# Draft Environmental Impact Statement for the Bull Mountain Unit Master Development Plan

DOI-BLM-CO-S050-2013-0022-EIS

**U.S. Department of the Interior**
**Bureau of Land Management**
**Uncompahgre Field Office**
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# United States Department of the Interior

## BUREAU OF LAND MANAGEMENT

**Southwest District Office**
**2465 S. Townsend Ave.**
**Montrose, CO 81401**

In Reply Refer To
1792

January 2015

Dear Reader:

Attached for your review and comment is the Draft Environmental Impact Statement (EIS) for the Bull Mountain Master Development Plan (MDP). The United States (US) Department of the Interior, Bureau of Land Management (BLM), Uncompahgre Field Office (UFO), has received a proposed MDP for natural gas exploration and development from SG Interests I, Ltd. for the Bull Mountain Unit. The BLM prepared this document in consultation with cooperating agencies, and in accordance with the National Environmental Policy Act of 1969 (NEPA), as amended, the Federal Land Policy and Management Act of 1976, as amended, implementing regulations, the BLM's NEPA Handbook (H-1790-1), and other applicable law and policy.

The boundaries of the Unit encompass approximately 19,670 acres federal and private oil and gas mineral estate in Gunnison County, Colorado. The Unit consists of 440 acres of federal surface underlain by federal mineral estate and administered by the BLM UFO; 12,900 acres of split-estate lands consisting of private surface and federal minerals administered by the BLM; and 6,330 acres of fee land consisting of private surface and private minerals regulated by the Colorado Oil and Gas Conservation Commission (COGCC). The Bull Mountain MDP Draft EIS and supporting information is available on the project web site at:
http://www.blm.gov/co/st/en/BLM_Information/nepa/ufo/Bull_Mountain_EIS.html.

A MDP provides information common to multiple planned wells, including drilling plans, Surface Use Plans of Operations, and plans for future production; they are typically prepared for a planned cluster of wells and associated facilities in close proximity, or for multiple in-fill wells scattered throughout an oil and gas Unit or field, and include information on associated facilities (roads, pipelines, utility corridors, compressor stations, etc.). If the MDP is approved, this EIS will provide an "umbrella" analysis to which subsequent federal actions proposed within the Unit (e.g.; APDs) would be tiered for additional NEPA compliance. The reader is referred to Chapter sections 1.3 *Decisions to be Made*, 1.6 *Scope of Analysis* and 2.2.3 *Elements Common to All, Siting* for further information.

The BLM encourages the public to provide information and comments pertaining to the analysis presented in the Draft EIS. We are particularly interested in feedback concerning the adequacy and accuracy of the proposed alternatives, the analysis of their respective management decisions, and any new information that would help the BLM determine which alternative should be the Preferred Alternative. In developing the Final EIS, the BLM decision maker may select various management decisions from each of the alternatives analyzed in the Draft EIS for the purpose of creating a management strategy that best meets the needs of the resources and values in this area under the BLM multiple-use and sustained-yield mandate. As a member of the public, your timely comments on the Bull Mountain MDP Draft EIS will help formulate the Final EIS and Preferred Alternative. Comments will be accepted for forty five (45) calendar days following the US Environmental Protection Agency's publication of its Notice of Availability in the *Federal Register*. The BLM can best utilize your comments and resource information submissions if received within the review period.

Comments may be submitted electronically at bullmtneis@blm.gov or by fax at 970-240-5367. Comments may also be submitted by mail to:

Bureau of Land Management
Uncompahgre Field Office
Attn: Jerry Jones
2465 South Townsend Ave
Montrose, CO 81401

To facilitate analysis of comments and information submitted, we strongly encourage you to submit comments in an electronic format.

Your review and comments on this document's content are critical to the success of this planning effort. If you wish to submit comments on the Draft EIS, we request that you make your comments as specific as possible. Comments will be more helpful if they include suggested changes, sources, or methodologies, and reference to a section or page number. Comments containing only opinion or preferences will be considered and included as part of the decision-making process, although they will not receive a formal response from the BLM.

Before including your address, phone number, email address, or other personal identifying information in your comment, be advised that your entire comment – including your personal identifying information – may be made publicly available at any time. While you can ask us in your comment to withhold your personal identifying information from public review, we cannot guarantee that we will be able to do so.

Public meetings will be held at a time and date to be determined and will be announced at least 15 days in advance through public notices, media news releases, website, and/or mailings. The meetings will be an open-house format, and the purpose of these meetings is to provide an overview of the document, to give the public an opportunity discuss the EIS with BLM staff, and to take public (written) comment.

A limited number of the Bull Mountain MDP EIS have been printed. Viewing the document electronically from the project website or from a CD is encouraged. The Bull Mountain MDP Draft EIS is available for review at the following locations during regular business hours:

- Bureau of Land Management, Uncompahgre Field Office, 2465 South Townsend Ave., Montrose, CO 81401
- Bureau of Land Management, Colorado State Office, 2850 Youngfield Street, Lakewood, CO 80215U.S.
- Forest Service, Paonia Ranger District, North Rio Grande Ave., Paonia, CO 81428
- Paonia Public Library, 2 Third Street, Paonia, CO 81428

Thank you for your continued interest in the Bull Mountain MDP EIS. We appreciate the information and suggestions you contribute to the planning process. For additional information or clarification regarding this document or the planning process, please contact Mr. Jerry Jones at (970) 596-0251.

Sincerely,

Lori Armstrong
Southwest District Manager

1 Attachment:
1- Draft EIS

BLM

# United States Department of the Interior
# Bureau of Land Management

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**Environmental Impact Statement**

**DOI-BLM-CO-S050-2013-0022-EIS**

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**January 2015**

## Draft Environmental Impact Statement for the Bull Mountain Unit Master Development Plan

***Location:*** *Gunnison County, Colorado*

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**U.S. Department of the Interior**
**Bureau of Land Management**
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## ACRONYMS AND ABBREVIATIONS

| Acronym | Full Phrase |
|---|---|
| µeq/l | microequivalents per liter |
| APD | Application for Permit to Drill |
| AUM | Animal Unit Month |
| BLM | United States Department of the Interior, Bureau of Land Management |
| BMP | best management practice |
| CAAQS | Colorado Ambient Air Quality Standards |
| CDPHE | State of Colorado Department of Public Health and Environment |
| CDWR | Colorado Division of Water Resources |
| CEQ | Council on Environmental Quality |
| CERCLA | Comprehensive Environmental Response, Compensation, and Liability Act |
| CFR | Code of Federal Regulations |
| cfs | cubic feet per second |
| COGCC | Colorado Oil and Gas Conservation Commission |
| COGIS | Colorado Oil and Gas Information System |
| CPW | Colorado Parks and Wildlife |
| CSU | controlled surface use |
| dBA | A-weighted decibel |
| dBC | C-weighted decibel |
| DOI | United States Department of the Interior |
| DOT | Department of Transportation |
| EA | environmental assessment |
| EIS | environmental impact statement |
| EPA | Environmental Protection Agency |
| ESA | Endangered Species Act |
| FLPMA | Federal Land Policy and Management Act |
| Forest Service | United States Department of Agriculture, Forest Service |
| GIS | geographic information system |
| kg/ha/yr | kilogram per hectare per year |
| lbs | pounds |
| MBTA | Migratory Bird Treaty Act |
| MDP | Master Development Plan |
| NAAQS | National Ambient Air Quality Standards |
| NEPA | National Environmental Policy Act |
| NHPA | National Historic Preservation Act |
| NSO | no surface occupancy |
| PFYC | potential fossil yield count |
| POD | Plans of Development |
| ppm | parts per million |
| PSD | prevention of significant deterioration |
| RAC | Resource Advisory Council |
| RDFs | Required Design Features |
| RMP | Resource Management Plan |
| ROD | Record of Decision |
| ROW | right-of-way |

| | |
|---|---|
| SGI | SG Interests I, LTD |
| SPCC | Spill Prevention Control and Countermeasures |
| TDS | total dissolved solids |
| TL | timing limitation |
| UFO | Uncompahgre Field Office |
| the Unit | Bull Mountain Unit |
| US | United States |
| USC | United States Code |
| USDA | United States Department of Agriculture |
| USFWS | United States Fish and Wildlife Service |
| USGS | United States Geological Survey |
| VOCs | volatile organic compounds |
| VRI | Visual Resource Inventory |
| VRM | Visual Resource Management |

# Executive Summary

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# EXECUTIVE SUMMARY

## ES.1 OVERVIEW

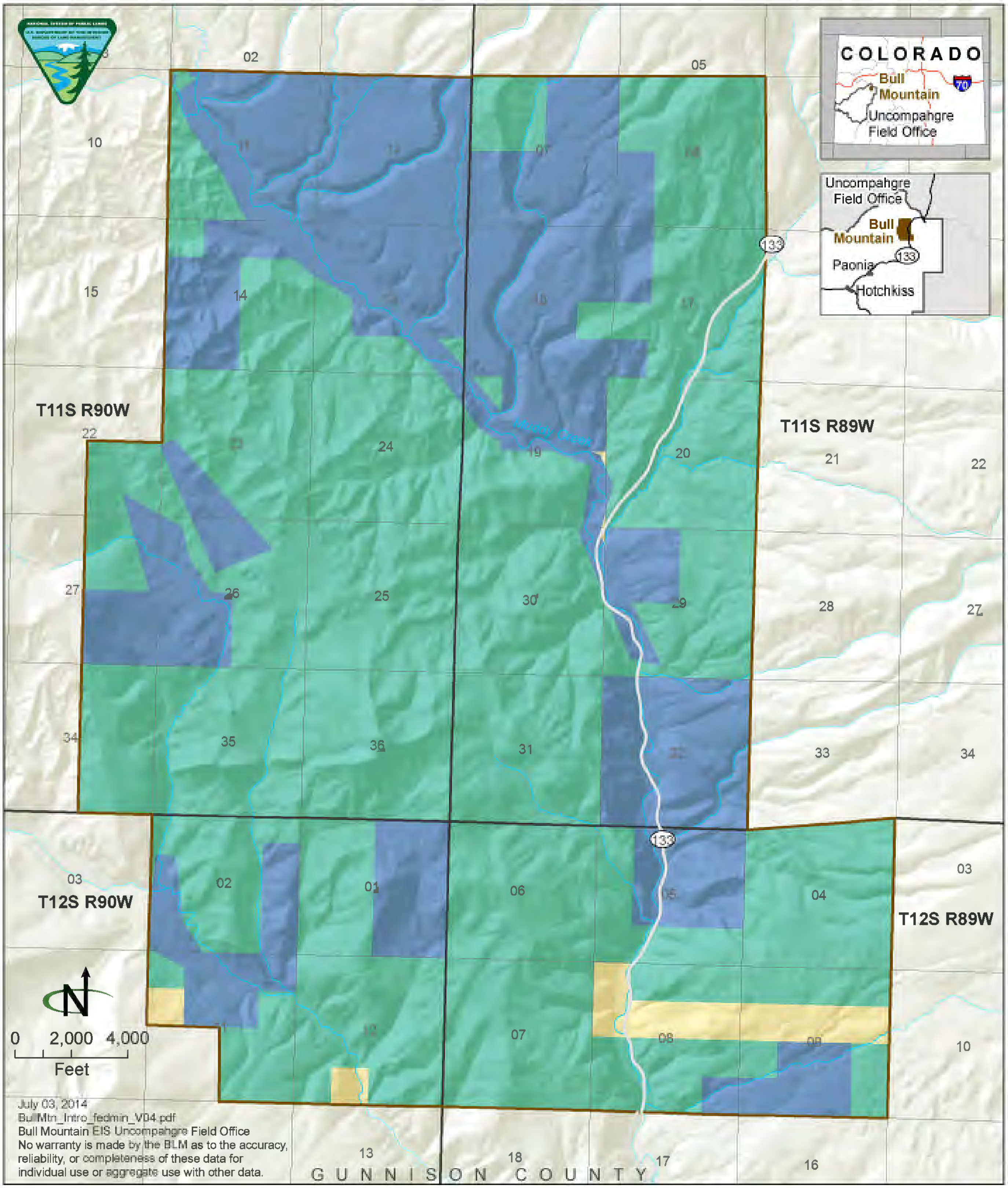
The United States Department of the Interior, Bureau of Land Management (BLM), Uncompahgre Field Office, has received a proposed Master Development Plan (MDP) for natural gas exploration and development from SG Interests I, Ltd. (SGI) for the Bull Mountain Unit. The Bull Mountain Unit MDP describes the exploration and development of up to 146 natural gas wells, 4 water disposal wells, and associated infrastructure on federal and private mineral leases. An MDP provides information common to multiple planned wells, including drilling plans, Surface Use Plans of Operations, and plans for future production. MDPs are typically prepared for a planned cluster of wells and associated facilities near, or for multiple in-fill wells scattered throughout, an oil and gas unit or field. They have information on associated facilities, such as roads, pipelines, utility corridors, and compressor stations.

In 2003 (and updated in 2008), the BLM approved the unit agreement for the Bull Mountain Unit to provide for the orderly, planned, and structured development for extraction of the natural gas resources. "The objective of unitization is to proceed with a program that will adequately and timely explore and develop all committed lands within the unit area without regard to internal ownership boundaries…. By effectively eliminating internal property boundaries within the unit area, unitization permits the most efficient and cost effective means of developing the underlying oil and gas resources" (Draft BLM Manual, Section 3180-1 Unitization [Exploratory], p. 2-7).

Under terms of the unit agreement, SGI is required to diligently develop at least two producing wells per year in order to maintain the Bull Mountain Unit designation. This requirement is currently suspended under an approved Suspension of Operations and Production while this EIS is being prepared.

### ES.1.1 Project Setting

The boundaries of the Unit encompass approximately 19,670 acres of federal and private oil and gas mineral estate in Gunnison County, Colorado. The Unit consists of 440 acres of federal surface underlain by federal mineral estate and administered by the BLM; 12,900 acres of private surface with federal mineral estate (split-estate) administered by the BLM; and 6,330 acres of private surface with private mineral estate (**Figure ES-1**, Bull Mountain Unit).




Bull Mountain Unit

Source: BLM GIS 2014

- Bull Mountain Unit
- Perennial stream
- Federal surface, federal minerals
- Private surface, federal minerals
- Private surface, private minerals

Figure ES-1

The Unit is in the Colorado River basin, approximately 30 miles northeast of the town of Paonia and is bisected by State Highway 133. The elevation is approximately 7,400 feet, consisting of rolling topography in a mountainous region (**Figure ES-1**, Project Area). The Unit is dominated by sagebrush (*Artemisia tridentata* subsp. *vaseyana*). The second most common vegetation community is oakbrush, which is composed of Gambel's oak (*Quercus gambelii*), Saskatoon and Utah serviceberry (*Amelanchier utahensis* and *A. alnifolia*), and chokecherry (*Padus virginiana*), followed by mixed mountain shrubland. Other vegetation communities are aspen (*Populus tremuloides*) woodlands and irrigated pasturelands.

Cattle graze over most of the area during the snow-free months, typically mid-May through mid-October; sheep graze in spring and fall. In the fall, cattle and sheep gather in portions of the Unit, coming off grazing allotments on the adjacent Grand Mesa, Uncompahgre, and Gunnison National Forest. A few residential sites are within the Unit, generally near the State Highway 133 corridor. Further details for the project's regional setting are described in **Chapter 3**, Affected Environment.

## ES.2 Purpose and Need

The BLM's purpose is to consider the proponent's request for an MDP to develop federal fluid minerals in the Bull Mountain Unit. The BLM also must consider its multiple-use mission. In addition to managing such activities as fluid mineral development, the mission is to conserve natural, historical, cultural, and other resources on the lands it administers.

The BLM's need arises from its responsibility under the Federal Land Policy and Management Act, the Mineral Leasing Act, and other legislation to respond to the applicant's request. These acts emphasize the development of domestic natural gas reserves for supply and economic stability. Also, the BLM is considering the proposed MDP, which takes into account field development in total. This is intended to facilitate infrastructure planning and to increase the orderly development of natural gas resources, consistent with the Energy Policy Acts of 2001 and 2005.

## ES.3 Relationship to Laws, Regulations, and Policies

This environmental impact statement (EIS) is prepared under the authority of and complies with the following:

- National Environmental Policy Act of 1969 (NEPA), as amended
- Council on Environmental Quality regulations for implementing NEPA (40 Code of Federal Regulations [CFR], Parts 1500-1508)
- Department of the Interior NEPA regulations (43 CFR Part 46)
- Endangered Species Act of 1973, as amended
- National Historic Preservation Act of 1966
- Department of the Interior and BLM policies (BLM NEPA Handbook H-1790-1 [BLM 2008a])

The BLM regulates environmental aspects of oil and gas exploration, development, and production of deposits from federal and Native American leases (43 CFR Part 3162.5-1, and 25 CFR Part 225.4). Exploration and development of federal oil and gas resources by private industry is under the authority of the following:

- Mineral Leasing Act of 1920
- Mining and Minerals Policy Act of 1970
- National Materials and Minerals Policy, Research, and Development Act of 1980
- Federal Onshore Oil and Gas Leasing Reform Act of 1987
- Various regulations specific to implementing those laws (e.g., 43 CFR 3100)

Onshore Oil and Gas Order Number 1 describes the application requirements for the approval of all proposed oil and gas exploratory, development, or service wells on all federal and Native American onshore oil and gas leases (other than those of the Osage Tribe). This includes leases where the surface is managed by the Forest Service. The Order addresses procedures for processing APDs and the use of best management practices (BMPs) in lease development, operations in split-estate situations, and defines MDPs including information on drilling plans, surface use plans of operations, and plans for future production.

## ES.4 DECISIONS TO BE MADE

The BLM must decide whether to approve the Bull Mountain Unit MDP as proposed, approve the MDP with modification and mitigation, or reject the MDP. Any decisions made in the BLM's Record of Decision (ROD) will provide a blueprint for future anticipated actions; the decisions would not grant SGI or a future Unit operator any permit to begin well pad, road, pipeline, facility construction, or well drilling and completion. Additional applications and approvals would be required and additional NEPA analysis may be required prior to BLM making decisions on the applications (see **Section ES.5.1**, Requirements for Future NEPA Analysis).

The only decision the BLM is considering is whether to approve the MDP. SGI has submitted one APD for well pad 12-89-7-1, which has been pending since October 25, 2012. The BLM conducted an on-site inspection for this APD on May 16, 2011. SGI has not submitted APDs for any other wells, well pads, or associated infrastructure, and the BLM has not conducted on-site inspections. A signed ROD would not grant SGI any permits to begin construction, nor would the ROD approve future APDs or the one pending APD. Should an action alternative be selected in the ROD, the exact locations of wells, roads, pipelines, and other facilities would be determined at the site-specific implementation level when those wells or facilities are proposed for drilling or construction, such as when the BLM receives an APD for review. Siting of these locations would be subject to design features and BMPs in the ROD for the MDP, as well as any other conditions of approval that the BLM may determine to be appropriate.

## ES.5 Scope of Analysis

The analysis of the proposed MDP is programmatic; that is, it considers the impacts associated with potential development of the entire unit, and provides an analytical framework to which subsequent analyses of site-specific decisions may be tiered. The life of any individual well is estimated to be 40 years; this includes the coalbed natural gas, shale gas, and water disposal wells, although the actual production years could vary by individual wells. For purposes of analysis, the BLM therefore assumed that the analysis horizon for the project would be 50 years. The analysis focuses on the direct, indirect, and cumulative impacts that could eventually result from activities associated with development of the unit. This analysis identifies impacts that may result in some level of change to the resources, regardless of whether that change is beneficial or adverse.

All phases of natural gas field development, including siting, construction, drilling, completion, interim reclamation, production and maintenance, final wellbore abandonment, and reclamation are included in the analysis. The technologies described are representative of those most likely to be deployed over the life of the project.

### ES.5.1 Requirements for Future NEPA Analysis

The Bull Mountain Unit MDP EIS programmatic analysis relies on approximate information for the well pad locations, road alignments, pipeline routes, and other facilities. The purpose of this is to assess the cumulative resource impacts of SGI’s proposed well development in the overall Unit area.

If the MDP is approved, this EIS will provide an “umbrella” analysis to which analysis of subsequent federal actions (e.g., approval of APDs) proposed within the Unit would be tiered. Approval of these actions would require additional documentation of NEPA compliance, such as a tiered environmental assessment, a Documentation of NEPA Adequacy, or a Categorical Exclusion. Categorical exclusions that may apply to some future development activities include those provided in Section 390 of the Energy Policy Act of 2005, 42 U.S.C. § 15942(b). Approval would be subject to onsite examinations of each proposed well, pipeline, and road location, including current resource surveys. The BLM would apply appropriate and/or more effective mitigation measures (e.g., Conditions of Approval [COAs] and BMPs) to all permitted actions.

## ES.6 Summary of the Reasonably Foreseeable Development Scenario

The BLM developed a reasonably foreseeable development scenario (RFDS) for oil and gas from analyzing past activity, production, and other sources in support of the Uncompahgre RMP revision (BLM 2012). An RFD scenario provides information about the type and level of oil and gas activity and associated disturbance that could occur subsequent to leasing in the Uncompahgre Field Office planning area. The RFDS is unconstrained by management-imposed conditions as it is based primarily on geology and historical exploration and development activity. It provides information necessary to analyze long-term and/or widespread effects that could result from possible exploration and/or development activities on oil and gas leases. The RFD is not a decision, and it neither establishes nor implies a “cap” on development. The timeframe used in the Uncompahgre RMP/EIS’s RFDS is from 2010 through 2030. For more details regarding the cumulative development within the region, see Tables 7a, 7b, 8a, and 8b from the Reasonable Foreseeable Development Scenario for Oil and Gas for the Uncompahgre Field Office (BLM 2012).

## ES.7 ALTERNATIVES

The goal of developing feasible alternatives is to allow analysis of different combinations of resource uses and protections to address conflicts among resources and resource uses and meet the purpose of and need for the project.

The BLM identified a reasonable range of alternatives, including a No Action alternative (as required at 40 CFR 1502.14). It also identified the proposed action and a modified action. These are based on issues, concerns, and opportunities raised in public comments during scoping; interdisciplinary interaction between resource professionals; and collaboration with cooperating agencies. Meaningful differences among the three alternatives are described in **Table ES-1**.

### ES.7.1 Alternative A, No Action

Alternative A, No Action, is the only alternative that does not respond to the purpose of and need for the proposed action; rather it serves as a baseline for comparing the proposed action's and the alternatives' environmental effects (including cumulative effects). Under the no action alternative, the Bull Mountain Unit MDP would not be approved.

Due to the intermingling of federal and private minerals within the Unit, rejection of the MDP under the no action alternative would not mean that there would be no new gas development in the project area as private minerals may still be developed. Development of private mineral estate is regulated and approved through the Colorado Oil and Gas Conservation Commission.

In addition, existing lease rights granted by the BLM on federal mineral estate would remain in effect. At any time the BLM may consider proposals for individual APDs on federal mineral estate, for access across federal lands for oil and gas development, and for production-related activities. These additional individual proposals or applications would be analyzed separately at the time they were received. While other development of the federal leases is foreseeable even in the absence of an MDP, the no action alternative assumes only private mineral estate would be developed within the unit. However, as federal mineral estate development is a reasonably foreseeable action, the cumulative effects of private and federal mineral estate development are analyzed in the cumulative effects section of **Chapter 4**, Environmental Consequences. Based on this, Alternative A is comprised of activities, as follows:

- Continuation of previously authorized federal authorizations on the existing well pads
- Continued operation of previously authorized fee wells targeting fee minerals
- Development of new natural gas wells on fee surface targeting fee minerals that would be built on new and existing well pads approved through the COGCC

**Table ES-1**
**Summary of Actions by Alternative[1]**

| Phase | Action | Alternative A, No Action | Alternative B, Proposed Action | Alternative C, Modified Action |
|---|---|---|---|---|
| Construction | Well Pads | 11 new pads on Private mineral estate | 36 new pads on Federal mineral estate | 35 new pads on Federal mineral estate |
| | Access Roads | 26 miles upgrades to existing roads<br>5 miles new road construction | 53 miles upgrades to existing roads<br>16 miles new road construction | 13 miles upgrades to existing roads<br>12 miles new road construction |
| | | Construction Rate: 600-800 yards per day | | |
| | Pipelines | 4 miles new co-located with roads<br>8 miles new cross-country | 13 miles new co-located with roads<br>8 miles new cross-country | 19 miles new co-located with roads<br>0 miles new cross-country |
| | Electrical Lines | 1 new overhead electrical line<br>(up to 5 power poles) | 4 new overhead electrical lines<br>(up to 20 power poles) | 4 new buried electrical lines<br>(co-located with roads) |
| | Storage Areas | 1 new storage yard developed on land owned by SGI within the Unit | | |
| Drilling | Gas Wells | 55 new gas wells | 146 new gas wells | 146 new gas wells |
| | | Timeframe<br>Coalbed Methane Natural Gas – 60 days<br>Shale and Sandstone – 85 days | | |
| | Water-Disposal Wells | 1 new water disposal well | 4 new water disposal wells | 4 new water disposal wells |
| | | Timeframe: 60 – 120 days | | |
| | Total Wells | 56 wells | 150 wells | 150 wells |
| | Drilling Rate | 3 Tier-2 or cleaner rigs drilling 27 wells per year | | |
| | Drilling Duration | 3 years | 6 years | |
| Completion | Gas Wells | Well completion duration: 8 – 10 days<br>Flow testing duration: 25 – 50 days | | |
| | Water-Disposal Wells | Well completion duration: 8 – 10 days | | |

[1] If alternative B or C is approved, the operations and development of private minerals described in Alternative A would likely continue to be implemented. Alternatives B and C display development and actions that would occur on federal mineral estate only (which falls within BLM's decision making authority).

**Table ES-1**
**Summary of Actions by Alternative[1]**

| Phase | Action | Alternative A, No Action | Alternative B, Proposed Action | Alternative C, Modified Action |
|---|---|---|---|---|
| Production and Maintenance | Compressor Station | 1 new compressor station | 4 new compressor stations | |
| | Produced Water Management | Production: 500 – 3,000 barrels[2] per day | | |
| | | Coalbed Methane Natural Gas-produced water injected into water disposal wells or trucked to disposal location | | |
| Water Use and Sources | Drilling | 21.3 acre-feet[3] | 58 acre-feet | |
| | Completion | Up to 714.3 acre-feet | Up to 2,369.3 acre-feet | |
| | Dust abatement | Up to 13.2 acre-feet of fresh water | Up to 52.9 acre-feet of fresh water | |
| | Source for all uses | 30% fresh water and 70% recycled and/or produced water | | |
| | Total Water Useage for Drilling and Completion[4] (based on source percentages noted above) | Total water: 748.8 acre-feet<br>Fresh water: 224.6 acre-feet<br>Recycled/produced water: 524.2 acre-feet | Total water: 2,480.2 acre-feet<br>Fresh water: 744.1 acre-feet<br>Recycled/produced water: 1736.1 acre-feet | |

[2] 1 Barrel = 42 gallons, standard US oil barrel volume
[3] Combined water disposal and gas wells based on an average of 3,000 bbls per well. Conversion factor is 7,758 barrels per acre-foot.
[4] Amounts were calculated based on adding together the Drilling, Completion, and Dust abatement amounts together. The total was multiplied by 30% to determine the fresh water amount and 70% to determine the amount of recycled/produced water that would be used.

### ES.7.2 Alternative B, Proposed Action

Alternative B is largely the same as Alternative A in terms of the phases of development and actions anticipated to complete construction, drilling, completion, production, and reclamation. However, this alternative is specific to BLM-administered mineral estate. Alternative B assumes development would occur only on federal mineral estate within the unit for purposes of comparison with baseline conditions. However, if Alternative B were approved, the operations and development of private minerals described in Alternative A would likely continue to be implemented. The combination of federal mineral and private mineral development is discussed and analyzed in Chapter 4, Environmental Consequences, under cumulative effects.

### ES.7.3 Alternative C, Modified Action

Alternative C, the Modified Action, is similar to Alternative B in that it assumes development on federal mineral estate only. It considers the same number of wells (146 wells) but one less well pad (35 pads). However, it also uses different weighting factors in the site selection model to address issues of development impacts on vegetation resources, water quality, and soil resources, which resulted in different pad locations. The Alternative C siting model also added verified elk critical winter range data which eliminated one pad from the unit. Additionally, Alternative C provides additional mitigation measures and addresses issues regarding development impacts on the same resources noted above, as well as wildlife populations and air quality. If Alternative C were approved, the operations and development of private minerals described in Alternative A would likely continue to be implemented, and the cumulative effects of federal and private mineral estate development is discussed and analyzed in the cumulative effects section of Chapter 4, Environmental Consequences.

## ES.8 Summary of Environmental Consequences

The purpose of the environmental consequences analysis in this EIS is to determine and disclose the potential for significant impacts of the federal action on the human environment. Council on Environmental Quality regulations for implementing NEPA comprehensively interprets the "human environment" to include the natural and physical environment and the relationship of people with that environment (40 CFR 1508.14). The "federal action" is the BLM's decision whether to approve the Bull Mountain Unit MDP as proposed, to approve the MDP with modification and mitigation, or to reject the MDP. The environmental consequences provide the decision maker with the information necessary to compare and contrast the predicted effects of the proposed action and alternatives and to make a reasoned and informed decision regarding which alternative or course of action or combination of alternatives should be selected in the ROD.

**Chapter 4** objectively evaluates the likely direct, indirect, and cumulative impacts on the human and natural environment in terms of environmental, social, and economic consequences that are projected to occur from implementing the alternatives. Some types of impacts for resources or resource uses could be confined to BLM-administered lands, such as soil disturbance resulting from construction activities; some actions may have offsite/indirect impacts on resources on other land jurisdictions, such as private or state lands, overlying federal mineral estate. An example of the latter is requirements to protect special status species and cultural resources overlying mineral resources. Some BLM management actions might affect only certain resources and alternatives.

The impact analysis identifies both enhancing and improving effects on a resource from a management action, as well as those that have the potential to diminish resource values. See **Tables 2-11, 2-12, and 2-13** for summaries of resource-specific direct and indirect impacts that could or would result from implementing the alternatives.

## ES.9 PUBLIC INVOLVEMENT, CONSULTATION, AND COORDINATION

During the NEPA process for this EIS, the BLM consulted and coordinated formally and informally with other federal agencies, state and local governments, Native American tribes, and the interested public, in compliance with 40 CFR 1501.7, 1502.19, and 1503 and Department of Interior regulations 43 CFR 46.435.

The BLM conducted two scoping periods for the Bull Mountain Unit MDP Environmental Assessment: from October 28 to December 12, 2008, and from September 17 to November 13, 2009. The preliminary environmental assessment was available for a 30-day public comment period, from March 23 to April 23, 2012. Comments on the proposed action received during the public scoping period and comments received on the Bull Mountain Unit MDP Preliminary Environmental Assessment are summarized in the Bull Mountain Scoping Report. It is available on the project website at http://www.blm.gov/co/st/en/BLM_Information/nepa/ufo/Bull_Mountain_EIS.html.

