052	1,540	307	7	968,394	22,542	16	621
High	9,137	5,366	4,144	2,619	446	7	967,808	23,312	15	1,017

Source: Vijayaraghavan et al. 2017

[1]The medium scenario is a mitigated version of the high development scenario that assumes additional levels of emissions controls beyond the application of existing state and federal requirements. These controls are described in Table 2-2 of **Appendix J**.

CARMMS-Based Impact Analysis

Table EC-3 shows the indicators used for evaluating impacts on air quality and AQRVs. It should be noted that in CARMMS, projected oil and gas development for the planning area is made up of multiple hypothetical future oil and gas "projects" and thus is an approximation of impacts; as such, comparison of CARMMS output measurements to project-level indicators is more appropriate in a project-level analysis but is used here to describe potential impacts from BLM-authorized oil and gas permitting in the decision area (which includes permitting on lands for which BIA issues leases).

Summary of CARRMS-Based Impact Analysis

As described under *Applicability of CARMMS 2.0 Model Scenarios*, potential impacts on air quality and AQRVs through 2025 are best approximated using the low scenario, though the low scenario is still a conservative estimate of impacts because it uses a higher level of well development than the RFD. As detailed in the analysis below, the CARMMS 2.0 low scenario does not exceed the indicator thresholds for any of the NAAQS, prevention of significant deterioration (PSD) Class I or Class II increment thresholds, sulfur deposition threshold, change in visibility threshold at any Class I area, or the thresholds for acid-neutralizing capacity at sensitive lakes. The low 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.

Table EC-3
Air Quality and AQRV Indicators

NAAQS		
Pollutant (Averaging Time)	**NAAQS[1]**	**NAAQS SIL Thresholds[2]**
Ozone (8-hour)	70 ppb	1.0 ppb
$PM_{2.5}$ (24-hour)	35 μg/m^3	1.2 μg/m^3
$PM_{2.5}$ (Annual)	12 μg/m^3	0.2 μg/m^3
PM_{10} (24-hour)	150 μg/m^3	5 μg/m^3
NO_2 (1-hour)	100 ppb	10 ppb
NO_2 (Annual)	53 ppb	1 ppb
SO_2 (1-hour)	75 ppb	10 ppb
SO_2 (3-hour)	0.5 ppm	25 ppb
Prevention of Significant Deterioration[3]		
Pollutant (Averaging Time)	**Class I PSD Increment Thresholds**	**Class II PSD Increment Thresholds**
$PM_{2.5}$ (24-hour)	2 μg/m^3	9 μg/m^3
$PM_{2.5}$ (Annual)	1 μg/m^3	4 μg/m^3
PM_{10} (24-hour)	8 μg/m^3	30 μg/m^3
PM_{10} (24-hour)	4 μg/m^3	17 μg/m^3
NO_2 (Annual)	2.5 μg/m^3	25 μg/m^3
SO_2 (3-hour)	25 μg/m^3	512 μg/m^3
SO_2 (24-hour)	5 μg/m^3	91 μg/m^3
SO_2 (Annual)	2 μg/m^3	20 μg/m^3
Visibility Thresholds[4]		
Change in deciviews at each Class I and Class II area		
Number of days with change in deciviews > 0.5 at a Class I or sensitive Class II area		
Number of days with a change in deciviews > 1.0 at a Class I or sensitive Class II area		
Change in 20% worst days at a Class I or sensitive Class II area		
Change in 20% best days at a Class I or sensitive Class II area		
Deposition[5]		
		Thresholds
Deposition analysis threshold for nitrogen or sulfur (FFO contribution)		0.005 kg/ha-yr
Critical Load Value-Nitrogen (Cumulative contribution)		2.3 kg/ha-yr
Critical Load Value-Sulfur(Cumulative contribution)		5.0 kg/ha-yr
Acid Neutralizing Capacity at Sensitive Lakes[6]		
		Thresholds
Lakes with background levels greater than 25 μeq/L		10% change in ANL
Lakes with background levels equal to or less than 25 μeq/L		1 μeq/L change

Sources: [1]Appendix J, page 52; [2]SIL=significant impact level; 40 CFR 51.165(b)(2) and EPA 2018a; [3]EPA 2018b; [4]Appendix J, page 80, page 90; [5]Appendix J, page 96; [6]Appendix J, page 115

As described under *Applicability of CARMMS 2.0 Model Scenarios*, potential impacts on air quality and AQRVs over the life of the RMPA may be approximated using the CARMMS 2.0 high scenario, though with much less certainty for the reasons described in that section. As detailed in the analysis below, the CARMMS 2.0 high scenario would not exceed any of the PSD Class I or Class II increment thresholds, change in visibility threshold at Class I areas, sulfur deposition threshold, or the thresholds for acid-neutralizing capacity at sensitive lakes. It would exceed the NAAQS indicator thresholds for ozone, annual average $PM_{2.5}$, and annual average NO_2; as well as 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.

As described in the Environmental Consequences Supplemental Report, Section EC.4.1, Air Resources, applying the additional control measures described by the medium scenario would mitigate the impacts on all of the NAAQS indicator thresholds and on the nitrogen deposition threshold at Bandelier Wilderness, Dome Wilderness, and Sandia Mountain Wilderness.

NAAQS

An air impact assessment (Vijayaraghavan et al. 2018) was developed for the FMG RMPA/EIS using the information contained in CARMMS 2.0. This report is included as **Appendix J** of the FMG RMPA/EIS. For each pollutant modeled, the analysis shows the contribution of BLM-authorized oil and gas development in the Farmington Field Office under the high, medium, and low scenarios. This contribution is compared to the SILs shown in **Table EC-3** (the SIL is exceeded when the cell is grey). The analysis also shows the concentrations of each modeled pollutant from total sources in the 2011 base year and the 2025 future year to allow a comparison of air quality conditions between 2011 and 2025. Total sources include federal and nonfederal oil and gas sources; non-oil and gas sources such as electric generating units; mobile sources; and biogenic (natural) sources, including fires, both in and outside of the planning area.

Appendix J includes graphical representations (figures) of the NAAQS analyses for the 2011 base year and the 2025 modeled year under the low, medium, and high scenarios (Section 3 in **Appendix J**). These representations show where air quality exceeded (2011) or may exceed (2025) the NAAQS. Natural emissions, such as from wildfire, are also included in the figures for some pollutants to determine if 2011 exceedances could have been due primarily to these natural emissions.

Ozone. The ozone NAAQS of 70 ppb is defined as the three-year average of the 4th highest daily maximum 8-hour concentration. **Table EC-4** shows the maximum ozone contribution by the Farmington Field Office to modeled 2025 ozone concentrations under any conditions and under conditions where the ozone NAAQS is exceeded. As shown in the table, the Farmington Field Office maximum contribution would exceed the SIL of 1.0 ppb only under the high scenario.

Table EC-4
2025 Farmington Field Office Maximum Contribution to the 4th Highest Daily Maximum 8-Hour Ozone Concentration

Farmington Field Office – Modeling Scenario	Maximum 4th Highest Daily 8-hour Ozone Contribution Under Any Conditions[1] (ppb)	Maximum Ozone Contribution to 4th Highest Daily 8-hour Ozone under Conditions when the Ozone NAAQS is Exceeded (ppb)[2]		
		Maximum Contribution (ppb)	Corresponding Ozone NAAQS Exceedance (ppb)	FFO % of Maximum Contribution
High Scenario	1.7*	1.4391	71.7	2.01%
Medium Scenario	1.0	0.6111	72.6	0.84%
Low Scenario	0.9	0.6562	72.8	0.90%

Source: Appendix J

[1]See Section 3.1.1 of Appendix J; these are the modeled 2025 FFO contributions to the maximum 4th highest daily ozone concentration and could occur when the total 4th highest concentration is less than or greater than the ozone NAAQS

[2]See Section 3.1.2 of Appendix J; these are the modeled 2025 FFO contributions to the maximum 4th highest daily ozone concentration only when the total 4th highest concentration is greater than the ozone NAAQS

Ozone NAAQS = 0.070 ppm (70 ppb); annual fourth-highest daily maximum 8-hour concentration, averaged over 3 years

*Indicates that the deposition analysis threshold is exceeded (this cell is also shaded grey)

The maximum ozone contributions to the 4th highest daily maximum 8-hour concentration for the 2011 and 2025 total source groups and the FFO source group are shown in **Table EC-5**. As shown in the table, total source group emissions would decrease by 1.88 percent between 2011 and 2025. As also shown in the table, natural sources account for almost half of the ozone concentration in the total source categories.

Table EC-5
Maximum Contribution to the 4th Highest Daily Maximum 8-Hour Ozone Concentration, Farmington Field Office and Total Source Groups

Farmington Field Office Modeling Scenario	FFO Maximum 4th Highest 8-hour Ozone Contribution (ppb)	2025 Emissions, All Source Groups[1] (ppb)	2025 Emissions, All Source Groups Minus Natural Emissions (ppb)	2011 Emissions, All Source Groups[1] (ppb)	2011 Emissions, All Source Groups Minus Natural Emissions [1] (ppb)	Change in Ozone Contribution, All Source Groups, 2011 to 2025
High Scenario	1.7*	119.7	58.4	122.0	60.7	-1.88%
Medium Scenario	1.0	119.7	58.4	122.0	60.7	-1.88%
Low Scenario	0.9	119.7	58.4	122.0	60.7	-1.88%

Source: Appendix J
[1]The contribution of natural sources (biogenic, wildfires, prescribed burns, agricultural burning, lightning, and wind-blown dust emissions) under 2011 base year and 2025 future year is 61.3 ppb.
*Indicates that the deposition analysis threshold is exceeded (this cell is also shaded grey)

Table EC-6 describes ozone concentrations at air monitoring stations under base conditions (represented by air monitoring data for 2009 to 2013), under the 2014-2016 conditions as described in Section 3.2.1 of **Appendix J**, and 2025 conditions for the high, medium, and low scenarios; ozone concentrations in unmonitored areas are shown in Figures 3-6 through 3-8 in **Appendix J** for high, low, and medium scenarios, respectively. As shown in this table, ozone concentrations at air monitoring stations are expected to decrease in the planning area under all scenarios, with all monitoring stations showing ozone concentrations below the NAAQS. In unmonitored areas, ozone exceedances would be reduced under all three scenarios; Figures 3-6 through 3-8 in **Appendix J** show ozone concentrations below the NAAQS for all three scenarios.

Table EC-6
Base and 2025 Future Year Ozone Design Values at Monitoring Sites

Monitoring Station (Site ID)[1]	Maximum Ozone Base Design Value (2009-2013) (ppb)	Average Air Monitoring Values (2014-2016)[2]	Project 2025 Ozone Design Values (ppb)		
			High	Medium	Low
Shiprock Electrical Substation (-1005) San Juan County, NM	66.0	62	63.4	63.3	63.2
North Ist Street, Bloomfield (-0009) San Juan County, NM	65.3	63	62.8	62.5	62.4
Navajo Dam (-0018) San Juan County, NM	71.0*	66	68.0	67.7	67.5
600 Oak Street, Bernalillo (-1001) Sandoval County, NM	61.7	64	59.3	59.3	59.3
106 W. North Street, Cortez (-0006) Montezuma County, CO	67.3	63	64.4	64.3	64.2

Monitoring Station (Site ID)[1]	Maximum Ozone Base Design Value (2009-2013) (ppb)	Average Air Monitoring Values (2014-2016)[2]	Project 2025 Ozone Design Values (ppb)		
			High	Medium	Low
Mesa Verde National Park (-0101) Montezuma County, CO	68.3	65	65.3	65.1	65.0
Southern Ute Indian Tribe (-7001) La Plata County, CO	68.7	69	65.1	64.6	64.5
Weminuche Wilderness Area (-1004) La Plata County, CO	72.7*	65	70	69.7	69.6

Source: Appendix J (Table 3-3)
[1]Data are shown where available for monitoring stations in and near the planning area (**Table 3-4** and **Figure 3-1** in Section 3.2.1)
[2]See **Table 3-4**
*Indicates an exceedance of the ozone 8-hour NAAQS of 70 ppb (these cells are also shaded grey)

$PM_{2.5}$. There are two $PM_{2.5}$ NAAQS, a 24-hour averaging time that is expressed as a three-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 8th highest daily $PM_{2.5}$ concentration in a year.

Table EC-7 shows the maximum contribution to the 8th high 24-hour $PM_{2.5}$ concentration for the Farmington Field Office and the 2011 and 2025 total source groups. As shown in the table, total source group emissions would be similar between 2011 and 2025. As also shown in the table, natural sources account for the majority of the concentration in the total source categories. The Farmington Field Office maximum contribution would not exceed the SIL of 1.2 μg/m³ under any scenario.

Table EC-7
Maximum Contribution to the 8th High 24-hour $PM_{2.5}$ Concentration, Farmington Field Office and Total Source Groups

Farmington Field Office Modeling Scenario	FFO Maximum 8th High 24-hour $PM_{2.5}$ Contribution (μg/m³)	2025 Emissions, All Source Groups[1] (μg/m³)	2025 Emissions, All Source Groups Minus Natural Emissions (μg/m³)	2011 Emissions, All Source Groups[1] (μg/m³)	2011 Emissions, All Source Groups Minus Natural Emissions [1] (μg/m³)	Change in 24-Hour $PM_{2.5}$ Contribution, All Source Groups, 2011 to 2025
High Scenario	0.8	420.9	14.4	421.3	14.8	-0.09%
Medium Scenario	0.4	420.9	14.4	421.3	14.8	-0.09%
Low Scenario	0.4	420.9	14.4	421.3	14.8	-0.09%

Source: Vijayaraghavan et al. 2018
[1]The contribution of natural sources (biogenic, wildfires, prescribed burns, agricultural burning, lightning, and wind-blown dust emissions) under 2011 base year and 2025 future year is 406.5 μg/m³.

Table EC-8 shows the maximum contributions to the annual average $PM_{2.5}$ concentration for the Farmington Field Office and the 2011 and 2025 total source groups. As shown in the table, total source group emissions would decrease by 10 percent between 2011 and 2025. As also shown in the table, natural sources account for the majority of the $PM_{2.5}$ concentration in the 2011 and 2025 total source categories. The Farmington Field Office maximum contribution would exceed the SIL of 0.2 μg/m³ only under the high scenario.

Graphical representations of $PM_{2.5}$ concentrations for the 2011 base case and the 2025 modeled high, medium, and low scenarios are shown in **Appendix J** Figures 3-9 to 3-11 for the 24-hour $PM_{2.5}$ NAAQS and Figures 3-

13 to 3-15 for the annual $PM_{2.5}$ NAAQS. Unlike ozone, $PM_{2.5}$ concentrations under all three 2025 scenarios would increase in much of the planning area between 2011 and 2025, with some areas in north-central San Juan County exceeding the NAAQS for both $PM_{2.5}$ averaging periods due primarily to natural sources.

Table EC-8
2025 Farmington Field Office Maximum Contribution to Annual Average $PM_{2.5}$ Pollutant Concentrations

Farmington Field Office Modeling Scenario	FFO Maximum Annual Average $PM_{2.5}$ Contribution ($\mu g/m^3$)	2025 Emissions, All Source Groups[1] ($\mu g/m^3$)	2025 Emissions, All Source Groups Minus Natural Emissions ($\mu g/m^3$)	2011 Emissions, All Source Groups[1] ($\mu g/m^3$)	2011 Emissions, All Source Groups Minus Natural Emissions[1] ($\mu g/m^3$)	Change in Average Annual $PM_{2.5}$ Contribution, All Source Groups, 2011 to 2025
High Scenario	0.3	21.1	3.7	23.5	6.1	-10%
Medium Scenario	0.1	21.1	3.7	23.5	6.1	-10%
Low Scenario	0.1	21.1	3.7	23.5	6.1	-10%

Source: Appendix J
[1]The contribution of natural sources (biogenic, wildfires, prescribed burns, agricultural burning, lightning, and wind-blown dust emissions) under 2011 base year and 2025 future year is 17.4 $\mu g/m^3$.
*Indicates that the deposition analysis threshold is exceeded (this cell is also shaded grey).

<u>PM_{10}</u>. The PM_{10} 24-hour NAAQS of 150 $\mu g/m^3$ is not to be exceeded more than once per year on average over 3 years. **Table EC-9** shows the maximum contribution to the 2nd highest 24-hour average PM_{10} concentration for the Farmington Field Office and the 2011 and 2025 total source groups. As shown in the table, total source group emissions would be the same in 2011 and 2025. As also shown in the table, natural sources account for the majority of the PM_{10} concentration in the total source categories. The Farmington Field Office maximum contribution would not exceed the SIL of 5 $\mu g/m^3$ under any scenario.

Table EC-9
Maximum Contribution to the 2nd Highest 24-hour PM_{10} Concentration, Farmington Field Office and Total Source Groups

Farmington Field Office Modeling Scenario	FFO Maximum 2nd High 24-hour PM_{10} Contribution ($\mu g/m^3$)	2025 Emissions, All Source Groups[1] ($\mu g/m^3$)	2025 Emissions, All Source Groups Minus Natural Emissions ($\mu g/m^3$)	2011 Emissions, All Source Groups[1] ($\mu g/m^3$)	2011 Emissions, All Source Groups Minus Natural Emissions[1] ($\mu g/m^3$)	Change in 24-Hour $PM_{2.5}$ Contribution, All Source Groups, 2011 to 2025
High Scenario	2.7	1,045.2	14.6	1,045.2	14.6	0%
Medium Scenario	1.1	1,045.2	14.6	1,045.2	14.6	0%
Low Scenario	1.3	1,045.2	14.6	1,045.2	14.6	0%

Source: Appendix J
[1]The contribution of natural sources (biogenic, wildfires, prescribed burns, agricultural burning, lightning, and wind-blown dust emissions) under 2011 base year and 2025 future year is 1,030.6 $\mu g/m^3$.

Graphical representations of PM_{10} concentrations for the 2011 base case and the 2025 modeled high, medium, and low scenarios are shown in **Appendix J** Figures 3-17 to 3-19 for 24-hour PM_{10} concentrations. Like $PM_{2.5}$, modeled PM_{10} concentrations under all three 2025 scenarios would increase in much of the planning area between 2011 and 2025, with some areas in north-central San Juan County exceeding the NAAQS.

NO_2. There are two nitrogen dioxide (NO_2) NAAQS, a 1-hour averaging time that is expressed as a three-year average of the 98th percentile daily maximum with a threshold of 100 ppb, and an annual average over three years with a threshold of 53 ppb.

The 1-hour NO_2 maximum contributions from the FFO for the high, medium, and low scenarios would be 5.8, 3.2, and 3.0 ppb, respectively; these maximum contributions would not exceed the SIL of 10 ppb under any scenario.

The annual average NO_2 maximum contributions from the FFO for the high, medium, and low scenarios would be 1.5, 0.8, and 0.9 ppb, respectively; these maximum contributions would exceed the SIL of 1 ppb only under the high scenario.

Graphical representations of NO_2 concentrations for the 2011 base case and the 2025 modeled high, medium, and low scenarios are shown in **Appendix J** Figures 3-26 to 3-8 for the 1-hour NO_2 NAAQS and Figure 3-29 for the annual NO_2 NAAQS. Modeled 1-hour and annual NO_2 showed increases in concentrations between the 2011 base year and all three 2025 scenarios in the planning area; however, no exceedances were predicted in the planning area.

SO_2. The FFO contribution to the 1-hour, 3-hour, 24-hour, and annual average SO_2 concentrations would be less than 0.1 ppb under all modeling scenarios; the SILs for the 1-hour and 3-hour averaging periods are 10 ppb and 25 ppb, respectively, and would not be exceeded under any scenario; there are no SILs for the 24-hour and annual average NAAQS.

Graphical representations of SO_2 concentrations for the 2011 base case and the 2025 modeled high, medium, and low scenarios are shown in **Appendix J** Figures 3-21 to 3-24 for the 1-hour, 3-hour, 24-hour, and annual average SO_2 NAAQS. Modeled SO_2 for all averaging periods showed reductions in SO_2 concentrations between 2011 and 2025 under all scenarios, with no exceedance of any of the NAAQS in the planning area.

PSD Contributions at Class I and Sensitive Class II Areas

Air quality impacts were modeled at 26 Class I areas and 58 sensitive Class II areas (Figures 4-1 through 4-4 in **Appendix J** for names and locations of these areas); of these, three Class I areas and 12 sensitive Class II areas are in or within 100 kilometers of the planning area boundary (**Table 3-2** and **Table 3-3**, respectively, in the Farmington Mancos-Gallup 2018 Affected Environment Supplemental Report). PSD incremental concentrations are provided for informational purposes only, as this EIS does not constitute a formal PSD assessment.

The US Environmental Protection Agency (EPA) has defined PSD concentrations increments for eight different pollutant concentration and averaging time combinations. The maximum PSD concentration impacts at Class I and sensitive Class II areas due to Farmington Field Office oil and gas development are shown in **Table EC-10**. Concentrations from the Farmington Field Office are below the PSD thresholds at all Class I and sensitive Class II areas. The highest concentrations occur at the Mesa Verde Class I area and the Aztec Ruins sensitive Class II area. Mesa Verde is 11 miles north of the planning area, while the Aztec Ruins are in the planning area.

Table EC-10
Maximum Concentration at any Class I or Sensitive Class II Area from the Farmington Field Office Projected Oil and Gas Activities[1]

Farmington Field Office - Modeling Scenario	PSD Class I Increment	Max @ any Class I Area	Percent of PSD Class I Increment	Class I Area where Max Occurred	PSD Class II Increment	Max @ any Class II Area	Percent of PSD Class II Increment	Class II Area where Max Occurred
Annual NO_2								
High Scenario	2.5	0.033	1.3	Mesa_Verde	25	1.674	6.7	Aztec_Ruins
Med. Scenario	2.5	0.019	0.7	Mesa_Verde	25	0.947	3.8	Aztec_Ruins
Low Scenario	2.5	0.016	0.7	Mesa_Verde	25	0.828	3.3	Aztec_Ruins
Annual SO_2								
High Scenario	2	0.000	0.0	Mesa_Verde	20	0.003	0.0	Aztec_Ruins
Med. Scenario	2	0.000	0.0	Mesa_Verde	20	0.003	0.0	Aztec_Ruins
Low Scenario	2	0.000	0.0	Mesa_Verde	20	0.001	0.0	Aztec_Ruins
24-hour SO_2								
High Scenario	5	0.001	0.0	Mesa_Verde	91	0.008	0.0	Aztec_Ruins
Med. Scenario	5	0.001	0.0	Mesa_Verde	91	0.008	0.0	Aztec_Ruins
Low Scenario	5	0.000	0.0	Mesa_Verde	91	0.004	0.0	Aztec_Ruins
3-hr SO_2								
High Scenario	25	0.002	0.0	Mesa_Verde	512	0.013	0.0	Aztec_Ruins
Med. Scenario	25	0.002	0.0	Mesa_Verde	512	0.012	0.0	Aztec_Ruins
Low Scenario	25	0.001	0.0	Mesa_Verde	512	0.007	0.0	Aztec_Ruins
Annual $PM_{2.5}$								
High Scenario	1	0.006	0.6	Mesa_Verde	4	0.183	4.6	Aztec_Ruins
Med. Scenario	1	0.003	0.3	Mesa_Verde	4	0.095	2.4	Aztec_Ruins
Low Scenario	1	0.003	0.3	Mesa_Verde	4	0.092	2.3	Aztec_Ruins
24-Hour $PM_{2.5}$								
High Scenario	2	0.063	3.2	Mesa_Verde	9	0.595	6.6	Aztec_Ruins
Med. Scenario	2	0.033	1.6	Mesa_Verde	9	0.316	3.5	Aztec_Ruins
Low Scenario	2	0.032	1.6	Mesa_Verde	9	0.306	3.4	Aztec_Ruins
Annual PM_{10}								
High Scenario	4	0.022	0.6	Mesa_Verde	17	0.828	4.9	Aztec_Ruins
Med. Scenario	4	0.090	0.2	Mesa_Verde	17	0.324	1.9	Aztec_Ruins
Low Scenario	4	0.011	0.3	Mesa_Verde	17	0.416	2.4	Aztec_Ruins
24-Hour PM_{10}								
High Scenario	8	0.186	2.3	Mesa_Verde	30	2.129	7.1	Aztec_Ruins
Med. Scenario	8	0.076	0.9	Mesa_Verde	30	0.862	2.9	Aztec_Ruins
Low Scenario	8	0.094	1.2	Mesa_Verde	30	1.076	3.6	Aztec_Ruins

Source: Appendix J
[1]PSD incremental concentrations are provided for informational purposes only, as this EIS does not constitute a formal PSD assessment. In addition, air quality and AQRVs in sensitive Class II areas are not regulated under the Clean Air Act. These areas are analyzed pursuant to the *Memorandum of Understanding Regarding Air Quality Analyses and Mitigation for Federal Oil and Gas Decisions Through the National Environmental Policy Act Process* (USDA, USDOI, and USEPA 2011).

Table EC-11 shows the contributions of Farmington Field Office oil and gas-related emissions under the high scenario to PSD pollutant concentrations at Class I and sensitive Class II areas in and near the planning area (**Table 3-2** and **Table 3-3**, respectively, in the Farmington Mancos-Gallup 2018 Affected Environment Supplemental Report). As shown in this table, federal oil and gas development in the decision area would be well below the applicable PSD increments for all pollutants at all Class I and sensitive Class II areas in the planning area; medium and low scenario concentrations would be less and are shown in **Appendix J**, Tables 4-14 to 4-17.