A Notice of Intent to prepare an EIS was published in the *Federal Register* on April 3, 2013 (78 *Federal Register* 20133-20134), as well as provided general information regarding the project and how to participate in scoping through media outlets, postcards, emails, and its website. A project newsletter was issued on May 2, 2013, which provided information on the kickoff of the EIS and future opportunities for public involvement. This Draft EIS is available for public comment; in the Final EIS, the BLM will respond to all substantive comments received during the comment period.

A cooperating agency is any federal, state, or local government agency or Native American tribe that enters into a formal agreement with the lead federal agency to help develop an environmental analysis or EIS (40 CFR Part 1508.5). Throughout this EIS preparation, the BLM engaged multiple cooperating agencies and tribes for a broader understanding of their issues and concerns regarding the Bull Mountain Unit MDP and EIS. Interactions have included periodic briefings and reviews of preliminary, internal draft EIS text. Cooperating agencies are Region 8 of the US Environmental Protection Agency; the Grand Mesa, Uncompahgre, Gunnison National Forest; the Delta Conservation District; the Colorado Department of Natural Resources (including the Division of Parks and Wildlife); the Colorado Department of Public health and Environment; Gunnison County and Delta County.

Consistent with Section 7(c) of the Endangered Species Act, the BLM will consult with the US Fish and Wildlife Service regarding potential effects of the project on federally listed threatened or endangered species or critical habitat. The BLM will prepare a draft biological assessment that evaluates the impacts of the proposed alternative on federally listed threatened and endangered species. It will submit the draft biological assessment to the Fish and Wildlife Service for review. For each listed species, the BLM will provide a determination of whether the implementation of the final EIS “may affect” the species on which this consultation occurred. At that point, the Fish and Wildlife Service may either concur with the determination via memorandum or prepare a biological opinion.

The Draft Bull Mountain Unit MDP EIS has been submitted to the Environmental Protection Agency in accordance with 40 CFR 1506.9.The BLM has contacted and consulted with tribal governments of Ute Tribe of the Uintah and Ouray Reservation, the Southern Ute Indian Tribe, and the Ute Mountain Ute Indian Tribe. The BLM remains in contact via phone calls and emails and by responding to individual requests for additional information or meeting presentations.

The BLM began consultations with the Colorado State Historic Preservation Officer on September 10, 2013, in accordance with the Protocol for Managing Cultural Resources on Lands Administered by the Bureau of Land Management in Colorado. Consultations will continue through the course of the EIS process to ensure compliance with the National Historic Preservation Act and NEPA.

In addition, the Southwest Resource Advisory Council has been kept informed of the EIS progress throughout its development.

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# Chapter 1
## Introduction

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# CHAPTER 1
# INTRODUCTION

## 1.1 OVERVIEW

The United States (US) Department of the Interior, Bureau of Land Management (BLM), Uncompahgre Field Office, has received a proposed Master Development Plan (MDP) for natural gas exploration and development from SG Interests I, Ltd. (SGI) for the Bull Mountain Unit. An MDP provides information common to multiple planned wells, including drilling plans, Surface Use Plans of Operations, and plans for future production; they are typically prepared for a planned cluster of wells and associated facilities in close proximity, or for multiple in-fill wells scattered throughout an oil and gas unit or field, and include information on associated facilities (e.g., roads, pipelines, utility corridors, and compressor stations). The Bull Mountain Unit MDP describes the exploration and development of up to 146 natural gas wells, 4 water disposal wells, and associated infrastructure on federal and private mineral leases within a federally unitized area known as the Bull Mountain Unit (the Unit). Under terms of the Unit, SGI is required to diligently develop at least two producing wells per year in order to maintain the administrative structure of the Unit. This requirement is currently suspended under an approved Suspension of Operations and Production while this environmental impact statement (EIS) is being prepared. Instead of structuring the development of the federal leases as a series of individual actions, the BLM encourages the use of multi-well development plans to more effectively manage federal lease development (BLM IM 2005-247).

Additionally, federal unitization allows for placement of wells within the Unit in a logical fashion without regard to setbacks from committed lease lines in order to minimize road development, pipelines, and other surface impacts (BLM 2007c). The objective of unitization is to proceed with a program that will adequately and timely explore and develop all committed lands within the unit area without regard to internal ownership boundaries. By effectively eliminating internal property boundaries within the unit area, unitization permits the most efficient and cost effective means of developing the underlying oil and gas resources (BLM 2013g, pages 2-60).

In 2003, the BLM approved a unit agreement for the leases within the Bull Mountain area to provide for the orderly, planned, and structured development of extraction for natural gas resources. The boundaries of the Unit encompass approximately 19,670 acres federal and private oil and gas mineral estate in Gunnison County, Colorado. The Unit consists of 440 acres of federal surface underlain by BLM-administered mineral estate; 12,900 acres of split-estate lands consisting of private surface and BLM-administered minerals; and 6,330 acres of fee land consisting of private surface and private minerals regulated by the Colorado Oil and Gas Conservation Commission (COGCC; **Figure 1-1**, Project Area).

In split estate situations, the surface rights and subsurface rights (such as the rights to develop minerals) for a piece of land are owned by different parties. See BLM's website on Split Estate for additional information and details on BLM policies regarding split estate (http://www.blm.gov/wo/st/en/prog/energy/oil_and_gas/best_management_practices/split_estate.html); see also "Legal Responsibilities of BLM for Oil and Gas Leasing and Operations on Split Estate Land."

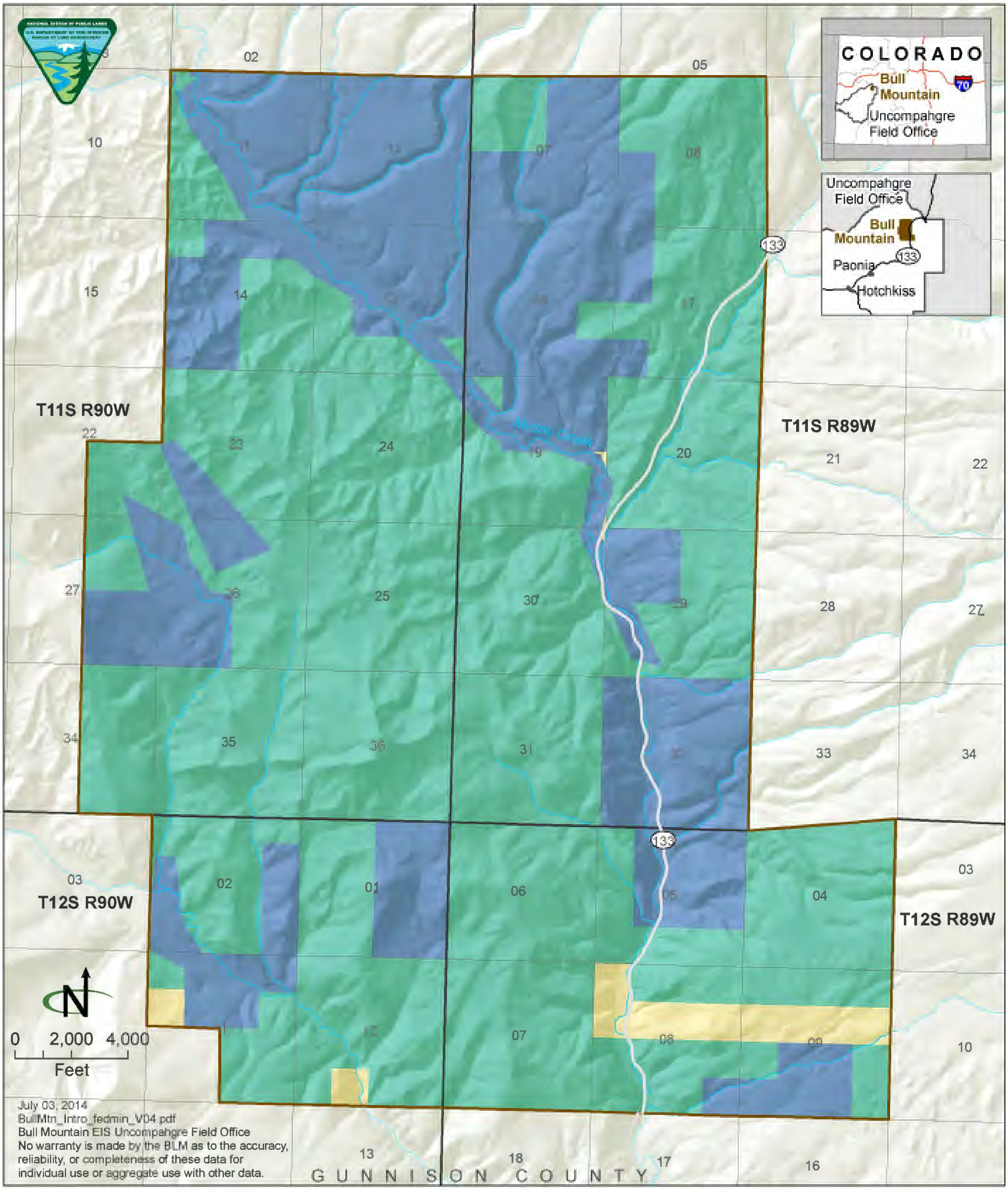
A Memorandum of Understanding is in effect between the BLM Colorado State Office; the US Department of Agriculture, Forest Service (Forest Service), Rocky Mountain Region; and the COGCC dated July 1, 2009, addresses the application to federal lands and minerals (including split-estate lands) of COGCC's final amended rules for oil and gas operations. The Memorandum of Understanding facilitates cooperative efforts among the agencies to limit potential for redundancy or conflicting regulations among the permitting authorities to the operator. However, it recognizes that each regulatory agency in Colorado must receive permits from oil and gas operators that comply with and include responses to their own specific rules and regulatory requirements.

The Memorandum of Understanding further instructs operators and regulatory agencies to identify and incorporate applicable standards and practices contained in the COGCC rules into federal Application for Permit to Drill (APD), MDP, or other authorizations related to oil and gas operations so long as such state standards or practices are at least as stringent as comparable federal standards or practices, in order to minimize the potential for multiple reviews.

### 1.1.1 Regional Setting

The Unit is located within the Colorado River basin, approximately 30 miles northeast of the Town of Paonia, and is bisected by State Highway 133. The elevation is approximately 7,400 feet and consists of rolling topography in a mountainous region (**Figure 1-1**, Bull Mountain Unit). Snow blankets most of the area from mid-October through mid-May, increasing from an average of a few inches through early December to an average high of 5.5 to 6 feet in March (NRCS 2011). South-facing slopes have more winter melting events, and north-facing slopes retain snow longer and accumulate more snow through the course of the winter. East and West Muddy Creek, the two main drainages that collect local surface waters within the Unit, reach their confluence just south and outside of the Unit, where they form Muddy Creek.

Expansive irrigated hay meadows are generally found in the bottomlands of the East Muddy Creek basin. Irrigated meadows are also found in the Ault Creek basin at the far western side of the Unit. There are many irrigation diversions off of the larger creeks, especially on the eastern side of the Unit. Stock ponds for domestic cattle and sheep grazing occur frequently on the landscape, and in general retain surface waters throughout the year.




**Bull Mountain Unit**

Source: BLM GIS 2014

Bull Mountain Unit
Perennial stream
Federal surface, federal minerals
Private surface, federal minerals
Private surface, private minerals

Figure 1-1

The Unit is dominated by sagebrush (*Artemisia tridentata* subsp. *vaseyana*). Oakbrush communities comprised of Gambel's oak (*Quercus gambelii*), Saskatoon and Utah serviceberry (*Amelanchier utahensis* and *A. alnifolia*), and chokecherry (*Padus virginiana*) are the second most common, followed by mixed mountain shrubland. Other vegetation communities include aspen (*Populus tremuloides*) woodlands and irrigated pasturelands.

Cattle grazing occurs over most of the area during the snow-free months, typically mid-May through mid-October. Some springtime and fall sheep grazing occurs as well. In the fall, portions of the Unit are used for gathering cattle and sheep coming off of grazing allotments on the adjacent Grand Mesa, Uncompahgre, and Gunnison National Forest. A few residential sites are located within the Unit, generally near the State Highway 133 corridor.

## 1.2 Purpose and Need

The BLM's purpose is to consider the proponent's request for an MDP to develop federal fluid minerals in the Unit, while also considering BLM's multiple-use mission which, in addition to managing activities on federal land such as fluid mineral development, includes conserving natural, historical, cultural, and other resources on the BLM-administered lands.

The BLM's need arises from its responsibilities under the Federal Land Policy and Management Act of 1976 (FLPMA), the Mineral Leasing Act, and other legislation to respond to the applicant's request. To increase the orderly development of natural gas resources consistent with the Energy Policy Acts of 2001 and 2005, which emphasize the development of domestic natural gas reserves for supply and economic stability, and to better facilitate the planning of infrastructure, the BLM is considering the proposed MDP. The MDP takes into account field development as a whole rather than as individual actions.

## 1.3 Decisions to be Made

The decision to be made by the BLM is whether to approve the Bull Mountain Unit MDP as proposed, approve the plan with modification and mitigation, or reject the MDP.

Any decisions made in the Record of Decision (ROD) will provide a blueprint for future anticipated actions; the decisions would not grant SGI or future Unit operators any permit to begin well pad, road, pipeline, and facility construction or well drilling and completion. Future ground-disturbing activity and construction would require additional authorizations from BLM and/or COGCC.

Although SGI has submitted one APD (for well pad 12-89-7-1)[1], the BLM is not including it for consideration and will not approve it as part of the Bull Mountain Unit MDP ROD. Other than this one APD, SGI has not submitted APDs for any other wells, well pads, or associated infrastructure, and the BLM has not conducted on-site inspections. Therefore, a signed ROD would not grant SGI any permits to begin construction. See **Section 1.6.1**, Requirements for Future NEPA Analysis, for additional details.

[1] The well pad 12-89-7-1 APD was submitted and had an on-site inspection by BLM on May 16, 2011. The APD has been pending since October 25, 2012.

## 1.4 Relationship to BLM Plans and Policies

### 1.4.1 BLM National and Statewide Regulations and Policies

This EIS is prepared under the authority of and complies with the National Environmental Policy Act of 1969 (NEPA), as amended; the Council on Environmental Quality (CEQ) Regulations for Implementing the Procedural Provisions of NEPA, outlined in Part 40 of the Code of Federal Regulations (40 Code of Federal Regulations [CFR] Parts 1500-1508) and Department of the Interior NEPA regulations at 43 CFR 46; Department of the Interior and BLM policies and manuals (BLM 2008); the Endangered Species Act of 1973 (ESA); and the National Historic Preservation Act of 1966 (NHPA).

Exploration and development of federal oil and gas resources by private industry is under authority of the Mineral Leasing Act of 1920, as amended; the Mining and Minerals Policy Act of 1970; the National Materials and Minerals Policy, Research and Development Act of 1980; the Federal Onshore Oil and Gas Leasing Reform Act of 1987; and various other regulations specific to implementation of those laws (e.g., 43 CFR 3100).

Onshore Oil and Gas Order Number 1 (Order) contains the requirements necessary for the approval of all proposed oil and gas exploratory, development, or service wells on all federal and Native American onshore oil and gas leases (other than those of the Osage Tribe), including leases where the surface is managed by the Forest Service.

In 2007, the Order was revised to reflect passage of the 1987 Onshore Oil and Gas Leasing Reform Act and the Energy Policy Act of 2005. Major changes involve procedures for processing APDs, the use of Best Management Practices (BMPs) in lease development, and regulations and procedures for operating in split estate situations, where privately owned surface overlies federally owned minerals. The Order also defines master development plans, noting that they provide information common to multiple planned wells, including drilling plans, surface use plans of operations, and plans for future production.

### 1.4.2 Conformance with the Current Resource Management Plan

The BLM land use planning decisions for federal lands and minerals within the Unit are contained in the Uncompahgre Basin RMP (1989). The alternatives are subject to the decisions in the current RMP. The RMP decision relevant to the Bull Mountain Unit MDP states, “Federal oil and gas estate will be open to leasing. Seasonal restrictions are required on crucial deer and elk winter range and on bald eagle hunting habitat to protect crucial deer and elk winter range and bald eagle hunting habitat from disturbance” (BLM 1989, pages 28 and 32).

All of the alternatives in this EIS are in conformance with the Uncompahgre Basin RMP.

### 1.4.3 Uncompahgre Resource Management Plan Revision

The BLM is revising its Land Use Plan for the Uncompahgre Field Office. Existing land use plans decisions will remain in effect during the land use plan revision process until the revision is completed and approved (43 United States Code [USC] 1711- 1712, 43 CFR 1600).

Inventory information and baseline reports developed for the Uncompahgre RMP revision, as well as those for the Bull Mountain Unit MDP Environmental Assessment (EA, BLM 2012), were incorporated into this EIS to provide recent and best information available.

## 1.5 Federal, State, and Local Permitting and Approvals

The proposed action and alternatives would be in compliance with various federal, state, and local laws and regulations, and the operators would procure any required permits or easements (**Table 1-1**, Federal, State, and Local Permits and Approvals Applicable to the Bull Mountain Unit).

**Table 1-1**
**Federal, State, and Local Permits and Approvals Applicable to the Bull Mountain Unit**

| Agency | Permit, Approval, or Action |
|---|---|
| *Federal Agency* | |
| US Army Corps of Engineers | • Section 404 and 401 permits for compliance with Clean Water Act |
| US Bureau of Land Management | • NEPA<br>• Approval of the APDs<br>• Sundry notices for construction and other changes<br>• Permits to drill, deepen, or plug back on BLM-administered land (APD/Sundry Notice process)<br>• Right-of-way (ROW) grants and temporary use permits for pipelines on BLM-administered land outside the Unit<br>• ROW grants for access roads on BLM-administered land outside the Unit<br>• Authorization for flaring and venting of natural gas on BLM-administered land<br>• Plugging and abandonment of a well on BLM-administered land<br>• Modifications of and/or exceptions to lease stipulations<br>• Antiquities, cultural and historic resource permits on BLM-administered land<br>• Paleontological resource use permits<br>• Approval to dispose of produced water on BLM-administered land<br>• Pesticide use permits<br>• Noxious Weed Act enforcement<br>• Initiation of Section 7 consultation with US Fish and Wildlife Service (USFWS)<br>• Mineral material sales permits |
| US Department of Justice, Bureau of Alcohol, Tobacco and Firearms | • Explosives user permits |
| US Environmental Protection Agency – Region 8 | • Air quality permits (delegated to Colorado Department of Public Health and Environment)<br>• Review and comment on major federal actions<br>• Spill Prevention, Control, and Countermeasure Plan<br>• Underground Injection Control permits (delegated to COGCC) |
| US Fish and Wildlife Service | • Migratory Bird Treaty Act and Bald Eagle Protection Act consultations<br>• Section 7 consultation for compliance with Endangered Species Act |
| *State Agency* | |
| Colorado Division of Water Resources (Office of the State Engineer) | • Water well permits<br>• Stream alteration permits<br>• Change in nature of use water applications |

**Table 1-1**
**Federal, State, and Local Permits and Approvals Applicable to the Bull Mountain Unit**

| Agency | Permit, Approval, or Action |
|---|---|
| Colorado Parks and Wildlife | • Coordination regarding impacts on wildlife and state sensitive species<br>• Compliance with COGCC Rules and Regulations<br>• Consistency with essential elements of wildlife mitigation strategy |
| Colorado Oil and Gas Conservation Commission | • Coordination on APDs (including Oil and Gas Location Assessment)<br>• Permits to drill, deepen, or re-enter and operate oil and gas or disposal wells<br>• Underground Injection Control Permits (delegated by the Environmental Protection Agency)<br>• Pressure monitoring and well spacing<br>• Disposal facility permits<br>• Permits to flare natural gas<br>• Compliance with safety regulations for oil and gas activities |
| Colorado Department of Public Health and Environment, Division of Water Quality | • Construction Discharge Permit for stormwater discharges during project construction (according to current stormwater management plan)<br>• Coordination with COGCC for Injection Permit Applications<br>• Water Well Permit<br>• Section 401 Clean Water Act water quality certification stream and wetland crossing.<br>• Construction dewatering permits<br>• Stream alteration permits<br>• Solid and hazardous waste control |
| Colorado Department of Public Health and Environment, Division of Air Quality | • Air Quality Permits and Air Pollutant Emissions Notices (including delegations from the Environmental Protection Agency) for stationary and portable sources<br>• Approval orders and permits for compressors and other stationary emissions sources<br>• Air quality permits to construct<br>• New Source Review permits<br>• Fugitive dust control |
| Colorado Department of Transportation | • Access permits for access to and from State Highway 133<br>• Utility, relocation, and special use permit for work in the highway ROW<br>• Oversize/overweight vehicle permits for use of state highway<br>• Approval of construction and operation of natural gas pipelines<br>• Permits for encroachment and for crossing state roads |
| Colorado Water Court Division 4 | • Water Augmentation Plan |
| *Local Government* | |
| Gunnison County | • Gunnison County Land Use Resolution (riparian/wetland set back regulations)<br>• Application for an Oil & Gas/land use change permit<br>• Performance/utilization bond<br>• Driveway permits for county road access<br>• Permits for use of County Road 265 for overweight/oversize equipment<br>• County zoning/land use plan consultation<br>• Special use and conditional use permits<br>• Encroachment permits |

**Table 1-1**
**Federal, State, and Local Permits and Approvals Applicable to the Bull Mountain Unit**

| Agency | Permit, Approval, or Action |
|---|---|
| | • Road conditional use and opening permits<br>• Solid waste disposal permits<br>• Construction permits and licenses<br>• Colorado Noxious Weed Act enforcement |

Source: BLM 2012; Gunnison County 2013.

## 1.6 Scope of Analysis

As the decisions under consideration by the BLM are of a programmatic nature and would not result in on-the-ground actions (i.e., the BLM is not approving an APD to start drilling), the scope of the analysis was conducted at a programmatic level. In this manner, the BLM is able to analyze future potential energy development on the entire Bull Mountain Unit. As the life of any individual well is estimated to be 40 years, for purposes of analysis, it is assumed that the analysis horizon for the project would be 50 years. This includes all oil and gas wells and water disposal wells, although the actual production years may vary for individual wells. The analysis focuses on the direct, indirect, and cumulative impacts that could eventually result from activities resulting from the actions presented in the alternatives. This analysis identifies impacts that may result in some level of change to the resources, regardless of whether that change is beneficial or adverse.

All phases of natural gas field development are included in the scope of the analysis, including siting, construction, drilling, completion, interim reclamation, production and maintenance, final wellbore abandonment, and reclamation are included in the analysis. The technologies described here are representative of those most likely to be deployed over the life of the project.

Information provided within the environmental consequences section provides the decision maker with the information necessary to compare and contrast the predicted effects of the proposed action and alternatives and make a reasoned and informed decision regarding which alternative or combination of actions should be selected in the ROD.

### 1.6.1 Requirements for Future NEPA Analysis

The Bull Mountain Unit MDP EIS alternatives are programmatic in nature, meaning that the well pad and well locations, road alignments, pipeline routes, and other facility placements are conceptually illustrated for the purposes of assessing the cumulative resource impacts of SGI's proposed well development in the Unit. As noted in **Section 1.3**, Decisions to Be Made, above, the analysis level is also programmatic, and the only decision the BLM is considering is whether or not to approve the MDP. Regardless of which alternative may be selected in the ROD, the exact locations of wells, roads, pipelines, and other facilities would be determined when those wells or facilities are proposed for drilling or construction, such as when the BLM receives an APD for review. Siting of these locations would be subject to design features and best management practices (BMPs) adopted in the ROD for this EIS.

If the MDP is approved, this EIS will provide an "umbrella" analysis to which analysis of subsequent federal actions (e.g., approval of APDs) proposed within the Unit would be tiered.

Approval of these actions would require additional documentation of NEPA compliance, such as a tiered environmental assessment, a Documentation of NEPA Adequacy, or a categorical exclusion. Categorical exclusions that may apply to some future development activities include those provided in Section 390 of the Energy Policy Act of 2005, 42 USC 15942(b). Approval would be subject to onsite examinations of each proposed well, pipeline, and road location, including current resource surveys. The BLM would apply appropriate mitigation, design features, and BMPs to all permitted actions in accordance with federal and state oil and gas regulations, Washington Office Instruction Memorandum 2008-166, and the 1989 Uncompahgre Basin RMP or the future revised Uncompahgre RMP.

## 1.7 PUBLIC INVOLVEMENT

Public involvement is a vital component of the EIS processes (43 CFR 1506.6). Scoping is an early and open process for determining the scope of issues to be addressed and identifying the significant issues related to a proposed action. Information collected during scoping may also be used to develop the alternatives to be addressed in a NEPA document. Public involvement was conducted in the following phases for the Bull Mountain Unit MDP environmental review process:

- Public scoping prior to NEPA analysis to determine the scope of issues and alternatives to be addressed
- Public outreach, news releases, and newspaper advertisements
- Public review and input on the Bull Mountain Unit MDP EA
- Collaboration with federal, state, local, and tribal governments; the BLM Colorado Southwest Resource Advisory Council (RAC); and cooperating agencies
- A Notice of Intent (NOI) to prepare an EIS was published in the *Federal Register* on April 3, 34 2013 (78 *Federal Register* 20133-20134, April 3, 2013)

This Draft EIS is being made available for a public comment period of 45 days.

The scoping summary report documents the results of the public involvement process beginning with public scoping and including the comments received on the EA, and provides information about the ongoing collaboration process; a copy of the report is available on the Bull Mountain EIS project website: http://www.blm.gov/co/st/en/BLM_Information/nepa/ufo/Bull_Mountain_EIS.html.

### 1.7.1 Cooperating Agencies

The BLM engaged multiple cooperating agencies and tribes for a broader understanding on their issues and concerns regarding the Bull Mountain Unit Master Development Plan and EIS. Cooperating agencies are state or federal agencies, or local or tribal governments that enter into a formal relationship with the BLM to help develop EISs (40 CFR 1508.5). A cooperating agency's involvement can include participating in issue identification, collecting inventory data, contributing to alternative formulation, and estimating effects of alternatives (40 CFR 1501.6). The cooperating agencies on the Bull Mountain Unit MDP EIS are the following:

- Environmental Protection Agency, Region 8
- Grand Mesa, Uncompahgre, Gunnison National Forest
- Delta Conservation District
- Colorado Department of Natural Resources, including the Division of Parks and Wildlife
- Colorado Department of Public Health and Environment
- Delta County
- Gunnison County

The BLM initiated consultation with the Colorado State Historic Preservation Officer in August 2013 in accordance with the Protocol for Managing Cultural Resources on Lands Administered by the Bureau of Land Management in Colorado. Consultations will continue through the course of the EIS process to ensure compliance with the NHPA and NEPA.

The BLM has also contacted and consulted with Native American tribal governments including the Ute Tribe of the Uintah and Ouray Reservation, Southern Ute Indian Tribe, and Ute Mountain Ute Indian Tribe. Formal letters were sent to the three tribes in January 2014. The BLM continues to remain in contact via phone calls and emails, and by responding to individual requests for additional information or meeting presentations.

Finally, the Southwest RAC has been kept informed of the EIS progress throughout the document's development. For full details on the coordination and consultation conducted for the EIS, see **Chapter 5**, Consultation and Coordination.

## 1.8 Key Issues Addressed in this EIS

An issue is a point of disagreement or dispute with the proposed action based on some anticipated environmental effect (BLM 2008a, page 40). The BLM has used the issues and other information collected in the scoping and EA comment phases to help formulate a reasonable range of alternative management strategies that are analyzed in this Draft EIS.

The NOI invited further comments and the project has been discussed internally and externally during the interim. The issue statements below include those from the scoping period for the EA, as well as public comments received on the EA after its publication in March 2012. The process of developing this EIS afforded opportunities for collaboration with local, state, federal, and tribal governments; land-management agencies; public interest groups; and public land users. As a result, these issues and concerns may be modified and perfected to reflect public comments and concerns. The overarching issues the EIS addresses are listed below.

### 1.8.1 Issues Identified at Environmental Assessment Scoping

Information accepted during project scoping conducted in 2008 and 2009 was compiled to develop issue statements. The following issues of key environmental, social, and economic concern were identified:

Air Quality. How will harmful emissions and dust from construction and operations be monitored and controlled?

Water Quality and Supply. How will hydraulic fracturing and reinjection of produced water affect the short-term and long-term quality and supply of water for agricultural and residential use? What are the potential hazards from surface spills and various substances used during drilling and production? An inventory and performance monitoring program should be instituted to establish a baseline and provide regular reporting for the life of the project.

Threatened, Endangered, and Sensitive Wildlife Species. What are the potential impacts on species identified as threatened, endangered, or of concern to state and federal agencies, including Canada Lynx and Gunnison sage-grouse?

Wildlife and Wildlife Habitat. The area is used by a wide variety of species, including a large population of elk, and the potential impacts, duration, and density of development in this relatively undeveloped area is a concern. How will construction and ongoing use of access roads affect wildlife habitat utilization and connectivity within and adjacent to the Bull Mountain Unit?

Recreation and Visual Resources. The Bull Mountain Unit is adjacent to important recreation areas for camping, hunting, and sightseeing and includes a segment of the West Elk Scenic Byway. How will the project affect access to and quality of recreation and visual resources?

Socio-economics. How will development and operation of additional roads and infrastructure affect the rural character, lifestyle, and property values in the area, as well as tourism that relies on existing recreational and scenic values? What are the positive and negative economic impacts of developing the mineral resource?

Transportation. How will increased traffic and resulting impacts on road conditions, maintenance, and safety be addressed? How will new pipeline and access road corridors be minimized?

### 1.8.2 Additional Issues to Be Considered

Based on the comments received on the EA, many of the issues are similar to those identified from scoping; however, some additional concerns and key issues have been identified as noted below.

Climate Change. How will the BLM address climate change and greenhouse gas emissions that result from the project and other projects in the area in the EIS?

Cumulative Impacts. What area projects will the BLM include when considering cumulative impacts; will the BLM include projects such as the North Fork Valley Leasing and other leasing actions? Will the BLM address impacts from the project activities on the surrounding National Park Service Units, National Forest System lands, and the broader county socioeconomics?

Range of Alternatives. Will the BLM consider additional alternatives in the EIS, such as different water disposal systems or access points to the Bull Mountain Unit? Will the BLM consider additional required design features as part of the alternatives?

National Environmental Policy Act. How will the BLM coordinate the EIS development with the on-going Uncompahgre RMP revision? What is the appropriate level of analysis for the EIS – high-level programmatic analysis or site-specific analysis? Will there be additional NEPA analysis required for individual drilling permits? Since this is an EIS effort, will the BLM coordinate with cooperating agencies and other stakeholders?

Noise. What are the impacts from increased noise in the project area? Will noise diminish the quality of life and recreational experiences people currently enjoy?

Geologic Resources. What are the impacts on the geologic resources from water injection and hydraulic fracturing? Could there be increased risk for induced seismicity and geologic hazards (e.g., landslides and slope instability)?

Visual Resources, Vegetation, Soil Resources, Recreation. How will the BLM address impacts on these resources from the project's actions? What mitigation measures will the BLM include, such as design features, BMPs, or other required mitigation to address these impacts?

Health and Safety. What are the impacts on human health and safety that could result from the project actions? How will the BLM address project-related trash and reduce the risk for hazardous spills, traffic related safety issues, and release of toxic emissions?

# Chapter 2

## Alternatives

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# CHAPTER 2
# ALTERNATIVES

## 2.1 INTRODUCTION

This chapter details Alternatives A through C for the Bull Mountain Unit MDP Draft Environmental Impact Statement (Draft EIS). The BLM identified a range of alternatives, including a No Action alternative (as required at 43 CFR 1502.14), the Proposed Action, and a Modified Action. The Proposed Action and Modified Actions are based on the actions proposed by SGI, issues, concerns, and opportunities raised in public comments during scoping and comments on the Preliminary EA; interdisciplinary interaction between resource professionals; and collaboration with cooperating agencies. Comments on the Proposed Action received during the public scoping period and comments received on the Bull Mountain Unit MDP Preliminary EA are summarized in the Bull Mountain Scoping Report, available on the project website (http://www.blm.gov/co/st/en/BLM_Information/nepa/ufo/ Bull_Mountain_EIS.html).

The BLM NEPA Handbook (H-1790-1) also calls for expression of the BLM's preferred alternative in the Draft EIS if one exists (BLM 2008c). The BLM has not identified a preferred alternative for the Bull Mountain Unit Master Development Plan project at this time. The BLM believes that the Proposed Action and the action alternatives all have elements that would address the project purpose and need and will review public comment on the Draft EIS before determining a preferred alternative. A preferred alternative will be designated in the Final EIS.

Although the development activities anticipated in the alternatives would take place on federal and private mineral estate, the BLM's decisions are limited to federal lands and minerals. Those activities on BLM-administered mineral estate for the BLM's decision for the Bull Mountain Unit MDP must conform to the Uncompahgre Basin RMP (BLM 1989). See **Chapter 1**, Introduction, for further details regarding BLM authority.

## 2.2 ALTERNATIVES

### 2.2.1 Alternative Development

The CEQ regulations require an agency to consider significant issues when developing the range of alternatives to be considered in an EIS (43 CFR 1500.1, 1501.7, and 1502.1). As defined in the BLM's NEPA Handbook (H-1790-1, page 40), an issue is a point of disagreement, debate, or dispute with a proposed action based on some anticipated environmental effect; an issue has elements that distinguish it from a position statement including:

- Has a cause and effect relationship with the proposed action or alternatives
- Is within the scope of analysis
- Has not been decided by law, regulation, or previous decision
- Is amenable to scientific analysis rather than conjecture

Issues point to environmental effects, and may lead to the identification of design features that are incorporated into the proposed action or an alternative, or to mitigation measures.

Issues relevant to the Bull Mountain Unit MDP EIS were identified during internal and external scoping for this EIS, as well as public comments submitted on the Bull Mountain Unit MDP EA, and are presented in **Section 1.8**, Key Issues Addressed in this EIS.

Existing lease rights granted by the BLM on federal mineral estate remain in effect during this EIS process. The BLM may receive and consider proposals for individual APDs and/or associated facilities on federal surface, federal mineral estate, access across federal lands for oil and gas development, and production-related activities at any time. These additional individual actions submitted to the BLM will have separate NEPA review at the time they are received.

### 2.2.2 Alternatives Considered for Detailed Analysis

The two action alternatives (Alternative B, Proposed Action, and Alternative C, Modified Action) offer a range of possible management approaches for responding to the issues presented in **Section 1.8**, Key Issues Addressed in this EIS. When resources or resource uses are mandated by law, regulations, or policy, there are typically few or no distinctions between alternatives.

Meaningful differences among the three alternatives are described in **Table 2-9**, Summary of Actions by Alternative. Figures following the description of each alternative provide a visual representation of differences between alternatives. GIS has been used to perform acreage calculations and to generate these figures. Calculations are dependent upon the quality and availability of data, and most calculations in this EIS are rounded to the nearest 10 acres or 0.1 mile. Given the general scale of the analysis and the compatibility constraints between datasets, all calculations are approximate and serve for comparison and analytic purposes only. Likewise, the figures are provided for illustrative purposes and subject to the limitations discussed above. The BLM may receive additional or updated data; therefore, acreages may be recalculated and revised at a later date.

The Bull Mountain Unit MDP EIS alternatives are programmatic in nature, meaning that the well pad and well locations, road alignments, pipeline routes, and other facility placements discussed here are conceptually illustrated for the purposes of assessing the cumulative resource impacts of proposed development in the Unit. As noted in **Section 1.3**, Decisions to be Made, and **Section**

**1.6.1**, Requirements for Future NEPA Analysis, the only decision the BLM is considering is whether or not to approve the Master Development Plan.

### 2.2.3 Elements Common to All Alternatives

The following alternatives describe the range of possible actions that the BLM is considering in the EIS. There are several phases of the project and assumptions that would be the same across all alternatives. To eliminate redundancy and streamline presentation, those elements common to all alternatives are presented first, followed by the elements unique to each individual alternative. The actions are also summarized in **Table 2-9**, Summary of Actions by Alternative, and **Table 2-11**, Summary of Surface Disturbance Acres by Alternative, at the end of the chapter.

The life cycle of an individual well and its associated facilities and required infrastructure (e.g., roads, pipelines, and compressor stations) is composed of eight primary phases: siting, construction, drilling, completion, interim reclamation, production and maintenance, final wellbore abandonment, and reclamation. A siting design and constraints analysis for well pad placement was conducted as part the Bull Mountain EA and has been carried forward to determine approximate siting for the EIS. The siting design and constraints analysis was used as a baseline for all alternatives and is described below. Additionally, due to uncertainties inherent in the programmatic analysis approach of the MDP (e.g., site-specific locational information), several assumptions have been made for all alternatives and are provided in the section titled *Assumptions Common to All Alternatives*. Specific details of the remaining seven phases are described in each alternative.

***Siting***

As explained in detail in **Appendix A**, Well Pad Site Suitability Models and Methodology, GIS was utilized to find sites with respect to a number of environmental resource constraints. The GIS analysis was used by SGI to propose locations of well pads, roads, pipelines, and other infrastructure and utilized in all alternatives. GIS was also used to modify locations in Alternative C (see additional details in **Section 2.2.6**, Alternative C, Modified Action).

It is important to note that the locations of proposed well pads, access roads, pipelines, compressor stations, and other surface facilities for each alternative illustrated on **Figures 2-1** to **2-3** are conceptual in nature and may be modified at a later stage (e.g., during consideration of an APD), as noted above. Field verification of proposed locations is described in **Appendix A**. Drilling proposals would conform to the COGCC regulations and policies and to the objectives of the site selection model as described in **Appendix A**. On BLM-administered surface or mineral estate, where reasonably practicable, the onsite determinations would conform with the objectives of the site selection model and as described in the BLM Instruction Memorandum No. 2004-194: Integration of Best Management Practices into Application for Permit to Drill Approvals and Associated Rights of Way, IM 2013-033: Reducing Preventable Causes of Direct Wildlife Mortality Associated with Fluid Mineral Facilities Authorized by the BLM, and the BLM/Forest Service publication Surface Operating Standards and Guidelines for Oil and Gas Exploration and Development – The Gold Book (The Gold Book [DOI and USDA 2007]).

***Assumptions Common to All Alternatives***

Several assumptions have been made for all alternatives and are provided below.

- Rate of development: SGI anticipates using three drilling rigs to drill multiple wells per rig per year. It is assumed that the operator would drill up to 27 wells each year. The full-field development timeframe will differ based on the number of wells proposed under each alternative, as well as additional delay time for permitting.

- Wells would be drilled to develop productive formations in the Unit including the Cameo, South Canyon, and Coal Ridge coal formations, the Cozzette and Corcoran sandstone formations, and the Mancos shale formations.

- The extent of such development and prospective nature of the resources is based on geologic information, data derived from wells drilled to date, and economic factors. The resource is expected to be productive over the entire unit; however, it is possible for some areas to have more favorable economics than other areas due to varying reservoir qualities. It is possible that areas currently identified for development may not be economically viable; as a result, some of the proposed well pads and wells may not be constructed and drilled.

- The well-head density needed to develop the resources is expected to vary depending on the formation being developed. The geologic characteristics of the individual formations in the Unit would dictate this density. The ultimate well-head density per well pad would be defined through future drilling, and resource and formation analysis. Again, these well-head densities refer to downhole/bottomhole wellbore densities. The operator would use directional drilling and multiple well pad drilling and completion techniques to develop these resources that would minimize the number of well pads or surface locations.

  The number of wells per well pad would vary depending on the required downhole well density and how many directional wells can be drilled from the location, whether or not both shallow and deep horizons are being developed, and topographic considerations. Some well pad locations may therefore host as few as 1 well whereas others may have up to 12 wells drilled from a single well pad. Wellbores on multi-well pads would be offset in a line 15 to 20 feet from the previous wellbore. If more than approximately 6 wells are to be drilled from a well pad, parallel lines of wells spaced up to 15 to 20 feet apart may be employed.

- Across all alternatives, the life of any individual well is estimated to be 40 years based on use of current technologies and production methods, although the actual productive life of a single well may vary. This includes all oil, gas, and water disposal wells, although the actual production years may vary for individual wells. It is assumed for the purposes of analysis that the life of the project would be 50 years, but future technological advances and increased production efficiency may extend the life of the project beyond 50 years.

- The number of employees working in the Unit during the construction, drilling, and completion phases would depend on the number of drilling rigs operating at any one time. In addition to the workforce associated with well pad construction, and drilling and completion operations, personnel and contractors could be in the Unit during the construction or improvement of roads, installation of pipelines, and construction of new compressor stations or other surface facilities. These employment numbers would also vary depending on the amount of infrastructure proposed and the pace and level of development. Estimates are presented under each phase in each alternative.

Employment for production operations and well service would depend on the number of producing wells at any one time. The number of operations and service personnel would grow over time as the number of producing wells increased, but employment for production operations and well force would amount to a small percentage of the total workforce.

If the current employment patterns are maintained, the workforce and contractors associated with the project would be stationed in the areas of Grand Junction, Montrose, Delta, Paonia, Hotchkiss, Glenwood Springs, and Gunnison, Colorado.

- Reserve pit fences would be constructed and maintained according to the permitting agency requirements.
- All alternatives assume a standard traffic rate per well pad that will be used for calculations. **Table 2-1**, Traffic Estimates for Drilling, Completion, and Production Activities per Well Pad, presents the traffic that could occur for each individual well pad. Actual traffic volumes would vary depending on the level of drilling activity, the specific operations that might be underway at a well pad and the maturity of the project at any particular time. Actual and specific volumes will be determined in future APDs/Plans of Development (PODs) and disclosed in associated NEPA documents, as appropriate.

**Table 2-1**
**Traffic Estimates for Construction, Drilling, Completion, and Production Activities per Well Pad**

| Vehicle Type | Average Weight (pounds) | Estimated Round Trips |
|---|---|---|
| Vehicles for Pad and Access Road Construction | | |
| Gravel trucks | 110,000 | 160 |
| Semi trucks | 37,000 | 4 |
| Pick-up trucks | 6,000 | 40 |
| Motor grader on semi trailer | 40,000 | 1 |
| Dozer (2) on semi trailer | 19,000 | 2 |
| Trackhoe on semi-trailer | 43,000 | 1 |
| Pipeline Construction | | |
| Motor Grader on Lowboy Trailer with Truck | 50,800 | 2 |
| Bulldozer on Lowboy Trailer with Truck | 120,000 | 2 |
| 80-barrel water trucks – dust control | 54,000 loaded | 20 |
| 80-barrel water trucks – hydrostatic testing | 25,000 empty | 2-4 |
| Trackhoe on Lowboy Trailer with Truck | 91,000 | 2 |
| Welding trucks | 9,500 | 2 |

**Table 2-1**
**Traffic Estimates for Construction, Drilling, Completion, and Production Activities per Well Pad**

| Vehicle Type | Average Weight (pounds) | Estimated Round Trips |
|---|---|---|
| Crew cab Pick Ups | 5,200 | 40 |
| Bending Machine/Trailer | 48,000 | 2 |
| Sidebooms on Lowboy Trailer with Truck | 63,000 | 2 |
| X-Ray Truck | 5,200 | 4 |
| Testing Truck | 6,000 | 2 |
| Pipe Trucks | 120000 loaded | 1 |
| | 36000 unloaded | 1 |
| Utility Tractor and Truck with Low Boy Trailer | 40,000 | 2 |
| Vehicles for Drilling/Completing First Well on the Pad | | |
| Drilling/Completion Rig | 120,000 | 1 |
| Rig-Up Trucks Loaded (e.g., cement or fracturing) | 120,000 | 25 |
| Rig-Up Trucks Empty | 36,500 | 4-6 |
| 80-barrel water trucks loaded | 54,000 | 40 |
| 80-barrel water trucks empty | 25,000 | 40 |
| Crew-cab pick ups | 6,000 | 40 |
| Vehicles for Drilling/Completing Subsequent Wells on the same Pad | | |
| Motor Grader | 50,000 | 2 |
| Drilling/Completion Rig | 120,000 | 2 |
| Rig-Up Trucks Loaded (e.g., cement or fracturing) | 120,000 | 25 |
| Rig-Up Trucks Empty | 36,500 | 4-6 |
| 80-barrel water trucks loaded | 54,000 | 45 |
| 80-barrel water trucks empty | 25,000 | 45 |
| Crew Cab Pick-Ups | 6,000 | 40 |
| Vehicles for Well Production | | |
| Workover rig | 120,000 | 1 round trip every 2 years |
| Haul trucks | 120,000 | 6 |

- All alternatives assume a standard area of disturbance that will be used for calculations. Due to the unknown number of wells per pad and alignments for roads and pipelines, the disturbance areas used are estimates only and were developed based on the assumption that the disturbance area would need to be large enough to reasonably accommodate future permitted construction or realignments. Additionally, an adequately sized well pad would accommodate the drilling equipment while providing a safe offset from other existing wellbore(s). **Table 2-2**, Project Feature Assumed Short- and Long-term Disturbance Estimates, presents the assumed short- and long-term estimates.  Actual and specific well pad size, pipeline width or road width will be determined in future APDs and analyzed in subsequent NEPA actions.

**Table 2-2**
**Project Feature Assumed Short- and Long-Term Disturbance Estimates**

| Project Feature | Short-Term Surface Disturbance | Long-Term Surface Disturbance |
|---|---|---|
| Well Pads | | |
| New well pads | 5 acres | 2 acres |
| Existing well pads | 2 acres | 2 acres |
| Access Roads (width) | | |
| Existing improved roads | 0 feet | 16 feet |
| Upgrades to existing 2-track roads | 25 feet | 16 feet |
| New road construction | 25 feet | 16 feet |
| Pipelines (analysis area) | | |
| Co-located with roads | 100 feet | 16 feet |
| Not co-located with roads (cross country) | 50 feet | 0 feet |
| Facilities | | |
| Compressor station | 5 acres per station | 2 acres per station |

NOTE: Estimated acreages according to the assumed short- and long-term disturbance are for analysis purposes. The permitted rights-of-way for construction would cover fewer acres.

### *Existing Facilities*

There are already existing well pads, wells, roads, pipelines, and other facilities within the Unit to which any alternative (including No Action) would add developments. Listed below in **Table 2-3**, Existing Features within the Unit, are the current number of productive/active pads, wells, facilities, and miles of roads that would remain consistent across all alternatives.

**Table 2-3**
**Existing Features within the Unit**

| Feature | Number of Features or Miles of Road |
|---|---:|
| Well Pads | 18 |
| Natural Gas Wells | 17 |
| Water Disposal Wells | 1 |
| Access Roads – currently suitable for use | 21 miles |
| Pipelines – co-located with roads | 5 miles |
| Pipelines – cross country | 12 miles |
| Overhead electrical lines (to water disposal well) | 1 |
| Flowback pits | 4 |
| Existing storage yard outside the Unit | 1 |

As noted above in the table, SGI would use an existing equipment storage yard located on private land at the Forest Service boundary outside of the Unit, as well as existing well pads to temporarily house construction equipment, vehicles, pipe and pipe welding materials, hydraulic fracturing tanks, production equipment, and other standard gas field equipment. The existing storage area would be used continuously throughout the project development phase. Storage of sensitive or hazardous materials would be handled in compliance with all applicable federal and State of Colorado regulations. Temporary use of existing pads for equipment storage would occur with appropriate permitting and notice to agencies and landowners. These locations would be chosen to accommodate nearby construction, drilling, and completion activities. Upon completion of the development phase of the project, or when storage areas are no longer needed, all remaining equipment would be removed and the storage areas would be reclaimed according to standards of the appropriate surface management agency.

A complete listing of producing, active, inactive, closed, abandoned, dry, and plugged features are listed in **Section 3.3.2**, Minerals.

### 2.2.4 Alternative A, No Action

NEPA regulations require that the EIS alternatives analysis "include the alternative of no action" (40 CFR 1502.14(d)). The No Action Alternative does not respond to the purpose and need for the Proposed Action. Rather, it serves as a baseline for comparing the Proposed Action's and alternative's environmental effects (including cumulative effects) and it illustrates the consequences of not meeting the stated purpose and need. Under the No Action Alternative, the Bull Mountain Unit MDP would be denied.

Rejection of an MDP under the No Action Alternative would not mean that there would be no new gas development in the project area; development may be authorized on private lands with non-federal minerals as the BLM does not approve or control development on these lands. Development of private lands/private mineral estate is regulated and approved through the COGCC. For the purposes of analysis and comparison, the No Action Alternative assumes no further federal mineral development. If the No Action Alternative were selected, some federal mineral development may still occur under individual authorizations.

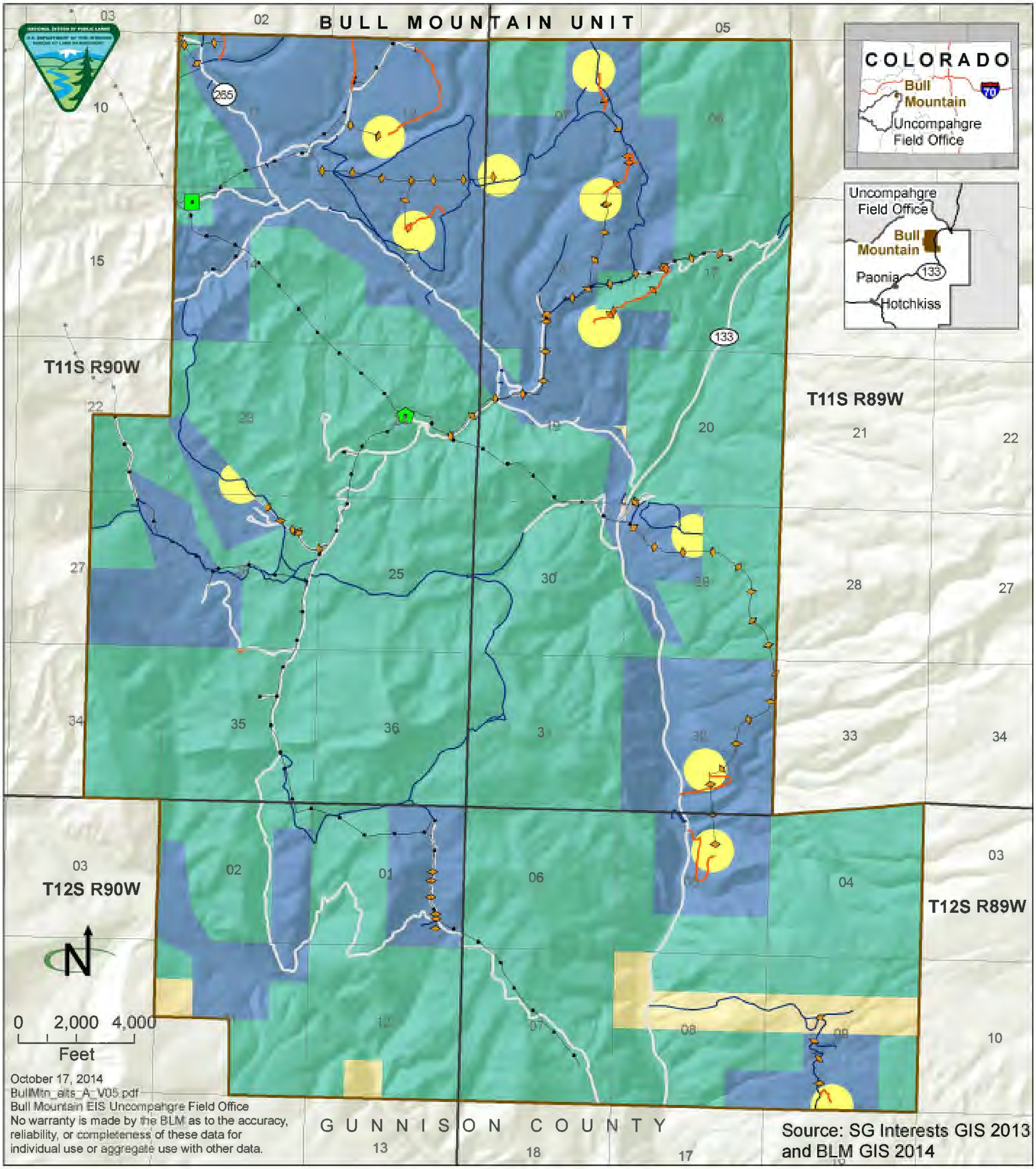
The components described for Alternative A (e.g. development, construction, drilling, etc.) are assumptions only. The BLM's analysis of the No Action alternative assumes that previously authorized activities and activities on private mineral estate would continue, but there would be no new development on federal mineral estate under an MDP; development on private mineral estate would occur as authorized by COGCC.

**Figure 2-1**, Alternative A, No Action, presents the conceptual locations of potential well pads over areas currently thought to be most prospective for natural gas development.

***New Developments***

Alternative A comprises up to 55 new natural gas wells on privately owned surface lands targeting private minerals. The 55 wells would be built on existing well pads and as many as 11 new well pads. There would be one new water disposal well, construction of new pipelines and some new roads, and upgrades to existing roads. Based on these numbers, a total of 56 new wells drilled, and the assumed drilling rate noted in the common assumptions, the BLM estimates that drilling activities would occur for approximately 3 years.

One of the new well pads would be constructed specifically to drill and maintain a new water disposal well. Some of the new gas wells would be drilled on the existing water disposal well pad; however, the quantity and combination of conventional sandstone, coalbed methane natural




Alternative A, No Action

- Proposed well pad analysis area
- Proposed screw compressor
- Potential storage yard
- Proposed pipeline
- Proposed new road construction
- Existing road requires upgrade for use

Existing Infrastructure

- Existing road currently suitable for use
- Existing pipeline
- Federal surface, federal minerals
- Private surface, federal minerals
- Private surface, private minerals

## Alternative A, No Action

The No Action alternative is specific to previously authorized activities and activities on private (fee) lands/private (fee) mineral estate. No new development on federal mineral estate would occur under a Master Development Plan.

Figure 2-1

gas, and shale gas wells on each pad is not known at this time and would be determined at the permitting stage.

***Construction***

Implementation of any alternative would require the construction of roads, well pads, pipelines, and ancillary facilities.

*Access Road Construction*

The primary access roads within the Unit are State Highway 133 and County Road 265. In addition to these primary access roads, gas development of the Bull Mountain Unit would require the construction and improvement of multiple access roads. Site-specific plans for road construction and upgrades would be included as part of individual future State APDs and would be subject to approval from the COGCC and/or landowners.

New road construction and improvements of existing roads would typically require the use of motor graders, crawler tractors, 10-yard end dump trucks, and water trucks. The standard methodology for building new roads involves the use of a bulldozer or track hoe to segregate and windrow the vegetation to one side of the route, remove topsoil to the opposing side of the route, and rough-in the roadway. As access roads would be constructed using standard crown-and-ditch specifications, a grader or bulldozer would establish barrow ditches and crown the road surface. Roads would be constructed with appropriate drainage and erosion-control features/structures (e.g., cut-and-fill slope and drainage-ditch stabilization, relief and drainage culverts, water bars, wing ditches, and rip-rap). On roads with grades between 3 and 15 percent, rolling dips could be used rather than culverts. Where culverts are required, a track hoe or backhoe would trench the road and install the culverts. Some hand labor would be required when installing and armoring culverts.

The new roads and improved existing road surfaces would be composed of an appropriate volume of road base compacted using a roller and fresh water as necessary. Approximately 6 to 8 inches of road base would be used in road construction and reconstruction. Road base or gravel needed would be hauled in and a grader used to smooth the running surface. Rock, road base, and gravel materials for all uses would be obtained from local permitted, commercial sources outside the Unit near Paonia and either Carbondale or Delta, Colorado. Specifics on where the source materials would be obtained from would be identified on the individual APD when submitted. Upgrade and graveling of these roads would occur as necessary to maintain the post-construction surface quality.

Fresh water would be used in initial road construction and rock/gravel surfacing to improve the workability of the soil and the rock and gravel, and for dust abatement. Fresh water needed for access road construction would be obtained from nearby sources (per agreements with landowners), or would be under the guidance of SGI’s water augmentation plan (see **Appendix L**, Bainard Augmentation Plan). Fresh water application to roads for dust abatement would be applied to the road more frequently as traffic volumes increase and according to weather patterns. Approximately 5,000 to 8,000 gallons of fresh water may be used each day to control fugitive dust per mile during dry months (for example in a typical June). Approximately 2,000 to 5,000 gallons of fresh water may be used to control fugitive dust per mile of road during wet months (for example during a typical August).

On average, SGI estimates that roads would be constructed at a rate of approximately 600 to 800 yards per day. Spur roads to individual well pads would be constructed immediately prior to well pad construction. Each spur road workforce would include an average of five personnel to operate the equipment. For trunk roads (i.e., those providing access through the Unit or to multiple well pads), several crews could operate simultaneously on different roads or different portions of the same road. Total personnel working on trunk road construction or improvements could range in size from 6 to12 individuals.

*Well Pad Construction (Gas and Water Disposal Wells)*

Prior to individual well pad construction, SGI would obtain approval of an APD by the COGCC. Each application would contain site-specific details related to well pad size, construction and well operations, and mitigation measures; possible mitigation measures that could be applied as conditions of approval (COAs) for the drilling permit are noted in **Appendix B**, Construction, Drilling, Completion, and Reclamation, and **Appendix C**, Best Management Practices and Conditions of Approval.

Construction of a typical well pad would entail the use of bulldozers, motor graders, Class 125 or larger track hoes, backhoes, compacters, and 10- to 20-yard dump trucks. Well pad construction equipment needs would vary depending on site-specific conditions; however, methods for construction would be the same for all types of natural gas well pads and water disposal well pads proposed.

Within the approved well pad location, a leveled area would be graded by a bulldozer after or simultaneously with upgrade/construction of an access road to the well site. Standard cut-and-fill construction techniques and machinery (bulldozer or grader) would be used; stockpile, cut, and fill locations within the well pad construction area would be specified on the APD. Vegetation would be cleared and all available topsoil to a depth of 8 to 12 inches would be stockpiled and segregated from subsoils over the entire disturbed surface to create the well pad area. The well pad would be surfaced using “pit run,” or equivalent material, which generally consists of rock less than 6 inches in diameter. The area within the anchor bolt pattern and around tank batteries or facilities would also be surfaced with a top dressing of 3-inch road base. Pit run and road base would both be trucked in to the site from local gravel pits near Carbondale, Delta, Paonia, or other local areas. If the well location requires only minimal grading, 8 inches of topsoil would be salvaged from the entire disturbed surface and stockpiled in contiguous berms or stockpiles at the edges of the well pad to facilitate future reclamation. Stockpiled topsoil would be protected against wind and water erosion and seeded with approved seed mix concurrent with cessation of well pad construction and earth-moving operations. Native seed mixes would be required for reclamation.

On average, five personnel, mostly equipment operators, would work on the construction of an individual well pad. Construction of an individual well pad could take from 1 to 3 weeks depending on the features of each particular site. Under Alternative A, SGI has a range of possible drilling methods that could be used, including a system that utilizes a reserve pit or one that does not use a pit (referred to as “closed-loop”). If SGI utilized a drilling system with a reserve pit to hold drill cuttings and fluids, a lined reserve pit system would be constructed on the well pad. The reserve pit sizes vary with well type and site conditions, but would typically be approximately 50 feet by 150 feet and lined with an impermeable minimum 24-mil plastic liner so as not to leak, break, or allow discharge. The reserve pit would be fenced on three sides during drilling and on the fourth side immediately after the removal of the drilling rig. The well pad itself may also be fenced. Bird netting would be installed over the pit and silt fencing would be installed around the base of the fences. Two feet of freeboard is required at all times. Any reserve pits, which are left open over the winter months, would be fenced to keep big game and wildlife off of the pits. Pits would have a 2-foot unlined berm in addition to the minimum 2 feet of freeboard around them to prevent snowmelt on the pad from flowing into pits.

Fill from the pit would be stockpiled along the edge of the pit and the adjacent edge of the well pad. Use of erosion control measures, including proper grading to minimize slopes, diversion ditches, mulching, riprap, fiber matting, temporary sediment traps, and broad-based drainage dips would be employed by SGI as necessary and appropriate to minimize erosion and surface runoff during well pad construction and operation.

*Pipeline Construction*

Pipelines would be necessary to transport gas from producing wells to the existing sales gas pipeline and to transport produced water to proposed water disposal wells or flowback pits. The following sections describe the various pipeline construction phases, which are typical for this type of development.

<u>Clearing and Grading</u>

At the start of pipeline construction, the route would be cleared of vegetation to remove any obstacles or debris. Grading would follow to remove the topsoil and surface rock, and stockpile it within the edge of the route for redistribution following construction. All brush and other materials that are cleared would be windrowed within the route or in temporary use areas. If the pipeline is not collocated with a road, then these materials may be dispersed over the route to impede future access along it following construction. Trees and rocks would be strategically placed on the pipeline corridor to impede future access as stipulated by individual permit conditions or surface landowner agreements.

<u>Trenching</u>

Construction methods used to excavate a trench would vary depending on soil, terrain, and related factors. Rotary trenching machines would be used where possible. In situations such as steep slopes, unstable soils, high water tables, or deep or wide trench requirements, conventional tracked backhoes (trackhoes) would generally be used. Highway crossing methods and construction requirements would be according to the Colorado Department of Transportation (CDOT) permit stipulations and general conditions as necessary.

Measures would be taken during construction to ensure that access is provided for property owners, tenants, or ROW holders to move vehicles, equipment, and livestock across the trench where necessary. Adequate precautions would also be taken to ensure that livestock are not prevented from reaching water sources because of the open trench. These would include contacting livestock operators, providing adequate crossing facilities, fencing, or other measures as needed.

If a pipeline should be routed to cross a road or wetland, SGI could utilize a pipeline bore for the crossing. If boring were utilized, the bore operations would be set up outside of the wetland or road right-of-way, and designed to minimize impacts on these features. Temporary use areas before and after the feature to be bored may be needed, and would vary in size depending on the terrain and the size of the feature to be bored. Specific route determinations, siting design, and boring methods would be determined at the permitting stage.