Table EC-11
Contributions of Farmington Field Office Emissions to PSD Pollutant Concentrations at Class I and Sensitive Class II Areas for the 2025 High Development Scenario

Pollutant	NO_2 (µg/m³)		PM_{10} (µg/m³)		$PM_{2.5}$ (µg/m³)		SO_2 (µg/m³)	
Averaging Time	**Annual**	**24-hr**	**Annual**	**24-hr**	**Annual**	**3-hr**	**24-hr**	**Annual**
Class I Areas	**PSD Increment**							
	2.5	**8**	**4**	**2**	**1**	**25**	**5**	**2**
Mesa Verde National Park, Colorado	0.033	0.186	0.022	0.063	0.006	0.002	0.001	0.000
San Pedro Parks Wilderness, New Mexico	0.014	0.086	0.010	0.022	0.003	0.001	0.000	0.000
Bandelier National Monument, New Mexico	0.010	0.085	0.009	0.027	0.002	0.001	0.000	0.000
Weminuche Wilderness	0.031	0.121	0.021	0.042	0.006	0.002	0.001	0.000
Sensitive Class II Areas[1]	**PSD Increment**							
	25	**30**	**17**	**9**	**4**	**512**	**91**	**20**
Chaco Culture National Historical Park	0.006	0.066	0.004	0.023	0.001	0.001	0.000	0.000
Aztec Ruins National Monument	1.674	2.129	0.828	0.595	0.183	0.013	0.008	0.003
Canyon de Chelly National Monument	0.001	0.061	0.001	0.044	0.001	0.001	0.000	0.000
Monte Vista National Wildlife Refuge	0.011	0.052	0.008	0.039	0.003	0.000	0.000	0.000
Petroglyph National Monument	0.004	0.054	0.004	0.026	0.001	0.001	0.000	0.000
El Malpais National Monument	0.001	0.028	0.001	0.009	0.000	0.000	0.000	0.000
South San Juan Wilderness	0.057	0.162	0.037	0.050	0.010	0.002	0.001	0.000
Cruces Basin Wilderness	0.024	0.089	0.017	0.024	0.005	0.001	0.000	0.000
Chama River Canyon Wilderness	0.057	0.219	0.333	0.063	0.009	0.002	0.001	0.000
Dome Wilderness	0.007	0.049	0.006	0.020	0.002	0.000	0.000	0.000
Sandia Mountain Wilderness	0.003	0.036	0.004	0.019	0.001	0.000	0.000	0.000

Source: Appendix J
[1]Air quality and AQRVs in sensitive Class II areas are not regulated under the Clean Air Act. These areas are analyzed pursuant to the Memorandum of Understanding Regarding Air Quality Analyses and Mitigation for Federal Oil and Gas Decisions Through the National Environmental Policy Act Process (USDA, USDOI, and USEPA 2011).

The maximum PSD concentration impacts at Class I and sensitive Class II areas due to all sources are shown in **Table EC-12**. In most cases, the maximum concentrations decreased only slightly between the 2011 base case and the 2025 future year under all three scenarios. Exceptions included a large improvement in annual NO_2 at the Bandelier Class I area and the Aztec Ruins sensitive Class II area and a slight worsening of annual $PM_{2.5}$ and PM_{10} at the Valle De Oro National Wildlife Refuge sensitive Class II area and annual PM_{10} at the Bandelier Class I area.

Table EC-12
Maximum Concentration at any Class I or Sensitive Class II Area[1]

Source Group Name	PSD Class I Incre-ment	Max @ any Class I Area	% of PSD Class I Incre-ment	Class I Area where Max Occurred	PSD Class II Incre-ment	Max @ any Class II Area	% of PSD Class II Incre-ment	Class II Area where Max Occurred
Annual NO_2								
Natural Emissions	2.5	5.562	222.5	Bandelier	25	4.281	17.1	Bear Wallow
High Scenario	2.5	6.097	243.9	Bandelier	25	9.901	39.6	Aztec Ruins
Medium Scenario	2.5	6.093	243.7	Bandelier	25	8.783	35.1	Aztec Ruins
Low Scenario	2.5	6.088	243.5	Bandelier	25	8.330	33.3	Aztec Ruins
2011 Base Case	2.5	7.986	319.5	Petrified Forest	25	23.06	92.2	Aztec Ruins
Annual SO_2								
Natural Emissions	2	2.726	136.3	Bandelier	20	2.002	10.0	Bear Wallow
High Scenario	2	2.888	144.4	Bandelier	20	2.270	11.3	Bear Wallow
Medium Scenario	2	2.888	144.4	Bandelier	20	2.270	11.3	Bear Wallow
Low Scenario	2	2.887	144.4	Bandelier	20	2.270	11.3	Bear Wallow
2011 Base Case	2	2.986	149.3	Bandelier	20	2.502	12.5	Bear Wallow
24-Hour SO_2								
Natural Emissions	5	210.991	4219.8	Bandelier	91	108.15	118.8	Bear Wallow
High Scenario	5	211.072	4221.4	Bandelier	91	108.27	119.0	Bear Wallow
Medium Scenario	5	211.072	4221.4	Bandelier	91	108.27	119.0	Bear Wallow
Low Scenario	5	211.072	4221.4	Bandelier	91	108.27	119.0	Bear Wallow
2011 Base Case	5	211.109	4222.2	Bandelier	91	108.73	119.5	Bear Wallow
3-Hour SO_2								
Natural Emissions	25	587.662	2350.6	Bandelier	512	337.32	65.9	Dome
High Scenario	25	587.878	2351.5	Bandelier	512	337.43	65.9	Dome
Medium Scenario	25	587.878	2351.5	Bandelier	512	337.43	65.9	Dome
Low Scenario	25	587.878	2351.5	Bandelier	512	337.43	65.9	Dome
2011 Base Case	25	587.900	2351.6	Bandelier	512	338.09	66.0	Dome
Annual $PM_{2.5}$								
Natural Emissions	1	7.833	783.3	Bandelier	4	6.155	153.9	Bear Wallow
High Scenario	1	9.724	972.4	Bandelier	4	12.140	303.5	Valle De Oro
Medium Scenario	1	9.722	972.2	Bandelier	4	12.137	303.4	Valle De Oro
Low Scenario	1	9.720	972.0	Bandelier	4	12.132	303.3	Valle De Oro
2011 Base Case	1	9.781	978.1	Bandelier	4	11.197	279.9	Valle De Oro
24-Hour $PM_{2.5}$								
Natural Emissions	2	593.477	29673.8	Bandelier	9	332.52	3694.6	Bear Wallow
High Scenario	2	608.768	30438.4	Bandelier	9	342.20	3802.2	Bear Wallow
Medium Scenario	2	608.767	30438.4	Bandelier	9	342.20	3802.2	Bear Wallow
Low Scenario	2	608.767	30438.3	Bandelier	9	342.20	3802.2	Bear Wallow
2011 Base Case	2	609.031	30451.6	Bandelier	9	342.84	3809.3	Bear Wallow

Source Group Name	PSD Class I Incre-ment	Max @ any Class I Area	% of PSD Class I Incre-ment	Class I Area where Max Occurred	PSD Class II Incre-ment	Max @ any Class II Area	% of PSD Class II Incre-ment	Class II Area where Max Occurred
Annual PM_{10}								
Natural Emissions	4	9.282	232.0	Bandelier	17	9.167	53.9	Sevilleta NWR
High Scenario	4	16.212	405.3	Bandelier	17	70.901	417.1	Valle De Oro
Medium Scenario	4	16.205	405.1	Bandelier	17	70.897	417.0	Valle De Oro
Low Scenario	4	16.201	405.0	Bandelier	17	70.890	417.0	Valle De Oro
2011 Base Case	4	13.893	347.3	Bandelier	17	58.983	347.0	Valle De Oro
24-Hour PM_{10}								
Natural Emissions	8	674.493	8431.2	Bandelier	30	372.75	1242.5	Bear Wallow
High Scenario	8	692.086	8651.1	Bandelier	30	383.65	1278.8	Bear Wallow
Medium Scenario	8	692.079	8651.0	Bandelier	30	383.65	1278.8	Bear Wallow
Low Scenario	8	692.079	8651.0	Bandelier	30	383.65	1278.8	Bear Wallow
2011 Base Case	8	692.117	8651.5	Bandelier	30	384.26	1280.9	Bear Wallow

Source: Appendix J

[1]Air quality and AQRVs in sensitive Class II areas are not regulated under the Clean Air Act. These areas are analyzed pursuant to the Memorandum of Understanding Regarding Air Quality Analyses and Mitigation for Federal Oil and Gas Decisions Through the National Environmental Policy Act Process (USDA, USDOI, and USEPA 2011).

Air Quality Related Values

Visibility. Under all scenarios, there are no days that the modeled 2025 FFO oil and gas emissions would cause a change in visibility of greater than 0.5 deciview or 1.0 deciview at any Class I area in or near the planning area (**Appendix J**, Table 5-1).

Under all scenarios, there are no days that the modeled 2025 FFO oil and gas emissions would cause a change in visibility of greater than 0.5 deciview or 1.0 deciview at any sensitive Class II area in or near the planning area, except at the Aztec Ruins National Monument (**Appendix J**, Table 5-1). The number of days above these levels under each scenario are shown in **Table EC-13**.

Table EC-13
Maximum Change in Deciviews at the Aztec Ruins National Monument Sensitive Class II Area[1]

Scenario	Number of Days >0.5	Number of Days >1.0
High Scenario	261	80
Medium Scenario	84	9
Low Scenario	82	6

Source: Appendix J

[1]Air quality and AQRVs in sensitive Class II areas are not regulated under the Clean Air Act. These areas are analyzed pursuant to the Memorandum of Understanding Regarding Air Quality Analyses and Mitigation for Federal Oil and Gas Decisions Through the National Environmental Policy Act Process (USDA, USDOI, and USEPA 2011).

CARMMS 2.0 assessed cumulative visibility impacts due to development of oil and gas and other activities on all BLM planning areas following the recommendations from the US Fish and Wildlife Service (USFWS) and National Park Service (NPS). This approach was based on an abbreviated regional haze rule method that estimates the future year visibility at Class I and sensitive Class II areas for the average of the worst 20 percent (W20%) and best 20 percent (B20%) visibility days with and without the effects of the cumulative emissions on visibility impairment (Section 5.3 in **Appendix J**). Visibility results at Class I and sensitive Class II areas are shown in Tables 5-7 to 5-9 in **Appendix J** for the high, low, and medium development scenarios, respectively. For both W20%

days and B20% days, visibility is predicted to be generally better in the year 2025 than it was in 2011 under all scenarios. The high development scenario reports an average 0.22 deciview improvement on W20% days and a 0.15 deciview improvement on B20% days. The visibility improvement is likely attributable to emissions reductions in non-oil and gas anthropogenic source categories.

Deposition. Annual nitrogen and sulfur deposition contributions for each scenario were compared against the deposition analysis threshold of 0.005 kilograms per hectare per year (kg/ha-yr) for 2025 Farmington Field Office oil and gas activities. Nitrogen deposition at some Class I and sensitive Class II areas in or near the planning area exceeded these values. **Table EC-14** shows the 2025 modeled nitrogen deposition for Class I and sensitive Class II areas in and near the planning area; cells where the deposition analysis threshold are exceeded are shaded in grey. Like PSD increments, the deposition analysis threshold is a project-level threshold that is more appropriate for analyzing specific proposed projects.

Table EC-14
2025 Farmington Field Office Maximum Planning Area New Federal Oil and Gas Contributions to Modeled Nitrogen Deposition Impacts

Farmington Field Office Modeling Scenario	Maximum Nitrogen Deposition (kg/ha-yr)	Average Nitrogen Deposition (kg/ha-yr)
High Scenario		
Class I Areas		
Bandelier Wilderness	0.0074*	0.0067*
Mesa Verde National Park, Colorado	0.0345*	0.0271*
San Pedro Parks Wilderness, New Mexico	0.0120*	0.0091*
Weminuche Wilderness	0.0328*	0.0161*
Sensitive Class II Areas[1]		
Aztec Ruins National Monument	0.1413*	0.1376*
Canyon de Chelly National Monument	0.0014	0.0010
Chaco Culture National Historical Park	0.0045	0.0039
Chama River Canyon Wilderness	0.0364*	0.0247*
Cruces Basin Wilderness	0.0277*	0.0237*
Dome Wilderness	0.0066*	0.0063*
El Malpais National Monument	0.0017	0.0010
Monte Vista National Wildlife Refuge	0.0098*	0.0081*
Petroglyph National Monument	0.0036	0.0034
Sandia Mountain Wilderness	0.0062*	0.0043
South San Juan Wilderness	0.0482*	0.0341*
Medium Scenario		
Class I Areas		
Bandelier Wilderness	0.0042	0.0038
Mesa Verde National Park, Colorado	0.0195*	0.0153*
San Pedro Parks Wilderness, New Mexico	0.0068*	0.0052*
Weminuche Wilderness	0.0186*	0.0091*
Sensitive Class II Areas[1]		
Aztec Ruins National Monument	0.0807*	0.0786*
Canyon de Chelly National Monument	0.0008	0.0005
Chaco Culture National Historical Park	0.0026	0.0022
Chama River Canyon Wilderness	0.0206*	0.0140*
Cruces Basin Wilderness	0.0156*	0.0134*
Dome Wilderness	0.0038	0.0036
El Malpais National Monument	0.0009	0.0006
Monte Vista National Wildlife Refuge	0.0056*	0.0046
Petroglyph National Monument	0.0021	0.0019
Sandia Mountain Wilderness	0.0035	0.0025
South San Juan Wilderness	0.0273*	0.0193*

Farmington Field Office Modeling Scenario	Maximum Nitrogen Deposition (kg/ha-yr)	Average Nitrogen Deposition (kg/ha-yr)
	Low Scenario	
Class I Areas		
Bandelier Wilderness	0.0037	0.0033
Mesa Verde National Park, Colorado	0.0172*	0.0134*
San Pedro Parks Wilderness, New Mexico	0.0060*	0.0045
Weminuche Wilderness	0.0163*	0.0080*
Sensitive Class II Areas[2]		
Aztec Ruins National Monument	0.0712*	0.0694*
Canyon de Chelly National Monument	0.0007	0.0005
Chaco Culture National Historical Park	0.0022	0.0020
Chama River Canyon Wilderness	0.0181*	0.0123*
Cruces Basin Wilderness	0.0137*	0.0117*
Dome Wilderness	0.0033	0.0031
El Malpais National Monument	0.0008	0.0005
Monte Vista National Wildlife Refuge	0.0049	0.0040
Petroglyph National Monument	0.0018	0.0017
Sandia Mountain Wilderness	0.0031	0.0022
South San Juan Wilderness	0.0240*	0.0170*

Source: Appendix J
[1]The deposition analysis threshold is a project-level threshold that is more appropriate for analyzing specific proposed projects.
[2]Air quality and AQRVs in sensitive Class II areas are not regulated under the Clean Air Act. These areas are analyzed pursuant to the Memorandum of Understanding Regarding Air Quality Analyses and Mitigation for Federal Oil and Gas Decisions Through the National Environmental Policy Act Process (USDA, USDOI, and USEPA 2011).
*Indicates that the deposition analysis threshold is exceeded (these cells are also shaded grey).

The annual sulfur deposition contribution was below the deposition analysis threshold of 0.005 kg/ha-yr in all Class I and sensitive Class II areas.

For 2025 total (cumulative) emissions, annual nitrogen deposition levels at Class I and sensitive Class II areas within 100 kilometers of the planning area were compared against a critical load value of 2.3 kg/ha-yr. **Table EC-15** shows Class I and sensitive Class II areas within 100 kilometers of the planning area and their associated 2025 nitrogen deposition levels; values in excess of critical load values are shaded. The fact that there is little change in values across the high, medium, and low scenarios indicates that federal oil and gas activities are not the main driver of regional nitrogen deposition impacts.

According to the CARMMS 2.0 report, all Class I and Class II areas would experience a reduction in annual nitrogen deposition between 2011 and 2025.

For 2025 total (cumulative) emissions, annual sulfur deposition levels at Class I and sensitive Class II areas within 100 kilometers of the planning area were compared against a critical load value of 5 kg/ha-yr. Sulfur deposition levels were below the critical load values at all Class I and sensitive Class II areas under all three development scenarios.

Acid Neutralizing Capacity (ANC). An analysis was performed to assess the change in water chemistry associated with atmospheric deposition from FFO oil and gas activities. This analysis assessed the change in the acid neutralizing capacity of sensitive lakes. Predicted changes in acid neutralizing capacity were compared with a threshold of 10 percent change in ANC for lakes with background acid neutralizing capacity values greater than 25 micro equivalents per liter (μeq/L) and no more than a 1 μeq/L change in acid neutralizing capacity for lakes with background acid neutralizing capacity values equal to or less than 25 μeq/L. The most impacted lake would be Lake South of Blues Lake in in the South San Juan Wilderness Area in southern Colorado, with a predicted change in acid neutralizing capacity of 0.3339 μeq/L under the high scenario, which would be well below the 1.0 μeq/L threshold. Section 7 in **Appendix J** contains a complete listing of sensitive lakes and the predicted change in acid neutralizing capacity for each lake.

Table EC-15
Nitrogen Deposition from Total 2025 Sources for Class I and Sensitive Class II Areas within 100 Kilometers of the Planning Area

Area	Maximum Nitrogen Deposition (kg/ha-yr)	Average Nitrogen Deposition (kg/ha-yr)
High Scenario		
Class I Areas		
Bandelier Wilderness, NM[1]	7.0526*	2.9486*
Mesa Verde National Park, CO	2.2714	2.0241
San Pedro Parks Wilderness, NM	2.0221	1.8944
Weminuche Wilderness	2.1008	1.6242
Sensitive Class II Areas[2]		
Aztec Ruins National Monument, NM	3.6796*	3.6167*
Chaco Culture NHP	3.2284*	1.5106
Canyon de Chelly National Monument, AZ	2.2300	1.3434
Cruces Basin Wilderness, NM	2.0753	1.7757
Chama River Canyon Wilderness, NM	2.2063	1.8721
Dome Wilderness, NM	3.4851*	3.0375*
El Malpais National Monument, NM	1.9295	1.5673
Monte Vista National Wildlife Refuge, CO	1.7027	1.3470
Petroglyph National Monument, NM	3.7103*	2.3813*
Sandia Mountain Wilderness, NM	4.4567*	2.8582*
South San Juan Wilderness, CO	2.1968	1.9442
Medium Scenario		
Class I Areas		
Bandelier Wilderness, NM[1]	7.0459*	2.9417*
Mesa Verde National Park, CO	2.2305	1.9880
San Pedro Parks Wilderness, NM	2.0135	1.8855
Weminuche Wilderness	2.0591	1.6024
Sensitive Class II Areas[2]		
Aztec Ruins National Monument, NM	3.6796*	3.6167*
Chaco Culture NHP	3.2246*	1.5061
Canyon de Chelly National Monument, AZ	2.2278	1.3417
Cruces Basin Wilderness, NM	2.0477	1.7522
Chama River Canyon Wilderness, NM	2.1763	1.8518
Dome Wilderness, NM	3.4788*	3.0309*
El Malpais National Monument, NM	1.9270	1.5658
Monte Vista National Wildlife Refuge, CO	1.6907	1.3375
Petroglyph National Monument, NM	3.7065*	2.3774*
Sandia Mountain Wilderness, NM	4.4513*	2.8530*
South San Juan Wilderness, CO	2.1450	1.9057
Low Scenario		
Class I Areas		
Bandelier Wilderness, NM[1]	7.0361*	2.9315*
Mesa Verde National Park, CO	2.2004	1.9632
San Pedro Parks Wilderness, NM	2.0013	1.8733
Weminuche Wilderness	2.0345	1.5836

Area	Maximum Nitrogen Deposition (kg/ha-yr)	Average Nitrogen Deposition (kg/ha-yr)
Sensitive Class II Areas[2]		
Aztec Ruins National Monument, NM	3.5358*	3.4815*
Chaco Culture NHP	3.2162*	1.4973
Canyon de Chelly National Monument, AZ	2.2199*	1.3345
Cruces Basin Wilderness, NM	2.0284	1.7354
Chama River Canyon Wilderness, NM	2.1534	1.8343
Dome Wilderness, NM	3.4687	3.0204*
El Malpais National Monument, NM	1.9200	1.5609
Monte Vista National Wildlife Refuge, CO	1.6724	1.3241
Petroglyph National Monument, NM	3.6992*	2.3698*
Sandia Mountain Wilderness, NM	4.4401*	2.8417*
South San Juan Wilderness, CO	2.1192	1.8838

Source: Appendix J, Tables 6-7 to 6-12
Critical load values:
2.3 kg/ha-yr for Colorado (nitrogen); the same critical load value was assumed for Arizona and New Mexico
[1]As reported in the CARMMS 2.0 report, most of the nitrogen deposition is due to natural emissions; when natural emission contributions are removed, the value drops below the nitrogen critical load value.
[2]Air quality and AQRVs in sensitive Class II areas are not regulated under the Clean Air Act. These areas are analyzed pursuant to the Memorandum of Understanding Regarding Air Quality Analyses and Mitigation for Federal Oil and Gas Decisions Through the National Environmental Policy Act Process (USDA, USDOI, and USEPA 2011).
*Indicates value above critical load value (these cells are also shaded grey).

Greenhouse Gas Emissions

Projected emissions from oil and gas production were described in **Table EC-2**. It showed projected 2025 GHG emissions (CO_2, CH_4, and N_2O) under the high, medium, and low scenarios for upstream and midstream emissions from federal and nonfederal oil and gas development and operations in the planning area. These emissions are converted to a carbon dioxide equivalent (CO_{2e}) in **Table EC-16**, below.

Table EC-16
2025 Upstream and Midstream Greenhouse Gas Emissions from Federal and Cumulative Oil and Gas Production

Scenario	CO_{2e} Emissions (Million Metric Tons per Year)	% of New Mexico Emissions (Million Metric Tons per Year)	Percent of US Emissions (Million Metric Tons per Year)
Federal Wells			
Low	0.52	0.7	0.01
Medium	0.97	1.3	0.02
High	1.03	1.4	0.02
Nonfederal Wells			
Low	0.22	0.3	0.00
Medium	0.49	0.6	0.01
High	0.44	0.6	0.01
All Wells			
Low	0.74	1.0	0.01
Medium	1.46	1.9	0.02
High	1.47	1.9	0.02

Source: EMPSi staff conversion of GHG emissions in **Table EC-2** to carbon dioxide equivalents (CO_2e), using global warming potentials (GWPs) for the 100-year time horizon of 28 for CH_4 and 298 for N_2O. Each GHG has a GWP that accounts for the intensity of each GHG's heat trapping effect and its longevity in the atmosphere. GWP values allow for a comparison of the impacts of emissions and reductions of different gases. According to the IPCC, GWPs typically have an uncertainty of ±35 percent. GWPs have been developed for several GHGs over different time horizons including 20 years, 100 years, and 500 years. The choice of emission metric and time horizon depends on the type of application and policy context; hence, no single metric is optimal for all policy goals. The 100-year GWP was adopted by the United Nations Framework Convention on Climate Change and its Kyoto Protocol and is now used widely as the default metric. In addition, the EPA uses the 100-year time horizon in its Inventory of US Greenhouse Gas Emissions and Sinks: 1990–2016 (April 2018), GHG Reporting Rule requirements under 40 CFR Part 98 Subpart A, and uses the GWPs and time horizon consistent with the IPCC Fifth Assessment Report, Climate Change Synthesis Report, 2014 in its science communications. In this EIS, the BLM uses GWPs and the 100-year time horizon consistent with EPA.

EC.2.2 Geology

Methods and Assumptions

Indicators

Indicators of topographic or geologic change are generally not used. This is due to the rate and unpredictability of such changes, from sedimentation over millions of years to sudden shifts in surface geology as a result of faulting. Instead, indicators were formed based on the potential effects on geologic resources based on management scenarios discussed in the FMG RMPA/EIS. As such, the indicators are as follows:

- Damage to unique geologic features
- The availability of culturally important minerals for traditional users to gather

Assumptions

The analysis includes the following assumption: Alternatives that reduce the number of wells drilled will result in less surface disturbance and a lower potential to affect culturally important minerals.

Nature and Type of Effects

Because the planning area is in the San Juan Basin which is part of the larger geologically stable Colorado Plateau that there is less potential for induced seismicity. Induced seismicity is mentioned here because it is a common concern in areas of hydraulic fracturing and wastewater injection, but it is not discussed further in this section. The US Geological Survey (USGS) earthquake mapper does not show any earthquakes in the project area with a magnitude greater than 3.0 on the Richter scale in the last 20 years (USGS 2018).

Groundwater extraction can contribute to a phenomenon known as ground subsidence. Ground subsidence is the reduction in the elevation of the land surface due to the removal of groundwater and subsequent compression of sediments. In some cases, ground subsidence can result in the formation of sinkholes, damage to utilities, roads, buildings and geologic features. Additional groundwater extraction for use in hydraulic fracturing could exacerbate ground subsidence. The propensity of an area to ground subsidence is based on the composition of the underlying formations. The project area does not appear to have a history of existing ground subsidence issues, suggesting that additional groundwater extraction for oil and gas development activities is unlikely to cause drastic subsidence (USGS 2000).

Alternatives that would continue to manage the two BLM areas of unique geologic significance, Angel Peak and Beechatuda Tongue, with an NSO stipulation would reduce the potential for damage to these features. Other culturally significant geologic features would be identified and impacts would be mitigated through the National Historic Preservation Act (NHPA) Section 106 consultation process. **Section EC.4.9**, Cultural Resources, includes further information on this consultation process and how it would mitigate impacts on cultural resources.

Traditional users gather certain minerals such as iron pyrite for use in traditional cultural practices. Alternatives that would result in less surface disturbance would reduce the potential for impacts on traditional mineral gathering areas. Impacts on specific areas used for gathering minerals would be assessed and mitigated through site-specific analysis at the leasing or APD phase.

Traditional Navajo beliefs include that Earth is the mother of the Navajo people and that they are guided by hózhó—a concept that is both a way of living and a state of being, emphasizing all-inclusiveness in the environment and such concepts as beauty, perfection, and harmony.

Given these beliefs, some Navajo feel hydraulic fracturing and oil and gas extraction from geologic formations would disrupt hózhó and thereby harm the Navajo people. For example, this could reduce the ability of cultural practitioners to complete traditional ceremonies, especially those that directly address the geology of the earth, such as the Red Ant Way (Begay 2001).

Further, impacts on geologic formations could affect their use, such as tséyáłti' dahólóógóó (Talking Rocks) that aid in diagnoses for Navajo people before certain ceremonies. While these are examples of the types of indirect impacts on CIMPPs for Navajo Tribal members, other Tribes may have similar (or dissimilar) indirect effects on the CIMPPs that they consider important. **Section EC.7.1**, Native American Tribal Interests and Uses, provides more information.