Pipe Installation

Gas gathering and subsurface water pipelines would be constructed of steel. Pipe installation would include stringing, bending for horizontal or vertical angles in the alignment, welding the pipe segments together, x-ray inspection, coating the joint areas to prevent corrosion, and then lowering-in and padding.

- Stringing. Line pipe would be trucked directly from the manufacturer or a contractor storage yard to the corridor. Each individual joint of pipe would be unloaded, and strung parallel to the trench. Sufficient pipe for road or stream crossings and steep slopes would be stockpiled at staging areas near the crossings or slope. Stringing operations would be coordinated with trenching and installation activities to properly manage the construction time at a particular tract of land. Gaps would be left at access points across the trench to allow crossing of the corridor.

- Bending. After the joints of pipe are strung along the trench but before the joints are welded together, individual joints of the pipe would be bent if necessary to accommodate horizontal and vertical changes in direction. Field bends would be made utilizing a hydraulically operated bending machine. Where the deflection of a bend exceeds the allowable limits for a field-bent pipe, factory (induction) bends would be installed.

- Welding. After the pipe joints are bent, the pipe would be lined up end-to-end and clamped into position. The pipe would then be welded in conformance with 49 CFR Part 192, Subpart E. “Welding of Steel Pipelines” and API 1104, “Standard for Welding Pipelines and Related Facilities,” latest edition.

- X-Ray Inspection. Welds would be visually inspected by a qualified inspector using non-destructive radiographic methods according to CDOT requirements. A specialized contractor, certified to perform radiographic inspection, would be employed to perform this work. Any defects would be repaired or cut out as required under the specified regulations and standards.

- Coating. To prevent corrosion, the pipe would be externally coated with fusion-bonded epoxy coating prior to delivery. Power Crete-coated pipe would be installed in all bore locations unless the pipe is cased. After welding, field joints would be sandblasted, flocked, and coated with a synergy coating. Before the pipe is lowered into the trench, the pipeline coating would be visually inspected and tested with an electronic detector, and any faults or scratches would be repaired.

- Lowering-In and Padding. Once the welding, inspection, and joint coating has been completed, a section of the pipe would be lowered into the trench. Sideboom tractors would be used to lift the pipe, position it over the trench, and lower it into place. Inspection would be conducted to verify that minimum cover is provided, the trench bottom is free of rocks or other debris, external pipe coating is not damaged, and the pipe is properly fitted and installed into the trench. Specialized machines would be used to sift soil fines from the excavated subsoils to provide rock-free pipeline padding and bedding. In rocky areas, padding material or a rock shield would be used to protect the pipe.

- Backfilling. Backfilling would begin after a section of the pipe has been successfully placed in the trench and final inspection has been completed. Backfill would be conducted using a trackhoe, rotary auger backfiller, padding machine, or other suitable equipment. Backfilling of the trench would generally use the subsoil previously excavated from the trench, except in rocky areas where imported select fill material may be needed. Backfill would be graded and compacted by tamping or walking-in with a wheeled or tracked vehicle. Compaction would be performed to 95 percent maximum density as determined by AASHTO T-99 at all county road crossings. Backfill of trenches would not be performed where the soil is frozen to the extent that large consolidated masses have formed that would not “break down.” The contractor would then re-spread the previously segregated topsoil to return the surface to its original grade. Any excavated materials or materials unfit for backfill would be utilized or properly disposed of in conformance with applicable laws or regulations. The construction contractor would place a mound over the trench approximately 6 inches high to account for subsidence. The entire construction zone would be seeded in the first appropriate season after disturbance.

- Pressure Testing. The entire pipeline would be tested in compliance with USDOT regulations (49 CFR Part 192). Prior to filling the pipeline for a pressure test, each section of the pipeline would be cleaned by passing reinforced poly pigs through the interior of the line. Incremental segments of the pipeline would then be filled with compressed water, air, or natural gas to the desired maximum pressure (up to 720 pounds per square inch), and held for the duration of the test (8 hours minimum if USDOT regulations apply). The compressed air would be discharged into the atmosphere following the completion of the test. Notification to all nearby residents as well as the Gunnison County Dispatch Center would be made prior to the pressure test and blowdown. Water discharge, if necessary, would occur into upland areas, on gentle slopes, and would be conducted in accordance to the conditions and stipulations in CDPHE’s Colorado Discharge Permit System for Hydrostatic Testing of Pipelines Tanks and Similar Vessels. These conditions and stipulations require permit-specific sampling, testing, filtering or mitigation, reporting, and a plan to prevent soil erosion or impacts on surface waters.

Gathering pipelines for individual well pads would consist of 6- to 8-inch outer diameter pipeline, and be designed for 720 pounds per square inch. Each gathering line would tie into a larger trunk line with a 12- to 16-inch outer diameter, which would eventually transport the gas to the Bull Mountain Pipeline; carsonite pipeline markers would be installed on the surface and tracer wire would be installed for all buried pipelines. The dimensions of the pipe used would be dependent on the number of wells served and production estimates.

Between 10 and 25 construction and supply-related personnel would be needed to install new sections of pipeline gathering system. All gas pipelines would be constructed to applicable American Petroleum Institute/industry standards.

*Overhead Electrical Line Construction for Water Disposal Wells*

For Alternative A, the new water disposal well would require construction of one new overhead electrical line (up to 5 power poles) to supply power to the water disposal wellhead. The overhead electrical line would be installed by the Delta Montrose Electrical Association (DMEA) to connect the new water disposal well facilities to power. Electrical line construction would take place following successful completion of the new water disposal well. Electrical power would be used for long-term operation of lights, water heaters, and ancillary needs at the water disposal facility. In most, but not all cases, well pumps would not use electricity, and would be run by natural gas-powered pumps.

The new line would be installed following the most practical route from existing lines to the new water disposal well site; two options would be to follow existing two-track roads or run the line cross-country. The average ROW width for power lines is 30 feet. Final routes would be subject to surface owner approval. If the line followed existing two-track roads construction vehicles would stay on existing disturbance areas. If the line ran cross-country, then appropriate access and vehicle routes would be approved as part of the project design. If the terrain allows for it, access could be overland along the route. Wooden power poles would be erected by DMEA's service trucks. Typical equipment includes pickups, auger/drilling rigs, bucket trucks and stringing equipment. Some Gambel's oak, aspen, and other taller shrubs may need to be pruned back for construction, and each power pole hole would disturb approximately 8 square feet of vegetation during excavation of the hole and setting of the power poles. There would be no prescriptive clearing of the corridor for electrical lines. Electrical line would run to the new water disposal well location.

***Drilling***

Drilling operations would be conducted in compliance with the APD issued by the State and any relevant Federal Regulations (i.e., USFWS and EPA regulations). Specific techniques for drilling wells would differ depending on whether SGI drilled a gas well or a water disposal well; the specific techniques for natural gas well and water well drilling are presented below. Trucks would be used to transport drilling components to the work site. Rig components are designed for portability and are easily loaded and unloaded and mostly self-contained on the mobile drill rig. Auxiliary equipment for the supply of electricity, compressed air, and fresh water would be trucked in for drilling operations. Drill pipe, drill bits, cement, fresh water, wire rope, and other supplies would be trucked to the well pad and stored temporarily until used. Traffic would consist of support equipment, contractor vehicles, construction personnel, and material delivery. Well pad activity would involve backhoes, front-end loaders, boom and winch trucks, delivery trucks, welding machinery, and personal conveyance vehicles.

*Gas Well Drilling*

Drilling gas wells can use a number of different wellbore directions, types of drilling technologies, target different formations, and utilize different drilling lubricants (commonly referred to as drilling fluids or drilling muds).

In its broadest definition, a wellbore is a hole that is drilled to aid in the exploration and recovery of natural resources including oil, gas or water. A wellbore is the actual hole that forms the well. A wellbore can be drilled vertically or directionally. A vertical wellbore is a wellbore drilled straight down below the drilling rig. A directional wellbore may start out vertically, but is then turned to move out at an angle, in an S-shape, or turned horizontally. Wellbores could be any of the mentioned varieties (vertical or directional), and would be encased by materials such as steel and cement. As applications to the COGCC are similar to Federal applications, illustrations of the different types of wellbores for Federal applications are provided in **Appendix E**, Master Drilling Plan.

As noted under the section describing the well pad construction techniques, drilling methods could fall within two broad categories – those drilling systems that utilize a reserve pit on the well pad or a pit-less system, generally called a "closed-loop system." Under Alternative A, SGI proposes to use either system: drilling with a reserve pit or closed-loop. Which system is utilized would depend on the type of well to be drilled, what drilling equipment may be available at the time, and/or economic factors such as a closed-loop system becoming cost-prohibitive. The type of drilling system would be determined when the drilling application is submitted to the COGCC.

In drilling with a reserve pit system, a small amount of fluid is retained in the cuttings and the cuttings are placed in the reserve pit. The reserve pit would also hold fresh and/or recycled water used in drilling and any excess drilling mud; the reserve pit is not used to store flowback water during the completion phase nor used to store produced water during the production phase. Drilling mud would be circulated by means of pump pressure from the rig mud pits down the drill pipe, through jets in the bit, and up the annulus (the space between the wellbore and the drill pipe). Drilling mud would flow through a series of equipment and tanks in order to recondition it. A small amount of mud and the cuttings from the wellbore would be placed in the reserve pit. Drill cuttings would be processed to remove excess drilling fluids. The cuttings would be stored on location in segregated lined piles or in a storage container. Cuttings would be sampled and tested according to COGCC 900 Series Rules, then transported to a permitted disposal/waste management facility.

Each reserve pit would be constructed with an impermeable liner so as to prevent releases. Reserve pit fences would be constructed and maintained according to the COGCC requirements. Once all drilling wastes are removed from the pit, the pit liners would be removed and disposed of at a permitted waste facility; the pit would be closed in compliance with all COGCC 900 Series pit closure rules.

A closed loop system is defined simply as a mechanical and chemical system that would allow an operator to drill a well without using a reserve pit. In a closed-loop drilling system, the reserve pit is replaced with a series of storage tanks that separate liquids and solids. Equipment to separate out solids (e.g., screen shakers, hydrocyclones, or centrifuges) and collection equipment (e.g., vacuum trucks) minimize the amount of drilling waste muds and cuttings that require disposal, and maximize the amount of drilling fluid recycled and reused in the drilling process. The recovered drilling fluid can be stored in 500-barrel tanks and re-used in active mud systems; consequently, drilling fluid is moved from well-to-well and reconditioned by the dewatering equipment and mud products. The solid wastes would be transferred off-site for disposal at oilfield waste disposal facilities.

Following well pad and access road construction, a Tier-2 or Tier-3 type drilling rig would be transported to the well pad along with other necessary equipment. A conventional drilling rig used for vertical wellbores would require construction as described above in the well pad construction section. The rig would operate 24 hours per day. If the well were proposed as a directional wellbore (e.g., horizontal or s-shaped), then directional drilling equipment would be used and would operate 24 hours per day. Additional equipment and materials needed for directional drilling operations would be trucked in to the well site.

Drilling would begin by digging a circular pit, called a cellar, and lining the pit with metal, where the wellbore would be drilled. The cellar would provide space for the casing head spools and blowout preventers that would be installed under the rig. Drilling operations normally include keeping a sharp bit on the bottom drilling as efficiently as possible, adding a new joint of pipe as the hole deepens, tripping the drill string out of the hole to put on a new bit as needed and running it back to the bottom, and installing steel casing and cementing the casing in the hole.

Drilling fluids are used to aid the drilling of boreholes regardless of the type of well being drilled. The main functions of drilling fluids include providing hydrostatic pressure to prevent formation fluids from entering into the wellbore, keeping the drill bit cool and clean during drilling, carrying out drill cuttings (i.e., pulverized rock generated from drilling), and suspending the drill cuttings while drilling is paused and when the drilling assembly is brought in and out of the hole.

Drilling fluid is a mixture of a fluid (either water or an oil-based product such as mineral oil) and "mud." For Alternative A, SGI plans to use fresh water-based drilling fluid but may also use oil-based drilling fluids in production formations where borehole stability requires it or for directionally drilled wells. Alternative A does not present a preference for one type of drilling fluid over another; specifics on which type of drilling fluid used would be included on the individual drilling application.

A water-based drilling fluid uses fresh or recycled[1] water or a combination of both mixed with the mud; SGI would use a fresh-water mud system. Up to approximately 3,000 barrels of water would be used for drilling a particular well. For Alternative A, that would result in up to 165,000 barrels of water that could be used for drilling (up to 3,000 barrels per well multiplied by up to 55 new wells drilled). In production level formations, where the borehole stability requires it, or for directionally drilled wells, an oil-based drilling fluid, using products such as mineral oil, may be used. The mud portion of a drilling fluid is composed of clays, minerals, and additives, such as bentonite, barite, soda ash, lime, polymer, lignite, and lost circulation material.

[1] Recycled water is water that has been used in other phases of the well development process. It could be water that has been removed from drilling mud, water used during completion that flows back after the well has been pressured and fractured, or water that has been produced as a by-product of gas production (known as produced water).

The drilling fluid used for a particular job is selected to avoid formation damage and to limit corrosion. For example, where borehole stability requires it, a mud typically consisting of potassium chloride substitute and commercial clay stabilizer (such as Di-Ammonium phosphate) would be used to drill the production hole section. This mud formulation inhibits potentially reactive shales to prevent shale swelling and hole sloughing. Drilling fluids and mud additives would be recirculated during drilling, and could be transported to another drilling location for reuse or treated and removed from the location.

Casing and cementing plans are designed by engineers and included in an APD and associated Drilling Plan. The casing and cementing program would be conducted as approved to protect and isolate all usable water zones, potentially productive zones, lost circulation zones, abnormally pressured zones, and any prospectively valuable deposits of minerals. Placement of steel casing would entail the connection and insertion of continuous sections of steel pipe into the drill hole. The casing would extend from the bottom of the hole to the surface except when drilling or production liner is used. Casing would be set in the hole, one joint at a time, threading one piece into a collar on the next. The wells would be lined with conductor casing to a depth of at least 80 feet; with surface casing to at least 400 feet; with intermediate casing to approximately 3,000 to 5,500 feet; then with production casing to the target well depth. Casing programs are dependent on the target depth and individual well casing plan.

The casing would be cemented into place in stages by pumping a slurry of dry cement and water into the casing head, down through the casing string to the bottom of a string stage, and then up through the spacing between the casing and the wellbore (annulus) back up to the surface except when a production string is used. Surface casing cement is calculated to return to the surface (100 percent excess volume). After the cement is pumped into the casing, a 1-inch pipe is run on the outside of the casing and approximately 50 sacks of cement are used to top off the annulus. If the cement does not circulate back to the surface, a temperature log is run to find the top of cement. At this point, corrective measures are taken if necessary.

A plug would be pushed to the bottom of the wellbore to remove any residual cement from the inside walls of the casing. If adequate cement coverage and quality were not attained, remedial actions would be taken based on site-specific situations. Calculated volumes of cement would be pumped into the annulus to fill the space, where it would be allowed to harden. A cement bond log would be run on the wellbore to ensure that no voids remain in the annulus. Cementing the annulus around the casing pipe restores the original formation isolation by posing a barrier to the vertical migration of fluids or gasses between rock formations within the annulus of the borehole, protects the well by preventing formation pressures from damaging the casing, and retards corrosion by minimizing contact between the casing and naturally occurring corrosive formation fluids. Each well may have multiple strings, and each string is cemented independently.

All drilling operations and other well site activities would be conducted in compliance with COGCC rules and regulations. Pressure tests are required before drilling out from under all casing strings set and cemented in place. Blowout preventer controls must be installed prior to drilling out the surface shoe and prior to starting workover or completion operations. Blowout preventers would be inspected and tested at regular intervals to insure good mechanical working order.

Site-specific descriptions of drilling procedures would be included in each APD submitted to the COGCC for each proposed well.

Drilling activities on individual wells would typically occur 24 hours per day, 7 days per week, and would require approximately 16 workers.

Coalbed methane natural gas wells would typically be drilled vertically, but some would be drilled directionally including horizontally, depending on the specific needs at that location, which are dictated by terrain in the surrounding areas, distance to the unit boundary, and other site-specific factors. There could also be multiple wells on one well pad. Development of coalbed methane natural gas wells on new well pads, including construction, drilling, stimulation, and completion, would require an average of 60 days.

Shale and sandstone gas wells could be drilled vertically, directionally, or with multiple horizontal wells from a single pad, where feasible, to minimize the number of well pads required to drain the resource. Directionally drilled wells, both shallow and deep, could take approximately 46 to 60 days per well to drill. Development of shale gas wells on new well pads would require an average of 85 days.

*Water Disposal Well Drilling*

For Alternative A, SGI proposes drilling one new water disposal well. For each water disposal well, a 24-inch-diameter hole would be drilled for the first 40 feet, and then gradually reduced with decreasing diameters of casing strings until the hole reaches its target depth, estimated at 10,000 feet. Once the casing strings are set and the outside annulus is cemented in place for each string of casing, the wells would be completed (see *Water Disposal Well Completion* below).

Tubing with a diameter of 2.875 to 3.5 inches would be run down the casing to the top of the target disposal zones. The tubing would be landed in a set packer approximately 100 feet above the uppermost-completed injection zone. A packer set has rubberized rings, which when activated seal off the bottom of the casing, preventing disposal waters from migrating up the insides of the casing. Above the packer set, the annulus between the tubing and inner casing walls would be filled with packer fluid. Pressure would be monitored at the surface to detect any loss of packer fluid into surrounding formations and to detect migration of injected water upward into non-target annulus zones, as well as to insure tubing, packer, and casing integrity.

The disposal wells may be completed in the Entrada or Maroon Formations; the primary injection target zone is the Entrada formation at 8,900 feet, with the Maroon in the secondary injection zone at 9,000 to 9,500 feet. The maximum daily injection rate for the Maroon formation is 4,000 barrels per day, while the maximum daily injection rate for the Entrada formation is 2,000 barrels per day. If these formations are not useable, the Dakota and Morrison Formations may also be evaluated. A water-based mud system would be used for drilling of the surface hole, and a low-solids, non-dispersed gel system would be used for the intermediate and production hole sections of the water disposal well.

Drilling water disposal wells would require 60 to 120 days. Up to approximately 3,000 barrels of water would be used for drilling a particular water disposal well. For Alternative A, that would result in up to 3,000 barrels of water that could be used for drilling (up to 3,000 barrels per well multiplied by up to one new water disposal well drilled).

### *Completion*

*Gas Well Completion*

After drilling and casing of the well, a completion program would be initiated to stimulate production of natural gas and to determine gas and water production characteristics. A mobile completion rig (also called a workover rig) similar to the drill rig may be used to complete each well. The well completion process, lasting 8 to 10 days, includes perforating the well's steel casing and cement, hydraulically fracturing the producing formation(s), and installing a series of valves and fittings on the wellhead. Hydraulic fracturing does not always require the presence of a workover rig.

Wells are often treated during completion to improve resource recovery by increasing the rate and volume of hydrocarbons moving from the natural gas reservoir into the wellbore. These processes are known as well-stimulation treatments and include hydraulic fracturing, acidizing, and other mechanical and chemical treatments, often used in combination.

Hydraulic fracturing is a 60-year-old process used to maximize the extraction of underground resources by allowing natural gas to move more freely from the rock pores to production wells that bring the gas to the surface. Fluids, commonly made up of water and chemical additives (e.g. recycled or fresh water, liquid carbon dioxide, sand, and chemical additives), are pumped into a geologic formation at high pressure during hydraulic fracturing. When the pressure exceeds the rock strength, the fluids open or enlarge fractures. After the fractures are created, a propping agent is pumped into the fractures to keep them from closing when the pumping pressure is released. After fracturing is completed, approximately 60 to 80 percent of the injected fracturing fluid returns to the wellbore (EPA 2004). The specific type and components of the fracturing fluid chemical vary based on geologic formation and by company, but may include constituents such as hydrochloric acid, anti-bacterial agents, corrosion inhibitors, and surfactants (BLM 2013a). Per COGCC Order No. 1R-114, operators are required to post their disclosure of chemicals intentionally added to hydraulic fracturing fluids on FracFocus per COGCC Order No. 1R-114.

Hydraulic fracturing is now being used more commonly due to advances in technology. Groundwater is protected during the fracturing process by a combination of the casing and cement that is installed when the well is drilled and by the depth of the rock between fracture zone and any fresh-water bearing zones or aquifers (EPA 2004). As state requirements for applications are similar to federal applications, illustrations of the different wellbores requirements are presented in **Appendix E**, Master Drilling Plan. Additionally, specific casing information would be included on the drilling applications. The casing and cementing techniques described in the drilling plan would provide redundant protection of all usable aquifers above the target zones by cementing both the surface and intermediate casing strings from the base of pipe back to the surface.

Water used during completion operations would be recycled, fresh, or a combination of both, and quantities used would vary in accordance with the formations the wells are completed in. Specifics for how much water each well type would require for completion is provided in **Appendix D**, Master Surface Use Plan of Operations. As each well type requires vastly different amounts of water, calculations for estimated water usage were based on assuming 50 percent CBNG wells and 50 percent shale wells as discussed in the Bull Mountain EA. Calculations used number of new wells per alternative divided in half for each type of well (CBNG/shale). To estimate the amount of water use per well type, the number of wells was multiplied by the highest amount of water use for that well type. Water usage totals were added together for a total maximum amount of water usage. The results showed that there could be up to 5,542,000 barrels (or 538 acre-feet) of water used for well completions during the 3 year development timeframe. If fewer shale wells were drilled and completed, the water use estimate could be lower. Recycled water could also be used for well completions when water conditions allow (see *Flowback Pits* discussion below).

Test gas could be flared (released to the atmosphere) or environmentally friendly green completion technology may be used. What makes the well completion "green" is that the gas is separated from the water and placed in a pipeline instead of being released to the atmosphere. Green completions take place during the flowback stage of the completion, during which natural gas is produced with the water. Green completion technologies capture the gas at the well head immediately after well completion instead of releasing it into the atmosphere or flaring it off, resulting in reducing volatile organic compound (VOC) emissions from wells. In green completions, gas and hydrocarbon liquids are physically separated from other fluids and delivered directly into equipment that holds or transports the hydrocarbons for productive use. There is no venting or flaring. See also COGCC regulation 800-4 for further details on green completion technologies.

If a well is flared, the flares are designed to be directed straight upward and are located in an area on pad to prevent damage to the environment or a safety hazard. In the event it becomes necessary to flare a well, a deflector and/or directional orifice would be designed and installed to safeguard both personnel and adjacent lands. The flowback involves removing the water that was used to stimulate the well.

Following the hydraulic fracturing of the well, a percentage of the fluid, consisting primarily of produced water, may be returned to the surface. This percentage of return varies between wells. Even though the produced water and gas can flow into the casing after it is perforated, a small-diameter pipe, called tubing, is placed in the well to serve as a way for the produced water to be brought to the surface. Typically, the start of the tubing is placed below the perforated interval to allow any fluids collecting at the bottom of the well to be pumped up through the tubing to the surface. The tubing in the well is suspended from the wellhead, so as the well production flows up, the production from the well can be controlled by opening and closing valves on the wellhead. Excess produced water would be stored on the pad in containers, piped to the McIntyre Flowback Pits (see *Flowback Pits,* below), or sent to a water disposal well for reinjection.

Typical equipment and vehicles used during completion activities include propane and carbon dioxide tanker trucks; hydraulic fracturing trucks; sand transport trucks; water trucks; oil service trucks used to transport pumps and equipment for hydraulic fracturing; flat beds and gin trucks to move water tanks, rigs, tubing, and hydraulic fracturing chemicals; logging trucks (cased hole wireline trucks); and pickup trucks to haul personnel and miscellaneous small materials.

Completion activities on individual wells would occur 24 hours per day, 7 days per week, and would require approximately 25 workers. Completion of an individual well would generally take approximately 7 days, depending on conditions at the individual well. Flow testing follows completion and takes 25 to 50 days. Only 2 workers are employed 24 hours per day for testing.

*Flowback Pits*
In order to minimize the consumptive use of water for completion operations, SGI has constructed four pits on private surface lands to temporarily store a mixture of fresh water, produced water, and recycled water prior to and after completion operations, per the regulatory guidance and permitting of COGCC. Water estimates for hydraulic fracturing operations by well type are presented in **Appendix D**. The flowback pits would reduce the amount of water transportation trucking traffic, on-site storage of water on pads in hydraulic fracturing tanks, and subsequent removal of waters between hydraulic fracturing operations. At this time the flowback pits are permitted as follows: two pits on Rock Creek Ranch (T11N, R90W, Section 24) immediately north of SGI's existing Federal 11-90-24-2 WDW, and two additional pits on Rock Creek Ranch lands in T11N, R90, Section 26. Since all four flowback pits would be located on lands previously owned by the McIntyre Ranch, they are referenced as follows:

**Table 2-4**
**McIntyre Flowback Pits**

| Pit Name | Dimensions | Fluid Volume Capacity (barrels) |
|---|---|---|
| McIntyre Flowback Pit 1 | 130 feet by 200 feet by 12 feet deep (10 feet fluid depth) | 31,463 |
| McIntyre Flowback Pit 2 | 110 feet by 230 feet by 12 feet deep (10 feet fluid depth) | 29,720 |
| McIntyre Flowback Pit 3 | 150 feet by 600 feet by 12 feet deep (10 feet fluid depth) | 144,247 |
| McIntyre Flowback Pit 4 | 150 feet by 600 feet by 13 feet deep (11 feet fluid depth) | 144,247 |

Fresh, production, and recycled water would be delivered to the McIntyre pits through surface polyethylene (HDPE, referred to here as poly) pipe and existing buried steel water pipelines for temporary storage prior to hydraulic fracturing operations. Temporary water pumps would draw water from the McIntyre pits into the temporary surface pipes and existing water pipelines (in order to reduce truck-based fluid hauling). Water would be mixed with sands and chemicals on a target pad site prior to injection into a wellbore (see the *Drilling* and *Hazardous Material and Solid Waste* sections below for details on chemicals used).

As noted above, SGI plans to temporarily lay down poly pipelines in order to transport the fresh or recycled water used for completions from the McIntyre Pits to storage tanks and then to the wellhead (see **Appendix M**, Poly Pipeline Operation Plan). Generally, the pipe strings would follow roads. The length of time the pipe is on the surface depends on where and when a well is to be completed; it is moved from one location to another when a new well is ready for completion. Temporary poly may be left in place for several months in some cases. Pipe diameter is dependent on the volume and pressure of water needed for the completion. SGI anticipates that 12-inch internal diameter would be the largest pipe required, but could also use a smaller interior diameter pipe if needed (e.g., 8-inch or 6-inch).

After hydraulic fracturing operations for a well are complete, used fluids would be flowed back out of a wellbore, filtered on the pad site, temporarily stored in tanks, and then pumped into transportation trucks (to be trucked to a McIntyre flowback pit) or pumped into an existing water pipeline or temporary surface poly pipe for delivery to a McIntyre flowback pit for temporary storage. These used fluids could then be re-used for additional hydraulic fracturing operations during the same season if water condition allows. The highest total dissolved solids (TDS) anticipated in the water contained within the pits would be 60,000 to 70,000 parts per million (ppm), with an average TDS of 40,000 ppm in the pits. Produced water TDS in the field is approximately 15,000 ppm

Construction of the McIntyre pits involved the salvaging of topsoils, the excavation of the pit itself, and compaction of the pit interior. Pits have been engineered with a triple liner system that includes surface and groundwater sites and monitoring of the four groundwater monitoring wells as required by the COGCC permits issued for the pits. There is a 1-foot berm surrounding the pit over which the liners are pulled and anchored in on the opposite side. At least 2 feet of freeboard is maintained in the pits at all times. Bird deterrent netting is stretched over the pits to keep birds out. Additionally, year-round wildlife and silt fencing has been placed around the pits to prevent terrestrial wildlife entry into a full or empty pit.

*Water Disposal Well Completion*

The additional water disposal well would also require completion. Similar to traditional wells, a workover rig would be used to complete the well. This process includes perforating the well's steel casing, and may include hydraulic fracturing of the formation to improve its ability to accept injected water. This supplemental hydraulic fracturing could also recur later in the life of the well. Drilling and hydraulic fracturing would follow standard industry and regulatory procedures, and be permitted as under producing wells with the additional process of converting it to a disposal well. Multiple disposal zones would be perforated in order to allow produced water to flow into any of the available receiving formations, and allow for redundancy in receiving formations.

***Interim Reclamation***

The goal of interim reclamation is to maintain soil productivity during the production phase. All surfaces not needed for long-term operations would be recontoured and seeded as per the requirements set by the COGCC. SGI's preferred upland native seed mix complies with Colorado Parks and Wildlife (CPW) and Gunnison County goals and objectives; SGI's seed mix does not contain forbs or shrub species due to interim noxious weed treatments, which would likely kill off any seeded forbs and shrubs. Seed availability may vary, so not all species may be available at the time they are needed. However, major species are generally available. If availability were a concern, the operator would request the use of COGCC's approved alternate seed mixture.

If the well(s) on a pad are not productive, the pad would be abandoned and reclaimed in accordance with applicable agency requirements stipulated in the permit for the well, and according to the reclamation portion of the surface-use plan submitted with the APD.

Reclamation areas would include, but not be limited to, fill slopes, trenches, wing ditches, edges of disturbance, temporary-use areas no longer needed, and embankments. Reclamation would involve recontouring the well pad to blend with the natural topography, even redistribution of segregated topsoil, seeding, and monitoring to ensure revegetation is successful. Reclamation efforts would continue until all related requirements were met. Removal or burial of any surfacing material used to complete the well pad would be according to the authorizing agency's standards.

Upon well completion, the well location and surrounding area would be cleared of all unused tubing, materials, trash, and debris. SGI would perform interim reclamation efforts on as much of the disturbed area as practicable after drilling and conducting subsequent operations. This process entails returning areas not needed for production operations or for subsequent drilling operations to near-original condition or to the land use designated by the surface land owner. SGI would minimize dust and erosion during the interim reclamation process. SGI would initiate interim reclamation within three months for projects on croplands and within 6 months for projects on non-crop lands after finishing drilling and subsequent operations, unless an exception was granted. Areas needed for production and subsequent drilling operations (those planned within 12 months) would be stabilized to minimize fugitive dust and erosion. Stockpiled topsoil, as well as remnant vegetation (e.g., uprooted sagebrush and oak brush) would be spread over interim reclamation areas, and then seeded with an approved seed mix per the landowner agreement. Any remaining stockpiled topsoil not needed for final interim reclamation would also be stabilized and reseeded. Prior to reseeding, all reclaimed areas would be scarified and left with as rough and uneven a surface as is practicable. The appropriate amount of seed would be applied across the reclaimed areas as prescribed in the permit.

If a reserve pit is utilized, it would be cleaned out, the liner removed and properly disposed of, backfilled, and reclaimed within 6 months from the date of well completion, weather permitting. Prior to any dirt work associated with reserve pit restoration, the reserve pits would be as dry as possible. Cuttings within the pit would be sampled and laboratory tested according to COGCC 900 Series Rules. Results of cuttings pit testing on federal well sites would be made available to the COGCC. Cuttings would then be trucked to an approved and permitted disposal facility (depending on the concentrations of potential soil contaminants listed in COGCC Table 910-1 and analyzed by an EPA-approved laboratory); fencing surrounding the pits would also be removed.