Alternatives that permit more ROWs could have a greater impact on unique geologic features and the mineral gathering areas. This would be due to the potential for increased surface disturbance.

Managing vegetation would have a negligible impact or no impact on geology and is, therefore, not discussed in detail.

EC.2.3 Water Resources

Methods and Assumptions

Indicators

Indicators of impacts on water resources are as follows:

- Alteration of the physical characteristics of streams, springs, seeps, and groundwater that affects the sustainability of these resources
- Ability to maintain sustainable yield of water resources, such as aquifers
- Miles of impaired streams that would be in areas open or closed to surface-disturbing activities
- Acres of land open or closed to surface-disturbing activities

Assumptions

The analysis includes the following assumptions:

- Projects that help restore watersheds, desirable vegetation communities, or wildlife habitats (including surface disturbance associated with these efforts) would benefit water resources over the short term and long term.
- Conforming with and attaining New Mexico's Standards and Guidelines ensures that the Fundamentals of Rangeland Health are met on BLM-managed lands.
- The degree of impact attributed to any one disturbance or series of disturbances would be influenced by several factors, including proximity to drainages and groundwater wells, location in the watershed, time and degree of disturbance, reclamation potential of the affected area, vegetation, precipitation, and mitigating actions applied to the disturbance.
- Surface-disturbing actions related to fluid mineral development would comply with onshore orders and the BLM Gold Book surface operating standards (and subsequent updates; BLM and Forest Service 2007).
- New transportation facilities (roads, sandstone pits, storage maintenance sites, or for fluid mineral development and ROWs) would be properly designed.
- Aquifers with shallower depths to water are more susceptible to contamination occurring at the surface. Fluid mineral development is the primary BLM-authorized activity with a potential to affect

groundwater quality and quantity. Locations in the planning area with shallow groundwater would be considered the most likely to be affected by mineral development. Shallow groundwater would be more vulnerable to leaks and spills of contaminants at the surface, as well as surface and underground mine dewatering; however, groundwater at greater depths would be vulnerable to casing failure, hydraulic fracturing, and drilling. Greater levels of fluid mineral development would require greater quantities of water.

- Fuels projects and planned and unplanned fires that contribute to establishing a more natural fire regime would have long-term benefits on water quality. There could be short-term impacts on water from unplanned fires (or other vegetation treatments) even if it benefits water in the long term.
- Riparian conditions and water quality are directly related, and improvements to riparian/wetland conditions would tend to improve water quality.
- Use of water from oil and gas development on BLM-managed or BIA-managed lands could reduce the finite water supply available to other users or for other beneficial uses.
- Water Resource is a natural resource; however, from a Navajo perspective it is one of the four core elements that make up the Navajo Universe.

Nature and Type of Effects

Surface-disturbing activities, such as well development, motorized travel, livestock grazing, and ROW development, can remove essential soil-stabilizing agents, such as vegetation, soil crusts, litter, and woody debris. These soil features function as living mulch by retaining soil moisture and discouraging annual weed growth (Belnap et al. 2001). Loss of one or more of these agents increases potential erosion and resulting sediment transport to water bodies, leading to water quality degradation.

Surface-disturbing activities carry more erosion risks in areas of low reclamation potential, sensitive areas (such as stream channels, floodplains, and riparian habitats), and areas prone to drought. Examples of low reclamation potential are soils with severe wind erosion susceptibility, severe or very severe water erosion susceptibility, and low restoration potential or soils in badlands or on rock outcrops. Disturbance in all these areas creates greater potential for erosion and sediment delivery to surface waters affect the physical characteristics of streams. Sedimentation can affect water quality and the physical characteristics of streams. In addition, reducing vegetation cover may lead to higher water temperatures. This would further affect the physical characteristics of streams.

Surface-disturbing activities in stream channels, 100-year floodplains, and riparian habitats are more likely to alter natural stability and 100-year floodplain function. For example, livestock seek out water and shade in riparian areas, leading to trampling and overgrazing of streambanks, soil erosion, loss of streambank stability, and declining water quality (Belsky et al. 1999). Destabilization and loss of 100-year floodplain function accelerate stream channel and bank erosion, increase sediment supply, and dewater near-stream deposits.

Surface-disturbing activities, such as road and mineral development, ROWs, and livestock grazing, can compact soil, which decreases infiltration rates and elevates the potential for increased overland flow. For example, during oil and gas development, soils compacted on existing roads, new access roads, and well pads generate more runoff than undisturbed sites. The increased runoff can lead to higher overland flows into streams, potentially increasing erosion of the channel banks. The increased runoff can also lead to more sediment delivery to surface water, resulting in increased turbidity (Tribal Energy and Environmental Information Clearinghouse 2018).

Reduced percolation of water through compacted soil can reduce groundwater flow. Reduced groundwater flow can affect surface water quantity by limiting the volume of water delivered to seeps and springs where water comes to the surface. These impacts could be short term or long term, depending on the type and amount of surface disturbances and local conditions.

The compaction of unconsolidated aquifer systems that can accompany excessive ground-water pumping is by far the single largest cause of subsidence. More information on subsidence is located in **Section EC.4.2**, Geology, The overdraft of such aquifer systems has resulted in permanent subsidence and related ground failures. In aquifer systems that include semiconsolidated silt and clay layers (aquitards) of sufficient aggregate thickness, long-term ground-water-level declines can result in a vast one-time release of “water of compaction” from compacting aquitards, which manifests itself as land subsidence. Accompanying this release of water is a largely nonrecoverable reduction in the pore volume of the compacted aquitards, and thus a reduction in the total storage capacity of the aquifer system. This “water of compaction” cannot be reinstated by allowing water levels to recover to their predevelopment status. The extraction of this resource for economic gain constitutes “ground-water mining” in the truest sense of the term (USGS 2000).

Certain surface-disturbing activities, such as road and well developments and occasionally wildfires, can remove vegetation completely. Other activities, such as prescribed fires or livestock grazing, may reduce the resiliency and vigor of vegetation. The loss of vegetation can increase soil instability, because plants would no longer be present to hold soil in place. Also, fires can cause soil surfaces to harden. Instead of the rain soaking into the soil, rainwater and melted snow can rush across the hardened surfaces, gaining enough power to erode loose sediments (USGS 2018a). This would result in sediment transport to surface water bodies, leading to water quality degradation.

Removing vegetation, and in turn, plants that absorb water, can also increase overland flow and lead to higher overland flows into streams, potentially increasing erosion of the channel banks. The increased runoff can also lead to more sediment delivery to surface water, resulting in increased turbidity. Impacts from vegetation removal may be short term or long term, depending on the degree and location of vegetation removal. Management actions to promote species diversity, restore vegetation to damaged areas, and limit long-term surface-disturbing activities on vegetation generally reduce impacts on water resources.

Vegetation treatments can involve vegetation thinning, fire breaks, habitat restorations, plantings, and seedings, and often make use of a combination of treatment methods. Treatments that improve soil stability benefit surface water by minimizing the potential for erosion. Also, treatments both in lowland riparian and upland vegetation areas that promote appropriate vegetation conditions and promote species diversity can help maintain or restore watershed function.

Controlling noxious weeds and invasive plants would indirectly improve water quality and quantity by reducing erosion. Noxious weeds tend to outcompete native species, creating monocultures, which are typically poorly suited to protect soils from erosional forces and can alter water movement in the soil (Westbrooks 1998). Increased erosion and sediment delivery to water bodies can change water chemistry and alter stream channel morphology.

Treatment methods for noxious weed and invasive plant management involve an integrated approach that minimizes impacts on the environment and human health. This would include following the most current vegetation treatment EIS record of decision and following label instructions for the application of herbicides. Herbicides would be applied so that they do not contaminate surface water or groundwater.

Surface-disturbing activities associated with mineral exploration and development in areas open to development are such activities as road construction and use, facility construction, well pad and pipeline construction, and minerals excavation. These activities would affect soils through vegetation removal, soil compaction, and soil erosion. If this happens near a surface water resource, it could result in additional sediment delivery, which can alter water quality over the short and long term (Tribal Energy and Environmental Information Clearinghouse 2018).

During the drilling/development phase, water would be required for dust control, making concrete, consumptive use by the construction crew, and in drilling of wells. Depending on availability, water may be trucked in from off-site or obtained from local groundwater wells or nearby surface water bodies. Where surface waters are used to meet drilling and development needs, depletion of stream flows could occur. Drilling and well development often remove groundwater. The generation of produced water can deplete nearby aquifers. Also, produced groundwater that is saline or contaminated with drilling fluids can contaminate soils or surface waters if brought to the surface and unintentionally spilled or not reinjected to a suitable subsurface unit. Produced water also may contain organic acids, alkalis, diesel oil, crankcase oils, and acidic stimulation fluids (e.g., hydrochloric and hydrofluoric acids; Tribal Energy and Environmental Information Clearinghouse 2018). Also, unintended spills from fluid mineral operations (that involve drilling fluids, diesel, etc.) and improperly maintained facilities or improperly stored materials (such as drilling fluids) can contaminate surface water or groundwater.

Mineral development can involve the disposal of drilling fluids outside of a basin or injection of wastewater into deep wells. This can directly reduce the supply of groundwater. If the rate of aquifer depletion exceeds the rate of recharge, groundwater aquifers can shrink, permanently reducing water supply and altering the aquifer (USGS 2016). Reduced groundwater flow can affect surface water quantity by limiting the volume of water delivered to streams, seeps, and springs. Also, properly constructed wells prevent drilling fluids, hydraulic fracturing fluids, deep saline formation waters, or oil and gas from entering aquifers. As with any industrial process, accidents can occur during hydraulic fracturing. In particular, improperly constructed wells can allow fluids to migrate up from deep formations and into shallow aquifers, and improperly contained surface spills can potentially contaminate surface water (USGS 2018b). The impacts on water quantity and quality from mineral development can be short term or long term, depending on the rate of use or the water source and whether the water is recycled. The BLM has permitted at least one water recycling facility and several operators are currently using recycled water in their hydraulic fracturing operations within the planning area.

Protective minerals stipulations would reduce soil and vegetation disturbance, help to improve riparian areas, and indirectly protect water quality over the long term. This would occur by reducing the potential for altering the physical characteristics of surface water features.

ROW avoidance and exclusion areas would reduce surface-disturbing activities or cause them to be avoided. Additionally, ROW corridors could concentrate large linear facilities and other ROW development in less sensitive or previously disturbed areas, reducing the potential for increased erosion and sediment delivery.

Areas managed to maintain wilderness characteristics would have restrictions on certain uses and activities, such as ROW development. This would protect these areas from surface-disturbing activities that could remove or weaken vegetation, increasing erosion and sediment delivery into streams. These areas directly protect waters from surface-disturbing activities over the long term.

ROW avoidance areas would provide some protection from surface-disturbing activities. If there were ROWs in these areas, they would likely require mitigation measures to minimize impacts on identified resources. If surface disturbances were to occur, there could be indirect, short-term impacts on water quality from increased erosion and sediment delivery into streams. In areas available for ROW routes, the following could also indirectly affect water resources in the short term: surface-disturbing activities from new transmission lines, access roads, or other utilities. This would occur from increased erosion and sediment delivery into streams.

EC.2.4 Riparian Areas and Wetlands

Methods and Assumptions

Areas discussed are those outside of the River Tracts ACEC's. River Tract ACEC's management will not be changing in this RMPA.

Indicators

Indicators of impacts are as follows:

- Any unmitigated loss of riparian areas, wetlands, or wetland function
- Projected change in condition of existing wetland and riparian vegetation, including maintenance of or movement toward or away from BLM management of proper functioning condition (PFC) (e.g., increase in noxious weeds or invasive plants)
- Alteration of the physical characteristics of watersheds, streams, riparian and wetland areas, and groundwater aquifers to a point that they no longer achieve the BLM's or BIA's resource objectives or are no longer sustainable or functioning properly

Assumptions

The analysis includes the following assumptions:

- Impacts on riparian and wetland areas on BLM-managed and BIA-managed lands would be similar.
- Riparian conditions and water quality are directly related, and improvements to riparian and wetland conditions would tend to improve water quality and vice versa.
- The degree of impact attributed to any one disturbance or series of disturbances would be influenced by location in the watershed; the type, time, and degree of disturbance; existing vegetation; precipitation; and mitigating actions applied to the disturbance.
- Wetland and riparian vegetation, hydrology, and erosion/deposition are important processes of wetland and riparian functional condition, as described in BLM Technical References 1737-15 and 1737-16 (Prichard et al. 1998). Actions that affect vegetation, hydrology, and erosion/deposition will affect the wetland and riparian functional condition indicators.
- BLM-managed designated riparian areas would continue to have seasonal livestock grazing restrictions. Conforming with and attaining New Mexico's Standards and Guidelines ensures that the Fundamentals of Rangeland Health are met. Grazing authorizations would be adjusted on a case-by-case basis, when site-specific studies indicate changes in management are needed.

Nature and Type of Effects

In general, increasing surface disturbance from human activities could increase erosion or runoff rates in riparian and wetland areas. This would have impacts by increasing deposition in wetland and riparian areas, changing the physical characteristics of riparian and wetland areas, decreasing condition and moving these areas away from PFC, or resulting in wetland and riparian vegetation loss. This could lead to damaged vegetation, loss of hydrologic function and wildlife habitat, and reduced water retention.

Further, activities that reduce vegetation cover both in riparian and upland vegetation would expose soil, indirectly causing more runoff and increasing the likelihood of stream bank erosion. Higher runoff and erosion would cause additional vegetation to be washed away. It also would increase sediment loading, which would be compounded because riparian and wetland areas trap sediment and nutrients running off adjacent areas (Lee et al. 2003). When riparian and wetland vegetation cover is reduced, this ecosystem service may be impaired. The magnitude of impacts from surface-disturbing activities would depend on the type, extent, and duration of activities.

Fluid mineral exploration and development and ROW development in open areas would affect riparian areas and wetlands as described above and would disturb soils, remove or fragment wetland and riparian vegetation, and increase the potential for noxious weed and invasive plant establishment and spread. If noxious weeds or invasive plant species were to become established in wetland and riparian areas, these species could outcompete native vegetation and alter the species composition and diversity of wetland and riparian vegetation. This would affect functional class through changes in vegetation composition and noxious weed and invasive plant cover. Closing areas to leasing or restricting uses in wetland and riparian areas would help maintain wetland and riparian functional class. Impacts would be more likely in areas open to ROWs and likely not occur in ROW avoidance areas. Impacts would be prevented in ROW exclusion areas.

Wetland and riparian areas are particularly vulnerable to all impacts on water resources because they are the interface between groundwater and land surface (Sutter et al. 2015). Impacts from fluid mineral development on wetlands and riparian areas can come from contaminated surface water, well pad construction, increased areas of impervious surfaces, and depleted local water resources. Impacts of development on water resources are discussed further in **Section EC.4.4**, Water Resources.

Through the process of hydraulic fracturing, returned water contains a mix of injection fluid and brine from within the rock strata (Sutter et al. 2015). If this fluid is not properly collected and treated, it can contaminate aquatic resources (Sutter et al. 2015). In an experimental forest in 2011 vegetation sprayed with hydraulic fracturing fluid resulted in severe damage and high mortality rates (Adams 2011). The brine in hydraulic fracturing fluid is high in chloride; chloride concentrations have been found to be the cause of contamination in many wetlands throughout the prairie pothole region of the United States (Post Van der Burg and Tangen 2015).

Additionally, hydraulic fracturing requires millions of gallons of water, and these water withdrawals may stress wetlands and riparian systems by further depleting local water resources (Sutter et al. 2015). As a result, riparian and wetland areas could decrease condition and move away from PFC, and riparian and wetland vegetation could die or suffer reduced vigor.

Climate changes or fluctuations may affect wetland and riparian vegetation extent and functional condition. This is because it contributes to changes in streamflow, temperature, and snowpack across the western United States (Barnett et al. 2008). Precipitation patterns will continue to shift, resulting in decreased winter snowpack and increased precipitation falling as rain (Garbrecht et al. 2004; Burris and Skagen 2013).

Decreased winter snowpack also decreases the short-term spring runoff and the long-term moisture availability in wetland and riparian systems during the dry summer and fall (Assal et al. 2015). The impacts of reduced moisture availability may allow drought-tolerant, invasive plant species, like tamarisk (*Tamarix* spp.), to expand (Bisson et al. 2003; Polley et al. 2013). This would reduce the functional condition of wetland and riparian areas. Drought-stressed wetland and riparian vegetation may be more susceptible to wildfire, which could increase in extent and frequency (Stocker et al. 2013), reducing wetland and riparian vegetation and moving these areas away from PFC.

Management to protect lands with wilderness characteristics may restrict or reduce surface-disturbing activities, including mineral development. As a result, such management would help to prevent the impacts on riparian areas and wetlands described above. Existing riparian and wetland areas would be retained, and some areas would have improved conditions and move toward PFC.

Fluid mineral exploration and development and ROW development have the potential to affect riparian areas as road and pipeline ROWs cross ephemeral riparian areas at times. This may cause increases in erosion and deposition caused by the loss of vegetation and bank stability. Impacts would be more likely in areas open to ROWs and would likely not occur in ROW avoidance areas. Impacts would be prevented in ROW exclusion areas. Avoidance of destruction of vegetation trend and monitoring plots and rangeland improvements would help ensure long-term data are preserved for scientific studies.

Some vegetation management actions may have short-term impacts as described in **Section EC.4.2**, Upland Vegetation and Soil. Over the long term, activities in riparian areas and upland areas such as noxious weed and invasive plants removal, fuels reduction, native species plantings, erosion control, and wetland creation and restoration, would improve wetland and riparian conditions by improving species composition and hydrology.

EC.2.5 Upland Vegetation and Soils

Methods and Assumptions

The methods of analysis are the same for BLM- and BIA-managed lands and fluid minerals, unless otherwise noted.

Indicators

Indicators of impacts on upland vegetation and soil resources are as follows:

- Changes in the condition, cover, density, quality, diversity, and distribution of native vegetation communities and individual native plant species
- Changes in LANDFIRE VCC (for vegetation on BLM-managed lands only)
- Habitat fragmentation and disruption of landscape connectivity and habitat corridors
- Changes in age class distribution and successional stages that lead to less diversity in age classes and more vulnerability to disturbance
- Declining soil surface resiliency and condition, as expressed through physical or chemical degradation, either with soils unable to support vegetation or soils that are not functioning at potential for a particular ecological site (e.g., vegetation type, diversity, density, cover, and vigor)
- Acres protected from or open to surface-disturbing activities
- Acres with fragile soils susceptible to erosion that would be open or closed to surface-disturbing activities
- Areas with sensitive soils (e.g., biological soil crusts and badlands) that would be protected from or open to surface-disturbing activities

Assumptions

The analysis includes the following assumptions:

- The BLM has mapped vegetation throughout the planning area; however, it did not complete condition inventories. The conditions of these resources were estimated, based on existing knowledge.
- The BIA completed range inventories throughout the planning area.
- Annual fluctuation of weather patterns would continue to influence the resiliency and condition and productivity of plant communities.
- Short-term disturbance is expected to begin and end in the first 2 years after the action is implemented; long-term disturbance is defined as lasting beyond 2 years to the end of, or beyond, the 20-year planning time frame addressed in the RMPA.
- Permitted uses such as livestock grazing, and community development would continue in the planning area.
- Conforming with and attaining New Mexico's Standards and Guidelines ensures that the Fundamentals of Rangeland Health are met. Grazing authorizations would be adjusted on a case-by-case basis, when site-specific studies indicate changes in management are needed.
- Soils would be managed to maintain inherent productivity and to promote sustained yields. At the same time, BMPs will keep surface disturbance at minimal acceptable levels, thus preventing physical or chemical degradation. Proposed surface-disturbing projects would be analyzed to determine the suitability of soils to support or sustain such projects, and the projects would be designed to minimize soil loss.

- Conforming with and attaining New Mexico's Standards and Guidelines ensures that the Fundamentals of Rangeland Health are met on BLM-managed lands. Grazing authorizations would be adjusted on a case-by-case basis, when site-specific studies indicate changes in management are needed.
- Land management would be consistent with soil resource capabilities.
- Fuels projects and wildland fires that contribute to establishing a more natural fire regime would result in long-term benefits to soil resiliency and condition.
- Roads and trails and their use contribute to soil compaction and erosion. Higher road and trail densities would result in more of these impacts on soil resources. Roads and trails that receive more traffic would be at greater risk for soil erosion, unless they are improved.
- All surface-disturbing activities include mitigation, standard operating procedures (SOPs), and/or BMPs to reduce impacts on soil resources; these would be addressed at the site-specific project level. Erosion controls and other mitigation measures, when implemented, would minimize soil erosion.
- As slopes approach 30 percent, the risk of soil instability following disturbance increases, particularly if cover, structure, permeability, or bulk density has been altered (Monsen et al. 2004).
- Soils with high erodibility have a lower probability of success for restoration than soils with less erosion potential.
- It is not possible to predict when or where the surface disturbance would occur in the planning area; therefore, unless the surface use is not allowed, the assumption is that fragile soils could be disturbed.

Nature and Type of Effects

In general, management of upland vegetation and soil resources includes protecting soil and vegetation resiliency and condition and structure by limiting ground disturbance. Impacts on vegetation and soil from such activities as oil and gas development and grazing include disrupting, damaging, or removing vegetation, thereby reducing area, amount, or condition of native vegetation. Included among these are actions that reduce the total numbers of plant species and actions that reduce or cause the loss of diversity, vigor, or structure of vegetation, or that degrade its function as wildlife habitat or traditional plant gathering areas. Surface-disturbing activities would reduce vegetative ground cover and increase soil compaction or removal. Loss of vegetation would expose soil to accelerated wind and water erosion and would result in the irretrievable loss of topsoil and nutrients. This disturbance would also change soil structure, heterogeneity (variable characteristics), temperature regimes, nutrient cycling, biotic richness, and diversity.

Fewer impacts on vegetation would occur in previously disturbed or developed areas because past and current use has already affected these areas, although further impacts could still occur.

Vegetation treatments are implemented to restore natural and/or desired vegetation conditions. Short-term direct impacts may occur from surface disturbance, soil compaction, habitat enhancements, forage improvements, fuels treatments, restoration and rehabilitation, and vegetation, such as weeds, treatments.

Some vegetation treatments would directly alter age class distribution by converting areas of later seral vegetation to an earlier seral stage. Some restoration treatments could encourage development of later seral vegetation by introducing later seral species through seeding or planting or by speeding up seral transition times through actions like thinning woodland stands. Fuels treatments could affect natural fire patterns and frequencies, thereby reducing the incidence of large or severe wildfires (Van Leeuwen 2008) and the amount of early seral post-burn vegetation.

Habitat connectivity could be increased through vegetation treatment designed to restore vegetation or seral transition of an area to better match the surrounding vegetation. Vegetation treatments that change age class distribution within a larger area of a given age class could directly reduce habitat connectivity. Changes in age class, seral stage, and habitat connectivity could change vegetation community conditions, for example; the BLM LANDFIRE VCC could be changed if indicators move farther from the desired conditions. Surface-disturbing activities on areas with biological soil crusts can reduce lichen and moss cover and the overall species richness of the crusts, which can take 50 to 100 years to recover. Soil disturbance typically compacts soils or increases erosion. Compaction influences the capacity of soil to hold water and nutrients, which can change soil crust community species composition. These subtle compositional changes often occur before cover changes are apparent.

Soil structure alteration as a result of soil compaction can also reduce infiltration rates. Available soil moisture results from a complex interaction of many soil and plant characteristics, including infiltration, soil moisture-holding capacity, and plant root density (Belnap et al. 2001). Altering such characteristics would reduce the soil system's ability to adapt to climate change and to withstand future disturbances.

Limiting surface-disturbing activities, especially in areas with fragile soils, steep slopes, or biological soil crusts, would help maintain soil components by limiting human impacts. This would improve soil resiliency and functionality by increasing vegetation cover, soil development, soil organic matter, soil fertility, and water-holding capacity and by reducing soil loss from wind and water erosion.

Vegetation stabilizes soils and reduces the effects of wind and water erosion. When vegetation is properly maintained, soil resiliency and condition is protected. Actions that maintain or improve vegetation are improving or restoring desirable plant cover and limiting the extent or expansion of noxious weeds and invasive plants.

Vegetation management, such as vegetation treatments, is the practice of promoting desirable, stable plant communities using appropriate, environmentally sound, and cost-effective control methods. Although some vegetation management would disturb the soil surface in the short term (which can result in wind and water erosion), management designed to enhance native vegetation would promote nutrient cycling, soil development, soil biodiversity, and site stability in the long term. Vegetation management may initially disturb soils by removing undesirable vegetation (through, for example, prescribed fire, chemical treatments, or planting native seed), which can increase wind and water erosion in the short term. Vegetation management may have varying levels of success that may or may not improve soil conditions for years after the initial disturbance. Vegetation management would be implemented to achieve or trend toward enhancing and achieving rangeland resiliency; this would result in long-term, indirect impacts by improving soil stability and reducing wind and water erosion by enhancing ecosystem function and vegetation diversity.

Avoidance of destruction of vegetation trend and monitoring plots and rangeland improvements would help ensure long-term data is preserved for scientific studies.

Soils that are not considered fragile tend to respond well to vegetation restoration. This is due to more suitable soil conditions, such as low salt content, adequate water retention, and soil depth for available rooting depth. Soils with biological soil crusts may require additional management to prevent undue degradation of the microbial communities during vegetation management.

Examples of surface-disturbing activities associated with fluid minerals exploration and development in areas open to development are road construction and use, facility construction, and minerals excavation. These activities would directly affect soils through vegetation removal, soil compaction, and wind and water erosion. For example, vehicles and humans trample vegetation and reduce the lichen/moss cover in biological soil crusts; this reduces crust species richness. These impacts on soils would be greater where hydraulic fracturing is used due to the increased truck traffic and human presence associated with this process compared with conventional oil and gas development.

Soil compaction may also affect the size and abundance of plants by reducing moisture availability and precluding adequate taproot penetration to deeper horizons (Ouren et al. 2007). Furthermore, surface-disturbing activities could increase dust, which could cover vegetation and impair plant photosynthesis and respiration. The resulting indirect impacts could lower plant vigor and growth rate, alter or disrupt pollination, and increase susceptibility to disease, drought, or insect attack. As a result, surface-disturbing activities could affect the density, composition, and frequency of species in an area, thus affecting the condition of native vegetation. Impacts from fluid mineral development are regulated and mitigated through federal, Tribal, and state laws. Other impacts are regulated by stipulations and conditions of approval, which can reduce the level of soil disturbance for a project on a case-by-case basis. Once minerals extraction is complete, restoration methods may result in varying levels of soil and plant resiliency and condition.

Surface-disturbing activities associated with land use authorizations would have impacts similar to those involving minerals, above. Vegetation loss would be caused by road and ROW construction, which could compact soil and increase wind and water erosion rates, depending on reclamation and authorized use requirements. Typically, the footprints of authorized activities are localized and cover a small area, but ROWs can be linear and may stretch for miles. ROW avoidance and exclusion areas would reduce or avoid impacts on soil resources and biological soil crusts. Additionally, ROW corridors can concentrate large linear facilities and other ROW development in less sensitive or previously disturbed areas, thereby reducing the total acreage of soil disturbance.

Pipelines would continue to follow existing roads, where feasible, in order to minimize surface disturbance and potential impacts on soils, vegetation, and habitats.

To accommodate multiple wells being drilled from one well pad location, utilizing horizontal drilling, the well pads are larger in size than typical vertical wells. This is required to provide enough room for more equipment on the location during drilling and fracturing; however, consolidation of multiple well heads on one well pad would create less overall disturbance to vegetation than drilling single wells from numerous well pads.

Once the permitted activities are complete, restoration and reclamation may result in varying levels of vegetation community resiliency and condition over the short and long term. Restoration and reclamation procedures are critical to mitigating the impacts on soil as previously described. There are also large-scale vegetation treatments that manipulate vegetation, causing minimal surface disturbance, such as aerial chemical treatments, tebuthiuron, and weed spraying. Habitat improvement projects, using mechanical treatment methods for resource management, would disturb the surface in the short term through vegetation removal and manipulation; however, this management would ultimately improve vegetation conditions over the long term.

Managing lands to protect wilderness characteristics as a priority over other multiple uses would restrict certain uses and activities, such as mineral and ROW development, and would close the areas to off-road motorized vehicles and road construction. This would protect vegetation and soils from the impacts associated with surface-disturbing activities.

Various surface-disturbing activities may be authorized under all visual resource management (VRM) classes; however, these activities would have to occur in such a way as to meet the VRM class objective for the area. The management objective for VRM Class I and Class II requires preserving or retaining the visual character of the landscape. Because of this, surface-disturbing activities are designed or modified so they repeat the basic elements of form, line, color, and texture found in the predominant natural features of the characteristic landscape. In VRM Class III and Class IV areas, approved surface-disturbing activities are likely to modify the character of the landscape.

Impacts on vegetation and soil are more likely to occur in easily accessible areas, where visitation would be high, and in areas open to cross-country travel, particularly motorized use and, to a lesser extent, mechanized use.

Potential weather fluctuations could affect a variety of vegetation species and habitat; some species may benefit from these changes, while others may be negatively affected. Fluctuations in temperature and precipitation patterns may drive changes in timing and geographic ranges for plant species. Additionally, the increased occurrences of fires, insect pests, disease pathogens, and invasive weed species are likely to continue as a result of changing weather patterns (BLM 2010).

EC.2.6 Noxious Weeds and Invasive Plants

Methods and Assumptions

Indicators

Indicators of impacts are as follows:

- Increase in noxious weeds and invasive plants
- The degree to which areas are open to surface-disturbing activities
- The type of vegetation treatments that would be allowed under each alternative
- The noxious weed and invasive plant treatment methods that would be available under each alternative

Assumptions

The analysis includes the following assumptions:

- Noxious weed inventories were not completed throughout the planning area. The conditions of these resources were estimated, based on existing knowledge.
- Annual weather fluctuations and increases in surface disturbance and resultant transport by oil and gas development vehicles and personnel would continue to influence the spread of noxious weed populations and invasive plants.
- The integrated weed management plan under development by the BIA would guide management of noxious weeds and invasive plants on the Navajo Nation, once it is published.

Nature and Type of Effects

Noxious weeds and invasive plants change the vegetation condition by outcompeting native plants for space, water, nutrients (Sakai et al. 2001), and other resources and by preventing native species seedlings to germinate and become established. All types of vegetation treatments affect noxious weeds and invasive plants, both directly and indirectly.

Among the different types of vegetation treatments, weed treatments are the most likely to directly reduce noxious weeds and invasive plants; however, they can also result in unintended damage to native, desirable species (Crone et al. 2009). Other vegetation treatments often result in an unintended increase of noxious weeds and invasive plants through associated soil disturbance, seed and soil introductions, and reduced native species competition (Merriam et al. 2006).

Wildland fire increases the opportunity for noxious weeds and invasive plants to establish populations and to expand. Vegetation treatments, such as controlled burns or any treatment that increases the risk of wildfires, would also increase the risk of noxious weeds and invasive plants expansion; conversely, fire suppression can indirectly limit noxious weed expansion.

Surface disturbance could occur as a result of permitted activities, such as fluid mineral exploration and development or ROWs; casual use, such as recreation and motorized vehicle use; and resource management, such as fire suppression and fuels treatments.

Permitted surface-disturbing activities often involve removing vegetation, making communities less able to compete with noxious weeds and invasive plants, which would encourage the spread of invasive plants. Activities that would disturb soils could cause soil erosion, topsoil loss, and soil compaction. Any of these conditions could affect the ability of native vegetation to regenerate and could indirectly facilitate noxious weed and invasive plant infestation.

NSO stipulations and ROW exclusion areas would not allow surface-disturbing activities and thus would reduce the likelihood of noxious weeds and invasive plants spread or establishment. For CSU and ROW avoidance, there may be some reduction in surface disturbance if these developments are re-sited in previously disturbed areas.

Impacts are more likely to occur in easily accessible areas, where visitation would be high, and in areas open to cross-country travel, particularly motorized use and, to a lesser extent, mechanized use. Some vegetation communities, such as salt desert shrub, lower elevation sagebrush, and riparian areas and wetlands, are more susceptible to weed invasion. Impacts on these communities would be greater than on other vegetation communities.

EC.2.7 Wildlife

Methods and Assumptions

Methods of Analysis

Indicators of impacts on wildlife (terrestrial species) are as follows:

- Disturbance and changes in habitat, food supplies, cover, breeding sites, and other habitat components necessary to maintain a population and used by any species to a degree that would lead to substantial population change
- Disturbance to prey habitat, such as reduction of cover and forage
- Disturbance and change of seasonally important habitat, such as critical for overwintering or successful breeding, to a degree that would lead to substantial population change
- Interference with a species' movement pattern that affects its ability to breed or overwinter successfully to a degree that would lead to substantial population change
- Direct destruction of, or injury to, individual species to a degree that would lead to a substantial population change

Indicators of impacts on migratory birds (excluding raptors) are as follows:

- Direct destruction of, or injury to, individual species to a degree that would lead to a substantial population change
- Disturbance to the quantity of migratory bird nesting habitat, especially habitat specialists such as sagebrush obligate birds
- Disturbance to nesting individuals leading to increased potential for nesting failure as a result of direct mortalities or abandonment of nests
- Alteration of nesting density, nesting success, and nest site selection
- Measurements of quality/effective nesting habitat

Assumptions

The analysis includes the following assumptions:

- Wildlife and migratory bird occurrence and condition were not inventoried throughout the planning area. Estimates were made concerning the significance of these resources based on previous surveys and existing knowledge.
- Estimates would be based on the availability of suitable habitat in the decision area.
- In lentic water systems, water depth and reservoir volume will decrease as a result of sediment deposition.
  - It is generally true that wildlife and migratory bird habitat needs vary substantially by species; however, resilient wildlife populations can be supported where there is a diverse mix of plant communities with multiple seral stages to supply structure, forage, cover, and other specific habitat requirements. Thus, managing for a diverse mix of native plant communities is an important component of managing for species diversity.
  - Impacts on wildlife and migratory birds from displacement depend on the location, extent, timing, or intensity of the disruption, or they could depend on all four factors. Furthermore, impacts from displacement would be greater for wildlife and migratory bird species that have limited habitat or a low tolerance for disturbance.
  - Human disturbance would displace wildlife and migratory birds beyond the actual disturbance footprint.
  - Short term is defined as anticipated to begin and end in the first 2 years after the action is implemented; long term is defined as lasting beyond 2 years to the end of, or beyond, the 20-year planning time frame addressed in the RMPA.
  - In the context of this analysis, the term avoidance means reduced use and does not imply a complete absence of use by wildlife and migratory birds.
  - Best management practices would be implemented to mitigate/minimize impacts on nesting migratory birds; however, incidental removal/take of migratory bird nests may occur, through ground disturbing activities.

Nature and Type of Effects

Wildlife and Migratory Bird Habitat

Disturbance from permitted activities can affect species and their habitats through loss of habitat quality and quantity through habitat fragmentation, modification, physiological stress, habitat avoidance, direct mortality, and the interference with movement patterns. Examples of permitted surface-disturbing activities with the potential to affect wildlife and habitat are mineral exploration and development and ROW construction and use. Importantly, new ground/vegetation disturbed in the course of oil and gas development will remain disturbed over the long term. Even if impacts related to well construction were minimized through BMPs, such impacts would persist for the lifetime of the well and beyond.

Both short-term, loud noise, such as that from vehicles, construction, or hydraulic fracturing, and long-term, low-level noise, such as that from oil and gas operations, has been documented to increase heart rates, alter metabolism, and change wildlife species' hormone balances (Radle 2007). Determining the impact of noise is complicated; this is because different species and individuals have varying responses, and certain species rely more heavily on acoustical cues than others (Radle 2007; Barber et al. 2009).

Compressor noise has been demonstrated to have variable effects on migratory birds in New Mexico. Compressor noise has been documented to positively correlate with nest success but negatively correlate with useable habitat (Ortega and Francis 2007); however, compressor noise had no significant effect on the abundance or diversity of avian species. Compressor noise may benefit avian species as nest predation is lower around sites with compressor noise than without (Ortega and Francis 2007). Those avian species shown to have significantly fewer nests around sites with compressor noise included mourning doves, gray flycatchers, gray vireos, blackthroated gray warblers, and spotted towhees (Ortega and Francis 2007). For a detailed discussion of the impacts of the alternatives on noise levels, see **Section EC.4.13**, Noise Resources.

Although data are preliminary and limited, an unpublished study by Western Ecosystems Technology, Inc. Environmental & Statistical Consultants (2017), observed avoidance of drilling activities, that when compared to the previous year's location of the collared mule deer, showed a 1,312-foot (400-meter) shift away from the drill rig[1]. Permitted surface-disturbing activities, such as conventional and unconventional mineral development and ROWs, potentially result in short-term, direct impacts through mortality, injury, displacement, and noise or human disturbance caused by increased vehicle traffic and heavy machinery use. Hydraulic fracturing would increase these impacts compared with conventional oil and gas development because of the increased vehicle traffic and heavy machinery use associated with this process. Long term, these activities can remove and fragment habitats due to construction of roads and facilities. ROW avoidance and exclusion areas would be managed to reduce or avoid habitat impacts, and utility corridors would be used to concentrate utility and facility development and reduce disturbance and habitat loss and fragmentation.

Well density varies across the decision areas based on levels of historical development. In areas with higher well density, habitat fragmentation is greater. Currently, well density is highest in the north-central portion of the BLM and BIA mineral decision areas (many sections have between 13 and 25 wells) and lowest in the southwest portion of the decision areas, in the White Rock, Lake Valley, Whitehorse Lake Chapters, and near CCNHP (**Figure EC-1**, Existing Well Densities in the BIA and BLM Decision Areas). In these areas, many sections have zero wells.

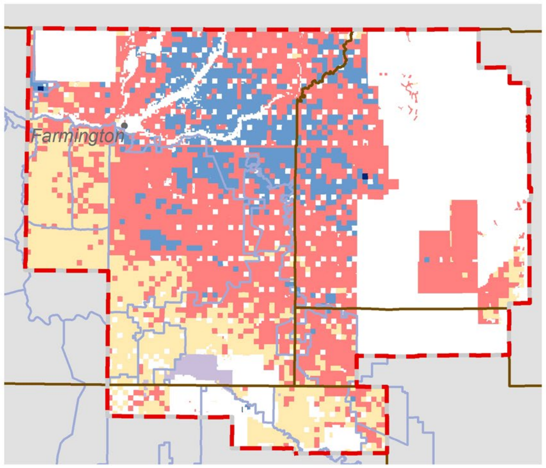
Future increases in well density, and resulting habitat fragmentation, are most likely to occur in areas that are unleased but have high oil and gas potential and are open to fluid mineral leasing. As described in **Chapter 1** of the FMG RMPA/EIS, most of the BLM mineral decision area and approximately one-third of the BIA mineral decision areas are already leased. Unleased areas are primarily in the same areas with the lowest well density (i.e., White Rock, Lake Valley, Whitehorse Lake Chapters, and near CCNHP; **Figure EC-2**, Existing Leases in the BIA and BLM Decision Areas). The highest potential areas in the planning area are in the south-central portion, near Nageezi (**Figure EC-3**, Development Potential). This area is almost entirely leased and has low well density. The southern portion of this high-potential area overlaps with an area that is leased but has low well density. In this area, well density and habitat fragmentation could increase if additional APDs are approved on existing leases. These existing leases would not be subject to the stipulations in the FMG RMPA/EIS, but additional COAs could be applied to new APDs to mitigate impacts. Additionally, moderate-potential resources extend further south into the unleased, low or zero well-density area. Under alternatives where this area is open to development, well density and habitat fragmentation are likely to increase. The 2019 BLM RFD projections for the BLM and BIA anticipates an increase in the number of wells between 2018 and 2037 on BLM (baseline estimate) by 3,200 wells, entire BIA decision area by 510 wells; specific to Navajo Tribal Trust minerals by 141 wells and Navajo Allotted minerals by 369 wells.

Bird deaths and injury could occur from collision with or electrocution from transmission lines and other ROW structures (APLIC 2012). Oil field waste pits and open ponds may affect birds and wildlife through the following (USFWS 2000):

- Entrapping them in oil, causing them to drown
- Killing or sickening them, from ingesting produced water or preening feathers or cleaning fur that is covered with oil
- Stressing them with cold, if oil damages the insulating properties of feathers or fur
- Increasing their susceptibility to disease or predation
- Reducing hatching success of eggs

[1] Jeff Tafoya, BLM FFO, Supervisor, personal communication with Dan Morta, EMPSi Biological Specialist. February 2018.

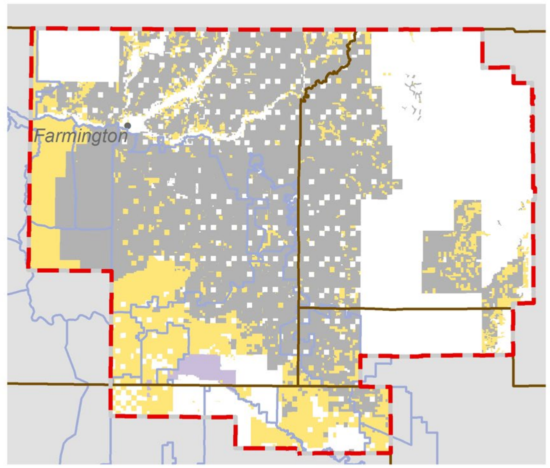
Figure EC-1
Existing Well Densities in the BIA and BLM Decision Areas



Existing wells per PLSS section
- 0 Zero
- 01–12 Low
- 13–25 Medium
- 26–72 High

- Planning area
- National Park Service
- Navajo Nation Chapter
- County

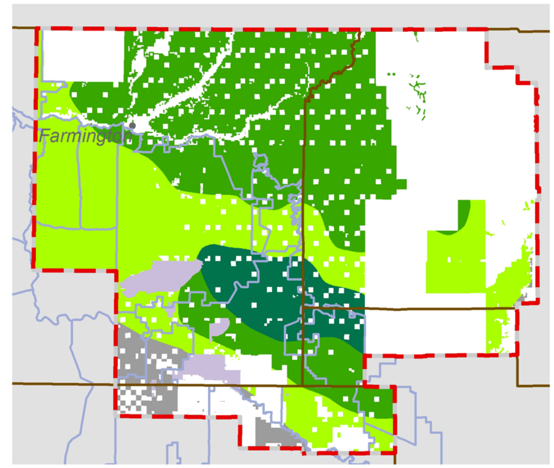
Figure EC-2
Existing Leases in the BIA and BLM Decision Areas



BLM and BIA decision area
- Leased
- Unleased

- Planning area
- National Park Service
- Navajo Nation Chapter
- County

Figure EC-3
Development Potential



Development potential
- High
- Medium
- Low
- Negligible

- Planning area
- National Park Service or nondiscretionary closure
- Navajo Nation Chapter
- County

As described above for *Wildlife*, managing lands with wilderness characteristics generally restricts surface-disturbing activities, thereby reducing the likelihood for habitat disturbance, vegetation removal, and fragmentation. Overall, such management would retain wildlife habitats, limit the loss or disturbance to wildlife communities, and maintain or recover populations.

Weather fluctuations could affect a variety of wildlife species and habitat; some species may benefit from these changes, while others may be negatively affected. Climate change may drive changes in timing and geographic ranges for wildlife species. Additionally, increased occurrences of fires, insect pests, disease pathogens, and invasive weed species are likely to continue as a result of rising global temperatures (BLM 2010).

Other indirect impacts from climate change may include the following:

- Introduction of invasive vegetation that can compete with native vegetation, resulting in changed habitat and altered fire cycles
- Decreased habitat suitability
- Increased impact on obligate species through habitat alteration (habitat loss)
- A disproportionate effect on species endemic to habitat types that are susceptible to weather fluctuations

EC.2.8 Special Status Species

Methods and Assumptions

This analysis focuses on impacts on key special status species, as identified in the Farmington Mancos-Gallup 2018 Affected Environment Supplemental Report. Key special status species are those with known occurrences in the decision area. (**Table 3-25** for a list of special status species.) Management for, and impacts on, vegetation types and habitats have a direct link to special status species; therefore, this analysis focuses on impacts on habitats occupied by, or potentially occupied by, special status species.

Indicators

Indicators of impacts on special status species would be the same as wildlife indicators (**Section EC.4.7**, Wildlife), but they would be specific to each special status species. Additional indicators of impacts include:

- A decrease in acreage or quality of occupied, suitable, or potential habitat for special status plant species
- A decrease in the acreage or quality of nesting or foraging habitat for special status species raptors
- A decrease in acreage or quality of breeding or rearing habitat for special status species mammals with narrow habitat requirements
- An increase in fragmentation for all respective special status species habitats

Assumptions

- The analysis generally includes the same assumptions as identified under **Section EC.4.7**, Wildlife; however, impacts on general wildlife and their habitats are more easily recoverable than impacts on special status species and their habitats. This is because of the small size and reduced genetic diversity in many special status species populations.
- For those federally listed threatened and endangered species found in the project area, a biological assessment would be prepared to satisfy the requirements of Section 7 (Interagency Cooperation) of the Endangered Species Act (ESA). The biological assessment and effects determinations for each of these listed species are forthcoming.

Nature and Type of Effects

The Nature and Type of Effects on special status species are similar to those described under **Section EC.2.7**, Wildlife; however, habitat disturbance may have a greater magnitude of impact on special status plant species, as some species occur within unique environments which are disproportionately vulnerable to disturbance activities.

Fluid mineral exploration and development and ROW development in special status species habitat may disturb soils. This could result in individual special status plant mortality and the loss and fragmentation of habitat. Soil disturbance in special status species habitat would result in long-term reduction in the acreage or quality of habitat, including habitat for special status plants, nesting and foraging habitat for special status raptors, and breeding and rearing habitat for special status mammals. Habitat fragmentation may separate special status species populations, causing changes in movement patterns, genetic isolation or reduced access to important habitat components.

Soil disturbances may also result in the introduction and proliferation of invasive plant species and/or noxious weeds. The establishment of invasive plant species or noxious weeds would contribute to the degradation or long-term elimination of special status plant habitat. Invasive plant species and noxious weeds may act to replace special status plant communities and compete with special status plants for resources such as light, water, nutrients, and space. Hydraulic fracturing would increase these impacts compared with conventional oil and gas development because of the increased vehicle traffic and heavy machinery use associated with this process.

In addition to habitat impacts, oil and gas and ROW development could increase the risk of direct mortality of individual special status plants and animals. This would come about through destruction of plants and collisions with or disturbance of animals during well pad, road, and ancillary facility construction and during maintenance. Potential indirect impacts are damage or mortality to special status plants and animals by unauthorized vehicle or human access. Viability of individual special status plants could also be reduced, due to increased dust deposition, soil erosion from surface-disturbing activities, competition with introduced invasive plant species, and disruption of seed dispersal and pollination from habitat fragmentation and human activity.

In general, management goals, objectives, and actions for wildlife would complement goals for special status species. In addition to the Nature and Type of Effects discussed under **Section EC.2.7**, Wildlife, fluid mineral exploration and development and ROW authorizations that disturb the surface would affect habitat for special status plants. These types of impacts are likely to occur only where potential habitat or occupied habitat overlaps or is next to areas that would be open to such uses.

EC.2.9 Cultural Resources

Methods and Assumptions

Indicators

Indicators of impacts on cultural resources may be any direct or indirect effect that that ultimately diminishes the characteristics that qualify a historic property for inclusion in or eligibility for listing in the National Register of Historic Places (NRHP). It also includes direct impacts on the physical integrity of a culturally important property (CIMPP) or indirect impacts on a CIMPP's setting, feeling, or association, or its significance. These indirect impacts on CIMPPs could also result from subsurface activities in NSO areas that diminish the ability of Tribes to conduct ceremonies or otherwise use these cultural resources (Begay 2001).

Assumptions

The analysis includes the following assumptions:

- The BLM and BIA will follow the applicable regulations, such as the Section 106 process of the NHPA (36 CFR 800), American Indian Religious Freedom Act (AIRFA), Executive Order (EO) 13007, Chaco Sites Protection Act, Archeological Resource Protection Act, Navajo Nation Cultural Resources Protection Act, Navajo Nation Policy for the Protection of Jishchaa'), and other relevant laws and regulations when addressing federal undertakings.
- When considering impacts, this discussion includes specific types of cultural resources—historic properties and CIMPPs. Historic properties are those cultural resources listed in, or eligible for inclusion in, the NRHP. The NHRP defines historic properties as districts, sites, buildings, structures, and objects significant in American history, archaeology, engineering, and culture. CIMPPs are defined for this analysis in **Section 3.3.9** of the FMG RMPA/EIS. This definition of CIMPPs acknowledges that the relevant Tribes or other cultural groups who have the best understanding of these resources define the importance of any CIMPPs, which typically occurs through consultation in the Section 106 process.
- Historic properties and CIMPPs in the planning area are protected by federal and Tribal laws; BLM, BIA, and Navajo Nation regulations and policies; and interagency or partnership agreements. The BLM and BIA will comply with these laws and regulations, where they are applicable.
- Human occupation of North America has left its mark on all landforms, and historic properties could be on the surface or deeply buried. There could be CIMPPs of importance to contemporary Native Americans or communities; however, their significance may not be readily identifiable outside of those communities.
- The information on historic properties and CIMPPs in the decision area is based on the results of industry and federal agency inventory and ethnographic projects and through consultation and coordination with Tribes. This information provides insight into the relative potential for historic properties and CIMPPs in the planning area; however, these data are geographically biased toward past project-oriented undertakings (i.e., where cultural resource surveys have taken place) and may not accurately predict where and how many resources may exist in unsurveyed areas. Because of that, this analysis does not attempt to quantify affected resources.
- The information on cultural resources derived from regional overviews and field inventories is currently the best data available to identify and analyze issues during NEPA and land use planning. Additional inventories to identify historic properties and CIMPPs may be necessary before any future land use actions are authorized.
- Tribal use of CIMPPs can occur throughout the planning area and does not always track with fixed dates or times.
- In general, cultural resources that are determined not eligible for listing on the NRHP do not need to be avoided by projects. An exception to this is with CIMPPs where these resources may not meet the eligibility requirements for the NRHP, but the BLM and BIA still manage them to avoid, minimize, or mitigate impacts.
- It is the BLM's policy (as outlined in BLM Manual 8140) that impacts on historic properties be avoided if possible. If they cannot be avoided, efforts to minimize impacts must be considered and, if necessary, impacts must be appropriately mitigated.
- Impacts on historic properties or CIMPPs from energy development or other projects are most often avoided through redesigning undertakings, which could include avoidance of sites. When avoidance is not possible, typically a data recovery plan for mitigation is prepared and implemented. Site excavation is most often included, but there are numerous components to mitigating adverse impacts. For example, ethnographic studies with Tribes, and others with traditional knowledge are often a component of mitigation for CIMPPs. Frequently the research topics and excavation/data

analysis are designed to inform regional data needs and syntheses. Further, the Navajo Nation has included a community-based approach to data recovery on their lands, which benefits schools with relevant curricula.

The appropriate way to resolve potential adverse effects on historic properties and CIMPPs would be defined by the lead federal agency. This would be done through the Section 106 process and consultation with the relevant State Historic Preservation Officer (SHPO), Tribal Historic Preservation Officers (THPOs), Tribes, consulting parties, the public, and potentially the Advisory Council on Historic Preservation (ACHP).

- Identifying historic properties or CIMPPs and findings of effect in the Section 106 process, and, if possible, avoiding impacts, are conducted for the BLM through the protocol between the BLM and SHPO (BLM 2014). For the BIA, this process occurs through the PL 93-638 contract between the BIA and Navajo Nation THPO, which came about due to the Indian Self-Determination and Education Assistance Act of 1975 (PL 93-638), wherein the federal government empowers Tribes to conduct certain tasks, and the BIA has the Navajo Nation review undertakings related to cultural resources on Tribal trust lands and individual Indian allotments (discussed further in **Section 3.6.1** of the FMG RMPA/EIS, Native American Tribal Interests and Uses). Final mitigation strategies and approaches, along with the approval and implementation of a data recovery/mitigation plan, are carried out by the BLM and BIA.
- Restriction zones on federal mineral estate surrounding the CCNHP are meant to protect these resources from the potential for indirect visual, auditory and other impacts of fluid mineral development. This management incorporates strategies from BLM VRM guidelines (BLM 1984), NPS estimates on dark skies impacts, and NPS studies on noise impacts, while also trying to address Tribal concerns about impacts on cultural landscapes and the ability to complete certain ceremonies due to impaired settings.