It is estimated that well pads would be reduced in size to an average of 2 acres after interim reclamation is complete. However, the number of wells and associated production equipment needs on each pad would primarily dictate the size of an individual production pad.

Revegetation efforts would be considered satisfactory when soil erosion resulting from the operation has been stabilized, and a vegetation cover equal to 70 percent of pre-existing or seeded-in vegetation is reestablished (both cover and diversity of species) as evidenced by pre- and post-construction photo-point monitoring and vegetation plots and transects. SGI would monitor interim and final reclamation progress at 1-, 3-, and 5-year intervals. Reseeding would be required if satisfactory interim reclamation progress is not being made at year 2 or year 3 monitoring intervals, or if final reclamation is not achieved by year 5.

Interim reclamation would also include repair of range management facilities and improvements that had been altered by project-related activities, for example, the installation of cattle guards where new access roads crossed fences.

### *Production and Maintenance*

*Production*

If a well were determined to be commercially productive, production facilities would be installed on the well pad. Typically, up to eight (8) 200- to 400-barrel storage tanks would be installed per well for produced water and 1 storage tank for condensate (if needed). The produced water would be piped or trucked to the McIntyre pits, storage tanks, or water disposal wells (described below in the *Produced Water Management* section). Condensate, if produced, would be transferred to trucks as necessary and transported for sale or to an approved disposal site. Typically, a heated three-phase separator, rated at 0.125 mmBtu/day, would be necessary to separate fluids associated with each wellbore. Protective barriers would be installed around the production facilities, including tanks. Regardless of the alternative selected, the appropriate location of facilities would be determined during the APD process.

Dehydration facilities to separate water from natural gas would be centralized at compression facilities.

Where applicable, wells would be fitted with cavity pumps that would require generators to power them. Currently, there is 1 188-horsepower generator to run 2 existing cavity pumps, but smaller, more efficient turbine generators could also be used. These pump and generator systems could be used on any type of well, whether coalbed methane natural gas or shale, if needed. The prime mover for pump jacks would be small (50 horsepower or less) natural gas-fired internal combustion engines.

All site security guidelines would be followed as identified in the authorizing agency's statutes, regulations, and policy.

Existing wells in the Unit have seen steady increases in production since initial production year of 2010. **Table 2-5**, Bull Mountain Unit Annual Production Rates, illustrates the amounts of gas and water produced each year.

**Table 2-5**
**Bull Mountain Unit Annual Production Rates**

| Year | Average No. of Prod. Wells | Average No. of Prod. Days | Gas Production (MCF)[2] | Water Production (barrels) |
|---|---|---|---|---|
| 2010 | 12 | 30 | 133,455 | 10,911 |
| 2011 | 11 | 99 | 132,678 | 224,476 |
| 2012 | 9 | 110 | 95,299 | 254,944 |
| 2013[1] | 9 | 33 | 3,350 | 23,578 |

Source: COGCC 2013
Colorado Oil and Gas Conservation Commission's Colorado Oil and Gas Information System Production Data Inquiry web site: http://cogcc.state.co.us/cogis/ProductionSearch.asp. Last accessed June 19, 2013
[1] Production through March 2013
[2] Production amounts from SGI, August 7, 2013.

*Surface Facilities*

Installed surface facilities for each gas well would include the wellhead, and may include artificial lift, separators, water transfer, pumps, tank batteries, wellhead compression, and gas-metering facilities. If artificial lift is used, the driver may be natural gas powered. Facilities would occupy less than 1 acre on the site. All long-term facility structures would be painted in accordance with the authorizing agency's standards. Separated, produced water from each well would be transported or pumped through in-ground water lines to an approved disposal well. Disposal of produced water would be in accordance with a plan approved by the COGCC.

All permanent structures would be painted a flat, non-reflective standard environmental color as specified by the authorizing agency or private landowner. Facilities would be painted within 6 months of being located on site. As required by the Occupational Safety and Health Administration, some equipment would be painted for safety considerations (i.e., some parts of equipment would retain its safety coloration such that it does not blend with the surroundings).

Surface facilities for water disposal wells would include the wellhead, water injection pump and housing, filter skid and gas filter skid, and approximately 6 to 8 400-barrel holding tanks and 1 90-barrel facility drain tank. Water storage tanks would be heated during the winter months to prevent ice formation in the tanks and lines. The injection pumps for the water disposal well would be powered by electricity supplied by overhead or buried electrical lines or by natural gas engine. Facilities would occupy less than 1 acre on the well pad, which would be 1.4 acres following interim reclamation. All long-term facility structures would be painted in accordance with the authorizing agency's standards.

SGI would utilize a second storage yard sized approximately 250 feet by 400 feet, and it would be located on their property to store materials and equipment (T. 11 S, R. 90 W, Section 14).

*Compressor Stations*

Compression in the field may be necessary as wells come online. Under Alternative A, SGI proposes one new screw compressor located on previously disturbed land (T11S R90W Section 24 and adjacent to the Federal 24-1 and Federal 24-1a well pads, see **Figure 2-1**).

SGI is proposing to use natural gas-fired internal combustion engines to power the compressor. Emissions from natural gas-fired compressor at the compressor facility would typically be less than 2 grams per horsepower/hour of carbon monoxide (CO) and nitrous oxides ($NO_x$), and less than 1 gram per horsepower/hour of VOCs. The compressor would use hospital grade mufflers (an industry standard within the oil and gas industry) and would be housed in buildings or portable structures in an effort to abate noise from the compressor engine.

Up to 20 personnel may be involved in compressor station construction, with an average of 5 personnel on site at any one time.

*Produced Water Management*

Water to be injected into the water disposal wells would first be piped or delivered by truck into the holding tanks to allow sediments to settle out. The water would then pass through a series of filters to remove solids larger than 10 microns in diameter. Accumulated solids from the settling and filtration process would be periodically removed from the holding tanks and trucked to an approved off-site disposal facility. Chemical treatment of water would reduce scaling or deposition of minerals in the receiving formation, which would otherwise shorten the life of the disposal zones. Chemicals used for treatment would likely include acids, which would keep any minerals in suspension, retard scaling, and act as a biocide. Disposal of produced water would be in accordance with a plan approved by the COGCC rules and regulations.

SGI estimates that between 500 and 3,000 barrels per day of produced water would be injected into the water disposal well. Produced water could also be trucked to an approved disposal site.

Water disposal wells would be drilled to non-producing, non-useable water bearing, formations capable of accepting water. These formations do not produce gas, contain no useable water, and are capable of accepting large quantities of injected water. Conceptual locations for water disposal wells have been illustrated on each alternative map (**Figures 2-1** to **2-3**). In some cases, non-producing gas wells may also be converted for water disposal use. All water disposal wells would be permitted through the appropriate authority. Water disposal facilities would include natural gas-fired internal combustion engines to drive injection pumps directly or via a generator powering an electric motor.

*Workovers*

Periodic workovers would be required to correct downhole problems in a producing well, pump maintenance, and to return the well to production. Workovers are undertaken on an as-needed basis to increase or maintain production from downhole producing zones or to re-complete a well in a new zone.

A well would require a workover for any of several typical reasons including:

- Refracturing the producing formation(s) using advanced techniques designed to stimulate additional production
- Cleaning out the wellbore and perforations to stimulate/facilitate production
- Re-completing in another potentially productive zone that was not originally completed at the time the well was drilled
- Repairing casing and other downhole equipment

A workover would generally require three to five workers for four days. Workover activities would typically be implemented during daylight hours only.

*Maintenance*

During the normal life of the wells, routine production and maintenance operations would be conducted throughout the year to ensure that equipment is functioning properly. A well operations technician (referred to in the industry as a pumper) visits well pads in a pickup truck to monitor various operating conditions such as gas and water production rates, pipeline pressure, and separator pressure, to determine if abnormal conditions exist and make or schedule necessary repairs. Maintenance of the well pad would also include monitoring the establishment of desirable vegetation, repair of any erosion occurring on the location, and control of noxious or invasive weeds. Additionally, road maintenance would include dust abatement procedures such as application of magnesium chloride. In the case of the water disposal wells, routine maintenance ensures that the well can continue to accept injections of produced water efficiently.

All project roads would require routine year-round maintenance to provide year-round access. SGI would be required to prepare and implement a road maintenance plan for all roads used for project-related purposes. Maintenance would include inspections, reduction of ruts and holes, maintenance to keep water off the road, replacement of surfacing materials, and clearing of sediment blocking ditches and culverts. Should snow removal be necessary, roads would be cleared with a motor grader or snowplow, and where possible snow would be stored along the down gradient side to prohibit runoff onto the road. Road maintenance agreements and requirements would vary depending on the owner of a given road in the Unit. The operators have committed to adherence with county road maintenance and encroachment ordinance requirements. Aggregate would be used as necessary to maintain a solid running surface and minimize dust generation.

***Final Reclamation and Abandonment***

When a well is to be plugged and abandoned, SGI or subsequent operators would reclaim and revegetate the well pads. Site-specific reclamation plans would be included with the submitted drilling applications to the COGCC. Development of a site-specific reclamation plan would include consultation between the surface owner and the operator. The following minimum standards would be applied:

- All surface equipment would be removed
- Removal or burial of surfacing material would comply with the authorizing agency's standards

Wells would be plugged using COGCC standards and comply with all state regulations.

Revegetation efforts would be considered satisfactory when soil erosion resulting from the operation has been stabilized, and a vegetation cover equal to 70 percent (both cover and diversity of species) of pre-existing or seeded-in vegetation is reestablished as evidenced by pre- and post-construction photo-point monitoring and vegetation plots and transects. SGI would monitor interim and final reclamation progress at 1-, 3-, and 5-year intervals. Reseeding would be required if satisfactory interim reclamation progress is not being made at year 2 or year 3 monitoring intervals, or if final reclamation is not achieved by year 5.

***Water Use and Water Sources***

Specific volumes of water usage needed for any given phase of development are presented within that phase description.

Over the life of the project (approximately 50 years), an estimated 30 percent of project water would be obtained from fresh water sources. The remaining 70 percent of water needs could be supplied by various sources, and may include recycled or produced water (see **Appendix D** and **Appendix E**).

Water is needed for a variety of activities associated with development of the Unit, including dust abatement on roads, moistening of soils and gravels for compaction of well pad surfaces, production of drilling muds (to help lubricate the bore hole and circulate drill-bit cuttings), cementing the casing, and hydraulic fracturing and well stimulation. Water is also sometimes used to hydraulically test pipeline integrity (see "pressure testing" section in the pipe installation section). Water for drilling and cementing would be pumped to the well site and stored for operations or would be trucked in. After use, the water used for drilling/completion must be injected into a disposal well or, hauled off-site to an approved disposal facility or stored for reuse in the flowback pits. SGI plans to re-use water where possible. Flowback fluids to be used during the same drilling season may be stored in the McIntyre Flowback Pits (see above).

Use of surface water would be contingent upon the proper authorizations and permissions by the State of Colorado and water right holders (see **Appendix L**). Specific water withdrawal points would be identified in each future drilling application. However, as specific water withdrawal points have not yet been identified by SGI, it is assumed for the purposes of analysis and Section 7 Consultation that the entire depletion associated with this project would be a new depletion from the Colorado River, and thus would be subject to recovery fees as appropriate.

Water from all of these sources would be distributed by truck, buried pipeline, or surface polypipe to the point of use. Re-use of produced water and water from drilling and completion of other wells would be conducted to the maximum extent practical, estimated at 70 percent of total water needs.

Fresh water application to roads for dust abatement would be applied to the road more frequently as traffic volumes increase and according to weather patterns. Approximately 5,000 to 8,000 gallons of fresh water may be used each day to control fugitive dust per mile during dry months (for example in a typical June). Approximately 2,000 to 5,000 gallons of fresh water may be used to control fugitive dust per mile of road during wet months (for example during a typical August).

***Hazardous Materials and Solid Waste***

Natural gas development employs a variety of chemicals including solvents, lubricants, paints, and additives. A list of chemicals used during drilling, completion, and production is included in **Appendix G**, Hazardous Materials Management Summary. The listing identifies the chemical, its common application, and potentially hazardous components.

Drilling by-products produced include solid pieces of waste rock combined with fluids and/or lubricants used to maintain smooth drilling operations; the by-products are produced by the drill bit cutting through the various formations at intervals beginning 3 to 4 feet from the surface and ending at the bottom of the hole. After drilling is complete, closure of the reserve pit would be completed according to the appropriate regulatory requirements (see pit closure section below).

Emptied steel and plastic drums for materials such as caustic soda, citric acid, lubricating oil, methanol, and drilling additives would require disposal. Empty metal or plastic drums would be returned to the supplier of the product. Any waste lubricating oil would be disposed of properly by a third-party contractor.

SGI has prepared and implemented an Integrated Spill Prevention, Control, and Countermeasures Plan and Emergency Response Plan for containment and control of oil and chemicals used in the Unit, as well as fire prevention and protection and emergency reporting. Procedures outlined in the Plans are applicable to all SGI personnel and contractors. In accordance with the plans, SGI personnel are trained to conduct routine inspections of the containment areas and to promptly contain and clean up any accidental spills. SGI's plans can be provided upon request to BLM at their Montrose office.

Chemicals on the EPA's Consolidated List of Chemicals Subject to Reporting Under Title III of the Superfund Amendments and Reauthorization Act of 1986 (SARA Title III) may be used or stored in quantities over reportable quantities. In the course of drilling, SGI could potentially store and use diesel fuel, sand (silica), hydrochloric acid, and $CO_2$ gas, all described as hazardous substances in 40 CFR Part 302, Section 302.4. In addition, natural gas condensate and crude oil, described as hazardous substances in 40 CFR Part 302, Section 302.4, may be stored or used in reportable quantities. During production operations, triethylene glycol, ethylene glycol mix (50 percent), and methanol, all described as hazardous substances in 40 CFR Part 302, Section 302.4, may be stored or used on site. Small quantities of retail products (paint/spray paint, solvents [e.g., WD-40], and lubrication oil) containing non-reportable volumes of hazardous substances may be stored and used on site at any time. No extremely hazardous substances, as defined in 40 CFR Part 355, would be used, produced, stored, transported, or disposed of under any of the alternatives. Hazardous substances would be reported as required by Title III and COGCC chemical inventory programs.

Any surface spills or releases of oil, condensate, produced or flowback water, drilling fluids or other potentially harmful substances would be contained and immediately removed according to SGI's spill plan. The spilled or released fluids, along with any contaminated soils would be disposed of at an approved disposal site.

Tanks containing hazardous materials, including drilling fluids and/or muds, completion fluids, fuels, lubricants, produced liquid hydrocarbons, condensates, and produced water, would be surrounded by a secondary containment berm of sufficient capacity to contain the entire capacity of the largest single container and sufficient freeboard to contain precipitation as required in the authorizing agency's standards. For instance, EPA requires containment of 150 percent of the volume of the largest container. All loading lines and valves would be placed inside the berm surrounding the tank or would utilize catchment basins to contain spills. The tanks would be emptied as necessary, and the liquids transported to market via trucks.

Portable toilets and bear-resistant trash containers would be located on active construction sites. A commercial supplier would install and maintain portable toilets and equipment and would be responsible for removing sanitary waste. Sanitary waste facilities (i.e., toilet holding tanks) would be regularly pumped and their contents disposed of at approved sewage disposal facilities in Delta, Montrose, Garfield, or Gunnison Counties, in accordance with applicable rules and regulations regarding sewage treatment and disposal. Accumulated trash and nonflammable waste materials would be hauled to an approved landfill once a week or as often as necessary. All debris and waste materials not contained in the trash containers would be cleaned up, removed from the construction ROW or well pad, and disposed of at an approved landfill. Trash would be cleaned up every day.

Sanitary waste equipment and trash bins would be removed from the Unit upon completion of access road or pipeline construction, following drilling and completion operations at an individual well pad, or as required.

***Access and Traffic***

Traffic estimates would be the same as those described in **Section 2.2.3**, Elements Common to All Alternatives, above. Specific calculations for Alternative A are presented below in **Table 2-6**, Alternative A Traffic Estimates for Construction, Drilling, Completion, and Production Activities, based on eleven (11) new well pads.

**Table 2-6**
**Alternative A Traffic Estimates for Construction, Drilling, Completion, and Production Activities**

| Vehicle Type | Average Weight (lbs) | Estimated Round Trips |
|---|---|---|
| Vehicles for Pad and Access Road Construction | | |
| Gravel trucks | 110,000 | 1,760 |
| Semi trucks | 37,000 | 44 |
| Pick-up trucks | 6,000 | 440 |
| Motor grader on semi trailer | 40,000 | 11 |
| Dozer (2) on semi trailer | 19,000 | 22 |
| Trackhoe on semi trailer | 43,000 | 11 |
| Pipeline Construction | | |
| Motor Grader on Lowboy Trailer with Truck | 50,800 | 22 |
| Bulldozer on Lowboy Trailer with Truck | 120,000 | 22 |
| 80-barrel water trucks – dust control | 54,000 loaded | 220 |
| 80-barrel water trucks – hydrostatic testing | 25,000 empty | 22-44 |
| Trackhoe on Lowboy Trailer with Truck | 91,000 | 22 |
| Welding trucks | 9,500 | 22 |
| Crew cab Pick Ups | 5,200 | 440 |
| Bending Machine/Trailer | 48,000 | 22 |
| Sidebooms on Lowboy Trailer with Truck | 63,000 | 22 |
| X-Ray Truck | 5,200 | 44 |
| Testing Truck | 6,000 | 22 |
| Pipe Trucks | 120000 loaded<br>36000 unloaded | 11 |
| Utility Tractor and Truck with Low Boy Trailer | 40,000 | 22 |
| Vehicles for Drilling/Completing First Well on the Pad | | |
| Drilling/Completion Rig | 120,000 | 11 |
| Rig-Up Trucks Loaded (including cement and fracturing) | 120,000 | 275 |
| Rig-Up Trucks Empty | 36,500 | 44-66 |

**Table 2-6**
**Alternative A Traffic Estimates for Construction, Drilling, Completion, and Production Activities**

| Vehicle Type | Average Weight (lbs) | Estimated Round Trips |
|---|---|---|
| 80-barrel water trucks loaded | 54,000 | 440 |
| 80-barrel water trucks empty | 25,000 | 440 |
| Crew-cab pick ups | 6,000 | 440 |
| Vehicles for Drilling/Completing Subsequent Wells on the same Pad | | |
| Motor Grader | 50,000 | 22 |
| Drilling/Completion Rig | 120,000 | 22 |
| Rig-Up Trucks Loaded (including cement and fracturing) | 120,000 | 275 |
| Rig-Up Trucks Empty | 36,500 | 44-66 |
| 80-barrel water trucks loaded | 54,000 | 495 |
| 80-barrel water trucks empty | 25,000 | 495 |
| Crew Cab Pick-Ups | 6,000 | 440 |
| Vehicles for Well Production | | |
| Workover rig | 120,000 | 17 |
| Haul trucks | 120,000 | 66 |

### *Surface Disturbance*

Short-term surface disturbance (expressed as acres) would occur during and immediately after the construction, drilling, completion, and testing activities. Those portions of the well pads, access road ROWs, pipeline ROWs, and other facilities not needed for production operations or additional well drilling on the same pad would be reclaimed as conditions allow within one to two growing seasons following completion of the respective well, access road, or pipeline. What remains after interim reclamation and prior to final reclamation is considered long-term disturbance.

The No Action alternative would construct up to 11 new well pads that would result in approximately 55 acres of short-term disturbance and 22 acres of long-term disturbance, and require 5 miles of new road construction and 26 miles of improvements to existing roads for access (totaling 109 acres of short-term disturbance and 58 acres of long-term disturbance).[2] SGI also proposes 12 miles of new pipelines that would total 101 acres short-term disturbance and 9 acres long-term disturbance (cross-country pipelines would be fully reclaimed resulting in zero acres long term disturbance). Details for these actions are shown in **Table 2-9**, Summary of Actions by Alternative; acreage area of disturbance are shown in **Table 2-11**, Summary Surface Disturbance Acres by Alternative, which includes both short-term (during immediate construction and development) and long-term (after interim reclamation) disturbance.

Typical pumper traffic would be pick-up trucks estimated to have an average vehicle weight of 6,000 to 10,000 lbs for approximately 1 round trip per well per day; typical water disposal well

[2] Calculations of possible disturbance areas are based on the assumptions presented in **Section 2.2.3**, Elements Common to All Alternatives, and **Table 2-2**, Project Feature Assumed Short- and Long-Term Disturbance Estimates; the estimates below should be considered upper threshold limits for the purposes of summarizing the extent of possible disturbance under Alternative A, No Action.

traffic would be approximately 2 roundtrips per well per day. Typical water truck traffic for dust suppression activities is estimated at 2 roundtrips per well per day. All other traffic estimates would be the same as described in **Table 2-1**, Traffic Estimates for Construction, Drilling, Completion, and Production Activities per Well Pad.

*Best Management Practices*

Best Management Practices (BMPs) are practices or a combination of practices that are determined to provide the most effective, environmentally sound, and economically feasible means of managing an activity; they are state-of-the-art industry and agency recognized mitigation measures applied on a site-specific basis to avoid, minimize, reduce, rectify, or compensate for adverse environmental or social impacts. They are selectively applied to projects to aid in achieving desired outcomes for safe, environmentally responsible development by preventing, minimizing, or mitigating adverse impacts and reducing conflicts. BMPs can also be proposed by SGI for activities. BMPs not incorporated into the permit application by the applicant may be considered and evaluated through the environmental review process and incorporated into the use authorization as conditions of approval or ROW stipulations.

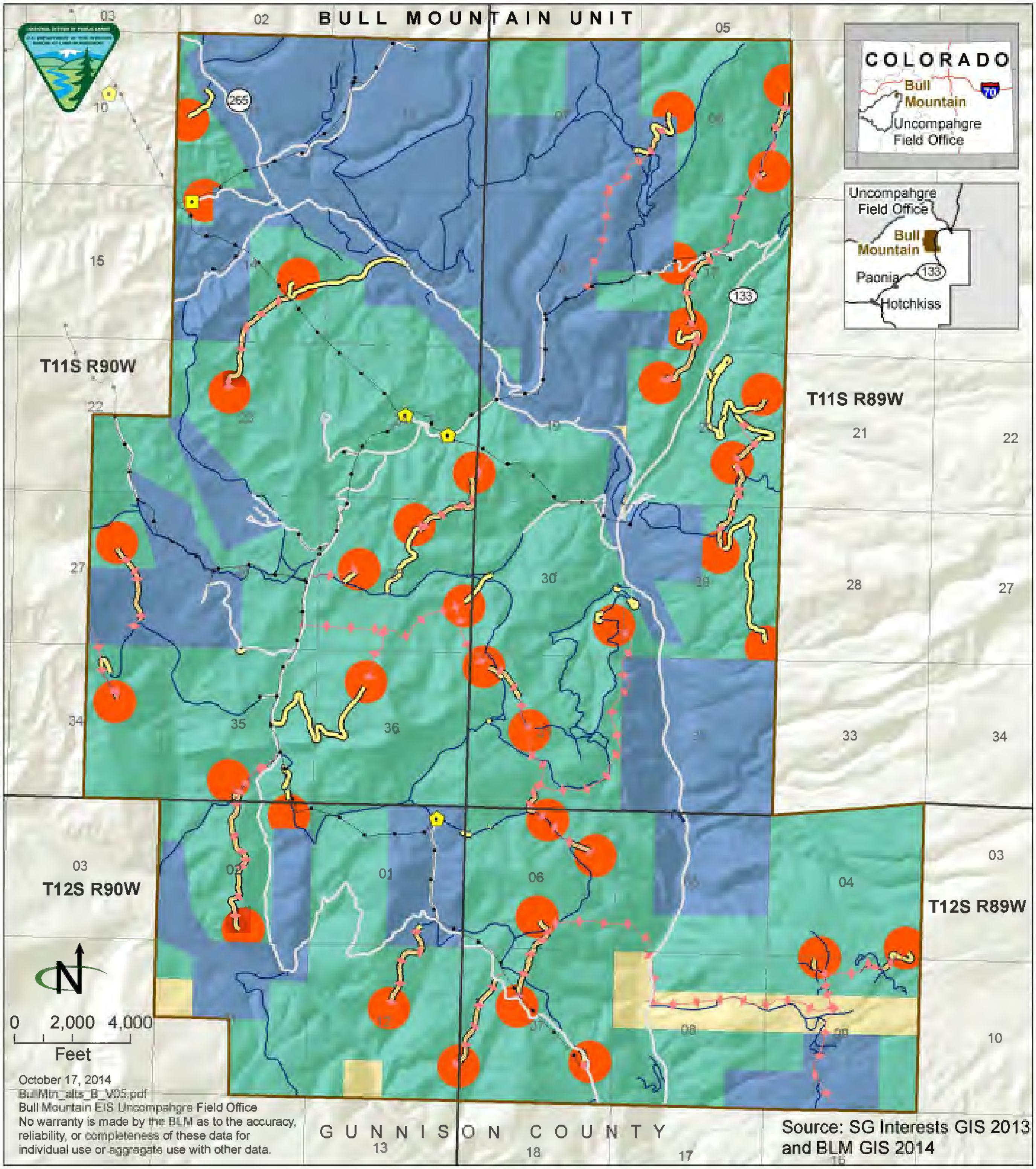
SGI has also provided a Master Surface Use Plan of Operations (see **Appendix D**) and a Master Drilling Plan (**Appendix E**) that provide measures for application under Alternative A. These generalized plans would be revised to include site-specific information for future drilling permits, and reviewed for adequacy by the COGCC prior to approval. Upon review of the individual drilling application, the COGCC may request additional mitigation measures.

### 2.2.5 Alternative B, Proposed Action

The phases of development and actions anticipated to complete construction, drilling, completion, production, and reclamation are largely the same as Alternative A. However, Alternative B is specific to BLM-administered mineral estate, the BLM's authority, and the actions they would approve under a Master Development Plan. If Alternative B is approved, the operations and development of private minerals described in Alternative A would likely continue to be implemented.  Alternative B assumes development would occur only on federal minerals within the unit for purposes of comparison with baseline conditions. The combination of federal mineral and private mineral development is discussed and analyzed in **Chapter 4**, Environmental Consequences, under cumulative effects.

**Figure 2-2**, Alternative B, Proposed Action, presents the conceptual locations of potential well pads over areas currently thought to be most prospective for natural gas development.

All actions described below, including those that occur on split-estate lands, would be in compliance with all laws, regulations, and BLM policies, including BLM Surface Operating Standards and Guidelines for Oil and Gas Exploration and Development (DOI and USDA 2007), the BLM Manual 9113 (BLM 1985), and additional requirements from the Uncompahgre Basin RMP (BLM 1989). COAs listed in **Appendix C** would apply to all permits, and BMPs would be selectively applied as additional COAs. Stipulations and COAs shown in **Table 2-10**, Stipulations and Conditions of Approval, would apply. In addition, a Master Surface Use Plan of Operations and a Master Drilling Plan (see **Appendix D and E**, respectively) must be submitted with an APD.




## Alternative B, Proposed Action

Alternative B, Proposed Action

- Proposed well pad analysis area
- Proposed screw compressor
- Potential storage yard
- Proposed pipeline
- Proposed new road construction
- Existing road requires upgrade for use

Existing Infrastructure

- Existing road currently suitable for use
- Existing pipeline
- Federal surface, federal minerals
- Private surface, federal minerals
- Private surface, private minerals

Alternative B is specific to BLM-administered federal mineral estate and surface and development would occur under a Master Development Plan.

Figure 2-2

***New Developments***

Alternative B includes up to 36 new well pads, up to 146 new natural gas wells, and up to 4 new water disposal wells to develop federal mineral estate. On average, there would be 4 to 5 wells on any individual well pad; however, depending on the location, formation, and other factors to be determined at the APD stage of development, an individual well pad could have 1 well or up to 12 wells per pad. Some of the new gas wells would be drilled on the existing water disposal or gas well pads. The quantity and combination of coalbed methane natural gas, sandstone gas wells, and shale gas wells on each pad is not known at this time and would also be determined at the APD stage.

Additionally, it is estimated that approximately 16 miles of new road construction and 53 miles of improvements to existing roads for access, 21 miles of new pipeline construction, and up to 4 new compressor stations would be constructed.

Based on these numbers, and the assumed drilling rate noted in the common assumptions, it is estimated that drilling activities would occur for approximately 6 years.

***Construction***

Pre-construction nesting surveys for migratory birds, including raptors, would be conducted prior to any surface disturbing construction activities scheduled between April 1 and June 30 each year to identify active migratory bird nest sites. Active nests would be avoided during construction activities using applicable species-specific CPW construction buffers to avoid disruption of migratory bird breeding activities. Stream crossing in active streams would be conducted outside the spawning season identified by CPW for applicable aquatic species.

*Access Road Construction*

Alternative B access road construction would be the same as Alternative A. The primary access roads would be State Highway 133 and County Road 265, and new road construction and improvements would only occur on an as-needed basis to facilitate access to well pads and other facilities. Site-specific plans for road construction and up-grades would be included as part of individual future APDs or PODs and would be subject to approval from the BLM.

*Well Pad Construction (Gas and Water Disposal Wells)*

Alternative B well pad construction would be the same as Alternative A. Prior to individual well pad construction, SGI would obtain approval of an APD or POD by the BLM. Each APD or POD would contain site-specific details related to well pad size, construction and well operations, and mitigation measures.

Under Alternative B, SGI could propose a reserve pit or pitless closed-loop drilling system, which would determine the size and construction needs of the well pad. The quantity and combination of coalbed methane natural gas, sandstone, and shale gas wells on each pad are unknown at this time, the same as described in Alternative A. Additionally, as part of individual APDs or PODs, SGI would identify the specific pipeline routes needed in order to transport the gas and/or water from the well head.

*Pipeline Construction*

Same as Alternative A.

*Overhead Electrical Line Construction for Water Disposal Wells*
Under Alternative B, SGI proposes up to four new water disposal wells that would require construction of four new overhead electrical lines (up to 20 power poles) to supply power to the water disposal well heads. The methods for installing the overhead power lines would be the same as described in Alternative A.

***Drilling***
Drilling operations would be conducted in compliance with all applicable and relevant state and federal regulations, and would be the same as described in Alternative A above except for the differences noted below.

*Gas Well Drilling*
Gas well drilling could use any of the different wellbore directions, types of drilling technologies (reserve pit and/or closed loop systems), target formations, and drilling lubricants noted in Alternative A. Alternative B, Proposed Action, does not present a preference for one type of technology or methodology over another. Under Alternative B, the type of wellbore, drilling system, target formation, and drilling lubricant would be specified in the APD and POD when submitted to the BLM. All drilling operations and other well site activities would be conducted in compliance with BLM policies, and regulations, and with the Master Surface Use Plan of Operations and Master Drilling Plan (see **Appendix D** and **E**, respectively)

The type of drilling rig to be used, whether a Tier-2 or Tier-3 rig, would be determined by SGI at the APD/POD stage and subject to BLM stipulations and COAs. All descriptions relating to drilling rig time frames, equipment, and materials are the same as described under Alternative A.

For Alternative B, SGI plans to utilize both water-based and oil-based drilling fluids, depending on the target formations. Specifics on which type of drilling fluid used would be included on the individual APD/POD.

Similar to Alternative A, on average, approximately 3,000 barrels of water would be used for drilling in any particular well. For Alternative B, that would result in up to 438,000 barrels of water for drilling (up to 3,000 barrels per well multiplied by up to 146 new wells drilled).

*Water Disposal Well Drilling*
For Alternative B, SGI proposes drilling up to four new water disposal wells. The methods and technologies used for water disposal well drilling are the same as described under Alternative A.

Like Alternative A, the disposal wells may be completed in the Dakota, Morrison, Entrada, or Maroon Formations. A water-based mud system would be used for drilling of the surface hole, and a low-solids, non-dispersed gel system would be used for the intermediate and production hole sections of the water disposal well. Up to approximately 3,000 barrels of water would be used for drilling a particular water disposal well. For Alternative B, that would result in up to 12,000 barrels of water that could be used for drilling (up to 3,000 barrels per well multiplied by up to four new water disposal wells drilled).

Water disposal wells would be permitted by the BLM as APDs if the wells are on-lease; the operator would then go through the conversion process with the BLM and COGCC to ensure that no production could come from the well prior to using the well for water disposal.

### *Completion*

*Gas Well Completion*
Gas well completions would largely be the same as described in Alternative A, except for the differences described below. Additionally, **Appendix E** and **Appendix D** are incorporated by reference for drilling and surface use descriptions.

Water used during completion operations would be recycled, fresh, or a combination of both, and quantities used would vary in accordance with the formations the wells are completed in. Specifics for how much water each well type would require for completion is provided in **Appendix E**. As each well type requires vastly different amounts of water, calculations for estimated water usage were based on assuming 50 percent CBNG wells and 50 percent shale wells as discussed in the Bull Mountain EA. Calculations used number of new wells per alternative divided in half for each type of well (CBNG/shale). To estimate the amount of water use per well type, the number of wells was multiplied by the highest amount of water use for that well type. Water usage totals were added together for a total maximum amount of water usage. The results showed that there could be up to 18,132,000 barrels (or 1,759 acre-feet) of water used for well completions during the 6-year development timeframe. If fewer shale wells were drilled and completed, the water use estimate would be lower.

As described in Alternative A, gas would either be flared or sold down the pipeline using green completions, and must meet additional federal requirements such as federal regulations and Onshore Orders. Recycled water could also be used for well completions when water conditions allow (see *Flowback Pits* discussion below). Additionally, operators are required to post their disclosure of chemicals intentionally added to hydraulic fracturing fluids on FracFocus per COGCC Order No. 1R-114.

*Flowback Pits*
At full build out, the four McIntyre Flowback Pits would be used for the proposed action in the same manner as described in Alternative A.

*Water Disposal Well Completion*
The methods, equipment and process used for water disposal well completions would be the same as described in Alternative A.

### *Interim Reclamation*
Following well completions, portions of the well pad not needed for production would be reseeded and reclaimed according to BLM specifications. Long-term well pad disturbance from the 36 new well pads would be reduced to 72 acres following successful interim reclamation; see **Appendix D** for reclamation details.

### *Production and Maintenance*

*Production*

Specifications and methodologies for production would be the same as described in Alternative A. Regardless of the alternative selected, the actual location of facilities would be determined during the APD/POD stage. All site security guidelines (Onshore Order #3) would be followed as identified in the BLM’s statutes, regulations, and policy.

*Surface Facilities*

Surface facilities, how and where they would be installed are the same as described in Alternative A, although their installation and regulatory requirements would be in accordance with BLM standards, policies, and regulations.

All permanent structures would be painted a flat, non-reflective standard environmental color as specified in the Federal APD authorization. Facilities would be painted within 6 months of being located on site. As required by the Occupational Safety and Health Administration, some equipment would be painted for safety considerations (i.e., some parts of equipment would retain its safety coloration such that it does not blend with the surroundings).

Specifications for water disposal wells’ surface facilities would be the same as described in Alternative A. Any long-term water disposal well structures would also be painted as specified in the Federal APD authorization.

*Compressor Stations*

Compression in the field may be necessary as wells come online. Under Alternative B, SGI proposes four new screw compressors (see **Figure 2-2**).

SGI is proposing to use natural gas-fired internal combustion engines to power the compressor. Emissions from natural gas-fired compressor at the compressor facility would typically be less than 2 grams per horsepower/hour of carbon monoxide and nitrous oxides, and less than 1 gram per horsepower/hour of VOCs. The compressor would use hospital grade mufflers (an industry standard within the oil and gas industry) and would be housed in buildings or portable structures in an effort to abate noise from the compressor engine.

Up to 20 personnel may be involved in constructing all of the compressor stations, with an average of 5 personnel on a site at any one time.

*Produced Water Management*

Methodologies for treating produced water would be the same as described in Alternative A; however, disposal of produced water would be in accordance with a plan approved by the BLM as provided for in Onshore Oil and Gas Order No. 7, Produced Ground Water.

SGI estimates that between 500 and 3,000 barrels per day of produced water would be injected into each of the water disposal wells at full build-out of the Unit. In the interim, produced water would be reinjected into the existing water disposal well within the Unit or trucked to an approved disposal site.

Water disposal wells would be drilled to non-producing, non-useable water bearing, formations capable of accepting water. These formations do not produce gas, contain no useable water, and are capable of accepting large quantities of injected water. Conceptual locations for water disposal wells have been illustrated on each alternative map (**Figures 2-1** to **2-3**). In some cases, non-producing gas wells may also be converted for water disposal use; if this were proposed, it would be described in detail in the specific APD or POD at the time of submission to the BLM. Water disposal facilities would include natural gas-fired internal combustion engines to drive injection pumps directly or via a generator powering an electric motor.

*Workover and Maintenance*
The workover and maintenance for Alternative B are the same as those described under Alternative A.

***Final Reclamation and Abandonment***
Standards and methodologies would be generally the same as described in Alternative A. Development of a site-specific reclamation plan, based on information provided in **Appendix D** would include consultation between the BLM, the surface owner, and the operator. Site-specific reclamation plans would be submitted to the BLM. Wells would be plugged in compliance with all BLM standards and all federal regulations. All surface equipment would be removed. Removal or burial of surfacing material would comply with the authorizing agency's standards. Wells would be plugged in compliance with all BLM standards and all federal regulations.

***Water Use and Sources***
Specific volumes of water usage needed for any given phase of development are presented within that phase description. Otherwise, the rest of the water usage information is the same as presented in Alternative A.

***Hazardous Materials and Solid Waste***
The hazardous materials actions for Alternative B are the same as those described under Alternative A.

***Access and Traffic***
Traffic estimates would be the same as those described in **Section 2.2.3**, Elements Common to All Alternatives, above. Specific calculations for Alternative B are presented below in **Table 2-7**, Alternative B Traffic Estimates for Construction, Drilling, Completion, and Production Activities, based on 36 new well pads.

**Table 2-7**
**Alternative B Traffic Estimates for Construction, Drilling, Completion, and Production Activities**

| Vehicle Type | Average Weight (lbs) | Estimated Round Trips |
|---|---|---|
| Vehicles for Pad and Access Road Construction | | |
| Gravel trucks | 110,000 | 5,760 |
| Semi trucks | 37,000 | 144 |
| Pick-up trucks | 6,000 | 1440 |
| Motor grader on semi trailer | 40,000 | 36 |
| Dozer (2) on semi trailer | 19,000 | 72 |
| Trackhoe on semi trailer | 43,000 | 36 |

**Table 2-7**
**Alternative B Traffic Estimates for Construction, Drilling, Completion, and Production Activities**

| Vehicle Type | Average Weight (lbs) | Estimated Round Trips |
|---|---|---|
| Pipeline Construction | | |
| Motor Grader on Lowboy Trailer with Truck | 50,800 | 72 |
| Bulldozer on Lowboy Trailer with Truck | 120,000 | 72 |
| 80-barrel water trucks – dust control | 54,000 loaded | 720 |
| 80-barrel water trucks – hydrostatic testing | 25,000 empty | 72-144 |
| Trackhoe on Lowboy Trailer with Truck | 91,000 | 72 |
| Welding trucks | 9,500 | 72 |
| Crew cab Pick Ups | 5,200 | 1,440 |
| Bending Machine/Trailer | 48,000 | 72 |
| Sidebooms on Lowboy Trailer with Truck | 63,000 | 72 |
| X-Ray Truck | 5,200 | 144 |
| Testing Truck | 6,000 | 72 |
| Pipe Trucks | 120000 loaded<br>36000 unloaded | 36 |
| Utility Tractor and Truck with Low Boy Trailer | 40,000 | 72 |
| Vehicles for Drilling/Completing First Well on the Pad | | |
| Drilling/Completion Rig | 120,000 | 36 |
| Rig-Up Trucks Loaded (including cement and fracturing) | 120,000 | 900 |
| Rig-Up Trucks Empty | 36,500 | 144-216 |
| 80-barrel water trucks loaded | 54,000 | 1,440 |
| 80-barrel water trucks empty | 25,000 | 1,440 |
| Crew-cab pick ups | 6,000 | 1,440 |
| Vehicles for Drilling/Completing Subsequent Wells on the same Pad | | |
| Motor Grader | 72 | 78 |
| Drilling/Completion Rig | 72 | 78 |
| Rig-Up Trucks Loaded (including cement and fracturing) | 900 | 1,755 |
| Rig-Up Trucks Empty | 144-216 | 1,755 |
| 80-barrel water trucks loaded | 1620 | 1,755 |
| 80-barrel water trucks empty | 1620 | 1,755 |
| Crew Cab Pick-Ups | 1440 | 2,535 |
| Vehicles for Well Production | | |
| Workover rig | 120,000 | 108 |
| Haul trucks | 120,000 | 216 |

***Surface Disturbance***

Alternative B would construct up to 36 new well pads to develop federal mineral estate that would result in approximately 180 acres of short-term disturbance and 72 acres of long-term disturbance, and would require 16 miles of new road construction and 53 miles of improvements to existing roads for access (totaling 243 acres of short-term disturbance and 129 acres of long-term disturbance).[3] SGI also proposes 21 miles of new pipelines that would total 206 acres short-term disturbance and 25 acres long-term disturbance (cross-country pipelines would be fully reclaimed resulting in zero acres long term disturbance). Details for these actions are shown in **Table 2-9**, Summary of Actions by Alternative; acreages for areas of disturbance are shown in **Table 2-11**, Summary Surface Disturbance Acres by Alternative, which includes both short-term (immediate construction) and long-term (interim reclamation) disturbance amounts.

Traffic estimates for Alternative B are the same as those described in Alternative A. Following well completions, portions of the federal well pad not needed for production would be reseeded and reclaimed according to BLM specifications. Long-term well pad disturbance from the 36 new well pads would be reduced to 72 acres following successful interim reclamation.

### 2.2.6 Alternative C, Modified Action

Alternative C was developed by modifying the GIS model to minimize surface disturbance by putting greater emphasis on soil types and co-locating roads and pipelines, which in turn would reduce the miles of road and pipeline needed to service the pad sites (see **Appendix A** for additional details). The phases of development, development methodologies, and actions anticipated during construction, drilling, completion, production, and reclamation of the Modified Action are similar to Alternative A. However, like Alternative B, this alternative is specific to BLM-administered mineral and surface estate, the BLM's authority, and the actions they would approve under a MDP.

Alternative C provides additional features and changes to actions in order to consider options for addressing the impacts of gas development on wildlife populations, vegetation resources, water quality, air quality, and soil resources. In order to highlight the substantive differences in Alternative C, the modified actions are described in detail; actions that are the same as those described in either Alternative A or B are noted as such and the reader is referred back to the previous discussion.

As noted in **Section 1.8**, Key Issues Addressed in the EIS, wildlife and habitat impacts are an issue to be addressed in the EIS. Federal minerals within the Unit are generally subject to a winter seasonal timing limitation (December 1 to April 30) to protect crucial deer and elk winter ranges from development activities (e.g., construction and drilling). Therefore, Alternative C includes the option to use voluntary seasonal winter timing limitations or a progressive development approach. The operator's desire to conduct winter construction and drilling activities over federal minerals could be accommodated while minimizing impacts on wintering

[3] Calculations of possible disturbance areas are based on the assumptions presented in **Section 2.2.3**, Elements Common to All Alternatives, and **Table 2-2**, Project Feature Assumed Short- and Long-Term Disturbance Estimates.

big game through voluntary winter timing limitations within the Negotiated Reduced Winter Activity Areas identified in **Figure 2-4**, Alternative C, Constraints.

Impacts on big game could be mitigated by creating a progressive movement of winter construction and drilling activities. The operator would voluntarily confine drilling and construction activities over private and federal minerals to no more than one-quarter of the Unit in any given winter period (December 1 to April 30). The portion or area of the unit where winter activity may occur would be mutually negotiated annually between the operator, the BLM, and CPW no later than August 1. Under this scenario, the BLM would consider exceptions to winter seasonal timing limitations within the agreed-upon area to allow ongoing winter drilling activity.

If Alternative C is approved, the operations and development of private minerals described in Alternative A would likely continue to be implemented. Alternative C assumes development would occur only on federal minerals within the unit for purposes of comparison. The combination of federal mineral and private mineral development is discussed and analyzed in **Chapter 4** under cumulative effects.

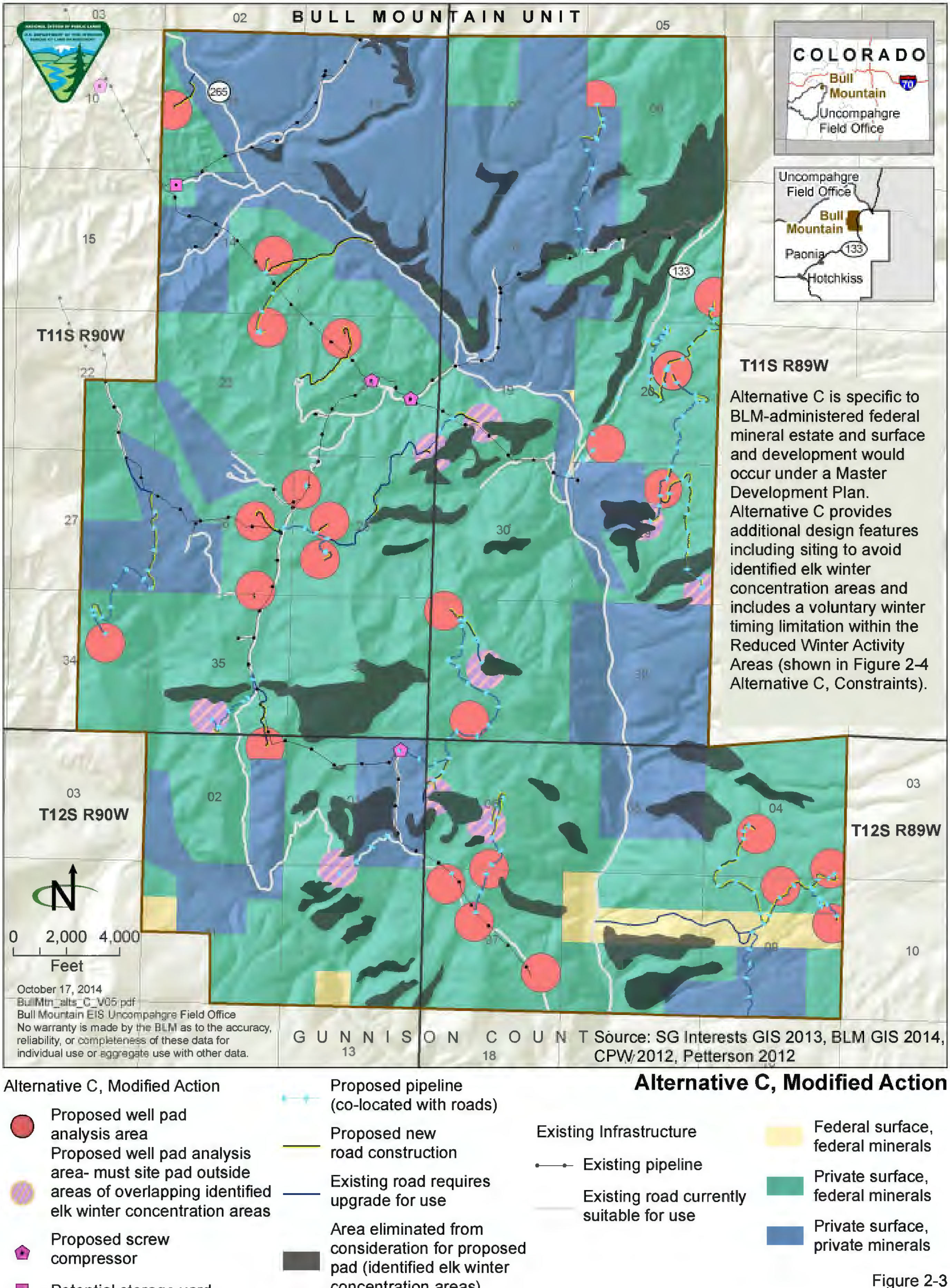
All actions described below, including those that occur on split-estate lands, would be in compliance with all laws, regulations, and BLM policies, including BLM Surface Operating Standards and Guidelines for Oil and Gas Exploration and Development (DOI and USDA 2007), the BLM Manual 9113 (BLM 1985), and additional requirements from the Uncompahgre Basin RMP (BLM 1989). COAs listed in **Appendix C** would apply to all permits, and BMPs would be selectively applied as additional COAs. Stipulations and COAs shown in **Table 2-10**, Stipulations and Best Management Practices would apply. In addition, a Surface Use Plan of Operations and a Drilling Plan (see Appendices D and E, respectively, for a general example) must be submitted with an APD.

***New Developments***

The techniques and methodologies described for construction, drilling, completion, reclamation, production, maintenance, water uses and sources, and other elements in **Section 2.2.3**, Elements Common to All Alternatives, are applicable to Alternative C. The information provided below is unique to Alternative C, Modified Action.

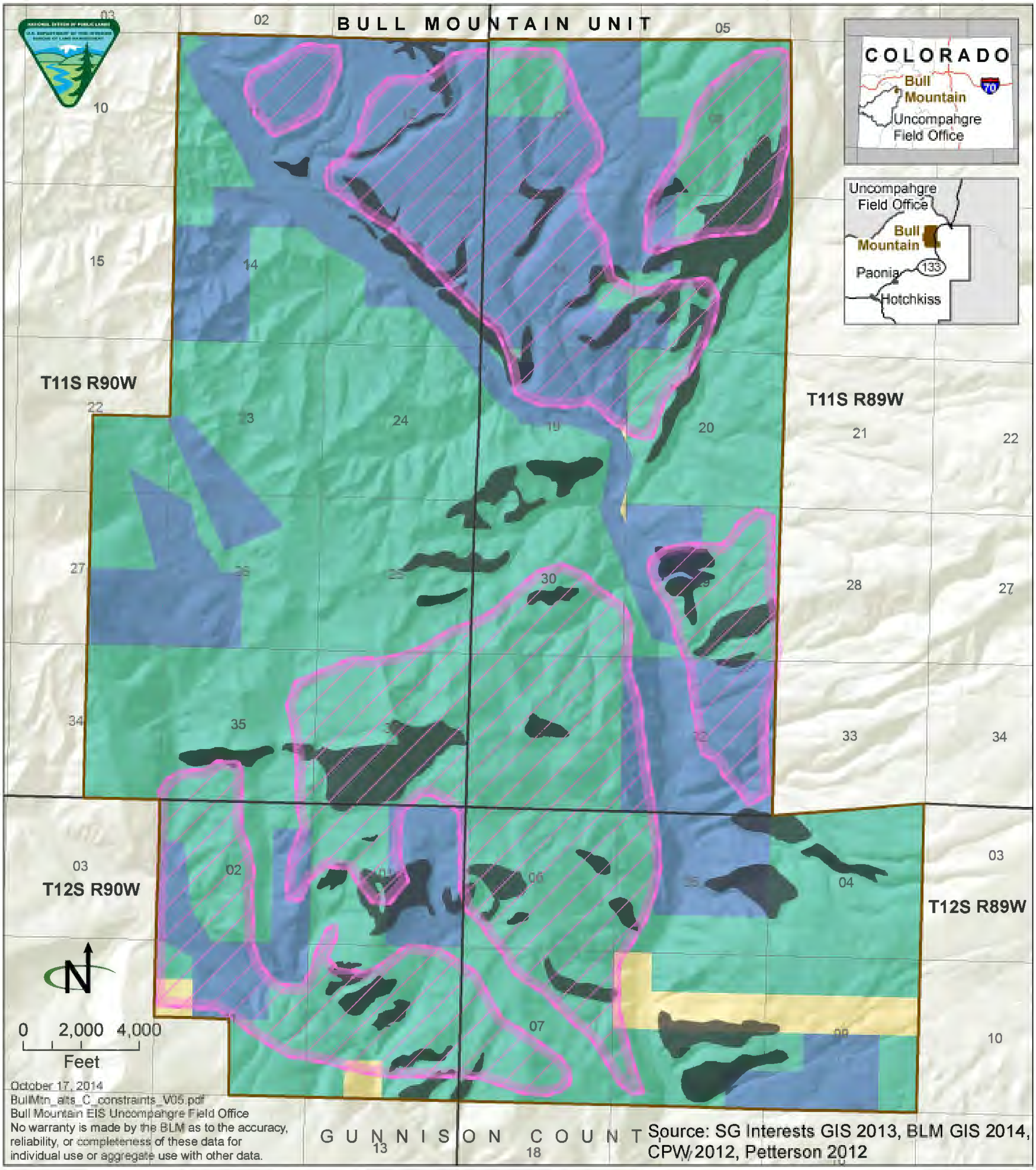
As noted above, Alternative C modified the weighting factors in the site selection model to minimize surface disturbance by putting greater emphasis on soil types and co-locating roads and pipelines, resulting in moving many of the well pad locations as illustrated on **Figure 2-3**, Alternative C, Modified Action. Additionally, well pads and roads would avoid identified elk winter concentration areas as illustrated on **Figure 2-4**, Alternative C, Constraints, unless avoiding such habitats would equate to greater net surface disturbance or is determined to be a detriment to other resource values.

With these constraints, SGI would construct up to 35 new well pads to develop Federal mineral estate, up to 146 new natural gas wells and up to 4 new water disposal wells. The average number of wells per pad would be the same as Alternative B. Some of the new gas wells would be drilled on the existing water disposal or gas well pads. The quantity and combination of




**Alternative C, Modified Action**

Figure 2-3




**Alternative C, Constraints**

Reduced Winter Activity Area (voluntary winter timing limitation)

Area eliminated from consideration for proposed pad (identified elk winter concentration areas)

Federal surface, federal minerals

Private surface, federal minerals

Private surface, private minerals

Figure 2-4

coalbed methane natural gas, sandstone, and shale gas wells on each pad is not known at this time and would also be determined at the APD/POD stage. Additionally, at the APD/POD stage, the exact locations of well pads would be sited in ecological sites within the 40-acre analysis areas best suited to achieve maximum reclamation success. Under Alternative C, new water disposal wells would be sited on existing pads.

Additionally, it is estimated that approximately 12 miles of new road construction and 13 miles of improvements to existing roads for access, 19 miles of new pipeline construction co-located with roads, and up to 4 new compressor stations would be constructed.

Based on these numbers, and the assumed drilling rate noted in the common assumptions, it is estimated that drilling activities would occur for approximately 6 years.

***Construction***

Pre-construction nesting surveys for migratory birds, including raptors, would be conducted prior to any surface disturbing construction activities scheduled between April 1 and June 30 each year to identify active migratory bird nest sites. Active nests would be avoided during construction activities using applicable species-specific CPW construction buffers to avoid disruption of migratory bird breeding activities. Stream crossing in active streams would be conducted outside the spawning season identified by CPW for applicable aquatic species.

*Access Road Construction*

As under Alternative B, the primary access roads would be State Highway 133 and County Road 265, and new road construction and improvements would only occur on an as-needed basis to facilitate access to well pads and other facilities. Site-specific plans for road construction and up-grades would be included as part of individual future APDs or PODs and would be subject to approval from the BLM (see **Appendix D**).

*Well Pad Construction (Gas and Water Disposal Wells)*

As under Alternative B, prior to individual well pad construction, SGI would obtain approval of an APD or POD by the BLM. Each APD or POD would contain site-specific details related to well pad size, construction and well operations, and mitigation measures.

Under Alternative C, the BLM is including additional design features to address issues raised during scoping and public comments on the EA. One such design feature requires SGI to use a closed loop drilling system, which would determine the size and construction needs of the well pad. Similar to Alternatives A and B, the quantity and combination of coalbed methane natural gas, sandstone, and shale gas wells on each pad are unknown at this time.

*Pipeline Construction*

No new cross country pipeline construction would be approved; the entire pipeline network would be required to be co-located with current and proposed road network development consistent with Gold Book recommendations unless deemed a detriment to resources. Where feasible, trunk lines shall be buried in the roadbed or within the borrow ditch to further reduce surface disturbance. No more than a 30-foot-wide disturbance route in addition to the average 16-foot road surface would be approved for co-located pipelines. All other construction methods would be the same as described in Alternative A.

*Overhead Electrical Line Construction for Water Disposal Wells*

Under Alternative C, up to four new water disposal wells that would require construction of four new electrical lines to supply power to the water disposal wellheads. Under Alternative C the new electrical lines would be buried adjacent to the roads to minimize overhead disturbance to wildlife resources.

***Drilling***

Drilling operations would be conducted in compliance with all applicable and relevant state and federal regulations, and would be the same as described in Alternative A above except for the differences noted below. However, under Alternative C, only closed loop drilling systems would be approved for federal wells. The BLM would review industry standards and procedures (BMPs) at the time of application and consider operator input when determining feasibility. See **Appendix E** for additional information.

*Gas Well Drilling*

Gas well drilling could use any of the different wellbore directions, target formations, and drilling lubricants noted in Alternative A. Under Alternative C, the type of wellbore, target formation, and drilling lubricant would be specified in the APD and/or POD when submitted to the BLM. More environmentally friendly additives (e.g. bio-diesel) would be considered for use. Required use would be based on factures such as economic feasibility and availability. All drilling operations and other well site activities would be conducted in compliance with BLM laws, policies, and regulations.

Under Alternative C, a Tier-2 drilling rig engine or cleaner would be required; this determination would be made by SGI at the APD/POD stage and subject to BLM stipulations and COAs. All descriptions relating to drilling rig time frames, equipment, and materials are the same as described under Alternative A.

Similar to Alternative A, approximately 3,000 barrels of water would be used for drilling in any particular well on average. For Alternative C, that would result in up to 438,000 barrels of water that could be used for drilling (up to 3,000 barrels per well multiplied by up to 146 new gas wells drilled).

*Water Disposal Well Drilling*

For Alternative C, SGI proposes drilling up to four new water disposal wells. The methods and technologies used for water disposal well drilling are the same as described under Alternative A. As described under New Developments for Alternative C, new water disposal wells would be sited on existing pads.

Like Alternative A, the disposal wells may be completed in the Dakota, Morrison, Entrada, or Maroon Formations. A water-based mud system would be used for drilling of the surface hole, and a low-solids, non-dispersed gel system would be used for the intermediate and production hole sections of the water disposal well. Water usage for each water disposal well would be the same as described in Alternative B.

Water disposal wells would be permitted by the BLM as APDs if the wells are on-lease; the operator would then go through the conversion process with the BLM and COGCC to ensure that no production could come from the well prior to using the well for water disposal.

***Completion***

*Gas Well Completion*
Gas well completions would largely be the same as described in Alternative A, except for the differences described below.

Water used during completion operations would be the same as described in Alternative B.

For Alternative C, SGI would be required to employ green completion technologies following EPA NSPS OOOO Regulations. Recycled water could also be used for well completions when water conditions allow (see *Flowback Pits* discussion below).

*Flowback Pits*
The four McIntyre Flowback Pits would be used for the proposed action in the same manner as described in Alternative A.

*Water Disposal Well Completion*
The methods, equipment and process used for water disposal well completions would be the same as described in Alternative A.

***Interim Reclamation***
Following well completions, portions of the well pad not needed for production would be reseeded and reclaimed according to specifications of the approved Federal APD. Interim reclamation would be designed to develop a suitable plant community capable of competitively excluding invasive species while also providing for wildlife and livestock objectives and would include appropriate composition of grasses, forbs, and shrubs for the ecological site. Long-term well pad disturbance from the 35 new well pads would be reduced to 70 acres following successful interim reclamation (see **Appendix D**).

***Production and Maintenance***

*Production*
Specifications and methodologies for production would be the same as described in Alternative A. Regardless of the alternative selected, the actual location of facilities would be determined during the APD/POD stage. All site security guidelines as identified in the BLM's statutes, regulations, and policy would be followed.

*Surface Facilities*
How and where surface facilities would be installed are the same as described in Alternative A, although their installation and regulatory requirements would be in accordance with BLM standards, policies, and regulations, and the modifications unique to Alternative C as described below.

All permanent structures would be painted a flat, non-reflective standard environmental color as specified in the authorized Federal APD. Facilities would be painted within 6 months of being located on site. As required by the Occupational Safety and Health Administration, some equipment would be painted for safety considerations (i.e., some parts of equipment would retain its safety coloration such that it does not blend with the surroundings).

Specifications for water disposal wells' surface facilities would be the same as described in Alternative A. Any long-term water disposal well structures would also be painted in accordance with the BLM's standards.

Centralized production facilities would be established outside of the Negotiated Reduced Winter Activity Areas shown in **Figure 2-4** to significantly reduce year round truck traffic to the individual wells located within these areas to enhance their utility as winter refugia for wildlife. Centralized production facilities would ideally be situated on existing pads down gradient and would serve to further maximize interim reclamation as the outlying pads would not necessarily need traditional production facilities. The centralized production facilities may result in larger pad sizes at centralized production facilities or the development of additional pads to accommodate such facilities. Successful implementation of the centralized production facilities concept could result in a substantial reduction in the number of annual truck miles driven within the unit and result in corresponding reduced disturbance to wildlife.

Once a well is put into production, the operator would use remote telemetry or equivalent technology at all unit wells and flowback pits to minimize well monitoring trips throughout the Unit, unless another proven method would create less environmental impact. Locked gates would be established at the access points for well pad roads that occur within the Negotiated Reduced Winter Activity Areas (see **Figure 2-4**) and only emergency related trips would occur within these areas from Dec. 1 - April 30 annually between the hours of 9 A.M. and 3 P.M. For Alternative C, emergency is defined as:

- Non-routine pipeline facility maintenance to remedy unanticipated production or safety problems, and
- Emergency workovers to remedy equipment failures, loss of well integrity, unanticipated rapid declines in production, or threats to life, property, or resources.

The BLM Authorized Officer would be promptly notified of any emergency work commencing. The minimal amount of seasonal road maintenance required to pump the well or conduct emergency activities would be conducted by the operator.