Nature and Type of Effects

There is the potential for impacts on historic properties and CIMPPs under all alternatives. There may also be direct and indirect impacts from future implementation of management actions, although these would require additional environmental review under NEPA and the NHPA. Impacts from planning actions under NEPA can be difficult to quantify, given that the nature and location of most historic properties and CIMPPs in the planning area are unknown. Further, planning alternatives typically do not identify specific areas or times for surface-disturbing activities.

The following actions can contribute to impacts on historic properties and CIMPPs:

- ROW, oil and gas, or other development at historic properties or CIMPPs
- ROW, oil and gas, or other development near historic properties or CIMPPs that are important because of their setting, feeling, or association
- Recreation along, near, or crossing historic properties or CIMPPs

Any future activities that would disturb the surface could have direct and indirect impacts on historic properties or CIMPPs. Examples of these are damaging, destroying, or displacing artifacts and features and constructing infrastructure out of character with setting, feeling or association. Damaging, displacing, or destroying historic properties could include obliterating artifacts, breaking or removing them from their context, or excavating features without appropriate scientific recording. Additionally, future activities that disturb the surface could have an impact on the physical integrity of these resources.

Indirect impacts on historic properties or CIMPPs could include those that change the character of a property's use or physical features in its setting, feeling, or association that contribute to its historic integrity; an example of this is isolating the property from its setting. Other indirect adverse impacts could result from introducing visual, atmospheric, or audible elements that diminish a historic property's integrity or reduce the significance of a CIMPP to Tribes. This could include limiting the ability of Tribal members to conduct ceremonies or otherwise use these cultural resources. This, in turn, could affect the health or mental well-being of certain Tribal members, as described by Begay (2001). Indirect impacts could also come from erosion, exacerbated by nearby development.

As discussed in **Section EC.2.2**, Geology, fluid mineral development could disrupt hózhó and harm the Navajo people or indirectly affect CIMPPs. This would come about by reducing the ability of cultural practitioners to complete traditional ceremonies. For example, impacts on geologic formations could affect their cultural use, such as tséyáłti' dahólóógóó (Talking Rocks) that aid in diagnoses for Navajo people before certain ceremonies related to the geology of the earth, such as the Red Ant Way (Begay 2001).

While these are examples of the types of indirect impacts on CIMPPs for Navajo Tribal members, other Tribes may have similar (or dissimilar) indirect effects on the CIMPPs that they consider important.

There is the potential for direct and indirect impacts on cultural resources with each phase of fluid mineral development from planning, leasing, and an APD. The ACHP has acknowledged that the early phases of fluid mineral development, such as leasing (or planning), could affect historic properties (ACHP 2016, 2017, 2018).

The ACHP also acknowledged that a phased approach to Section 106 of the NHPA is reasonable and in good faith, provided the agencies complete all appropriate Section 106 requirements for each phase: identifying historic properties, assessing effects, and consulting with agencies, Tribes, and other parties. These actions are considered separate undertakings. Agencies also must commit to additional Section 106 requirements when an APD is submitted. Examples of this are a further and more detailed identification of historic properties, assessment of adverse effects, and consultation with agencies, Tribes, and other parties.

The ACHP (2018) further acknowledged that, when there are known important historic properties or CIMPPs in a leasing or planning area and impacts may be difficult to avoid, the development of a programmatic agreement could be appropriate for minimizing or avoiding impacts. The agencies' understanding of how historic properties and CIMPPs could be affected by fluid mineral development would increase in specificity at each stage and separate undertaking (planning, leasing, and APD). This would come about through the relevant Section 106 and NEPA processes and consultation with Tribes as more detail is known about the locations of proposed development. For example, the site-specific APD phase would have the most information about proposed development.

EC.2.10 Paleontological Resources

The term 'paleontological resource' means any fossilized remains, traces, or imprints of organisms, preserved in the Earth's crust, that are of paleontological interest and that provide information about the history of life on Earth (PRPA 6301, 16 USC 470aaa-1).

Methods and Assumptions

The planning area for the RMPA includes fossil-bearing geologic units, surface and near-surface exposures or known and/or recorded fossil localities that may contain specimens of scientific interest.

Paleontological resources are considered fragile and nonrenewable, so direct impacts are considered permanent. BLM policy is to manage paleontological resources for scientific, educational, and recreational values and to protect these resources from adverse impacts. The BLM manages fossils to promote their use in research, education, and recreation, in accordance with the Paleontological Resources Preservation Act (PRPA), Subtitle D of the Omnibus Public Land Management Act of 2009 (16 USC 470aaa through 470aaa-11), and the general guidance of FLPMA and NEPA. Scientifically significant fossils, as defined in BLM Manual 8270 and BLM Handbook H-8270-1 (BLM 1998), are vertebrate fossils and their traces, as well as uncommon invertebrate and plant fossils.

Paleontological resources are part of the surface estate. If the BLM is going to approve an action involving the mineral estate, such as an APD, that may affect the paleontological resources, the action should be conditioned with appropriate paleontological mitigation recommendations to protect the interests of the surface owner. Generally, the surface owner may elect to waive these recommendations.

The PRPA does not apply to fossils on BIA-managed lands or private lands; however, the BLM does provide paleontological expertise to the BIA and other federal agencies. The BIA decision area for leasing includes BIA-managed Tribal trust lands and minerals and Tribal allotted surface land and minerals administered by the BIA Navajo Regional Office. Indian Affairs Manual (Indian Affairs 2012) (Part 59, Chapter 7—Paleontological Resources) guides permitting by the BIA for excavating and removing imbedded fossils from Tribal trust lands and individual Indian allotments.

Paleontological resources that are under BIA management are considered Indian Trust Assets (ITAs). ITAs are defined as lands, natural resources, money or other assets held by the Federal Government in trust or that are restricted against alienation for Indian Tribes and individual Indians (BIA 303, DM 2.5 C). It is BIA policy to ensure that these ITAs are not poached or trafficked. As the Trustee, it is part of the Federal Government's fiduciary responsibility to ensure that the owner receives fair compensation when ITAs are removed from the trust, as well as the responsibility to ensure that the use of an asset is in the best interest of the trustee. Permits for collecting fossils on the Navajo Nation are issued by the Minerals Department and are issued only for scientific research or mitigation.

No permit is required for exploration or surface collecting of non-imbedded fossils; however, these exempted activities are subject to Tribal jurisdiction and landowner consent.

For this analysis, impacts on paleontological resources would be significant if there were direct or indirect damage to or destruction or loss of vertebrate or other scientifically significant paleontological resources. This includes destruction as the result of surface and subsurface disturbance and the unlawful or unauthorized collection of fossil remains (SVP 2010; Santucci et al. 2009).

The potential for paleontological resources is based on the regional and surface geology of proposed project areas. To assess the potential for paleontological resources associated with the alternatives, the BLM's Potential Fossil Yield Classification (PFYC) BLM GIS 2017) layer is overlaid on the planning area. See **Section 3.3.10** of the FMG RMPA/EIS, Paleontological Resources for a more detailed discussion of the PFYC. Similarly, a review of BLM SDAs where the presence of paleontological resources is recognized is also conducted. The BLM uses the PFYC system as a management tool to assist in determining which geologic units potentially contain fossil resources (BLM 1998). Most of the decision area is classified as PFYC Class 5 (very high potential) for paleontological resources, so local surface geology and known localities are the primary references used to assess resource potential. The BIA does not recognize any designated areas for paleontology, but the PFYC is inclusive of the entire planning area.

Indicators

Indicators of impacts on paleontological resources are as follows:

- Physical damage or destruction of fossils or the fossil-bearing rock units
- Increased access or activity where fossils may be present, increasing the risk of vandalism, unauthorized collection, or inadvertent damage or loss

Assumptions

The analysis includes the following assumptions:

- Occurrences of paleontological resources are closely tied to the geologic units (e.g., formations, members, or beds) that contain them. The probability for finding paleontological resources can be broadly predicted from the geologic units present at or near the surface.
- Geologic mapping can be used for assessing the potential for the occurrence of paleontological resources using the BLM's PFYC classes; however, because of the overall high and very high potential of the decision area for paleontological resources, confidential recorded locality records are most useful for determining the impact potential of site-specific agency actions.
- In the decision area, PFYC Class 1 makes up approximately 0 acres, PFYC Class 2 makes up approximately 22,000 acres, and Class 3 geologic formations account for approximately 389,300 acres on federal mineral estate. PFYC Class 4 formations comprise only 7,400 acres of the decision area. There are 2,181,100 acres of PFYC Class 5 (very high potential) for the decision area. Acreages of each PFYC class can be expected to change as more data are collected from ongoing field surveys and inventories (BLM GIS 2017).
- Scientifically significant fossils would continue to be discovered throughout the planning area. Discoveries are most likely to occur in specific geologic formations with surface exposure.
- Those conducting inventories before and during surface-disturbing activities may identify and evaluate previously undiscovered paleontological resources. These resources would be managed according to BLM, BIA, and Tribal policy, depending on jurisdiction.
- The potential for impacts on both surface and subsurface paleontological resources is proportional to the extent and depth of disturbance associated with the action.
- At the resource management planning level of analysis, the precise locations, extent, and depth of any anticipated surface disturbance resulting from each alternative is unknown. The relative potential for impacts on paleontological resources under each alternative can only be generally estimated.

Nature and Type of Effects

While there would be no direct impacts from the goals, objectives, and allocations noted in the alternatives, there may be direct impacts associated with some management actions. Direct impacts from the alternatives can be described as increasing the risk or likelihood of resource impacts. Indirect impacts are those that would result from implementing the planning decisions at a later time. The impacts on paleontological resources would be considered during site-specific analyses as federal actions are proposed.

Actions involving substantial excavation have the most potential for affecting paleontological resources, if the resource cannot be avoided. Excavations can recover the fossils that would otherwise be destroyed if the resources cannot be left in situ.

Surface and near-surface exposures can also be affected by shallow ground-disturbing activities, such as field studies, access road construction, cross-country travel, vegetation treatments, and drilling or excavating mineral samples. Shallowly buried paleontological resources can be exposed by natural erosion, which can be worsened by surface-disturbing activities. Surface exposure can lead to discovery of paleontological resources; however, fossils can be damaged or lost by the direct action of ground disturbance, subsequent erosion, and unauthorized collection.

Increased access and workers on-site could affect resources through vandalism and unauthorized collection. Over the long term, additional impacts from extraction, transport, production expansion, and standard operation and maintenance could enlarge the disturbance footprint.

Land use authorizations, exchanges, or special designations can incidentally increase or reduce protections for any paleontological resources in these areas.

Impacts can be minimized by implementing mitigation measures, such as monitoring during construction, excavating and recovering materials, or avoiding surface exposures. If excavation and removal is the prescribed mitigation, this can also result in fossils being salvaged that may never have been unearthed by natural processes. These newly exposed fossils could become available for scientific research, education, display, preservation, cultural uses, or sale, depending on ownership and jurisdiction. Unmitigated surface-disturbing activities could dislodge or damage paleontological resources that were not visible before the surface was disturbed.

Further site-specific review would be conducted to determine areas that may be identified as sensitive for paleontological resources and to determine the potential for direct impacts.

EC.2.11 Visual Resources

Methods and Assumptions

The components of the visual resource inventory (VRI) form the basis for analysis in this section. VRI classes use the same numerical scale, I through IV, as VRM classes. They are the categories that the BLM uses to classify the current visual character of the landscape and are a way to communicate the degree of visual value in the area.

VRI Class I areas are those where congressional or administrative decisions were already made to maintain a natural landscape, for example, wilderness areas. Generally, VRI Class II indicates the most naturally appearing or pristine landscapes, VRI Class III represents visual resources of a moderate value, and VRI Class IV indicates landscapes that are not as sensitive to changes or that are already modified from their natural appearance.

Impacts on visual resources from visual resources management are assessed by comparing the VRI class of an area to the VRM class for the same area and assessing the potential for change in the three components of VRI classification: scenic quality, sensitivity level, and distance zones. Proposed management impacts on visual resources are also examined. No VRM allocation decisions are being made in the FMG RMPA/EIS.

Impacts on visual resources from the management of other resources are assessed by qualitatively describing their impacts on scenic quality, sensitivity, and distance zones. The most prevalent impacts would be from surface disturbance, which can affect scenic quality, particularly landform, vegetation, color, adjacent scenery, and cultural modifications.

When assessing scenic quality, seven factors are considered: landform, vegetation, water, color, adjacent scenery, scarcity, and cultural modifications. Where cultural modifications would be allowed, there could be a change in the variety of vegetation forms, patterns, or texture from such activities as construction, vegetation removal, and soil composition changes.

Furthermore, where cultural modifications would be allowed to the extent that the basic components of the landscape (e.g., vegetation, soil, and rock) would change drastically, the variety, contrast, and harmony of color could change as well. Under no alternative would the scenic quality noticeably improve.

When assessing sensitivity, at least five factors are considered: type of users, amount of use, public interest, adjacent land uses, and special areas. The designated use of BIA- and BLM-managed lands can influence the types of users and the amount of use. Also, the designated use of BIA- and BLM-managed lands can create special areas to preserve the natural landscape setting.

When assessing distance zones, landscapes are subdivided into three distance zones, based on relative visibility from travel routes or observation points, as follows:

- Foreground-middle ground zone—Areas seen from highways, rivers, or other viewing locations that are less than 3 to 5 miles away

- Background zone—Areas seen beyond the foreground-middle ground zone but usually less than 15 miles away
- Seldom seen zone—Areas not seen as foreground-middle ground or background; that is, they are hidden from view

If access to an area is increased or decreased, this could, for example, change a seldom seen zone to a foreground-middle ground zone or background zone.

Indicators

Indicators of impacts are as follows:

- The degree of contrast that an action would cause to the visual landscape; greater degrees of contrast would result in greater impacts on visual resources.
- Actions that would allow changes to the inventoried landscape that could alter its character enough that future visual resource inventories would result in a reclassification.

Assumptions

The analysis includes the following assumptions:

- The scenic vistas in the planning area would become more sensitive to visual change; in other words, they would increase in value over time.
- Scenic resources would become increasingly important to residents of, and visitors to, the area.
- Visitors to BIA- and BLM-managed lands or residents living near those lands are sensitive to changes in visual quality.
- Activities that cause the most contrast and are the most noticeable to the viewer and to the public would be considered to have the greatest impact on scenic quality.
- The severity of a visual impact depends on a variety of factors, including the size of a project (i.e., the area disturbed and physical size of structures), the location and design of roads and trails, and the overall visibility of disturbed areas.
- The more protection that is associated with the management of other resources and special designations, the greater the benefit to visual resources of the surrounding viewsheds.
- VRM class objectives apply to all resources. Class objectives would be adhered to through project design, avoidance, or other mitigation.
- Visual resources design techniques and BMPs would be implemented to mitigate potentially harmful impacts.
- Visual contrast ratings would be required for projects that fall within VRM Classes I, II and III, and as needed in IV. The visual contrast rating system would be used as a guide to analyze site-specific impacts from projects, as well as project design and placement. Projects would be designed to minimize their visual impacts in order to conform to the area's VRM class objective. This would allow the BLM and BIA to reduce impacts on a site-specific basis to ensure compliance with the assigned VRM class.
- Areas without either VRI or VRM classes cannot be effectively managed for visual resources.

Nature and Type of Effects

The management decisions being made for the FMG RMPA/EIS include the following resources; vegetation, lands with wilderness characteristics, fluid minerals, and lands and realty, which could impact visual resources; therefore, the nature and type of effects below are discussed in terms of the impacts of management of only these four resources.

Vegetation

Visual resources can be impacted by removing or disturbing vegetation to reveal colors or vegetation patterns or textures that contrast with the surrounding landscape. This would be the case with vegetation treatments, revegetation, and restoration, which would decrease scenic quality. Scenic quality could be directly changed in the short term by changing landscape color and vegetation. In the long term, once desired vegetation becomes established and matures, it can indirectly create a landscape with vegetation and color that does not contrast with the local visual landscape. Wood product gathering and cutting would affect apparent naturalness by disturbing the natural visual setting.

Actions to restrict or prohibit surface-disturbing activities to protect vegetation communities can help to maintain the scenic quality of an area by maintaining or limiting changes to vegetation and color.

Lands with Wilderness Characteristics

Managing lands to protect wilderness characteristics as a priority over other multiple uses would generally protect visual resources in those areas. Conversely, not managing areas for their wilderness characteristics would allow for activities and development that are in opposition to the natural setting and associated visual resources. Analysis of impacts in lands with wilderness characteristics by alternative can be found in **Section EC.4.13**, Lands with Wilderness Characteristics.

Fluid Minerals

There would be no mineral development in areas that are closed to such uses, thereby preventing development that degrades visual resources. In open areas, mineral development may be subject to BMPs or stipulations that restrict the location and types of mineral development. Mineral development could disturb the surface, which would remove the top layers of soil or vegetation to reveal colors that contrast with the surrounding landscape.

New roads to access development sites would add artificial elements to the landscape. Improving roads typically enhances the contrast of the road with the adjacent landscape. Roads lack vegetation and create an abrupt vegetation edge along the roadside. Smooth roads would stand out against the moderately coarse texture of the terrain. This would affect visual resources by dividing the landscape with areas that lack vegetation and altering the natural topography and the texture and color of the land surface. The visibility of the new and improved roads would vary, depending on viewer distance and location, topography, and screening vegetation.

Facilities association with minerals development would add artificial elements, such as cultural modifications, to the landscape. These areas would be cleared of vegetation, thereby contrasting with the surrounding landscape. The form, line, color, and texture of these facilities would not resemble nearby structures, unless they are collocated with similar existing industrial facilities. The visibility of the facilities would vary, depending on viewer distance and location, topography, color and composition of the facilities, and screening vegetation.

In general, surface disturbance from mineral development would directly decrease the scenic quality by changing vegetation and color. Actions to restrict or prohibit this surface disturbance can maintain the scenic quality of an area by preserving vegetation and color in the long term.

Lights could be installed for safety and to illuminate work areas at night. This would reduce nighttime darkness by adding artificial light to areas lacking it. As a result, this would diminish opportunities for viewing visual resources between dusk and dawn, particularly stargazing.

Lands and Realty

Managing ROW exclusion areas would protect visual resources by prohibiting roads, pipelines, transmission lines, communication sites, wind, solar, development, and other land use authorizations that alter the landscape. In other areas, utilities, such as transmission lines, access roads, and related development, could permanently alter the visual quality of an area, especially if they do not repeat the basic elements of the landscape.

Land use authorizations for utility corridors can affect visual resources by adding cultural modifications to the landscape and creating disturbances that change the vegetation pattern. Both of these can affect the color of the landscape and, in extreme cases, the landform. In addition, these types of developments can impact the viewshed of sensitive landscapes next to the area of development. The magnitude of these impacts would be the greatest where scenic quality or sensitivity is highest. Furthermore, the creation of new access roads, if needed, could affect the distance zone of the area. If development were to occur in a seldom seen area, new access roads could make the development more accessible and thus more visible to the public. This could change the distance zone from seldom seen to background or foreground-middle ground.

Land exchanges would not degrade visual resources because lands would be exchanged with the NPS to make them part of the CCNHP (Chaco Culture National Historical Park). The park purpose of preserving archaeological resources would also preserve the scenic quality of these areas. Visual quality could improve in areas exchanged with the NPS.

EC.2.12 Noise Resources

Methods and Assumptions

Indicators

Indicators of impacts are as follows:

- A change in the ambient noise levels in the planning area and at sensitive receptor locations.

Assumptions

The analysis includes the following assumptions:

- Noise is any unwanted sound as perceived by a receptor. The most common method for describing noise levels is the long-term equivalent A-weighted decibel (dBA).
- Because noise attenuates with distance, receptors located further from a noise source are less impacted by that noise compared with those located closer to the noise source.
- Sound levels decrease by 3 dBAs for every doubling in distance from a line source and 6 dBAs for every doubling in distance from a point source (La Plata County 2002).
- Depending on the decibel level of the noise source, other ambient noise sources, and topography, at a certain distance it becomes impossible for the human ear to differentiate a specific noise source from the ambient noise conditions.
- Individuals and wildlife react differently to changes in ambient noise levels and to various types of sound; therefore, the perceived level of impact varies by receptor. Noise levels that meet maximum permissible noise levels may still be perceived as an impact on noise for some sensitive receptors. For this analysis, the assumption is that all sensitive receptors react the same to changes in noise levels.
- Sustained noise is more disruptive than short duration noise events of the same decibel level. Similarly, people react less favorably to frequent noise events compared with infrequent noise of the same decibel level.
- Noise that occurs at night is viewed as more disruptive than daytime noise, mostly because the actual and expected ambient sound levels are lower at night.

Nature and Type of Effects

Impacts on noise are the result of activities that contribute noise that is audible above the ambient noise conditions or decrease or eliminate noise sources to lower the ambient noise levels across the landscape. Management that places design features or other requirements on resource uses to reduce noise impacts on wildlife, cultural resources, Native American concerns, and recreation would support noise resources. Similarly, management to maintain desired ambient noise levels at wilderness or other special designation boundaries would affect ambient noise levels in the planning area.

Sensitive receptors can include, but are not limited to, homes, parks, schools, hospitals, recreation sites, wildlife viewing areas, trails, wilderness boundaries, and sensitive cultural or Native American sites. Resource uses that increase noise levels at receptor locations are considered an impact. The magnitude of impacts on sensitive receptors depends on the following factors:

- Distance between the sensitive receptor and the noise source
- Type of receptor
- Duration and frequency of the noise
- Time at which the noise occurs
- Presence of topographical features or vegetation that attenuates noise
- Mitigation strategies that reduce noise levels

Over time, new sensitive noise receptors may be identified. The magnitude of impacts on those receptors would depend on the factors listed above.

As new development occurs in the planning area, the magnitude of noise impacts on sensitive receptors could increase. Applying mitigation measures to new development would minimize noise impacts.

Compression technology used at oil and gas wells increases the noise levels associated with production. Particularly in the northern portion of the planning area where resource extraction requires additional compression, there is a greater potential for higher ambient noise levels and associated impacts at receptor locations.

In addition to noise levels measured on the dBA Leq scale, as outlined in the Management of Sound Generated by Oil and Gas Production and Transportation (NTL 04-2 FFO), oil and gas drilling and production activities may be measured on the dBC Leq scale. This is to identify the impact of low-frequency noise (frequency below 100 Hz) on the environment, especially when operations occur within 0.25 mile of occupied buildings. Rather than being considered audible or loud, low-frequency noise is experienced more as a rumbling or vibration sensation.

EC.2.13 Lands with Wilderness Characteristics

Lands with wilderness characteristics are parcels that meet a size requirement of 5,000 roadless acres (or exception criteria) and contain the characteristics of naturalness and either outstanding opportunities for solitude or primitive and unconfined recreation. In addition, they also may possess supplemental values, such as ecological, geological, or other features of scientific, educational, scenic, or historic value.

Lands with wilderness characteristics are identified through a process described in BLM Manual 6310, Conducting Wilderness Characteristics Inventory on BLM-managed Lands (BLM 2012a [Manual 6310]). They are analyzed in the land use planning process under BLM Manual 6320, Considering Lands with Wilderness Characteristics in the BLM Land Use Planning Process (BLM 2012b [Manual 6320]). All areas that were inventoried and that are proposed for maintaining wilderness characteristics apply only to BLM-managed surface lands in the planning area. The BIA does not currently have a guidance manual for inventorying or maintaining wilderness characteristics on BIA-managed surface lands outside of designated wilderness areas;

therefore, impacts of the BIA alternatives are not analyzed in this section. See **Section EC.4.8**, Special Status Species, for a discussion of impacts on Navajo Nation sensitive areas.

Methods and Assumptions

There are currently no lands being managed for wilderness characteristics as a priority over other multiple uses outside of existing designated wilderness or WSAs in the FMG RMPA/EIS planning area. The BLM updated the inventory for wilderness characteristics in summer 2014 and finalized the inventory unit descriptions in spring 2016. This assessment identified four inventory units (24,300 total acres in the BLM surface decision area) meeting the criteria described in BLM Manual 6310 as possessing lands with wilderness characteristics. This review included only BLM-managed lands outside designated wilderness or WSAs.

The environmental consequences analysis was prepared using the current assessment and analysis of lands with wilderness characteristics from the following sources:

- Notes and field data from the original and updated inventories conducted in the FMG RMPA/EIS planning area
- Public input received during scoping and public review periods that delineated tracts of BLM-managed lands reported to possess or lack wilderness characteristics
- The New Mexico Wilderness Alliance proposal for lands with wilderness characteristics, based on their application of BLM Manual 6310, submitted to the BLM in May 2014
- A field review conducted by the BLM interdisciplinary team
- BLM and BIA management actions in **Tables 2-3** and **2-4**

Indicators

Wilderness characteristics are primarily influenced by actions that affect the undeveloped nature of the area or activities that increase the sights and sounds of other visitors. In general, wilderness characteristic conditions tend to be more qualitative. They are measured by the overall visual quality and naturalness of an area that may be affected by changes to levels of recreation, development, and surrounding land use. Indicators that can quantitatively be measured are changes to the frequency and number of routes, including the number of unauthorized trails, the number of encounters with other users, and increased requests for use of areas with wilderness characteristics for renewable or nonrenewable resource development.

Indicators of impacts are as follows:

- Degradation of wilderness characteristics to a level at which the wilderness characteristic would no longer be present in the specific area.
- Roadless areas of sufficient size—Impacts would result from building and maintaining roads.
- Naturalness (apparent naturalness, not ecological naturalness)—Impacts would result from developing facilities, vegetation manipulations that make an area appear less natural, or CSU and NSO stipulations, which would limit surface disturbances from oil and gas development.
- Opportunities for solitude or primitive and unconfined recreation—Impacts would result from changes in visitation, facilities development, motorized or mechanized routes, or management constraints on primitive recreation.
- Supplemental values—Impacts would result from any action that degrades the inventoried values.