Where strict adherence to mitigations is required in order to prevent significant environmental impacts related to the proposed project (e.g., in cases of winter construction or drilling activities, operations in groundwater recharge areas, or facilities in riparian or wetland areas), the BLM may require a third-party compliance contractor. The third-party contractor shall be responsible for monitoring and compliance reporting and would be under the direct supervision and control of the BLM with input and participation by the operator at the discretion of the BLM. Multiple third-party contractors may be required to ensure that monitoring is conducted by professionals with the appropriate expertise.

*Compressor Stations*
Compression in the field may be necessary as wells come online. Under Alternative B, SGI proposes four new screw compressors (see **Figure 2-3**).

SGI is proposing to use natural gas-fired internal combustion engines to power the compressor. Emissions from natural gas-fired compressor at the compressor facility would typically be less than 2 grams per horsepower/hour of carbon monoxide and nitrous oxides, and less than 1 gram per horsepower/hour of VOCs. The compressor would use hospital-grade mufflers (an industry standard within the oil and gas industry) and would be housed in buildings or portable structures in an effort to abate noise from the compressor engine.

Up to 20 personnel may be involved in constructing all of the compressor stations, with an average of 5 personnel on a site at any one time.

*Produced Water*
Methodologies for treating produced water would be the same as described in Alternative A; however, disposal of produced water would be in accordance with a plan approved by the BLM as provided for in Onshore Oil and Gas Order No. 7, Disposal of Produced Water.

SGI estimates that between 500 and 3,000 barrels per day of produced water from the coalbed methane natural gas wells would be injected into each of the water disposal wells at full build-out of the Unit. In the interim, produced water would be reinjected into the existing water disposal well within the Unit or trucked to an approved disposal site.

Water disposal wells would be drilled to non-producing, non-useable water bearing, formations capable of accepting water. These formations do not produce gas, contain no useable water, and are capable of accepting large quantities of injected water. In some cases, non-producing gas wells may also be converted for water disposal use; if this were proposed, it would be described in detail in the specific APD or POD at the time of submission to the BLM. Water disposal facilities would include natural gas-fired internal combustion engines to drive injection pumps directly or via a generator powering an electric motor.

*Workover and Maintenance*
The workover and maintenance for Alternative C are the same as those described under Alternative A. Additionally, all workover related traffic would be limited to travelling to and from location prior to 9 a.m. after 3 p.m.  The operator shall minimize trips between the hours of 9 a.m. and 3 p.m. as much as possible.

***Final Reclamation and Abandonment***
Standards and methodologies would be generally the same as described in Alternative A. Development of a site-specific reclamation plan, based on information provided in **Appendix D** would include consultation between the BLM, the surface owner, and the operator. Site-specific reclamation plans would be submitted to the BLM. Wells would be plugged in compliance with all BLM standards and all federal regulations.

- All surface equipment would be removed

- Removal or burial of surfacing material would comply with the authorizing agency's standards

Wells would be plugged in compliance with all BLM standards and all federal regulations.

***Water Use and Sources***
Specific volumes of water usage needed for any given phase of development are presented within that phase description. Otherwise, the rest of the water usage information is the same as presented in Alternative A.

***Hazardous Materials and Solid Waste***
The hazardous materials actions for Alternative C are generally the same as those described under Alternative A. Specific provisions for Alternative C are previously described (e.g. use of remote telemetry).

***Access and Traffic***
Traffic estimates would be the same as those described in **Section 2.2.3**, Elements Common to All Alternatives, above. Specific calculations for Alternative C are presented below in **Table 2-8**, Alternative C Traffic Estimates for Construction, Drilling, Completion, and Production Activities, based on 35 new well pads.

**Table 2-8**
**Alternative C Traffic Estimates for Construction, Drilling, Completion, and Production Activities**

| Vehicle Type | Average Weight (lbs) | Estimated Round Trips |
|---|---|---|
| Vehicles for Pad and Access Road Construction | | |
| Gravel trucks | 110,000 | 5,600 |
| Semi trucks | 37,000 | 140 |
| Pick-up trucks | 6,000 | 1,400 |
| Motor grader on semi trailer | 40,000 | 35 |
| Dozer (2) on semi trailer | 19,000 | 70 |
| Trackhoe on semi trailer | 43,000 | 35 |
| Pipeline Construction | | |
| Motor Grader on Lowboy Trailer with Truck | 50,800 | 70 |
| Bulldozer on Lowboy Trailer with Truck | 120,000 | 70 |
| 80-barrel water trucks – dust control | 54,000 loaded | 700 |
| 80-barrel water trucks – hydrostatic testing | 25,000 empty | 70-140 |
| Trackhoe on Lowboy Trailer with Truck | 91,000 | 70 |
| Welding trucks | 9,500 | 70 |
| Crew cab Pick Ups | 5,200 | 1,400 |
| Bending Machine/Trailer | 48,000 | 70 |
| Sidebooms on Lowboy Trailer with Truck | 63,000 | 70 |
| X-Ray Truck | 5,200 | 140 |
| Testing Truck | 6,000 | 70 |

**Table 2-8**
**Alternative C Traffic Estimates for Construction, Drilling, Completion, and Production Activities**

| Vehicle Type | Average Weight (lbs) | Estimated Round Trips |
|---|---|---|
| Pipe Trucks | 120000 loaded<br>36000 unloaded | 35 |
| Utility Tractor and Truck with Low Boy Trailer | 40,000 | 70 |
| Vehicles for Drilling/Completing First Well on the Pad | | |
| Drilling/Completion Rig | 120,000 | 35 |
| Rig-Up Trucks Loaded (including cement and fracturing) | 120,000 | 875 |
| Rig-Up Trucks Empty | 36,500 | 140-210 |
| 80-barrel water trucks loaded | 54,000 | 1,400 |
| 80-barrel water trucks empty | 25,000 | 1,400 |
| Crew-cab pick ups | 6,000 | 1,400 |
| Vehicles for Drilling/Completing Subsequent Wells on the same Pad | | |
| Motor Grader | 50,000 | 70 |
| Drilling/Completion Rig | 120,000 | 70 |
| Rig-Up Trucks Loaded (including cement and fracturing) | 120,000 | 875 |
| Rig-Up Trucks Empty | 36,500 | 140-210 |
| 80-barrel water trucks loaded | 54,000 | 1,575 |
| 80-barrel water trucks empty | 25,000 | 1,575 |
| Crew Cab Pick-Ups | 6,000 | 1,400 |
| Vehicles for Well Production | | |
| Workover rig | 120,000 | 105 |
| Haul trucks | 120,000 | 210 |

***Surface Disturbance***

Alternative C would construct up to 35 new well pads that would result in approximately 175 acres of short term disturbance and 70 acres of long term disturbance, and require 12 miles of new road construction and 13 miles of improvements to existing roads for access (totaling 91 acres of short-term disturbance and 48 acres of long-term disturbance). Under this alternative, there would also be 19 miles of new pipelines co-located with roads that would total 231 acres short-term disturbance and 37 acres long-term disturbance (there are no cross-country pipelines as part of this alternative). Details for these actions are shown in **Table 2-9**, Summary of Actions by Alternative; acreage area of disturbance are shown in **Table 2-11**, Summary of Surface Disturbance Acre by Alternative, which includes both short term (immediate construction) and long term (interim reclamation) disturbance amounts.

Traffic estimates are the same as those described in Alternative A. Following the cessation of disturbance operations necessary to facilitate drilling the first well on the pad, portions of the well pad and access road not needed for drilling would be reseeded and stabilized according to BLM specifications. Following well completions or the 6th year of development anticipated as the final season necessary for full build-out of this alternative, all portions of existing well pads not needed for production would be reseeded and reclaimed according to BLM specifications. Long-term well pad disturbance from the 35 new well pads would be reduced to 70 acres following successful interim reclamation.

**Figure 2-3**, Alternative C, Modified Action, presents the conceptual locations of potential well pads over areas currently thought to be most prospective for natural gas development.

*Conditions of Approval*
Alternative C includes additional design features to address air quality, wildlife, and water issues:

- The operator would be required to utilize and operate pneumatic devices, tanks and dehydrators in accordance with CDPHE and EPA Oil and Gas Regulations.
- The operator would apply dust abatement to unpaved roads to achieve at least 50 percent control during all construction and development phases. The operator would also apply dust abatement (greater than or equal to 50 percent) to unpaved roads during the production phase when expected traffic rates exceed 2 trips to each well-pad within the Unit per day.
- The operator would have a yearly meeting with the BLM to present an annual construction and operational activities plan of operations prior to the construction season.
- With an annual agreement by the operator as part of the annual Operations Plan, the operator would present the order for development phasing around the Unit to avoid widespread impacts on wintering big game species during a winter period.
- The operator would provide an annual reclamation monitoring status report that would present reclamation status, maps of reclamation areas, and identifying appropriate native seed mixes and their proper application.
- The operator would conduct annual raptor nesting surveys in the Unit to ensure compliance with the Migratory Bird Treaty Act. The surveys would occur within 0.25 mile of surface disturbing activities from April 15 to July 15 or until young of the year have fledged Activities would be avoided around occupied nests from April 15 to July 15; exceptions would be discussed with the authorized officer on a case-by-case basis.
- The operator would ensure that water accumulation on pads is not allowed to drain into wetlands or riparian areas down-gradient from the Unit.
- The operator would control noxious weeds within the Unit, including on or within wells pads, pipeline corridors, access roads and adjacent areas, temporary use areas, and any other area associated with natural gas development. The measures identified in **Appendix I**, Noxious Weed Management Plan, would be followed.

## 2.3 ALTERNATIVES CONSIDERED BUT ELIMINATED FROM DETAILED ANALYSIS

There were several elements of alternatives considered by the BLM during the development of the EA and the EIS. The elements considered during EA development came during the initial scoping period on the EA; those considered during EIS development came from public comments on the EA or were received after publication of the Notice of Intent. No individual or group submitted a complete alternative that included all elements of the project (well pads, well drilling, and pipelines). The elements and the reasons for eliminating them are described below.

### 2.3.1 Alternatives Considered and Eliminated during EA Development

***500-foot Development Setback***

During initial EA scoping, the Gunnison County Temporary Regulations for Oil and Gas Operations were discussed, and implementation of a required 500-foot development setback from waterways and riparian areas was considered. This setback requirement has since been changed to be a 300-foot requirement.

SGI and the BLM ran a modified GIS modeling program to incorporate this 500-foot setback from waterways and riparian areas. The resulting well site locations would have required an additional 5.6 miles of access roads and an additional 8.3 acres of long-term surface disturbance. This alternative also placed development higher on ridges and side-slopes. Therefore, the alternative was considered but eliminated from further analysis due to increased surface impacts associated with increased development and development on ridges and side slopes.

***Proximity to Road Networks***

Another alternative considered but not carried forward during EA development raised the issue of the overall length of roads and the amount of surface disturbance under the Proposed Action as an environmental concern. The BLM developed a set of weights and values for the GIS model criteria that would minimize road lengths and, therefore, surface disturbance, emphasizing proximity to existing road networks while reducing the weights on surface water and surrounding buffer zones. The well pad locations produced from the modified model were not uniformly distributed throughout the Unit and occurred in high-density groups in close proximity to existing roads, and many pad sites were within 300 feet of waterways. As a result, large portions of the Unit were excluded from development and only about half of the Unit's natural gas resource would have been drained. This alternative was considered but eliminated from further analysis because it did not meet the purpose and need for the proposal, and it was not consistent with the existing Unit agreement to efficiently develop the federal mineral resources.

### 2.3.2 Alternatives Considered and Eliminated from EIS Development

The alternatives considered but not carried forward in the earlier Draft EA and the public comments on the Draft EA were considered in the alternatives development for the EIS. Issues and comments are summarized in the Scoping Summary Report (BLM 2013b). Several commenters suggested additional mitigation measures for consideration in the alternatives. The comments were provided to the resource authors for consideration and inclusion in the impact analysis as appropriate. In addition, Alternative C was reviewed and modified to incorporate some suggestions. Comments requesting specific actions or alternatives are addressed below.

***Alternative Water Treatment Facilities***

Comments suggested that the BLM consider an alternative form of produced water management. Specifically the potential for on-site produced water treatment to meet NPDES discharge permit requirements and reuse water rather than deep well injection. During the development phase water is being managed and reused for operations (e.g., completion) as practicable. Large evaporation pond(s) and smaller on-site treatment (e.g., reverse osmosis units) were considered for dealing with produced water after the drilling and development and during the production and maintenance phase. Evaporation rates at higher altitudes and cooler temperatures hinder the ability to evaporate large volumes of water from ponds. Potential mitigation measures and/or processes such as smaller on-site units to address this issue at the APD stage are identified in Chapter 4, Environmental Consequences. Consequently a separate alternative was eliminated from further analysis.

***New Access Route Entry Points to the Unit***

Several commenters on the EA suggested that the BLM consider different access routes to well pads that would remove new roads or eliminate upgrades to roads, including highlighting specific sections of the Unit to avoid such as the Bull Mountain Ranch. Siting of access routes into the Unit was considered early on in the Proposed Action design process by the siting study (see **Appendix A**) that was specifically intended to take advantage of existing access routes and minimize the need for new roads and upgrades. In addition, other existing roads that could possibly provide access to the analysis area are shown on the maps. The MDP would not foreclose consideration of alternate access routes in the future, and other routes may be considered during site-specific analysis at the APD stage. Therefore, Alternatives A, B, and C provide an appropriate range of alternatives for analysis at this time.

***Extending Development to a Longer or Shorter Time Period***

Commenters suggested considering additional phasing timeframes to extend the drilling horizon past the 6 years estimated in the Proposed Action. Other commenters suggested the BLM consider requiring all of the development to occur at once and to be completed within 1 year. Drilling all 146 gas wells and 4 water disposal wells in one construction season is unviable due to insufficient rig and labor availability and limits the ability to incorporate the results of recent drilling into future drilling plans. The 6-year period is an assertive estimate.

***Additional Mitigation Measures***

Several commenters suggested that additional mitigation measures should be considered in the alternatives, including greenhouse gas and criteria pollutants emission mitigation measures, and well pad berming and lining measures. Several of these suggestions are already addressed under existing regulations such as New Source Performance Standards Subparts W and OOOO (40 CFR Part 60). Additionally, SGI includes emission reducing mitigations in their Greenhouse Gas Strategy and adopted as standard operating procedures for projects. Measures that were not covered under existing regulations or included as operator committed design measures were included for consideration in one or more alternative.

## 2.4 SUMMARY OF ALTERNATIVES

**Table 2-9**
**Summary of Actions by Alternative**[4]

| Phase | Action | Alternative A, No Action | Alternative B, Proposed Action | Alternative C, Modified Action |
|---|---|---|---|---|
| Construction | Well Pads | 11 new pads on Private mineral estate | 36 new pads on Federal mineral estate | 35 new pads on Federal mineral estate |
| | Access Roads | 26 miles upgrades to existing roads<br>5 miles new road construction | 53 miles upgrades to existing roads<br>16 miles new road construction | 13 miles upgrades to existing roads<br>12 miles new road construction |
| | | Construction Rate: 600-800 yards per day | | |
| | Pipelines | 4 miles new co-located with roads<br>8 miles new cross-country | 13 miles new co-located with roads<br>8 miles new cross-country | 19 miles new co-located with roads<br>0 miles new cross-country |
| | Electrical Lines | 1 new overhead electrical line<br>(up to 5 power poles) | 4 new overhead electrical lines<br>(up to 20 power poles) | 4 new buried electrical lines<br>(co-located with roads) |
| | Storage Areas | 1 additional storage yard developed on land owned by SGI within the Unit | | |
| Drilling | Gas Wells | 55 new gas wells | 146 new gas wells | 146 new gas wells |
| | | Timeframe<br>Coalbed Methane Natural Gas – 60 days<br>Shale and Sandstone – 85 days | | |
| | Water disposal Wells | 1 new water disposal well | 4 new water disposal wells | 4 new water disposal wells |
| | | Timeframe: 60 – 120 days | | |
| | Total Wells | 56 wells | 150 wells | 150 wells |
| | Drilling Rate | 3 Tier-2 or cleaner rigs drilling 27 wells per year | | |
| | Drilling Duration | 3 years | 6 years | |
| Completion | Gas Wells | Well completion duration: 8 – 10 days<br>Flow testing duration: 25 – 50 days | | |
| | Water disposal Wells | Well completion duration: 8 – 10 days | | |
| Production and Maintenance | Compressor Station | 1 new compressor station | 4 new compressor stations | |
| | Produced Water Management | Production: 500 – 3,000 barrels[5] per day | | |
| | | Coalbed Methane Natural Gas-produced water injected into water disposal wells or trucked to disposal location | | |

[4] If Alternative B or C is approved, the operations and development of private minerals described in Alternative A would likely continue to be implemented. Alternatives B and C display development and actions that would occur only on federal mineral estate (which falls within the BLM's decision making authority).
[5] 1 barrel = 42 gallons, standard US oil barrel volume

**Table 2-9**
**Summary of Actions by Alternative[4]**

| Phase | Action | Alternative A, No Action | Alternative B, Proposed Action | Alternative C, Modified Action |
|---|---|---|---|---|
| Water Use and Sources | Drilling | Up to 21.3 acre-feet[6] | 58 acre-feet | |
| | Completion | Up to 714.3 acre-feet[7] | Up to 2,369.3 acre-feet | |
| | Dust abatement | Up to 13.2 acre-feet of fresh water | Up to 52.9 acre-feet of fresh water | |
| | Source for all uses | 30% fresh water and 70% recycled and/or produced water | | |
| | Total Water Usage for Drilling and Completion[8] (based on source percentages noted above) | Total water: 748.8 acre-feet<br>Fresh water: 220.7 acre-feet<br>Recycled/produced water: 514.9 acre-feet | Total water: 2,480.2 acre-feet<br>Fresh water: 744.1 acre-feet<br>Recycled/produced water: 1736.1 acre-feet | |

[6] Combined water disposal and gas wells, based on an average of 3,000 barrels per well. Conversion factor is 7,758 barrels per acre-foot.

[7] Calculated based on assuming 50 percent coalbed natural gas wells and 50 percent shale wells as discussed in the Bull Mountain EA. Water amounts for each type of well were taken from the Master Drilling Plan in Appendix E. Calculations used number of new gas wells per alternative divided in half for each type of well (coalbed methane/shale). To estimate the amount of water use per well type, the number of wells was multiplied by the highest amount of water use for that well type. Water usage totals were added together for a total maximum amount of water usage during completion.

[8] Amounts were calculated based on adding together the Drilling, Completion, and Dust abatement amounts together. The total was multiplied by 30 percent to determine the fresh water amount and 70 percent to determine the amount of recycled/produced water that would be used.

**Table 2-10**
**Stipulations and Conditions of Approval**

<table>
<tr><th></th><th>Alternative A, No Action</th><th>Alternative B, Proposed Action</th><th>Alternative C, Modified Action</th></tr>
<tr><td>Lease Stipulations</td><td colspan="3">Standard stipulations as listed on individual leases apply.<br>Additional lease stipulations that apply within the Unit:<br>• Timing Limitation Stipulation: To protect crucial deer and elk winter ranges. No surface use is allowed from December 1 through April 30. This stipulation does not apply to operation and maintenance of production facilities.<br>• All lands of the following leases are subject to Colorado lease notice exhibit CO-34, Lease Notice: To alert lessee of potential habitat for threatened endangered, candidate, or other special status plant or animal.<br>Bull Mountain Unit Agreement stipulations:<br>• The terms, conditions, and provisions of all leases, subleases, and other contracts relating to exploration, drilling, development or operation for oil or gas on lands committed to this agreement are hereby expressly modified and amended to the extent necessary to make the same conform to the provisions hereof, but otherwise to remain in full force and effect.</td></tr>
<tr><td rowspan="6">Plans and Strategy Documents</td><td colspan="3">Master Surface Use Plan of Operations (Appendix D)</td></tr>
<tr><td colspan="3">Master Drilling Plan (Appendix E)</td></tr>
<tr><td colspan="3">Hazardous Materials Management Summary (Appendix G)</td></tr>
<tr><td colspan="3">Noxious Weed Management Plan (Appendix I)</td></tr>
<tr><td colspan="3">Bainard Augmentation Plan (Appendix L)</td></tr>
<tr><td colspan="3">Poly Pipeline Operations Plan (Appendix M)</td></tr>
<tr><td>Factors and Constraints for Site Suitability</td><td colspan="2">Weighted Factors<br>• Slope<br>• Sensitivity to visual impacts from Highway 133 and County Road 265 travel routes<br>• Proximity to existing road networks<br>• Proximity to existing gathering pipeline system<br>• Proximity to delineated wetlands and wetland buffer zones<br>• Proximity to stream networks and stream buffer zones<br>• Proximity to known streams containing Colorado River Cutthroat Trout<br>• Soil erosion factors<br>• Vegetated areas and open meadows</td><td>Weighted Factors are the same as Alternatives A and B; however, the factors were re-weighted to minimize surface disturbance by putting greater emphasis on soil types and co-locating roads and pipelines.<br><br>Additional factor considered:<br>• Verified elk winter concentration areas</td></tr>
<tr><td>Conditions of Approval</td><td>No similar action[9]</td><td>Alternative B includes the COAs in</td><td>Alternative C includes the COAs listed</td></tr>
</table>

[9] Alternative A only includes non-federal wells; BLM conditions of approval, stipulations, and best management practices would only apply to BLM-permitted actions. As such, the noted conditions of approval would not apply to Alternative A, therefore there is no similar action under Alternative A.

**Table 2-10**
**Stipulations and Conditions of Approval**

| | Alternative A, No Action | Alternative B, Proposed Action | Alternative C, Modified Action |
|---|---|---|---|
| | | Appendix C plus the following:<br>• The operator would conduct raptor nesting surveys in the Unit to ensure compliance with the Migratory Bird Treaty Act. The surveys would occur within 0.25 mile of surface disturbing activities from April 15 to July 15. Activities would be avoided around occupied nests from April 15 to July 15; exceptions would be discussed with the authorized officer on a case-by-case basis.<br>• Potential BMPs in Appendix C would be selectively applied as mitigation. | in Appendix C plus the following:<br>• The operator would be required to use and operate pneumatic devices, tanks and dehydrators in accordance with CDPHE and EPA Oil and Gas Regulations..<br>• The operator would apply dust abatement to unpaved roads to achieve at least 50% control during all construction and development phases. The operator would also apply dust abatement (greater than or equal to 50%) to unpaved roads during the production phase when expected traffic rates exceed 2 trips to each well pad within the Unit per day.<br>• The operator would have a yearly meeting with the BLM to present an annual construction and operational activities plan of operations prior to the construction season.<br>• With an annual agreement by the operator as part of the annual Operations Plan, the operator would present the order for development phasing around the Unit to avoid widespread impacts on wintering big game species during a winter period.<br>• The operator would provide an annual reclamation monitoring status report that would present reclamation status, maps of reclamation areas, and identifying appropriate native seed mixes and |

**Table 2-10**
**Stipulations and Conditions of Approval**

| | Alternative A, No Action | Alternative B, Proposed Action | Alternative C, Modified Action |
|---|---|---|---|
| | | | their proper application.<br>• The operator would conduct raptor nesting surveys in the Unit to ensure compliance with the Migratory Bird Treaty Act. The surveys would occur within 0.25 mile of surface disturbing activities from April 15 to July 15 or until young of the year have fledged. Activities would be avoided around occupied nests from April 15 to July 15; exceptions would be discussed with the authorized officer on a case-by-case basis.<br>• The operator would ensure that water accumulation on pads is not allowed to drain into wetlands or riparian areas down-gradient from the Unit.<br>• The operator would control noxious weeds within the Unit, including on or within wells pads, pipeline corridors, access roads and adjacent areas, temporary use areas, and any other area associated with natural gas development. The measures identified in Appendix I would be followed.<br>• Potential BMPs in Appendix C would be selectively applied as mitigation. |

## 2.5 SUMMARY OF IMPACTS

**Table 2-11**
**Summary of Surface Disturbance Acres by Alternative**

| | Alternative A | | Alternative B | | Alternative C | |
|---|---|---|---|---|---|---|
| **Project Feature** | **Short-term surface disturbance** | **Long-term surface disturbance** | **Short-term surface disturbance** | **Long-term surface disturbance** | **Short-term surface disturbance** | **Long-term surface disturbance** |
| New well pads | 55 acres | 22 acres | 180 acres | 72 acres | 175 acres | 70 acres |
| Access Roads | | | | | | |
| Upgrades to existing | 92 acres | 49 acres | 183 acres | 97 acres | 47 acres | 25 acres |
| New road construction | 17 acres | 9 acres | 60 acres | 32 acres | 44 acres | 23 acres |
| Pipelines | | | | | | |
| New co-located with roads | 54 acres | 9 acres | 159 acres | 25 acres | 231 acres | 37 acres |
| New cross-country | 47 acres | 0 acres | 47 acres | 0 acres | 0 acres | 0 acres |
| Facilities | | | | | | |
| New Compressor Stations | 5 acres | 2 acres | 20 acres | 8 acres | 20 acres | 8 acres |
| Storage Yard | 5 acres | 2 acres | 5 acres | 2 acres | 5 acres | 2 acres |
| **Total Acres[10]** | **260 acres** | **88 acres** | **592 acres** | **214 acres** | **441 acres** | **126 acres** |

[10] Acreage amounts presented under each type of disturbance (roads, pipelines, etc.) are not summed to give the total estimated short- and long-term disturbance acreages. The total short- and long-term disturbance acreages are calculated without any overlapping areas; for example, co-located pipelines and roads are only counted once rather than double counted. Cumulative impacts are discussed in Chapter 4.

**Table 2-12**
**Estimated Total Traffic Round Trips for Drilling, Completion, and Production Activities by Alternative[1]**

| Vehicle Type | Alternative A, No Action (11 well pads) | Alternative B, Proposed Action (36 well pads) | Alternative C, Modified Action (35 well pads) |
|---|---|---|---|
| Vehicles for Pad and Access Road Construction | | | |
| Gravel trucks | 1,760 | 5,760 | 5,600 |
| Semi trucks | 44 | 144 | 140 |
| Pick-up trucks | 440 | 1,440 | 1,400 |
| Motor grader | 11 | 36 | 35 |
| Dozer (2) | 22 | 72 | 70 |
| Trackhoe | 11 | 36 | 35 |
| Pipeline Construction | | | |
| Motor Grader on Lowboy Trailer with Truck | 22 | 72 | 70 |
| Bulldozer on Lowboy Trailer with Truck | 22 | 72 | 70 |
| 80-barrel water trucks – dust control | 220 | 720 | 700 |
| 80-barrel water trucks – hydrostatic testing | 22-44 | 72-144 | 70-140 |
| Trackhoe on Lowboy Trailer with Truck | 22 | 72 | 70 |
| Welding trucks | 22 | 72 | 70 |
| Crew cab Pick Ups | 440 | 1,440 | 1,400 |
| Bending Machine/Trailer | 22 | 72 | 70 |
| Sidebooms on Lowboy Trailer with Truck | 22 | 72 | 70 |
| X-Ray Truck | 44 | 144 | 140 |
| Testing Truck | 22 | 72 | 70 |
| Pipe Trucks | 11 | 36 | 35 |
| Utility Tractor and Truck with Low Boy Trailer | 22 | 72 | 70 |
| Vehicles for Drilling/Completing First Well on the Pad | | | |
| Drilling/Completion Rig | 11 | 36 | 35 |
| Rig-Up Trucks Loaded | 275 | 900 | 875 |
| Rig-Up Trucks Empty | 44-66 | 144-216 | 140-210 |
| 80-barrel water trucks loaded | 440 | 1,440 | 1,400 |
| 80-barrel water trucks empty | 440 | 1,440 | 1,400 |
| Crew-cab pick ups | 440 | 1,440 | 1,400 |
| Vehicles for Drilling/Completing Subsequent Wells on the same Pad | | | |
| Motor Grader | 22 | 72 | 70 |
| Drilling/Completion Rig | 22 | 72 | 70 |
| Rig-Up Trucks Loaded | 275 | 900 | 875 |
| Rig-Up Trucks Empty | 44-66 | 144-216 | 140-210 |
| 80-barrel water trucks loaded | 495 | 1,620 | 1,575 |
| 80-barrel water trucks empty | 495 | 1,620 | 1,575 |

**Table 2-12**
**Estimated Total Traffic Round Trips for Drilling, Completion, and Production Activities by Alternative[1]**

| Vehicle Type | Alternative A, No Action (11 well pads) | Alternative B, Proposed Action (36 well pads) | Alternative C, Modified Action (35 well pads) |
|---|---|---|---|
| Crew Cab Pick-Ups | 440 | 1,440 | 1,400 |
| Vehicles for Well Production | | | |
| Workover rig | 17 | 108 | 105 |
| Haul trucks | 66 | 216 | 210 |
| Pick-up trucks (trips per well) | 4 round trips per day for WDWs<br>71 round trips per day for gas wells | 8 round trips per day for WDWs<br>162 round trips per day for gas wells | 8 round trips per day for WDWs<br>162 round trips per day for gas wells |

[1] Number of trips per well pad are found in **Table 2-1**, Traffic Estimates for Construction, Drilling, Completion, and Production Activities per Well Pad

**Table 2-13**, Summary of Environmental Consequences by Alternative, provides a brief summary comparison of resource-specific direct and indirect impacts that could or would result from implementation of the alternatives. Detailed discussions (including quantitative and cumulative) on impacts or environmental consequences are addressed within Chapter 4 of this EIS.