Assumptions

The analysis includes the following assumptions:

- Use and development of BLM-managed lands would increase into the foreseeable future.
- Management and activities outside of lands with wilderness characteristics would not affect those characteristics, so long as they are not pervasive and omnipresent.

- Any proposed action in an area to be maintained for wilderness characteristics would be processed in accordance with the policies stated in BLM Manual 6320 (BLM 2012b [Manual 6320]).

Nature and Type of Effects

Wilderness characteristics are primarily influenced by actions that affect the undeveloped nature of the area or activities that increase the sights and sounds of other visitors. These actions are analyzed for the degree to which use or resource development is compatible with protecting wilderness characteristics.

Management actions that could affect an area's natural appearance could include the presence or absence of roads and trails, the use of motorized vehicles on those roads and trails, fences and other structural range improvements, nature and extent of landscape modifications, mineral and oil and gas development, or other actions that result in or prevent surface-disturbing activities. These activities affect the presence or absence of human activity and, therefore, could affect an area's natural appearance. Prohibiting surface-disturbing activities and new developments on lands with wilderness characteristics would protect naturalness.

Two other wilderness characteristics—outstanding opportunities for solitude or primitive and unconfined types of recreation—are related to the human experience in an area.

Visitors can have outstanding opportunities for solitude or for primitive, unconfined recreation under the following conditions:

- When the sights, sounds, and evidence of other people are rare or infrequent
- Where visitors can be isolated, alone, or secluded from others
- Where the use of the area is through nonmotorized or nonmechanized means
- Where there are no or only minimal developed recreation facilities

Wilderness characteristics of naturalness could be maintained or enhanced in the long term from vegetation treatments. Properly designed treatments improve ecosystem composition, structure, and diversity, which would improve the overall apparent naturalness of the area; however, in the short term, wilderness characteristics of naturalness and solitude would be affected. This would be due to the noticeable unnatural manipulation of the environment and an increase in human presence and vehicle traffic.

Livestock grazing may indirectly change wilderness characteristics in the long term by trampling and compacting soils, grazing vegetation, and incising channels, all of which could change the naturalness characteristic. Structures associated with livestock grazing management could directly affect naturalness and opportunities for solitude and primitive and unconfined recreation in the long term. Examples of these structures are fences, stock ponds, water savers, cattle guards, stock water pipelines, storage tanks and water tanks, and supplemental feeders. These types of development would be site specific, though, and would not likely affect a unit as a whole.

Allowing any type of energy or mineral development (fluid, nonenergy solid, locatable, saleable materials, and renewable energy) would result in surface disturbance that would diminish the area's natural characteristic. Any new roads authorized for access to the development area could eliminate wilderness characteristics of the entire unit. This would be the case if the road were to bisect the unit so that it would no longer be considered a roadless area of adequate size. In addition, regular access to the lease area or mine site by developers would reduce the opportunities for solitude.

Issuing new ROWs would affect wilderness characteristics. This is because they would require vegetation clearing and access roads and would increase human presence, machinery, noise, weed potential, and habitat fragmentation. This would degrade wilderness characteristics over the long term. To minimize impacts, the BLM would implement BMPs, stipulations for fluid minerals, and mitigation measures, such as ROW exclusion and avoidance areas, subject to valid and existing rights.

Where lands maintained for wilderness characteristics overlap ACECs or other Specially Designated Areas, management of these other areas could also indirectly protect wilderness characteristics. This would be due to the protective measures proposed for the other areas. These protective measures would include complementary management objectives, where lands with wilderness characteristics would be managed to protect them. This could offer some indirect protection of wilderness characteristics for units managed primarily for other resource considerations.

EC.3 Resource Uses

EC.3.1 Livestock Grazing

Methods and Assumptions

Proposed management would not directly change the number of acres available or unavailable for livestock grazing or level of permitted grazing. As a result, the analysis of impacts focuses on the indirect impacts of surface-disturbing activities on available forage and on the ability of permittees and lessees to manage structural and nonstructural range improvements. Impacts are discussed by comparing the intensity of surface-disturbing activities in areas available to grazing.

Indicators

The indicators of impacts on range management are as follows:

- Level of forage in areas available to livestock grazing
- Ability to build or maintain structural (e.g.., water developments and fences) and nonstructural (e.g., vegetation treatments) range improvements
- Level of disturbance to livestock, including unwanted dispersal

Assumptions

The analysis has the following assumptions:

- All new and existing leases and permits administered by the BLM and BIA would be subject to terms and conditions determined by the BLM Authorized Officer or the BIA Authorized Officer. This would be to achieve the management and resource condition objectives for BLM-managed and BIA-managed lands and to meet rangeland health standards, in accordance with BLM and BIA grazing regulations.
- Existing memoranda of understanding (MOUs) governing management of livestock grazing allotments for the BLM, BIA, and the Navajo Nation would remain in place.
- Existing Tribal ranch leases would remain in place.

Nature and Type of Effects

Impacts on rangeland management are generally the result of activities that affect forage levels, areas available to grazing, the ability to construct range improvements, availability and access to water or those that disturb or harass livestock in grazing allotments.

As discussed in **Section 3.4.1** of the FMG RMPA/EIS, for BLM-managed allotments, management would be applied to grazing permits and leases following land health standards and guidelines. BIA grazing permits and Tribal ranch leases would follow individual conservation plans.

Vegetation management could affect livestock grazing if management requires temporary or permanent limitations on available grazing acreage, grazing strategies, or season of use. This could result in short-term reductions in forage available for livestock and increased time and costs of management for permittees. In the long term, vegetation management is likely to promote increases in forage, and the ability to manage livestock may be improved.

Lands and realty actions, such as small land transfers and ROW authorizations, such as those for power lines, pipelines, and other structures, could have short-term indirect impacts from ROW development. Construction impacts are those from the direct loss of forage, dust reducing forage palatability, and introduction of noxious weeds, which can affect quality and quantity of forage.

In addition, construction can disturb livestock. They can be injured or killed from open trenches and vehicle collisions if proper mitigation measures are not in place. Unwanted dispersal of livestock may also occur, for example, when gates are inadvertently left open. This increases the time and costs of management for permittees and lessees. The time frame for short-term displacement of livestock from a ROW can vary from a few weeks to months during construction; it also could last as long as 2 years or more following reclamation, depending on the activity permitted in the ROW.

Long-term impacts on livestock would result from land use authorizations, such as aboveground pipelines or power line infrastructure, that permanently occupy the land. Long-term impacts on livestock from site-specific lands and realty actions include changes in and loss of forage, reduced forage palatability because of dust on vegetation, and livestock disturbance and harassment from increased levels of human activities.

Restrictions on ROWs, particularly ROW exclusion areas, may indirectly affect grazing by reducing construction impacts from developing these ROWs. In all cases, reduced impacts would be concentrated in areas where restrictions on development overlap with areas available for livestock grazing. Conversely, increases in areas available for ROW development may increase these impacts.

The impacts of energy and mineral development differ by phase of development. During the exploration and testing phase of mineral development, the footprint of disturbance is usually small and localized; therefore, minimal acres available for grazing would be directly affected; however, during the exploration phase, impacts on livestock dispersal and trespass could occur, increasing the time and cost of management.

Surface-disturbing mineral development directly affects areas of grazing in the short term during construction of well pads, roads, pipelines, and other facilities. Potential impacts include changes in available forage due to land disturbance.

Support vehicles on new and existing routes for energy and mineral development and construction equipment may also have indirect impacts on forage availability. Fugitive dust caused by vehicles could settle on vegetation, especially alongside routes with heavy traffic. This dust could affect the quality and regenerative capacity of roadside grasses and forbs and could decrease the palatability of the forage for livestock.

The construction of new routes may also improve access to remote facilities and grazing areas, which could reduce time and costs for management; however, increased access could increase the disturbance to livestock, increase the number of undesignated routes, and increase the distribution problems associated with unclosed cattle gates and gaps created in cut fences. Vehicles would also present a potential collision hazard for livestock.

Areas of disturbed soil could increase the potential for the introduction and proliferation of noxious weeds that lack the nutritional value needed for productive grazing. These species could reduce rangeland and forage values by replacing preferred forage species, leading to a reduction in grazing capacity. Without proper management and control, invasive plant species become established and cause severe infestations. Additionally, some invasive plants are poisonous to livestock and can kill or impair them if ingested.

Limits on livestock movement and harassment, injury, and temporary displacement of livestock may also occur because of development. In the long term, a smaller area of grazing acreage is permanently lost from operations following rehabilitation. Improving roads associated with mineral development could facilitate livestock management by maintaining or improving access to remote locations in allotments; however, increased access may also increase the potential for vandalism or damage to range improvement. Properly implemented BMPs and reclamation mitigation measures would likely maintain rangeland health and forage levels for livestock.

In addition, development has the potential for indirect impacts on livestock grazing, by affecting air and water quality, which in turn could affect livestock health (**Section EC.4.4**, Water Resources, and **Section EC.4.1**, Air Resources). The use of waters of the Navajo Nation for oil and gas development could reduce the availability of water for range improvements.

Where livestock grazing has been an ongoing use, it should not conflict with management of lands with wilderness characteristics; however, it could restrict structural and nonstructural range improvements that increase the time or costs for livestock management.

EC.3.2 Minerals

Methods and Assumptions

Indicators and Assumptions

Fluid Minerals

Indicators of impacts on fluid minerals are the following:

- The amount of land closed to or withdrawn from fluid mineral leasing
- The amount of land open to fluid mineral leasing that is subject to NSO stipulations
- The amount of land open to fluid mineral leasing that is subject to CSU stipulations
- The amount of land open to fluid mineral leasing that is subject to TL stipulations
- The amount of land managed as ROW avoidance
- The amount of land managed as ROW exclusion

The fluid mineral analysis has the following assumptions:

- Valid existing leases would be managed under the stipulations in effect when the leases were issued.
- Oil and gas operations on existing leases would be subject to conditions of approval by the BLM Authorized Officer.
- Management actions also apply to oil and gas leasing on split estate lands overlying federal mineral estate. This includes federal mineral estate underlying BLM-managed lands and BIA-managed lands, and federal mineral estate underlying private surface, state surface, and surface lands administered by other federal and state agencies. The Forest Service works with the BLM in areas where federal mineral estate exists beneath National Forest System lands. Federal mineral estate under Forest Service lands is part of the planning area but not the decision area for the FMG RMPA/EIS.
- If an area has been leased, it could be developed; however, not all leases would be developed in the life of the FMG RMPA/EIS. Leases that have not been developed within the required timeframe could be auctioned off again unless they are within a closed area. New lease conditions would be applied.
- As discussed in **Section 3.4.2** of the FMG RMPA/EIS, most new development in oil and gas production during the life of the FMG RMPA/EIS is expected to be unconventional wells in the Mancos-Gallup Formations. Conventional drilling and coalbed methane development are also expected to occur.

Energy Solid Leasable Minerals

The indicator of impacts on energy solid leasable minerals is the amount of land that becomes unavailable to coal extraction due to conflicting fluid mineral extraction, ROW restrictions or NSO stipulations.

BLM Nonenergy Solid Leasable Minerals and BLM Salable, and BIA Solid Leasable Minerals

Indicators of impacts on BLM nonenergy solid leasable minerals and BLM salable minerals, and BIA solid leasable minerals are the following:

- The amount of land managed as ROW avoidance
- The amount of land managed as ROW exclusion

The BLM nonenergy solid leasable minerals and BLM salable minerals, and BIA solid leasable minerals analyses are based on the following assumptions:

- If an area has been leased, it could be developed; however, not all leases would be developed in the life of the FMG RMPA/EIS.
- Existing permits and lease conditions for all these minerals would not be affected by the FMG RMPA/EIS, unless the lessee proposed to modify the lease. Development activity for all these minerals is anticipated to stay approximately the same for the life of this RMPA/EIS, see **Section 3.4.2** of the FMG RMPA/EIS, Trends, for more information.
- There are no active locatable mineral mines on the BLM federal mineral estate in the planning area, and future locatable mineral activity is not anticipated for the life of the FMG RMPA/EIS.

Management of certain resources would result in leasing stipulations or closures, under some or all of the alternatives and could therefore impact minerals and energy resources. These closures and restrictions are discussed together under *Impacts from Minerals and Energy* under each alternative.

Nature and Type of Effects

The following analysis describes the Nature and Type of Effects that could affect minerals and energy resources in the decision areas. Details on how the occurrence of each impact would vary by alternative are described under the various alternatives' subheadings.

Fluid Minerals

Closing areas to fluid mineral leasing would have the greatest impact on oil and gas leasables by prohibiting new oil and gas leasing and development on federal or Tribal mineral estate. Total oil and gas development in the decision area may be reduced due to resources in closed areas being inaccessible.

In areas where fluid mineral NSO stipulations are applied, drilling would need to be done by directional or horizontal methods in order to reach subsurface targets. These drilling methods are more expensive than conventional drilling, and the target area where they could reach is limited. This means that some minerals may be inaccessible in areas where an NSO stipulation covers a large area or where no leasing is allowed on surrounding lands.

Closures and NSO stipulations would have the greatest impact in unleased areas, as these management actions would not apply to existing leases. In unleased areas, impacts could be mitigated where the fluid minerals underlying these areas could be extracted (or drained) via wells drilled nearby without having to drill into the actual area subject to the NSO stipulation. This could be accomplished if the parcel subject to NSO stipulations were part of a unit or communization agreement, if favorable landownership patterns and geology exist. Circumstances where this method of exploration and development is possible may be limited.

Fluid mineral CSU stipulations allow some use and occupancy in areas where they are applied. While less restrictive than an NSO, a CSU stipulation allows the BLM to require special operational constraints, to shift surface-disturbing activity, or to require additional measures to protect a specified resource or value. While not prohibiting surface-disturbing activities, a CSU stipulation does influence the location and level of operations in the subject area, limiting development.

Areas where TL stipulations are applied are closed to fluid mineral exploration and development, surface-disturbing activities, and intensive human activity during identified time frames, usually based on seasons or species' breeding times. Some operations would be allowed at all times, such as maintenance and vehicle travel; however, construction, drilling, completions, and other intensive operations would not be allowed during the restricted time frame, thereby limiting development. Most activities, however, can be initiated and completed outside of the restricted dates specified in the TL stipulation.

Other requirements applied to oil and gas development, such as setbacks, notification requirements, and plans of development, could make development more burdensome but are unlikely to prevent development from occurring or change the total amount of development in an area. The exception would be if a requirement made development so burdensome that it became uneconomical.

In ROW exclusion areas, the placement of new off-lease ROWs for infrastructure, such as roads and pipelines, or even wellpads, would be prohibited for new leases. The lack of available means for transporting oil and gas to processing facilities and markets could indirectly affect oil and gas development in these areas. Oil and gas activities would be similarly affected by ROW avoidance areas; however, because ROW avoidance areas may allow some ROW placement with restrictions or under other special conditions, impacts on oil and gas development could potentially be mitigated.

<u>BLM Energy Solid Leasable Minerals (Coal)</u>
The decisions in the FMG RMPA/EIS will not directly affect energy solid leasable minerals; however, they could be impacted by conflicting leases for oil and gas resources. ROW restrictions are not expected to impact access to energy solid leasable minerals because ROWs needed for mining are included within the mine lease area.

<u>BLM Nonenergy Solid Leasable Minerals</u>
Management actions that result in ROW avoidance or exclusion restrictions could reduce the total amount of nonenergy solid leasable mineral development in the decision area because they would restrict the building of new roads; however, ROWs needed for nonenergy solid leasable minerals are usually contained within mine lease area so impacts are expected to be minimal.

<u>BLM Locatable Minerals</u>
Historical uranium mining has taken place in the decision area; however, because no new development is anticipated for the life of this RMPA/EIS, no effects on locatable minerals are anticipated. This resource is not discussed further in this section.

<u>BLM Salable Minerals</u>
Demand for salable mineral is generated primarily from road maintenance needs. Alternatives that are projected to reduce the amount of fluid mineral development could reduce demand for minerals used in the construction of roads, well pads, and other facilities. The locations of new sand and gravel pits could shift based on the locations of NSO areas and ROW avoidance or exclusion areas. If more material is needed due to longer road routes to avoid ROW or NSO restrictions, additional pits could open under some alternatives.

<u>BIA Solid Leasable Minerals</u>
The decisions in the FMG RMPA/EIS will not directly affect solid leasable minerals; however, they could be impacted by conflicting leases from fluid energy resources. ROW restrictions are not expected to impact access to solid leasable minerals because ROWs needed for mining are included within the mine lease area. Sand and gravel demand is primarily driven by local road and facility construction, and the locations or new pits may shift based on NSO and ROW exclusion or avoidance areas. There is an abandoned uranium mine

in the BIA planning area that is undergoing cleanup and closure (USEPA 2018). No new uranium mines are anticipated for the life of the FMG RMPA/EIS.

EC.3.3 Forestry

Methods and Assumptions

The methods of analysis are the same for BLM- and BIA-managed lands and minerals, unless otherwise noted.

Indicator

The indicators of impacts on forestry are:

- The loss or alteration of the quality and quantity of forest and woodland products available for gathering and cutting, to the extent that the forest is no longer in a continuously productive state in accordance with principles of sustained yield
- The loss of Indian forest land in its natural state when an Indian Tribe determines that the recreational, cultural, aesthetic, or traditional values of the Indian forest land represents the highest and best use of the land

Because vegetation condition class is analyzed under **Section EC.4.2**, Upland Vegetation and Soil, impacts on vegetation condition class are not repeated in this section.

Assumptions

The analysis includes the following assumptions:

- There is a direct relationship between forest resiliency and condition and surface disturbances.
- Any loss of oak woodlands or ponderosa pine-mixed conifer forests would threaten the long-term viability of those plant communities and associated forest products due to the small amount of remaining land they occupy (each less than 1 percent of the total BLM-managed surface land).
- The BLM and BIA would work with other landowners to coordinate forest management on adjacent lands.
- Forests would be managed to minimize potential threats, including fragmentation, wildland urban interface expansion, and wildfires.
- Management actions related to protecting resources, such as water quality, soils, wildlife, and plants, affect the acres and output of forest products.

Nature and Type of Effects

Vegetation management in forest and woodland vegetation communities may result in both direct and indirect impacts on forest and woodland products. If vegetation treatments were to yield forest products, there may be a direct increase in the volume of forest products; however, not all vegetation treatments, such as slash disposal through burning, would provide usable forest products. Increasing the number of vegetation treatments that do yield forest products would directly increase the volume of forest products.

Vegetation treatments may also indirectly affect forest and woodland products by influencing growth, vigor, and productivity of stands, which in turn may affect the volume or type of products. Thinning can reduce inter-tree competition and stimulate growth of large, insect-resistant trees. In this manner, vegetation treatments designed to increase growth, productivity, and vigor can indirectly increase the volume of forest products.

Mineral and ROW development impact forestry through the direct removal of vegetation/trees, which reduces the volume of forest products. There would be long-term impacts from vegetation removal where mineral and ROW development creates permanent surface disturbance, such as well pads, access roads, or pipelines. The extent and magnitude of the impacts would depend on how much forest or woodland is removed to accommodate mineral and ROW uses. Excluding ROWs or applying ROW avoidance criteria or mineral stipulations would restrict development in certain areas, thereby eliminating or reducing the potential for development in areas that might otherwise be used for forest and woodland products.

On lands managed to protect wilderness characteristics, restricting treatments could affect the intensity, volume, or type of products. This would occur by limiting or prohibiting wood product gathering and cutting to preserve wilderness characteristics. The extent of these impacts would depend on the number of acres managed to protect wilderness characteristics in forest and woodland vegetation communities and whether any treatments are allowed.

Various surface-disturbing activities may be authorized under all VRM classes; however, these activities would have to occur in such a way as to meet the VRM class objective for the area. Because the management objective for VRM Classes I and II requires preserving or retaining the visual character of the landscape, surface-disturbing activities are designed or modified so they repeat the basic elements of form, line, color, and texture found in the predominant natural features of the characteristic landscape. In VRM Class III and Class IV areas, approved surface-disturbing activities are likely to modify the character of the landscape, which could include removing forest vegetation.

EC.3.4 Lands and Realty

Methods and Assumptions

Impacts on lands and realty would result from actions that increase the demand for or restrict the number or location of ROWs, communication site leases, and other land use authorizations; that result in a change to landownership; or that create or revoke land withdrawals.

Indicators

Indicators of impacts are as follows:

- For assessing land tenure, the changes to land tenure and ownership
- The ability to accommodate land tenure adjustments necessary to meet resource use objectives, based on lands available for sale, exchange, conveyance, retention, or acquisition
- For assessing BLM land use authorizations, the ability to accommodate preferred ROW locations, including transportation systems, pipelines, and transmission lines, based on the acres and locations of ROW exclusion and avoidance areas
- For assessing land use authorizations, the increase or decrease in the BIA's ability to accommodate land use authorizations
- Management that increases or decreases the demand for new or expanded ROWs
- For withdrawals, the number of acres available for withdrawal (BLM only).

Assumptions

The analysis includes the following assumptions:

- Existing ROWs, designated utility corridors, and communication sites will be managed to protect valid existing rights.
- On renewal, assignment, or amendment of existing ROWs, additional stipulations can be included in the land use authorization.
- ROW holders may continue their authorized use as long as they are in compliance with the terms and conditions of their grant.
- The BLM and BIA will continue to process land tenure adjustments and land use authorizations as workforce and workload allow.

- Ongoing lend tenure changes to allotted lands, such as the Navajo Land Buyback Program, will continue.
- The demand for all types of land use authorizations (including communication site leases and utility ROWs) will increase over the life of the FMG RMPA/EIS.
- Maintaining and upgrading utilities, communication sites, and other ROWs is preferred before new facilities are constructed in the decision area.
- Demand for small distribution facilities to extend and upgrade services, such as communication sites and utilities, will increase as oil and gas development occurs in the planning area.
- Demand for both regional and interstate transmission lines will increase as regional populations and nearby urban areas grow.
- Retention areas include all lands in the decision area, with the exception of lands identified for sale, exchange, or conveyance (BLM only).

Nature and Type of Effects

Land Tenure

For the BLM, land tenure adjustments, such as sale, conveyance, or exchange, that acquire and convey lands out of federal ownership can increase management efficiency of BLM-managed lands by creating more contiguous ownership patterns. Land tenure adjustments also allow the BLM to acquire lands to protect sensitive resources, maintain public values, and improve overall resource management.

In some cases, lands acquired to protect or improve resources can result in isolated parcels, decreased management efficiency, and increased management costs. Such resources are threatened, endangered, or BLM sensitive species habitat, riparian areas, wetlands, recreation areas, visually sensitive areas, and cultural resource sites. Retaining noncontiguous parcels to protect resource values can also complicate access, decrease BLM management efficiency, and increase management costs.

Land sales, conveyances, or exchanges near cities or towns could accommodate community expansion needs by enabling lands to be used for public purposes, such as conveyance to a local government under the provisions of the Recreation and Public Purposes Act. Lands conveyed under this act that no longer meet the stated public purpose for which they were conveyed could revert to federal ownership. Reverting lands previously conveyed could decrease the BLM's ability to efficiently manage lands in the decision area.

Management that limits the conveyance of lands out of public ownership or that prioritizes acquisition of parcels for resource protection influences land tenure decisions. The nature and extent of the impact would be determined by the extent to which the management affects the BLM's ability to consolidate landownership, maintain access to other BLM-managed lands, and carry out its multiple-use mandate under FLPMA.

For the BIA, land tenure adjustments support consolidation of Tribal trust lands, create more contiguous ownership patterns and effective jurisdiction, and protect sensitive resources. Lands acquired through fee to trust actions to protect sensitive resources, such as cultural resource sites, can result in isolated trust parcels that may complicate access and result in a less contiguous land pattern.

Land Use Authorizations

Resources and resource uses affect the lands and realty program by prescribing ROW exclusion and avoidance areas to protect resources or limit conflicts with other uses. In ROW exclusion areas, the BLM would not permit new ROWs. Applicants could apply for new land use authorizations in ROW avoidance areas; however, to be approved, a proposed project may be subject to resource surveys and reports, construction and reclamation engineering, long-term monitoring, special design features, special siting requirements, TLs, relocation, or other special conditions. Due to the land ownership pattern in the planning area, the use of the ROW corridors will need landowner consents and BIA approval. Such requirements could restrict project location, delay the availability of energy supply by delaying or restricting pipelines or transmission lines, or delay or restrict communications service availability.

As a result of specialist surveys and reports, the BLM or BIA may require that alternative routes be identified and selected to protect sensitive resources. Designating ROW avoidance areas and applying special stipulations would increase application processing time and costs, due to the potential need to relocate facilities or due to greater design, mitigation, and siting requirements. These requirements could shift development to adjacent private lands, especially if developing there would achieve the same objectives (e.g., power transmission).

The following resource programs may contain ROW avoidance or exclusion areas to protect resources: soil and water resources, wildlife, cultural and heritage resources, lands with wilderness characteristics, special designation areas, national historic trails, and wilderness. In addition to avoidance or exclusion area management, the BLM and BIA may require more specific conditions of approval, depending on the type of land use authorization and resource being protected. These conditions of approval would affect the nature and type of land use authorizations on a case-by-case basis.

Surveys for special status plant and animal species and cultural and paleontological resources could identify resources that would, through subsequent project-level NEPA analysis, necessitate the relocation or mitigation of a project in areas not identified as ROW avoidance or exclusion areas. These surveys would most likely be completed for projects proposed in avoidance areas, but they could also be required for projects in open areas.

On BLM-managed lands, VRM classes influence the level of disturbance allowed to the natural landscape for a given area (**Section EC.4.12**). A VRM Class I designation allows for fewer modifications to the natural landscape than a VRM Class IV designation. Land uses are authorized so long as structures and activities associated with the land use comply with the VRM class management objectives for the area. For example, fewer land use authorizations are capable of meeting VRM Class II management objectives than VRM Class IV management objectives; therefore, VRM class management objectives limit locations and types of land use authorizations. Land use authorizations proposed in VRM Class I and Class II would likely have longer application processing times and increased project costs than those in Class III or Class IV. This would be due to the need to relocate facilities or apply more stringent design measures to mitigate potential visual impacts.

Prohibiting or restricting salable mineral sale, exchange, or conveyance, nonenergy solid mineral leasing, and fluid mineral leasing and placing NSO stipulations on fluid mineral development would indirectly affect lands and realty. This would come about by eliminating or reducing the demand for new roads, pipelines, transmission lines, and other land use authorizations typically needed to support oil and gas development. In the planning area, fluid mineral leasing would create the greatest demand for new land use authorizations.

Renewable energy development places a demand on the BLM and BIA lands and realty programs, both in the form of new site ROWs for generation facilities and for power lines, roads, and other supporting infrastructure. Impacts on lands and realty would primarily be the result of new or expanded wind and solar energy development. Management that avoids or excludes ROWs would reduce or eliminate the demand for new land use authorizations associated with renewable energy development.

For BLM-managed lands, recreation management actions involve managing the locations and types of recreation in certain areas, which may include the designation of SRMAs and ERMAs. In these areas, the BLM establishes appropriate recreation management to support desired recreation settings and opportunities for certain activities, such as hiking, camping, motorized and mechanized travel, and equestrian use. Unless it manages them as exclusion areas, the BLM can authorize land uses in SRMAs and ERMAs. This would be allowed so long as the development does not conflict with the management goals and objectives of the SRMAs and ERMAs and does not physically displace recreation in those areas. Management of SRMAs and ERMAs as ROW exclusion or avoidance would limit the locations and types of land use authorizations in those areas.

Collocating new infrastructure in existing ROWs or in previously disturbed areas reduces the potential for land use conflicts and additional land disturbance. Collocation policies also clarify the preferred locations for new utilities; however, such policies limit an applicant's options for selecting viable ROW locations, which could result in fewer land use authorizations in the decision area over the long term. Collocation of access ROWs and use of these ROWs, if coupled with increased maintenance of these roads, could reduce the current impacts on the overall road network in the planning area.

Withdrawals (BLM Only)

Land withdrawals transfer the land management authority from the BLM to another federal entity, such as the BIA, Department of Defense, or Bureau of Reclamation. The purposes are to limit or change the nature of activities on the land to maintain other public values in the area or to reserve the area for a particular public purpose or program. Unlike a land tenure adjustment, which conveys lands out of federal ownership and involves a change in title, withdrawals transfer administrative authority over an area of federal land from one department, bureau, or agency to another without transferring ownership. Because some acres are withdrawn from a type of use, they can affect the number of available acres for certain types of land use authorizations or land tenure.

EC.3.5 Recreation and Visitor Services

There are no decisions being considered that would significantly affect recreation areas and visitor services on BLM- and BIA-managed lands in the decision areas. BLM management of designate recreation and visitor areas would continue under the 2003 RMP. Hunting, fishing, and recreational shooting would not be affected by the alternatives considered in the FMG RMPA/EIS; therefore, these topics are not discussed in the FMG RMPA/EIS.

EC.4 Specially Designated Areas

EC.4.1 Wilderness and Wilderness Study Areas

Methods and Assumptions

Impacts on the wilderness character of untrammeled, natural, undeveloped, solitude or primitive and unconfined recreation, and unique or supplemental values are considered in this analysis.

The BLM administers 41,600 acres of the 47,900 acre-Bisti/De-Na-Zin Wilderness Area; the remaining 6,300 acres are Tribal trust and Tribal allotted lands. The BLM administers all 7,200 acres of the Ah-shi-sle-pah Wilderness Area.

Indicators

Indicators of impacts are as follows:

- Changes in apparent naturalness resulting from management actions or vegetation manipulations that make the area appear less natural
- Impacts on opportunities for solitude or primitive and unconfined recreation, as measured by the amount and type of visitor use
- Severity of disturbances or changes in unique and supplemental values or cultural resources

Assumptions

The analysis includes the following assumptions:

- The Bisti/De-na-zin Wilderness Area and the Ah-shi-sle-pah Wilderness Area would continue to be managed according to BLM Manual 6340, Management of Designated Wilderness Areas (BLM 2012d [Manuals]), and in coordination and cooperation with the BIA or other agencies with authority.
- Implementation-level activities in wilderness would be evaluated on a case-by-case basis to determine whether the activity would affect wilderness characteristics.

Nature and Type of Effects

The purpose of the Wilderness Act is to preserve the wilderness character of designated areas. The public purposes would be administered to preserve the wilderness character of the area.

There could be incidental impacts from management of other resources, which would protect wilderness characteristics in the Bisti/De-na-zin Wilderness Area or Ah-shi-sle-pah Wilderness Area, such as overlapping acres of wilderness areas with an ACEC or a National Historic Trail. This is because they often include complementary management objectives.

In wilderness areas, no new mineral leases, licenses, or permits are permitted under the mineral leasing laws, or sales contracts or free use permits (other than for research) under the Materials Act. Mineral leases, permits, or licenses existing before the date of an area's designation as wilderness can be operated under the original terms and conditions.

EC.4.2 Specially Designated Areas

The BLM alternatives, including the No Action Alternative, do not create any new ACECs or change the boundary or management of existing ACECs. The total number of acres of ACECs in the decision area would not change under any alterative and would remain the same at 89,300 total acres. The surface allocation of current ACECs would not change under any alternative. There may be impacts on the setting of an ACEC outside of the ACEC boundary, such as increased noise or light from development. None of the alternatives, however, would alter the relevant and important values for which these ACECs were designated, and they would continue to be managed following the specific management prescriptions outlined in the 2003 RMP; thus, there would be no impacts on ACECs under any BLM alternatives.

Impacts on other SDAs are described throughout **Chapter 3**, in **Section 3.3.7**, Wildlife; **Section 3.3.8**, Special Status Species; **Section 3.3.9**, Cultural Resources; **Section 3.3.10**, Paleontological Resources; and **Section 3.4.6**, Wilderness and Wilderness Study Areas.

Impacts on specific resources protected by Navajo Nation sensitive areas are discussed in **Section 3.3.8**, Special Status Species. These are designated as highly sensitive areas, moderately sensitive areas, less sensitive areas, community development areas, biological preserves, and recreation areas. For this reason, impacts of BIA alternatives on SDAs are not further discussed in this section.

EC.5 Social and Economic Conditions

EC.5.1 Native American Tribal Interests and Uses

Methods and Assumptions

Indicators

The significance of CIMPPs and other Tribal resources or practices would be determined through consultation with Tribes. For purposes of this document, CIMPP is a term that includes a variety of resource types generally distinguished because their significance lies in their importance to living communities such as Tribes or Tribal individuals, as described in detail in **Section 3.3.9** of the FMG RMPA/EIS, Cultural Resources. CIMPPs include, but are not limited to, traditional cultural properties (TCPs) as defined by the NPS and Navajo Nation; sites and sacred sites as defined in AIRFA and EO 13007; and loci of traditional cultural practices and Jishchaa' as defined by the Navajo Nation. CIMPPs also include resources such as water, geologic formations, air quality, and vegetation, which are integral resources for Navajo lifeway, ceremonial life, and healing Navajo peoples.

While some CIMPPs are well known, other locations or resources may be privileged information that is restricted to specific Tribes or individual Tribal members. The Section 106 process of the NHPA recognizes that there may be instances where a Tribe's leadership is willing to share sensitive information only with the federal agency and not with the other consulting parties. This would be the case if the disclosure of such information "may cause a significant invasion of privacy; risk harm to the historic property; or, impede the use of a traditional religious site by practitioners" (36 CFR 800.11[c][1]). For Tribes, maintaining confidentiality and customs of traditional knowledge may take precedence over identifying and evaluating these resources. Under such circumstances, this would result in information being unavailable for inclusion in the NEPA analysis.

The Navajo Nation's Traditional Cultural Program maintains records of previously published CIMPPs, specifically TCPs. These CIMPPs are generally of significance to the entire Navajo Nation, while other CIMPPs in the planning area may be of significance to local Navajo Chapters, families, or individuals, and their significance would be determined through consultation. In contrast, the significance of such ITAs as water and fluid mineral rights for the Navajo Nation and Navajo allottees are more clearly identifiable.

In summary, indicators of impacts on ITAs are as follows:

- Direct or indirect impacts diminishing the qualities that make a CIMPP eligible for listing on the NRHP or considered under AIRFA, EO 13007, and Tribal regulations. Given that a CIMPP's significance is defined by the Tribes, practitioners, or clans to whom it is important, and that this knowledge may be privileged and not subject to disclosure, these same groups would also be most able to suggest how a CIMPP could be affected. This could include traditional cultural use areas, places of cultural importance, and other landscapes and areas of traditional cultural or ethnic importance, valuable or needed for use by Tribes, Tribal members, or other communities. Indirect impacts on CIMPPs could result from subsurface activities in NSO areas that diminish the ability of Tribes to conduct ceremonies or otherwise use these cultural resources (Begay 2001).
- Acres removed from potential development of fluid mineral ITAs for Tribal trust lands and individual Indian allotments
- Alteration of the physical characteristics of groundwater and other watercourses that affects the sustainability of water-related ITAs

Assumptions

The analysis includes the following assumptions:

- The BLM and BIA will follow the Section 106 process of the NHPA; AIRFA; EO 13007; Chaco Sites Protection Act; Archeological Resource Protection Act; Navajo Nation Cultural Resources Protection Act, Jishchaa' Policy, Policy to Protect Traditional Cultural Properties, Policy for the Disposition of Cultural Resources Collections, and Guidelines for the Treatment of Historic, Modern and Contemporary Abandoned Sites; and other relevant laws and regulations when addressing federal undertakings.
- The criteria of adverse effect (as defined in 36 CFR 800.5a) provide a general framework for identifying and determining the context and intensity of potential impacts on ITAs or CIMPPs, if these are present. Assessing the impacts on these resources requires consultation with the affected group, as defined in 36 CFR 800.2. AIRFA and EO 13007 also apply to impacts.
- Native American CIMPPs include locations (sites, natural features, resource gathering areas, landscapes, places, water, geologic formations, air quality, and vegetation) of traditional cultural or religious importance to Tribes. The types of resources may or may not be historic properties under

the NHPA, but are considered under AIRFA, EO 13007, or relevant Tribal regulations. The types of impacts on CIMPPs are best determined through Tribal consultation. Due to the confidential nature of the information, the resource descriptions and impacts resulting from proposed actions may or may not be available as part of the FMG RMPA/EIS. Tribal use of CIMPPs can occur throughout the planning area and do not always track with fixed dates or times.

- Native Americans and other traditional communities have concerns about federal actions that could affect CIMPPs that include native resources, cultural practices, and gathering natural resources. In such cases, the BLM and BIA would consult with the potentially affected Tribes.
- There may be areas of importance to Tribes that are not readily identifiable outside of those communities.
- Consultation would continue with Tribes to identify any CIMPPs or resource uses and to address impacts. Through this process, impacts would be minimized or eliminated, although residual impacts would be possible.
- Consideration of the potential impacts on paleontological resources, which are considered ITAs as described in **Section 3.6.1** of the FMG RMPA/EIS, Native American Interests and Uses, are evaluated in greater detail under **Section 3.3.10** of the FMG RMPA/EIS, Paleontological Resources.

Nature and Type of Effects

There is the potential for direct and indirect impacts on Native American Tribal interests and uses under all the alternatives. There may also be direct and indirect impacts from implementing management actions in the future, although these would require additional environmental review under NEPA and the NHPA. Impacts from planning actions under NEPA can be difficult to quantify, because the nature and location of most Native American CIMPPs and uses in the planning area are often unknown and are determined through consultation; however, this may not be true of ITAs. Further, planning alternatives typically do not identify specific areas or timing for surface-disturbing activities.

The following actions can contribute to impacts on Native American Tribal interests and uses:

- ROW, oil and gas, or other development at Native American Tribal interests and uses
- ROW, oil and gas, or other development near and on Native American Tribal interests and uses that are important because of their setting, feeling, or association
- Recreation along, near, or crossing Native American Tribal interests and uses

Any future activities that would disturb the ground surface could have direct and indirect impacts on Native American ITAs and CIMPPs. Other types of impacts specific to Tribal CIMPPs could include constructing infrastructure at or near a CIMPP that is out of character with a property's setting or feeling. Such activity could make such CIMPPs no longer usable by Tribal members, or it could decrease access so that they could no longer exercise certain cultural uses and practices. These impacts would be greatest in areas with high well density (**Section EC.4.7**, Wildlife for further discussion of well density). For certain Tribes, ceremonial locations may change in response to development. If these Tribal practitioners lack the funds or abilities to travel elsewhere for certain ceremonies, or those ceremonies are no longer able to be practiced due to these impacts, there is the potential for a reduction in the Tribe's (or Tribal member's) health or well-being (Begay 2001).

As discussed in **Section EC.2.2**, Geology, fluid mineral development could disrupt hózhó and harm the Navajo people or indirectly affect CIMPPs by reducing the ability of cultural practitioners to complete traditional ceremonies. For example, impacts on geologic formations could affect their cultural use, such as tséyáłti' dahólóógóó (Talking Rocks) that aid in diagnoses for Navajo people before those ceremonies related to the geology of the earth, such as the Red Ant Way (Begay 2001). While these are examples of the types of indirect impacts on CIMPPs for Navajo Tribal members, other Tribes may have similar (or dissimilar) indirect effects on the CIMPPs that they consider important.

Additionally, fluid mineral leasing and subsurface development in areas with NSO or CSU stipulations could indirectly affect CIMPPs and diminish the ability of Tribes to conduct ceremonies or otherwise use these resources.

There is the potential for direct and indirect impacts on Native American ITAs and CIMPPs with each phase of fluid mineral development from planning, leasing, and an APD. The ACHP has acknowledged that the early phases of fluid mineral development, such as leasing or planning, could affect historic properties (ACHP 2016, 2017, 2018).

The ACHP also acknowledged that a phased approach to Section 106 of the NHPA is reasonable and in good faith, provided the agencies complete all appropriate Section 106 requirements for each phase: identifying historic properties, assessing effects, and consulting with agencies, Tribes, and other parties. These actions are considered separate undertakings. Agencies also must commit to additional Section 106 requirements when an APD is submitted. Examples of this are a further and more detailed identification of historic properties, assessment of adverse effects, and consultation with agencies, Tribes, and other parties.

The ACHP (2018) further acknowledged that when there are known important historic properties or CIMPPs in a leasing or planning area and impacts may be difficult to avoid, the development of a programmatic agreement could be appropriate for minimizing or avoiding impacts. The agencies' understanding of how Native American ITAs and CIMPPs could be affected by fluid mineral development would increase in specificity at each stage and separate undertaking (planning, leasing, APD). This would come about through the relevant Section 106 and NEPA processes and consultation with Tribes, as more detail is known about the locations of proposed development. For example, the site-specific APD phase would have the most information about proposed development.

Consultation through the Section 106 process is ongoing, and 34 Tribes were contacted. Various Tribes have responded during consultation to state their concerns about impacts on Native American Tribal interests and uses. An example is archaeological sites, such as those in or near Chaco Culture National Historical Park, to which certain Tribes claim cultural affiliation, and the CIMPPs important to these Tribes. Continued consultation is necessary to identify these CIMPPs and to understand how the relevant Tribes view the potential impacts from the alternatives.

EC.5.2 Social and Economic Uses

Methods and Assumptions

The methods of analysis are the same for BLM- and BIA-managed lands and minerals, unless otherwise noted.

The primary form of economic analysis in this assessment is economic impact analysis, which examines the changes in economic activity as a result of the proposed management (Watson et. al. 2007). Economic impact analysis in this assessment takes one of two forms depending on the available data: qualitative or quantitative assessment. For those activities that directly generate measurable spending, the analysis estimates economic impact in terms of output (total spending), jobs, and income in the regional economy.

For example, spending to drill gas wells from BLM-managed minerals fits this type of analysis. Using a regional input-output model (IMPLAN), an assessment of impacts on oil and gas development and production has been completed. IMPLAN is a regional economic impact model that provides a mathematical account of the flow of dollars and commodities through a region's economy. This model provides estimates of how a given amount of an economic activity translates into jobs and income in the region. These multipliers were applied to changes in final demand resulting from the differing BLM management alternatives in the RMP. The results measure the change in the level of output, jobs, and income for those industrial sectors affected by each action.

Economic impacts based on IMPLAN modeling are described in terms of direct, indirect, and induced impacts. Direct impacts, such as income and jobs, are directly affected by activity on BLM-managed land or minerals, such as jobs to drill a natural gas or oil well. Indirect impacts occur when related industries gain from purchases by the directly affected businesses, such as the oil and gas company buying supplies from local firms. Induced impacts are the results of spending by employees hired due to the business activity just described (e.g., the natural gas employee spending money in a local restaurant). Together, these are reported as the total economic impact of the different management alternatives. IMPLAN does not differentiate effects on specific cultural, social, or ethnic groups; impacts are reported in terms of economic sectors.

The quantitative socioeconomic impact analysis is based on the estimated values for the number of wells drilled per year by alternative and estimated production per year, as determined in the 2018 Farmington Mancos-Gallup Reasonably Foreseeable Development Scenario (**Appendix I**). The Farmington Mancos-Gallup RFD estimates a well completion ratio of 100 percent and assumes that all new wells drilled would be hydraulically fractured. These assumptions result in a maximum potential development scenario, maximum production output, and high-end estimate for the cost to drill and associated economic contributions for each alternative. It is recognized that actual development technology employed, and rate of completion may differ from these estimates.

The predicted number of wells drilled per year would vary throughout the planning period. In addition, production estimates account for declines in production over time for a given well. As a result, economic impacts for the development and production phases are provided for three different time points in the planning period: year 1 (2018), year 10 (2028) and year 19 (2037). These estimates represent total annual levels of jobs, income, and economic output, rather than cumulative impacts to that point in time. Due to the dynamic nature of oil and gas prices, technology, and market conditions, estimates may differ from actual drilling and production values. Market prices also affect the amount of federal mineral royalties. In addition, local variation in production and drilling, along with the related jobs, income, and taxes, is anticipated. This analysis does not serve to forecast exact economic outcomes (i.e., prices, production, or output), but instead seeks to model regional economic impacts for the purpose of comparing the alternatives based on the anticipated management actions and given the noted and common assumptions.

The RFD data used in quantitative economic analysis are specific to drilling and production of BLM-managed minerals. No specific projections by alternative were available for development of Tribal Trust or Indian Allotment minerals managed by the BIA, therefore no quantitative impact analysis could be provided for this development. Qualitative analysis is provided in the BIA Alternatives discussion for impacts of development specific to Tribal trust and Indian Allotted minerals. As discussed in *Nature and Type of Effects*, below, development of BLM and BIA-managed minerals would likely result in impacts throughout the socioeconomic analysis area.

Nonmarket values that affect the quality of life for residents and visitors to the planning area are discussed on a qualitative basis. The social impact analysis examines the impacts on specific user groups, as identified in the Farmington Mancos-Gallup 2018 Affected Environment Supplemental Report. The analysis is written in terms of impacts on individuals or groups who have interests in a stakeholder category. This is not meant to imply that all individuals and social groups fit neatly into a single category; many specific individuals or organizations may have multiple interests and would see themselves reflected in more than one stakeholder category. The social impact analysis is qualitative and based on the nature of the proposed action, socioeconomic characteristics of the area under study, social patterns and impacts observed in other areas, and professional judgment.

Analysis of ecosystem services is also addressed on a qualitative basis, with analysis provided by Alternative for the level of services provided.

Indicators

Indicators of impacts are as follows:

- Area employment levels and income changes
- County, Navajo Nation Chapter, and local population forecasts
- Housing costs, availability, and property values
- Demand for public services
- Local and Tribal government fiscal conditions
- Changes to other area land uses, including recreation, Tribal homesite or individual Indian allotment residential leases, and livestock grazing
- Quality of life factors, such as air and water quality, traffic, and crime, and changes to the social environment

Assumptions

The analysis includes the following assumptions:

- Implementing SOPs, BMPs, or mitigation measures to protect other resources could indirectly affect socioeconomics by increasing costs or precluding development (University of Colorado Boulder 2015). The analysis assumes that stipulations that affect cost, timing, and the level of drilling and/or the production level are considered in the RFD estimates. Socioeconomic modeling by alternative does not include further adjustments for oil and gas stipulations and their direct impacts on the costs of drilling or completion.
- Actual impacts of mineral exploration and development could vary. This would happen if the rate of development or production were to change over the study period, owing to factors outside the management decisions of the BLM and BIA. These include national and international energy demand and prices, production factors in the planning area, and business strategies of operators.
- Economically relevant laws, policies, and regulations, such as mineral access, federal mineral royalty rates, Tribal lease allocations, royalties for Tribal trust and Indian allotted lands, taxes, and state severance tax rates, would remain as they were at the time of production of this analysis.
- Quantitative estimates for state taxes collected from development of BLM-managed minerals are based on net value of sales (i.e., gross production value minus deductions for mineral royalties and transportation costs). This analysis assumes net value is approximately 75 percent of gross value to account for these deductions. Actual net value would vary based on specific transportation costs and other deductions.
- The quantitative economic impact analysis for BLM-managed minerals is based on the estimated RFD values for production per year and the number of wells per year by alternative.
- Quantitative impact analysis of development of BLM-managed minerals assumes a 100 percent completion ratio for all wells drilled.
- Quantitative impact analysis for BLM-managed minerals assumes that all wells will be hydraulically fractured.
- The quantitative economic impact analysis for BLM-managed minerals assumes that the estimated costs for drilling an oil well and a gas well are the same. The ratio of horizontal and vertical wells is the same for oil wells and for gas wells (approximately 72 percent horizontal and 28 percent vertical).
- The quantitative economic impact analysis for BLM-managed minerals presents job numbers based on IMPLAN output and represent the annual average of monthly jobs. Thus, one job may represent

one job lasting 12 months or two jobs lasting 6 months each, for example. Because jobs occurring over multiple years may not represent additional new employment opportunities (e.g., one employee working for 2 years represents two jobs), results are presented in the form of annual averages. Total jobs represent direct, indirect, and induced jobs supported.

- Labor income (earnings) represent all forms of employment income, including employee compensation (wages and benefits) and proprietor income. Total labor earnings include direct, indirect, and induced employment.
- Economic output (gross regional economic output) represents the value of industry production. Total economic output includes direct, indirect, and induced value.
- The quantitative economic impact analysis for BLM-managed minerals assumes approximately 50 percent of the workforce for the drilling and completion phase will be drawn from the local area (inside the four-county planning area). Induced impacts for the oil and gas drilling sectors (IMPLAN Sector 38- support activities for oil and gas, and Sector 37- oil and gas drilling) are reduced by 50 percent to account for this percentage. This is to account for the fact that nonlocal employees would spend limited income in the planning area.
- The quantitative economic impact analysis for BLM-managed minerals assumes 100 percent of the workforce for the operation (production) phase would come from the local area.
- The quantitative economic impact analysis for BLM-managed minerals utilizes oil production price based on the average 2018–2037 lower 48-well head price for the Gulf Region, reference condition. This is the best available forecast price. Energy Information Administration does not provide long-term forecasts for West Texas Intermediate prices. The natural gas price is based on the average 2018–2037 Henry Hub spot price forecast (EIA 2018). This is the best available forecast price. Energy Information Administration does not provide long-term forecasts for Biano Spot prices. The actual well-head price would vary based on market conditions and the timing of production. All data are presented in 2017 dollars. All input data were adjusted to 2017 dollars as appropriate, using the Bureau of Economic Analysis Consumer Price Index inflation calculator.

Nature and Type of Effects

For the purposes of this analysis, the nature and type of effects on social and economic conditions are analyzed under each of the four resource areas that management actions would concern: fluid mineral development, vegetation management, ROWs, and lands with wilderness characteristics. The proposed management actions do not provide management direction for other land uses that are of social and economic importance in the planning area, including recreation and livestock grazing. As a result, no direct impacts on these land uses and associated social and economic contributions are anticipated. Potential for indirect impacts on other land uses are discussed under *Fluid Minerals*, below.

Fluid Minerals

Potential economic impacts from proposed fluid mineral management actions are changes in jobs, income, and economic output. These changes may affect achievement of the goals outlined in EO 13790, Promoting Agriculture and Rural Prosperity in America (82 FR 20237-20239). In addition, changes may occur to tax revenue for local, state, Tribal, and federal governments. Though the economic contribution analysis focuses on federal mineral development impacts and economic contributions would not be contained to federal lands but would be dispersed throughout the socioeconomic planning area and region. Impacts can be directly related to proposed management, or they can be secondary to the initial economic impact. Fiscal impacts on local governments can be extrapolated by projecting the value of the gas that is produced, and from the value of oil and gas property. As described in **Section 3.6.2** of the FMG RMPA/EIS, Social and Economic Uses, approximately 49 percent of mineral royalties collected from development of federal minerals are transferred back to the state of origin. For Tribal royalties, 100 percent of royalties are distributed to Tribal (for Tribal minerals) or individual allottees (for allotted lands).

Additional taxes are collected at the state level on net mineral production revenue, including severance tax, conservation tax, and emergency school tax, at rates described in **Section 3.6.2** of the FMG RMPA/EIS. State taxes and the state portion of federal mineral royalties would not be distributed directly to local communities, but rather to the state general fund, or specific use funds. A portion of this revenue may be utilized in local areas. In contrast, ad valorum production and equipment taxes collected by local governments in the location of extraction would represent direct contributions to local communities. As discussed in **Section 3.6.2** of the FMG RMPA/EIS, the rate of taxation varies by municipality and is adjusted annually. Taxes specific to Tribal minerals are discussed in the *BIA Alternatives*.

Closing areas to new leasing and applying NSO and CSU stipulations would require the leaseholder/operator to limit the siting, design, and operations or to use off-site methods, such as directional or horizontal drilling, to access federal oil and gas resources. This could increase extraction costs for a given well, which may result in a higher per-unit economic contribution; however, should stipulations make some areas economically unfeasible to develop, this could result in direct and indirect economic impacts such as reduced jobs, employment, and federal mineral royalty payments and tax revenue. The level of economic impacts from stipulations would vary based on site specific conditions and costs.

TL stipulations that are applied would temporarily close areas to fluid mineral exploration and development. If these limitations were to make development uneconomical, the total amount of fluid mineral development in the planning area would be reduced, thereby reducing the economic contributions from production. Overall, any management actions that ultimately result in a lower level of production would affect the level of employment, income, taxes, and federal and Tribal mineral royalties.

Another secondary impact on increased oil and gas development could be changes to property values in the planning area. Property valuations of large tracts of land could increase, due to potential income from mineral development. Any influx of transient workers to the area for jobs in the oil and gas extraction or production sectors would increase demand for rental properties and the value of rental properties (Bennet 2013).

In contrast, real or perceived concerns about local water quality, air quality, and the visual setting could decrease residential property values in newly developed areas. It also could affect the ability to sell a property or see a return on investment. A 2010 study found that property values can decrease by between 3 and 14 percent if the property is near drilling sites and wells. This study indicated that the decrease in property values dissipates at around 6,600 feet (2,000 meters) from the well site (Integra Realty Resources 2010). While property value, in terms of equity, is affected by development on non-Indian lands, this may not be the case on Navajo Tribal trust and Indian allotments where equity is limited due to land status and limited infrastructure (i.e., electricity and water); however, the income influx of monetary gain for individual Indian allottees is often used to improve or obtain residential structures.

The method of mineral extraction used, such as conventional wells versus hydraulic fracturing, may also have unique impacts on local communities' quality of life. Potential impacts on local quality of life from the method of mineral extraction used could include impacts such as increased noise, traffic, ambient air quality, water quality, and the potential for induced seismicity. While the impacts would vary depending on the values of specific communities and user groups, impacts would likely be greatest in areas with high well density (**Section EC.4.7**, Wildlife for further discussion of well density). For a further discussion of the impacts of hydraulic fracturing, see **Section EC.4.3**, Geology; **Section EC.4.4**, Water Resources; and **Section EC.7.4**, Public Health and Safety.

Oil and gas development may also conflict with other land uses, including recreation, Tribal homesite and individual Indian allotted residential leases, agriculture, grazing, timber, and wind and solar energy developments. Conflicts with other land uses could reduce the economic contributions from these resources, but impacts are likely to be site-specific in nature. The level of impacts would depend on the exact timing and location of development. Conflicts also could affect traditional ways of life, as further discussed under the nonmarket considerations, below.

Changes in employment and income from oil and gas development may in turn cause other socioeconomic impacts, such as changes in local populations. This could lead to impacts on housing, infrastructure, and government services. There could also be impacts resulting from additional or new income afforded to lessees with limited financial literacy and management, resulting in negative social consequences.

Due to the current presence of natural gas drilling and skilled workers in the region, it is estimated that 50 percent of labor required could be drawn from the available workers in the region. Unlike the BIA, the BLM cannot require the preference hiring of Native American workers. The level of anticipated labor required would likely be filled by those currently unemployed residents who work in the oil and gas industry and experts in the field from in and outside the region; those employed would not permanently reside in the planning area due to reasons such as the following:

- The industry's requirement for rotational and transient crews
- Housing availability (scarcity of appropriate type or price)
- Lifestyle preferences (workers are socially invested elsewhere)
- Economic expectations (job permanence or job mobility)

Increased population growth, due to oil and gas development and temporary relocation, would increase economic activity, but it could alter the local social setting and strain public services, depending on the rate and level of growth (Smith et al. 2001). Additionally, increases in new income and a population influx have led some oil and gas boomtowns, unprepared for such demographic changes, to experience increased rates of crime and human trafficking (Horwitz 2014).

This would affect the level to which proposed management would result in changes to the demand for public services and housing. Workers who reside out of town could reduce the amount of household goods and services consumed and housing investments spent locally, as their incomes would be spent outside the planning area.

Changes in resource management may also have direct and indirect social implications for residents of and visitors to the planning area. Changing populations and demographic shifts could affect attitudes, opinions, quality of life, crime rates, and established social structures. As noted during the scoping process for the FMG RMPA/EIS, many planning area residents are concerned about the impact mineral development might have on traditional ways of life and the social structure of the planning area. Potential impacts are changing planning area demographics, changing local community social structures, and changing crime rates. Impacts associated with changes to traditional cultural ways of life are further discussed in **Section EC.7.1**, Native American Tribal Interests and Uses.

Potential impacts on public services could also occur as an indirect result of development. An increased temporary or permanent workforce could increase demand for community social services, such as education, police and fire departments, first responders, and local hospitals, and associated costs. Such cost increases have been documented in the Rocky Mountains and on the East Coast (Haefele and Morton 2009; Kelsey and Ward 2010). Impacts generally depend on the number of temporary workers required to relocate to the area during drilling operations; the higher the level of workers relocating, the greater the strain on local services.

As discussed in **Section 3.6.2** of the FMG RMPA/EIS, studies centered around crime in oil and gas boomtowns have shown that increases in crime rates and the public perception of increased crime rates may be driven by the rapid population growth associated with oil and gas development (Archbold 2015).

The potential for impacts on crime-rate as a result of proposed actions would depend on the timing of development, and the level to which a population influx is anticipated.

There may also be impacts on roads from increased traffic from drilling, particularly that involving large trucks. In a 2014 study, the estimated road reconstruction costs associated with a single horizontal well ranged from $13,000 to $23,000, or $5,000 to $10,000 per well, if state roads with the lowest traffic volumes are excluded (Abramzon et al. 2014). Increased severance and property taxes could off-set these cost pressures for public roads. The level to which costs affected local communities would depend on the level to which costs were offset by increased tax revenue.

Many of the quality of life components and other social impacts (as shown in **Table EC-17**, Potential Quality of Life Impacts from Oil and Gas Development) can be discussed only in terms of nonmarket values. As discussed in **Section 3.6.2** of the FMG RMPA/EIS, Social and Economic Uses, these are the benefits derived by society from the uses or experiences that are not dispensed through markets and do not require payment.

Table EC-17
Potential Quality of Life Impacts from Oil and Gas Development

Impacts	Associated Changes to Quality of Life
Excess vehicle traffic	Reductions to ambient air quality; increased road noise; dust accumulation; damaged roads; human safety issues; increased cost of road maintenance diverting monies from other uses
Population influx	Changes to community social structures; strain on resources such as government services, schools, and emergency services; increased demand for housing; increased crime and potential for human trafficking
New employment opportunities	Increased wages, tax revenues, and indirect economic contributions
Ongoing development activities	Potential to decrease water quality; potential for noise and low frequency noise; reductions to the visual setting; reduced opportunities for recreation
New oil and gas infrastructure	Reductions to ambient air quality from flaring, potential to decrease water quality; construction and drilling associated noise; reductions to the visual setting; reduced opportunities for recreation
Changes to traditional land uses	Reduced opportunities for traditional plant gathering and diminished opportunities for traditional ceremonies; impacts on nonmarket spiritual values

Types of impacts can include changes to such values as scenic views, preservation of local plant and animal habitats for traditional uses (**Section EC.7.1**), low crime rates, cultural sites, and traditional heritages. BLM and BIA management actions that change levels of development may change the social setting and non-market contributions for area groups of interest.

Increases in mineral development may result in impacts on other areas land uses, thereby impacting other land uses important for recreational users and outfitters, and livestock grazing lessees and area ranchers. Similarly, mineral development would have impacts on local traffic, noise, visual setting, and air and water quality.

All of these factors could affect the quality of life for local residents. Those who prioritize resource conservation may also have values, such open space, viewshed, and recreation opportunities impacted by development. In contrast, values important for mineral estate owners and those who prioritize resource use could be supported by increased mineral development.

Native Americans may have impacts on values associated with traditional cultural and historical uses and ways of life; however, some Tribal populations may have jobs supported by mineral development or receive mineral royalties. These groups or individuals may value opportunities presented by mineral development. The level of impacts for all groups would vary depending on the current setting, level of resultant development, application of mitigation measures, or other measures to reduce impacts such as COAs or BMPs.

Market and nonmarket values can also be discussed in the framework of ecosystem services. As discussed in **Section 3.6.2** of the FMG RMPA/EIS, Social and Economic Uses, these represent goods and services that an ecosystem provides for human use. Impacts on ecosystem services from mineral development activities would include potential impacts on the services such as provisioning services of minerals, and water, regulating services such as maintenance of water and air quality, supporting services of habitat for wildlife, and information services related to aesthetic values, and recreation opportunities.

Levels of development would also impact the ecosystem service contributions provided by area lands for local communities and the region as a whole. The level of impacts would vary depending level of development, application of mitigation measures, or other measures to reduce impacts such as COAs or BMPs.

Vegetation

Changes to vegetation management could affect traditional land uses in the planning area. Direct impacts could include changes to collecting wood for fuel and the level of permits issued by the BLM for BLM-managed lands and the for Navajo Nation permits on Tribal-trust lands managed by the BIA. Indirect impacts could result from changes in the level of forage availability for livestock grazing, which could affect the economic output in this industry. Other indirect impacts would include changes to the habitat for wildlife, affecting recreation, such as hunting and wildlife viewing. For a further discussion of impacts associated with vegetation management, see **Section EC.4.2**, Upland Vegetation and Soil.

Lands and Realty

Managing areas as on- and off-lease ROW avoidance or exclusion would indirectly affect the ability to develop minerals and associated economic contributions. These impacts could occur by limiting the means for transporting minerals to processing facilities and markets. This would be the result of fewer roads and pipelines to carry solid and fluid minerals. There would be fewer economic impacts in areas managed as ROW avoidance, compared with ROW exclusion. This is because some development could still be allowed in ROW avoidance areas.

Development of roads may also result in secondary impacts on residents. This would be due to increased access to area resources, such as fuel wood, as well as recreation opportunities. Increased access may also result in increased traffic to formerly isolated portions of the planning area. For a comprehensive look at impacts associated with lands and realty management decisions, see **Section EC.5.4**, Lands and Realty.

Lands with Wilderness Characteristics

Like on- and off-lease ROW exclusion areas, management actions on lands with wilderness characteristics would affect the ability to develop minerals and their related economic impacts. Inherent nonmarket values associated with undeveloped wilderness where people seek to recreate would be affected if these areas were not managed first for their wilderness character. These nonmarket uses again contribute to market values through money spent on tourism and recreation in the planning area. Another contributor to market values is the increase, both perceived nonmarket and real market, in property values near managed lands with wilderness characteristics. For a comprehensive analysis on impacts on lands with wilderness characteristics, see **Section EC.4.13**, Lands with Wilderness Characteristics.

EC.5.3 Environmental Justice

This section is a discussion of impacts on environmental justice populations from BLM and BIA proposed management actions under each alternative described in **Chapter 2** of the FMG RMPA/EIS. Environmental justice existing conditions and environmental justice populations in the planning area are described in **Section 3.6.3** of the FMG RMPA/EIS.

Methods and Assumptions

EO 12898 requires each federal agency to "make achieving environmental justice part of its mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental impacts of its programs, policies, and activities on minority populations and low-income populations" (EO 12898, Section 59, *Federal Register* 7629, 1994).

Environmental justice refers to the fair treatment and meaningful involvement of people of all races, cultures, and incomes with respect to the development, implementation, and enforcement of environmental laws, regulations, programs, and policies. It focuses on environmental hazards and human health to avoid disproportionately high and adverse human health or environmental impacts on minority and low-income populations; consequently, analyzing environmental justice impacts requires two steps: 1) an initial screening to identify the presence of minority, low-income, and Tribal populations and 2) identifying any impacts that disproportionately affect these populations, as compared with non-minority and middle- and upper-income populations.

The details for the first step are in **Section 3.6.3** of the FMG RMPA/EIS, Environmental Justice. As discussed in that section, based on the percent of minorities in the population, all counties and communities examined in the socioeconomic study area—McKinley, Rio Arriba, Sandoval, and San Juan Counties—were considered for environmental justice impacts.

Native Americans account for a substantial portion of the study area population in some areas, and a large portion of the planning area overlaps with Tribal reservations or other Tribal lands. As a result, the potential for disproportionate adverse impacts on Tribal populations was also considered.

The second step, identifying disproportionately adverse impacts, is completed using additional CEQ guidance, which states the following when considering if an impact is disproportionately high and adverse:

> "Disproportionately high and adverse human health effects: When determining whether human health effects are disproportionately high and adverse, agencies are to consider the following three factors to the extent practicable:
>
> a) Whether the health effects, which may be measured in risks and rates, are significant (as employed by NEPA), or above generally accepted norms. Adverse health effects may include bodily impairment, infirmity, illness, or death; and
>
> b) Whether the risk or rate of hazard exposure by a minority population, low-income population, or Indian Tribe to an environmental hazard is significant (as employed by NEPA) and appreciably exceeds or is likely to appreciably exceed the risk or rate to the general population or other appropriate comparison group; and
>
> c) Whether health effects occur in a minority population, low-income population, or Indian Tribe affected by cumulative or multiple adverse exposures from environmental hazards.

Disproportionately high and adverse environmental effects: When determining whether environmental effects are disproportionately high and adverse, agencies are to consider the following three factors to the extent practicable:

a) Whether there is or will be an impact on the natural or physical environment that significantly (as employed by NEPA) and adversely affects a minority population, low-income population, or Indian Tribe. Such effects may include ecological, cultural, human health, economic, or social impacts on minority communities, low-income communities, or Indian Tribes when those impacts are interrelated to impacts on the natural or physical environment; and

b) Whether environmental effects are significant (as employed by NEPA) and are or may be having an adverse impact on minority populations, low-income populations, or Indian Tribes that appreciably exceeds or is likely to appreciably exceed those on the general population or other appropriate comparison group; and

c) Whether the environmental effects occur or would occur in a minority population, low-income population, or Indian Tribe affected by cumulative or multiple adverse exposures from environmental hazards."

Indicators

Indicators of impacts on environmental justice populations are as follows:

- Changes in income or employment in low-income and minority populations or Tribes
- Impediments to economic development in low-income or minority communities or Tribes
- Disproportionate potential for human health and safety impacts on low-income or minority communities or Tribes

Nature and Type of Effects

Minority populations, low-income populations, and Tribal populations in the decision area may be at different risks for impacts. Populations identified for further consideration are identified in **Section 3.6.3** of the FMG RMPA/EIS, Environmental Justice, and are summarized under Methods and Assumptions, above.

The type of potential impacts on environmental justice populations would be the same as those described in the below sections for the general population, however environmental justice populations are at a greater risk for impacts due to disparities in these populations as described in **Section 3.6.3** of the FMG RMPA/EIS. Specific issues of concern for this analysis are the potential for economic impacts, such as direct and indirect impacts on the level of employment and income, and on the quality of life due to development (**Section EC.7.2**, Social and Economic Uses). These impacts include the potential for contaminating water or reducing water quantity (**Section EC.4.4**, Water Resources) and potential for impacts on air quality from emissions (**Section EC.4.1**, Air Resources). Similarly, there is potential for development to result in exposure of local populations to hazardous materials (**Section EC.7.4**, Public Health and Safety).

Impacts may disproportionately affect environmental justice populations if such populations use certain resources more than the general population. Some examples are impacts on livestock grazing, which is a traditional land use for the Navajo population in the area. In addition, changes to vegetation that affect traditional plant gathering areas could disproportionately affect Native populations (**Section EC.7.1**, Native American Tribal Interests and Uses).

As noted in **Section 3.6.3** of the FMG RMPA/EIS, Environmental Justice, some residents of the study area rely on fuel wood for home heating purposes. Consequently, management decisions that affect availability or access to fuel wood supplies in the study area may result in disproportionate impacts on these individuals and communities.

In addition, an area's social setting could be affected should there be an influx of population or if the traditional or cultural setting is affected (**Section 3.6.2** of the FMG RMPA/EIS, Social and Economic Uses, **Section 3.3.12** of the FMG RMPA/EIS, Noise, and **Section 3.3.11** of the FMG RMPA/EIS, Visual Resources).

There is some indication that social impacts may occur from large per capita distributions of money, such as seen from energy development or legalized gambling, in Native American populations (Cross 2011; Evans and Topoleski 2002). Families or individuals who have limited financial literacy and management experience may not see long-term benefits from payouts, and these distributions may result in economic disparities (Anderson 2009; First Nations Development Institute 2011).

The analysis of the alternatives examines the potential for impacts to disproportionately and adversely affect identified environmental justice populations in the decision area. Due to the uncertainty in specific development locations, further site-specific analysis would be required at the project level, leasing and APD phases. This analysis would include an additional examination of the site-specific impacts of management actions on low-income, minority, and Tribal populations.

EC.5.4 Public Health and Safety

This section is a discussion of the impacts on public health and safety from proposed BLM and BIA management actions described in **Chapter 2** of the FMG RMPA/EIS, Alternatives. Existing public health and safety conditions are described in **Section 3.6.4** of the FMG RMPA/EIS, Public Health and Safety.

Methods and Assumptions

Indicators

Indicators of impacts on public health and safety are as follows:

- Changes in the amount of oil and gas development in the planning area
- Changes in the type of oil and gas development (i.e., horizontal drilling and hydraulic fracturing)
- Changes in the level of vehicular traffic or the number of new roads and ROWs for oil and gas development
- The extent to which vegetation treatments, such as chemical spraying or prescribed burns, are authorized
- Changes to the air, water or other natural resource quality due to changes in normal operational discharges of hazardous chemicals or due to unintentional hazardous releases.

Assumptions

The analysis includes the following assumptions:

- Activities and resources available in and around the planning area would continue to be important to the health and safety of current and future residents and workers.
- The BLM's Hazardous Materials Management Program (also known as HAZMAT) responds to all hazardous material releases on BLM-managed surface land and federal mineral estate, and on Navajo Tribal trust minerals and allotted minerals, where the BLM approves APDs. Emergency cleanup actions are implemented on sites posing a substantial threat to the public, environment, or both.
- The number of acres open to fluid mineral leasing is considered proportional to the potential for long-term health and safety risks, both direct and indirect.

Nature and Type of Effects

Impacts on public health and safety are the result of management actions that increase or decrease the potential for hazardous conditions. Lands that are open for fluid mineral leasing have the potential for health and safety risks related to oil and gas exploration, development, operation, and well site decommissioning.

ROWs and public roads have the potential for public health and safety risks from spills, pipeline leaks and vehicle crashes. Public health and safety risks from well site operations would also include the negative effects from flaring and venting. Hazards associated with these sites include basic trip and fall hazards from debris and equipment, release of harmful chemicals and contamination of soils from spills at well sites or from petroleum product transport vehicles, and the increased need for storage and disposal of produced wastewater.

The Hydraulic Fracturing for Oil and Gas: Impacts from the Hydraulic Fracturing Water Cycle on Drinking Water Resources in the United States (EPA 2016) is incorporated by reference, hereinafter referred to as the Hydraulic Fracturing Water Cycle study. The information from the study is summarized below; for more detailed information refer directly to the original document.

The hydraulic fracturing water cycle has five stages; each stage is defined by an activity involving water that supports hydraulic fracturing:

- Water Acquisition: the withdrawal of groundwater or surface water to make hydraulic fracturing fluid
- Chemical Mixing: the mixing of a base fluid (typically water), proppant, and additives at the well site to create hydraulic fracturing fluids
- Well Injection: the injection and movement of hydraulic fracturing fluids through the oil and gas production well and in the targeted rock formation
- Produced Water Handling: the on-site collection and handling of water that returns to the surface after hydraulic fracturing and the transportation of that water for disposal or reuse
- Wastewater Disposal and Reuse: the disposal and reuse of hydraulic fracturing wastewater

The conclusions that the EPA made in the Hydraulic Fracturing Water Cycle study (EPA 2016) of the more severe impacts that could occur during the hydraulic fracturing process are as follows:

- Water withdrawals for hydraulic fracturing in times or areas of low water availability, particularly in areas with limited or declining groundwater resources
- Spills during the management of hydraulic fracturing fluids and chemicals or produced water that result in large volumes of high concentrations of chemicals reaching groundwater resources
- Injection of hydraulic fracturing fluids into wells with inadequate mechanical integrity, allowing gases or liquids to move to groundwater resources
- Injection of hydraulic fracturing fluids directly into groundwater resources
- Discharge of inadequately treated hydraulic fracturing wastewater to surface water resources
- Disposal or storage of hydraulic fracturing wastewater in unlined pits, resulting in contamination of groundwater resources

If impacts from the hydraulic fracturing water cycle occur, depending on the severity of the impact, drinking water resources may become unusable for consumption by humans or wildlife, and may negatively affect fish and vegetation.

Other potential impacts on public health and safety from oil and gas development may include:

- Releases of hydrogen sulfide (H_2S), benzene, and other harmful chemical emissions during oil and gas development, production, and flaring
- Drilling and water withdrawals have the potential to dislodge existing uranium deposits exacerbating potential health risks related to radiation

The Counselor Chapter conducted a health impact assessment to document health concerns expressed by community members and investigate certain water and air quality conditions in the Counselor-Nageezi area. The water samples taken from public water faucets did not detect any contaminants at levels violating EPA water quality standards. Total dissolved solids (over 600 mg/L), sodium, sulfates, and alkalinity levels were all high in the water, but not at levels that make the water unsafe to drink. A livestock pond was also sampled and was found to have lower total dissolved solids and alkalinity levels (Counselor Health Impact Assessment Committee 2017). Because the methodology for conducting the sampling was not provided, it is difficult to evaluate the conclusions.

Increased oil and gas exploration or development is also accompanied by an increase in vehicular traffic associated with those activities. This increase in vehicles on the roads leads to additional potential for crashes, either single or multi-vehicle, as well as pedestrian. Many of the roads used for oil and gas exploration or development in the planning area are unpaved county, BIA, or Tribal roads where, due to the remoteness of the roads, there is limited ability to enforce speed limits.

Continued use of these unpaved roads during muddy conditions by heavy oil and gas vehicles (including some vehicles that may potentially exceed the class for which the road was designed) could cause the road surface to become heavily rutted and result in rapid road degradation. In the absence of maintenance appropriate to the level of traffic, this leads to less safe driving conditions for all vehicles and increases fugitive dust.

Additionally, in some parts of the country, enhanced oil recovery wells or salt water disposal wells have been linked to increased occurrences of earthquakes, known as induced seismicity. Earthquakes present hazards to human health and safety from falling objects or structural damage to buildings or infrastructure. The San Juan Basin, however, has not been associated with induced seismicity from either well type (Weingarten et al. 2015); therefore, hazards associated with induced seismicity are not discussed further in this section.

Air quality impacts from equipment, generators, dust, and releases during drilling and flaring could cause respiratory and other health issues or increase the severity of existing respiratory and health problems. Studies on the health impacts of hydraulic fracturing and unconventional oil and gas are mixed, with some studies finding links to health problems in local communities and others finding no significant correlation (Shonkoff et al. 2014; Werner et al. 2015). From 2010 to 2013, 2.1 percent of deaths on the Navajo Nation were due to respiratory diseases (excluding chronic lower respiratory disease). The percentage of deaths caused by respiratory diseases from 2006 to 2009 was similar, at 2.2 percent (Navajo Epidemiology Center 2013); however, it is impossible to separate the impact of oil and gas development on respiratory deaths due to from other causes, such as smoking and radon exposure. Additional information on air quality can be found in **Section EC.4.1**, Air Resources; including information from the Navajo Nation Environmental Protection Agency Air & Toxics Department Air Quality Control Program Annual Ambient Air Monitoring Report Counselor, NM, September 2017.

The Counselor Chapter's health impact assessment anecdotally recorded incidences of respiratory and neurological issues and documented cancer deaths based on a 2016 Navajo Nation mortality report in residents from 2015 to 2017, as the number of wells in the area increased. Air sampling conducted as part of the health impact assessment found levels of hydrogen sulfide to be above the EPA reference level for long-term exposure at one location. The air sampling also detected other airborne chemicals, including toluene, ethyl acetate, A-pinene, and propane, at levels that did not pose a risk to human health. Because the methodology for conducting the sampling was not provided, it is difficult to evaluate the conclusions (Counselor Health Impact Assessment Committee 2017). An air monitoring study conducted from April 2016 to May 2017 by Navajo Nation Environmental Protection Agency in Counselor, NM, recorded no exceedances of primary or secondary NAAQS for all monitored pollutants (SO_2, PM_{10}, O_3, and NO_2). See **Section EC.4.1**, Air Resources, for more information on air quality impacts of each alternative.

Oil and gas operations produce noise and light pollution. The greatest levels of noise and light pollution would occur during the drilling and stimulation of a well. Short-term noise exposure of as little as 15 minutes has been linked to increased blood pressure, heart rate, and respiratory rate, and decreased performance on mental tasks (Mosskov and Ettema 1977). Longer-term noise and light pollution could occur due to increased heavy truck traffic, pumps, and nighttime flaring. Long-term exposure to noise and light pollution have been linked to a variety of health issues, including increased incidence of some types of cancers, increased blood pressure, and sleep disturbances (Van Kamp and Davies 2013; Navara and Nelson 2007).

Oil booms in other parts of the country have been linked to increases in crime in the area, especially drug-related crime (Hampton 2017) and sex trafficking (United States Department of State 2017).

Using chemical treatments for vegetation communities would increase use, storage, and transport of these chemicals; as a result, the risk of hazardous chemical spills would increase. Prescribed burns used for vegetation treatment could escape containment, which could increase risks to public safety and properties near the prescribed burn. Oil and gas operations could cause wildland fires. Equipment and pipelines damaged by wildland fire could release harmful chemicals into the environment.

Areas closed to leasing could have a reduced likelihood of health and public safety issues but would not be immune to all impacts. Air, light, noise, and water pollution could travel into closed areas from adjacent operations. Impacts such as increased traffic and the transportation and potential spills of hazardous chemicals are not confined to leased areas.

Areas where NSO stipulations are applied could have a reduced likelihood of health and public safety issues but would not be immune to all impacts. Prohibiting surface facilities would reduce the risk of surface spills, air emissions, noise, and light within the NSO area, but air, light, noise, and water pollution could still travel into NSO areas from adjacent operations. Impacts such as increased traffic and transportation of hazardous chemicals would not be restricted in NSO areas.

ROW exclusion areas would prohibit new ROWs for oil and gas access roads, and pipelines would not be granted in these areas; however, increased traffic and transportation of potentially hazardous chemicals could be expected on existing roads. ROW avoidance would seek to restrict to a minimum new ROWs for oil and gas access roads and pipelines, which would reduce the mileage of new roads but could concentrate traffic on fewer roads, potentially increasing the risk of crashes.

EC.6 REFERENCES

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