**Table 2-13**
**Summary of Environmental Consequences by Alternative**

| Resource/Use | Alternative A, No Action | Alternative B, Proposed Action | Alternative C, Modified Action |
|---|---|---|---|
| Air Resources | ▪ Near-field pollutant impacts would below the NAAQS or CAAQS. In addition impacts would not exceed the PSD Class II increments, with the exception of annual $NO_2$ concentrations that could exceed the annual increment value.<br>▪ Direct modeled concentrations of $NO_2$, $SO_2$, $PM_{10}$, and $PM_{2.5}$ at Class sensitive Class II areas and I are well below the PSD Class I and Class II increments.<br>▪ Visibility analysis indicated that there are zero days predicted above the 0.5 delta-deciview threshold at any of the Class I and sensitive Class II areas<br>▪ For all lakes the estimated changes in | ▪ Total ambient air concentrations are less than the applicable NAAQS and CAAQS.<br>▪ Direct modeled concentrations are below the applicable PSD Class II increments, with the exception of the modeled annual $NO_2$ concentration which is above the annual increment value.<br>▪ HAP impacts are below the applicable short-term RELs and the long-term non-carcinogenic RfCs, with the exception of the maximum modeled formaldehyde concentration from compression emissions which at 81.6 $\mu g/m^3$ is above the short-term REL | ▪ Near-field pollutant impacts for Alternative C would be similar to those presented below for Alternative B. Impacts from Alternative C sources would below the NAAQS or CAAQS. In addition impacts would not exceed the PSD Class II increments, with the exception of annual $NO_2$ concentrations which could exceed the annual increment value.<br>▪ HAP impacts from well site production would be similar to the impacts for the Alternative B<br>▪ Pollutant impacts would be similar to those presented in for Alternative B<br>▪ Visibility impacts estimated resulting |

**Table 2-13**
**Summary of Environmental Consequences by Alternative**

| Resource/Use | Alternative A, No Action | Alternative B, Proposed Action | Alternative C, Modified Action |
|---|---|---|---|
| | ANC are all predicted to be less than the significance thresholds of less than a 10 percent change in ANC for lakes with ANC values greater than 25 µeq/l, and a 1.0 µeq/l change in ANC for lakes with background ANC values equal to or less than 25 µeq/l<br>▪ The degree to which any observable changes can, or would, be attributable to Alternative A cannot be reasonably predicted at this time | threshold of 55 µg/m$^3$.<br>▪ Direct modeled concentrations of $NO_2$, $SO_2$, $PM_{10}$, and $PM_{2.5}$ at Class I and sensitive Class II areas are well below the PSD Class I and Class II increments.<br>▪ The visibility analysis indicated that there are zero days predicted above the 0.5- delta-deciview threshold at any of the Class I and sensitive Class II areas.<br>▪ The maximum predicted visibility impact was 0.45 delta-deciview occurring at the Maroon Bells - Snowmass Wilderness Area<br>▪ For all lakes the estimated changes in ANC are all predicted to be less than the significance thresholds of less than a 10 percent change in ANC for lakes with ANC values greater than 25 µeq/l, and a 1.0 µeq/l change in ANC for lakes with background ANC values equal to or less than 25 µeq/l.<br>▪ The degree to which any observable changes can, or would, be attributable to Alternative B cannot be reasonably predicted at this time | from Alternative C emissions would be similar to those presented for Alternative B<br>▪ Nitrogen deposition impacts under Alternative C would be less than the impacts for Alternative B and greater than the impacts for Alternative A. Sulfur deposition impacts would be below the DAT.<br>▪ The degree to which any observable changes can, or would, be attributable to Alternative C cannot be reasonably predicted at this time<br>▪ Additional Mitigation Measures:<br>o The BLM would place a COA on each permit, requiring the operator to apply continuous (keep surface moist) watering during access road and well-pad construction activities and during heavy traffic periods including drilling and completion phases of well development. The operator would be required to limit off-site transport by maintaining "no visible dust plume" operations.<br>o The BLM would place a COA on each permit, requiring the operator to emit 5 tons per year or less of NOx at each well-pad for production operations (post-construction and production phase) as defined by the acceptable emissions level analyzed in the $NO_2$ 1-hour modeling analysis. The operator |

**Table 2-13**
**Summary of Environmental Consequences by Alternative**

| Resource/Use | Alternative A, No Action | Alternative B, Proposed Action | Alternative C, Modified Action |
|---|---|---|---|
| | | | would be required to submit a detailed well-pad production emissions inventory for each APD or details for the well-pad production equipment and operations (including refined emissions factors) to use to develop project-specific emissions inventories. An annual NOx emissions rate greater than 5 tons per year may be acceptable if the operator can demonstrate compliance with the $NO_2$ 1-hour NAAQS for the APD. Any additional impacts analyses would be reviewed and approved by the BLM prior to BLM authorizing activities.<br>o The BLM would place a COA on each permit, requiring the operation of Tier 2 engines or cleaner for drilling, fracturing, and completion activities. The operator would be required to submit a detailed well-pad development phase emissions inventory for each APD or details for the well-pad development equipment and operations (including refined emissions factors and hours of operation) to use to develop project-specific emissions inventories. Operation of engines totaling greater than 2,000 hp at any one time during the development phase (this total |

**Table 2-13**
**Summary of Environmental Consequences by Alternative**

| Resource/Use | Alternative A, No Action | Alternative B, Proposed Action | Alternative C, Modified Action |
|---|---|---|---|
| | | | horsepower was analyzed for the EIS-specific NO2 1-hour impacts analysis) could trigger the need for additional impacts analysis and potentially warrant a requirement (COA) for Tier 3-4 engines. The goal of the requirement is for development-related (e.g., drill, completion, and fracturing) engines to emit no more than 1 gram per second of NOx total at any one time (total of all engines operating concurrently), unless another NOx emissions rate can be demonstrated to achieve compliance with the $NO_2$ 1-hour NAAQS<br>o The BLM would require the operator to provide a detailed Unit-wide equipment configuration plan (with specific information for the pumping units) and emissions inventory for BLM review that shows a plan and projection for Unit-wide federal wells production phase NOx emissions at or below 143 tons per year of NOx (annual NOx emissions level limit determined using the acceptable project-level nitrogen deposition threshold [0.005 kg/ha-yr] and an equation of a line for the annual NOx emissions levels and corresponding modeled nitrogen deposition for Alternatives A and |

**Table 2-13**
**Summary of Environmental Consequences by Alternative**

| Resource/Use | Alternative A, No Action | Alternative B, Proposed Action | Alternative C, Modified Action |
|---|---|---|---|
| | | | B). The BLM would place a COA on each permit (APD), requiring the operator to submit a NOx emissions accounting analysis summary that provides information for how the APD emissions fit into the overall Unit-wide production phase (post construction and development) NOx emissions budget (approximately143 tons per year of NOx). |
| Noise | ▪ Short-term, localized, and intermittent daytime noise impacts during approximately 60 days of construction. Localized impacts 24 hours per day during well drilling; potentially greater at night.<br>▪ Construction-related traffic would produce intermittent noise impacts, with greater impacts occurring on more heavily used routes such as SH 133. Construction traffic would generally not occur during nighttime hours; therefore, would not affect the more sensitive nighttime ambient noise levels.<br>▪ Potential for increased noise levels related to well drilling, pumping, and operations at:<br>  ▪ 1 residence (T11S R90W Section 13)<br>However, well pad construction, drilling, and operations are estimated to be within the maximum permissible noise levels allowed under COGCC | ▪ Impacts on noise from construction activities and construction traffic would be similar to Alternative A, but would be elevated given the increased level (3 times more than Alternative A) and duration (6 years) of development.<br>▪ Potential for increased noise levels related well drilling, pumping, and operations at:<br>  ▪ 3 residences (T11S R90W Section 27)<br>  ▪ 6 residences (T12S R89W Sections 4 and 9)<br>▪ Potential for increased noise levels related to pipeline construction at:<br>  ▪ 6 residences (T12S R89W Sections 4 and 9)<br>  ▪ 9 residences (T11S R89W Section 31)<br>▪ Potential for increased noise levels related to new access road at:<br>  ▪ 6 residences (T12S R89W Sections 4 and 9)<br>Similar to Alternative A, noise levels | ▪ Impacts on noise from construction activities would be similar to Alternative B, but the same number of wells would be concentrated in fewer areas, resulting in potential increased localized noise impacts during construction.<br>▪ Potential for increased noise levels related well drilling, pumping, and operations at:<br>  ▪ 1 residence (T11S R90W Section 11)<br>  ▪ 6 residences (T12S R89W Sections 4 and 9)<br>▪ Potential for increased noise levels related to pipeline construction at:<br>  ▪ 6 residences (T12S R89W Sections 4 and 9)<br>  ▪ 1 residence (T11S R89W Section 31)<br>▪ Potential for increased noise levels related to new access road at:<br>▪ 6 residences (T12S R89W Sections 4 and 9) |

**Table 2-13**
**Summary of Environmental Consequences by Alternative**

| Resource/Use | Alternative A, No Action | Alternative B, Proposed Action | Alternative C, Modified Action |
|---|---|---|---|
| | rules.<br>▪ Projected noise level from 1 new compressor station would be below 26 dBA. However, there would be potential low frequency sounds.<br>  ▪ nearest residence located approximately 3,000 feet east of the proposed site<br>▪ Mitigation measures (such as siting to avoid impacts and requiring mufflers and other sound reducing-measures) would be determined during permitting and subsequent environmental review. | are estimated to be within the maximum permissible allowed under COGCC rules.<br>▪ Similar to Alternative A, projected noise level from 4 new compressor stations would be below 26 dBA. Like Alternative A, there would be potential low frequency sounds.<br>  ▪ nearest residence located approximately 3,000 feet east of the proposed compressor station in T11S R90W Section 24<br>  ▪ nearest residents are 0.5 to 1 mile away from the other three compressor site locations<br>▪ Implementing specific BMPs would ensure compliance with COGCC maximum permissible noise levels and minimize potential noise impacts. | ▪ Like Alternative A, well pad construction, pipeline and access road construction, and well drilling and operations are estimated to be within the maximum permissible noise levels allowed under COGCC rules.<br>▪ Compressor station-related noise impacts and mitigation would be the same as described under Alternative B.<br>▪ Impacts from implementing specific BMPs would be the same as Alternative B. |
| Soil Resources | ▪ Impacts include compaction from overland travel and land grading, vegetation clearing, increased erosion, runoff and sedimentation. | ▪ Impacts on soils would be similar to Alternative A but on a larger scale.<br>▪ Design features for erosion and sediment control reduce the likelihood for long-term soil impacts. | ▪ Impacts on soils would be similar to Alternative A but on a larger scale.<br>▪ Design features for erosion and sediment control reduce the likelihood for long-term soil impacts. |
| Water Resources | ▪ Water quantity:<br>  ▪ 32 acre-feet required from Muddy Creek (minor % of total flow).<br>▪ Water quality:<br>  ▪ Least amount of impacts on surface water quality from spills or chemical releases.<br>  ▪ Potential impacts on groundwater quality from spills or releases from HPDE pipes.<br>▪ Groundwater:<br>  ▪ Least amount of impacts from | ▪ Water quantity:<br>  ▪ Same augmentation requirements as Alternative A but for a longer time.<br>▪ Water quality:<br>  ▪ More development over a larger area could result in greater impacts on surface water quality from spills and release of chemicals.<br>  ▪ Increased risk of impacts on groundwater quality resulting from the increased number of | ▪ Water quantity:<br>  ▪ Impacts would be nearly identical to those under Alternative B, except water consumption less for dust control.<br>▪ Water quality:<br>  ▪ Impacts on surface water and groundwater quality from spills and chemical releases would be the same as Alternative B.<br>  ▪ Increased risk of impacts on groundwater quality resulting |

**Table 2-13**
**Summary of Environmental Consequences by Alternative**

| Resource/Use | Alternative A, No Action | Alternative B, Proposed Action | Alternative C, Modified Action |
|---|---|---|---|
| | drilling.<br>▪ Least amount of impacts from hydraulic fracturing.<br>▪ Wastewater:<br>▪ Lowest volume of water to be disposed in the injection wells. | facilities than Alternative A.<br>▪ Groundwater:<br>▪ Drilling impacts similar to Alternative A, but would occur over a longer duration.<br>▪ Impacts from hydraulic fracturing would be minor and similar to Alternative A, but would occur over a longer duration. No impacts on potable groundwater expected.<br>▪ Wastewater:<br>▪ Impacts of disposal of production wastewater are expected to be minor.<br>▪ Design features 103-133 would reduce potential impacts. | from the increased number of facilities than Alternative A.<br>▪ Groundwater:<br>▪ Impacts from drilling and hydraulic fracturing activities would be the same as under Alternative B.<br>▪ Wastewater:<br>▪ Impacts would be the same as Alternative B.<br>▪ Design features 103-133 would reduce potential impacts. |
| Geology | ▪ Slope stability:<br>▪ Potential impacts on well pads east of SH 133 from slope failure less likely; however, creep may occur.<br>▪ Potential impacts on well pads west of SH 133 would likely be avoided.<br>▪ Roads would not likely contribute to slope failure.<br>▪ Earthquake potential:<br>▪ Low potential for inducing surface earthquakes. | ▪ Slope stability:<br>▪ Impacts would be similar to Alternative A, except risk is increased by a larger area of pads and larger number of miles of roads and pipelines.<br>▪ Design feature 97 would reduce potential impacts. Earthquake potential:<br>▪ Increased risk of inducing strong earthquakes due to increased volume of waste fluid disposal; however, degree of increased risk cannot be easily predicted. Overall risk considered low. | ▪ Slope stability:<br>▪ Impacts would be greater than under Alternative A, but the impacts would be minimized by avoidance of steep slopes to the extent possible, and by implementation of BMPs.<br>▪ Design feature 97 would reduce potential impacts.<br>▪ Earthquake potential:<br>▪ Impacts similar to Alternative B. |
| Vegetation | ▪ Impacts include increased fragmentation of vegetation communities; decreased productivity due to increased erosion, sediment deposition, and fugitive dust; increased | ▪ Impacts similar to Alternative A, but would occur over a larger area.<br>▪ Design features would be applied to minimize impacts on vegetation.<br>▪ Mandatory noxious and invasive weed | ▪ Impacts would be the same as Alternative B, but would occur over a smaller area.<br>▪ Interim reclamation would go further in restoring a native plant community |

**Table 2-13**
**Summary of Environmental Consequences by Alternative**

| Resource/Use | Alternative A, No Action | Alternative B, Proposed Action | Alternative C, Modified Action |
|---|---|---|---|
| | potential for wildfires; and increased potential for the spread of invasive and noxious plants. | controls would reduce likelihood of weed spread. | compared to Alternatives A. |
| Fish and Wildlife | ▪ Terrestrial wildlife:<br>▪ Impacts include increased fragmentation in disturbed areas; reduced habitat value or use by wildlife; temporary habitat loss due to changes in vegetation structure; avoidance of habitat or temporary displacement from habitat caused by increased human activity, traffic, noise, and lighting, which could increase physical distress, energy expenditure, competition for resources, and decrease nutritional condition and reproductive success; displacement from crucial winter habitats due to winter drilling; increased potential for disruption of migration routes and prevention of access to sufficient foraging and water resources; and increased potential for collisions with vehicles.<br>▪ Timing limitations may reduce impacts on deer and elk crucial winter range.<br>▪ Aquatic wildlife:<br>▪ Potential impacts on fish from boring pipelines.<br>▪ In the short and long term, water depletions would threaten the quantity of aquatic habitat for fish and other aquatic species known to inhabit the Unit. | ▪ Terrestrial wildlife:<br>▪ Impacts similar to Alternative A, but would be the greatest due to occurring over a larger area.<br>▪ Timing limitations may reduce impacts on deer and elk crucial winter range.<br>▪ Design features, and site-specific COAs and APDs would be applied to minimize impacts on wildlife.<br>▪ Aquatic wildlife:<br>▪ Potential impacts on fish from boring pipelines less than Alternative A.<br>▪ Aquatic habitat would be most affected by surface water depletions. | ▪ Terrestrial wildlife:<br>▪ Impacts similar to Alternative A, but would occur over a larger area.<br>▪ The progressive development plan would directly increase habitat protection for deer and elk winter habitat and indirectly increase habitat protection for other wildlife species which may inhabit those areas.<br>▪ Design features, and site-specific COAs and APDs would be applied to minimize impacts on wildlife.<br>▪ Aquatic wildlife:<br>▪ Potential impacts on fish from boring pipelines less than Alternative A.<br>▪ Aquatic wildlife and their habitat would be impacted more than Alternative A as a result of increased water depletions; however, water use would be less than the water withdrawals proposed under Alternative B. |

**Table 2-13**
**Summary of Environmental Consequences by Alternative**

| Resource/Use | Alternative A, No Action | Alternative B, Proposed Action | Alternative C, Modified Action |
|---|---|---|---|
| Migratory Birds | ▪ Neotropical species:<br>  ▪ Reduced habitat availability in the short and long term for sagebrush obligate species.<br>  ▪ Reduced irrigated meadow habitat could possibly impact American bittern, although habitat is limited within the Unit.<br>▪ Raptors:<br>  ▪ Surface disturbance within irrigated meadow and sagebrush vegetation would reduce habitat and hunting grounds for golden eagles and prairie falcons in the short and long term. | ▪ Neotropical species:<br>  ▪ Sagebrush vegetation would be most impacted under this alternative in both the short- and long-term; therefore, sagebrush obligate species would have decreased habitat.<br>  ▪ Oakbrush and some aspen habitat would be disturbed in the short and long term.<br>  ▪ Impacts on American bittern would be similar to Alternative A, but would occur over a larger area.<br>▪ Raptors:<br>  ▪ Impacts on golden eagles and prairie falcons from surface disturbance would be similar to Alternative A, but would occur over a larger area.<br>▪ Migratory bird impacts would be mitigated by applying design features and nesting surveys.<br>▪ From May 15- July 15, no surface-disturbing activities shall occur in order to protect breeding migratory birds. | ▪ Neotropical species:<br>  ▪ Impacts would be similar to Alternative B, but would occur over a smaller area.<br>▪ Raptors:<br>  ▪ Impacts would be similar to Alternative B but would occur over a smaller area.<br>▪ Like Alternative B, migratory bird impacts would be mitigated by applying design features and nesting surveys.<br>▪ Additionally, new electrical lines to power the four proposed water disposal wells would be buried adjacent to roads to minimize potential overhead disturbance. |
| Special Status Species | ▪ Impacts on special status wildlife includes increased fragmentation in disturbed areas; reduced habitat value or use by wildlife; temporary habitat loss due to changes in vegetation structure; avoidance of habitat or temporary displacement from habitat caused by increased human activity, traffic, noise, and lighting, which could | ▪ Impacts on special status wildlife are similar to Alternative A, but would be the greater due to occurring over a larger area. Adherence to applicable BMPs, and attaching site-specific COAs and APDs would minimize the potential for impacts on Threatened, Endangered, and Candidate species. BMPs and BLM adopted mitigation | ▪ Impacts on special status wildlife are similar to Alternative A, but would occur over a larger area. Adherence to applicable BMPs, and attaching site-specific COAs and APDs would minimize the potential for impacts on Threatened, Endangered, and Candidate species.<br>▪ Similar to Alternative B, implementing |

**Table 2-13**
**Summary of Environmental Consequences by Alternative**

| Resource/Use | Alternative A, No Action | Alternative B, Proposed Action | Alternative C, Modified Action |
|---|---|---|---|
| | increase physical distress, energy expenditure, competition for resources, and decrease nutritional condition and reproductive success; displacement from crucial winter habitats due to winter drilling; increased potential for disruption of migration routes and prevention of access to sufficient foraging and water resources; and increased potential for collisions with vehicles.<br>▪ Implementing SGI's Well Pad Site Suitability Models and Methodologies would likely result in no water quality impacts on the four endangered Colorado River fish species. Impacts of additional water depletions could be mitigated by SGI.<br>▪ *"No effect"* on no species,<br>▪ *"May affect but is not likely to adversely affect"* Canada lynx,<br>▪ *"May affect, and is likely to adversely affect"* Colorado pikeminnow, razor back sucker, humpback chub, and bonytail chub.<br>▪ *"May affect, and is not likely to adversely affect"* greenback cutthroat trout.<br>▪ *"May adversely impact individuals, but is not likely to result in a loss of viability on the Unit, nor cause a trend to federal listing or a loss of species viability range-wide"* northern goshawk, bald eagle, Brewer's sparrow, and leopard frog.<br>▪ *"No impacts on these species, and* | would make activities compliant with the 1999 Programmatic BO and Recovery Agreement and ensure continued recovery of those listed fish species.<br>▪ Implementing SGI's water augmentation plan would require much less water depletions within the Unit, reducing impacts on endangered Colorado and Gunnison River Fish.<br>▪ "*No effect"* on greenback cutthroat trout.<br>▪ *"May affect but is not likely to adversely affect"* Canada lynx and bald eagle.<br>▪ *"May affect, and is likely to adversely affect"* no species.<br>▪ *"Not likely to jeopardize the continued existence*" Colorado pikeminnow, razorback sucker, humpback chub, bonytail chub.<br>▪ *"May adversely impact individuals, but is not likely to result in a loss of viability on the Unit, nor cause a trend to federal listing or a loss of species viability range-wide"* northern goshawk, Brewer's sparrow, and leopard frog.<br>▪ *"No adverse impacts on these species, and would not result in a loss of viability on the project area, nor cause a trend to federal listing or a loss of species viability range-wide"* BLM listed bat species. | SGI's water augmentation plan would require much less water depletions within the Unit, reducing impacts on endangered Colorado and Gunnison River Fish.<br>▪ *"No effect"* on greenback cutthroat trout.<br>▪ *"May affect but is not likely to adversely affect"* Canada lynx and bald eagle.<br>▪ *"May affect, and is likely to adversely affect"* no species<br>▪ *"Not likely to jeopardize the continued existence"* Colorado pikeminnow, razorback sucker, humpback chub, and bonytail chub.<br>▪ *"May adversely impact individuals, but is not likely to result in a loss of viability on the Unit, or cause a trend to federal listing nor a loss of species viability range-wide"* northern goshawk, Brewer's sparrow, and leopard frog.<br>▪ *"No adverse impacts on these species, and would not result in a loss of viability on the project area, nor cause a trend to federal listing or a loss of species viability range-wide"* BLM listed bat species. |

**Table 2-13**
**Summary of Environmental Consequences by Alternative**

| Resource/Use | Alternative A, No Action | Alternative B, Proposed Action | Alternative C, Modified Action |
|---|---|---|---|
| | *would not result in a loss of viability on the project area, nor cause a trend to federal listing or a loss of species viability range-wide"* BLM listed bat species. | | |
| Wildland Fire Management | ▪ Natural gas well development may increase the risk of wildfires by introducing new ignition sources, increasing human activity, and increasing invasive weeds.<br>▪ Natural gas well development may pose a hazard to firefighters from toxins, fighting fires and evacuating personnel, and risks from overhead power lines.<br>▪ New and improved access roads may improve access for wildland fire suppression activities.<br>▪ Proposed development may also create fuel breaks that could prevent the spread of wildland fires. | ▪ Impacts would be similar to Alternative A; however, the risk of human caused ignition from construction and firefighter hazards would be increased due to increased level of development. | ▪ Impacts would be similar to Alternative B; however, fewer new well pads would be constructed, therefore the likelihood of ignition and hazards would be decreased.<br>▪ Additional design features to protect other resources, burying four overhead lines, and an annual reclamation monitoring status report may also provide indirect reduction of wildfire risk. |
| Cultural Resources | ▪ Specific numbers of impacted cultural resources under Alternative A are unavailable, though previous work in the Unit indicates that the resources are sparsely distributed (Millward 2013). Impacts on cultural resources would be assessed on a case-by-case or APD-specific basis.<br>▪ Potential effects, including direct and indirect impacts from surface-disturbing activities and soil erosion, on cultural resources eligible for listing on the NRHP would be avoided or mitigated. If previously undiscovered resources were identified during an | ▪ Under Alternative B, the total number of impacted resources is expected to be low (Greubel 2010; Millward 2013). Under Alternative B, impacts on cultural resources would be assessed on a case-by-case or APD-specific basis.<br>▪ Design features and site-specific COAs and APDs would be applied to minimize impacts on cultural resources. | ▪ Impacts under Alternative C are the same as Alternative B. |

**Table 2-13**
**Summary of Environmental Consequences by Alternative**

| Resource/Use | Alternative A, No Action | Alternative B, Proposed Action | Alternative C, Modified Action |
|---|---|---|---|
| | undertaking, work would be suspended while the resource is evaluated and mitigated to avoid any further effects. Through this process, effects would be minimized or eliminated, although residual effects and adverse effects would be possible. | | |
| Paleontological Resources | ▪ There would be few protections provided to paleontological resources that may occur within the Unit, and effects could be of the type and nature described above.<br>▪ If individual APDs are submitted to BLM for consideration (not under a Master Development Plan), then paleontological resources could be directly protected via the paleontological resources lease notification, which requires an inventory be performed by an accredited paleontologist approved by the BLM Authorized Officer before surface-disturbing activities are authorized in Class 4 and 5 Paleontological Areas. | ▪ If APDs are submitted to BLM for consideration (not under a Master Development Plan), paleontological resources could be directly protected via the paleontological resources lease notification, which requires an inventory be performed by an accredited paleontologist approved by the BLM Authorized Officer before surface-disturbing activities are authorized in Class 4 and 5 Paleontological Areas. | ▪ Same as Alternative B. |
| Visual Resources | ▪ Increase in long-term surface disturbance and permanent structures could diminish scenic quality evaluation ratings for vegetation, color, and cultural modifications enough to lower the scenic quality ratings of the Scenic Quality Rating Units from Class A to a Class B or Class C, thereby potentially changing the VRI to Class III or IV.<br>▪ Majority of visual impacts would be | ▪ Greater increase in long-term surface disturbance and permanent structures could diminish scenic quality evaluation ratings and more likely change the VRI to Class III or IV.<br>▪ Greatest potential for changing the VRI and having the most impacts near the West Elk Loop Scenic Byway.<br>▪ Design features would be applied to reduce impacts on visual resources. | ▪ Long-term surface disturbance and permanent structures similar to Alternative B would result in similar scenic quality impacts and VRI changes to Class III or IV.<br>▪ Some potential for visual impacts near the West Elk Loop Scenic Byway.<br>▪ Design features would be applied to reduce impacts on visual resources. |

**Table 2-13**
**Summary of Environmental Consequences by Alternative**

| Resource/Use | Alternative A, No Action | Alternative B, Proposed Action | Alternative C, Modified Action |
|---|---|---|---|
| | away from the West Elk Loop Scenic Byway. | | |
| Livestock Grazing | ▪ Construction-related disturbance would reduce available grazing acreage and forage for sheep and cattle in the short term. Installation of access roads, well pads and utility lines to access private mineral reserves would reduce forage and acreage in long term.<br>▪ Potential long-term loss of 14 acres on BLM allotments. Additional acreage lost on private lands.<br>▪ Potential for additional sources of income to ranches through lease fees or surface use agreements. Replacement of old fence lines could help with long-term costs of maintaining infrastructure. | ▪ Impacts from construction-related disturbance and the installation of access roads, well pads and utility lines to access mineral reserves would be similar to Alternative A, but would occur over a larger area.<br>▪ Potential long-term loss of 23 acres of vegetation on BLM allotments would be less than significant because only approximately 5% of acres on BLM land would be impacted and design features would be applied to minimize indirect impacts.<br>▪ Potential impacts from additional sources of income and replacement of old fence lines would be similar to Alternative A. | ▪ Impacts from construction-related disturbance and the installation of access roads, well pads and utility lines to access mineral reserves would be similar to Alternative A, but would occur over a larger area.<br>▪ Potential long-term loss of 8 acres of vegetation on BLM allotments. Additional BMPs and design features to reduce impacts on vegetation, and reclamation of pipeline corridors would ultimately increase forage. With this mitigation in place, impacts on livestock grazing would be less than significant.<br>▪ Potential impacts from additional sources of income and replacement of old fence lines would be similar to Alternative A. |
| Minerals | ▪ SGI would not pursue much near-term development of federal gas resources in the project area; therefore, development of federal gas resources would be reduced.<br>▪ Federal leases in the project area would continue to be subject to lease stipulations including the standard stipulations, and a timing limitation. Timing limitation stipulation could reduce development of federal gas resources.<br>▪ Factors and constraints for site suitability could reduce the total amount of development of federal gas resources. | ▪ SGI would pursue development of federal gas resources in the project area; therefore, development of federal gas resources would be increased.<br>▪ Impacts on federal leases from lease stipulations, site suitability, and various management plans would be similar to Alternative A; but the effects would be increased due to more development.<br>▪ Federal gas leases in the project area would be subject to the BMPs; however, overall development of federal gas resources in the project area would increase despite the added | ▪ Similar to Alternative B, SGI would pursue development of federal gas resources in the project area; therefore, development of federal gas resources would be increased. Additional restrictions to protect big game would be applied.<br>▪ Impacts on federal leases from lease stipulations, site suitability, and various management plans would be similar to Alternative B. The additional constraints to protect wildlife would not be likely to reduce the total amount of development of federal gas resources in the project area. |

**Table 2-13**
**Summary of Environmental Consequences by Alternative**

| Resource/Use | Alternative A, No Action | Alternative B, Proposed Action | Alternative C, Modified Action |
|---|---|---|---|
| | ▪ Implementing various management plans (i.e., noxious weeds, surface use, etc.) would restrict development of federal gas resources. | restrictions design features. | ▪ Impacts from BMPs would be similar to Alternative B. |
| Recreation | ▪ Fewer potential adverse impacts on hunting opportunities because less big game habitat fragmented.<br>▪ Fewer potential adverse impacts on scenic viewing and other recreational activities that occur along West Elk Loop Scenic Byway and CR 265. | ▪ Greatest disturbance of, and decrease in, big game would result in most potential adverse impacts on hunting opportunities, especially during construction activities. Long-term impacts would be less noticeable, but hunters could choose to go elsewhere.<br>▪ Noise, congestion, and safety concerns resulting from increased traffic on the West Elk Loop Scenic Byway and CR 265 would adversely impact scenic viewing and other recreational activities. | ▪ Impacts on hunting opportunities would be similar to Alternative B; however, comprehensive wildlife management actions would likely limit disturbance of and decrease in big game. Like Alternative B, hunters could choose to go elsewhere.<br>▪ Scenic viewing and other recreational activity impacts on the West Elk Loop Scenic Byway and CR 265 similar to Alternative B. |
| Lands and Realty | ▪ Approximately 88 acres long-term disturbance<br>  ▪ Federal surface – 4 acres<br>  ▪ Federal minerals-25 acres<br>  ▪ Private surface – 60 acres<br>▪ Approximately 259 acres short-term disturbance<br>  ▪ Federal surface – 7 acres<br>  ▪ Federal minerals-74 acres<br>  ▪ Private surface – 178 acres<br>▪ Implementation would lead to adjustments in existing land uses on BLM-administered and private lands and authorization of additional ROWs.<br>▪ Extent of land uses displaced would be mostly on private lands, including residential areas along State Highway 133. | ▪ Approximately 214 acres long-term disturbance<br>  ▪ Federal surface – 4 acres<br>  ▪ Federal minerals-164<br>  ▪ Private surface – 47 acres<br>▪ Approximately 591 acres short-term disturbance<br>  ▪ Federal surface – 17 acres<br>  ▪ Federal minerals-462 acres<br>  ▪ Private surface – 112 acres<br>▪ Impacts from additional ROW authorizations similar to Alternative A.<br>▪ Impacts on Federal surface lands would be similar to Alternative A. Increased development on private surface lands would be greater than under Alternative A, resulting in potential greater increase in impacts on land use on these lands. | ▪ Approximately 126 acres long-term disturbance<br>  ▪ Federal surface – 6 acres<br>  ▪ Federal minreals-109 acres<br>  ▪ Private surface – 12 acres<br>▪ Approximately 441 acres short-term disturbance<br>  ▪ Federal surface – 16 acres<br>  ▪ Federal minerals-369 acres<br>  ▪ Private surface – 56 acres<br>▪ Impacts from additional ROW authorizations similar to Alternative A.<br>▪ Extent of Federal and private surface land uses displaced would be less than under Alternatives A and B. During winter months, private landowners and public land users would not be as severely affected due to comprehensive wildlife management actions. |

**Table 2-13**
**Summary of Environmental Consequences by Alternative**

| Resource/Use | Alternative A, No Action | Alternative B, Proposed Action | Alternative C, Modified Action |
|---|---|---|---|
| Transportation and Access | ▪ Temporary decrease in access for property owners and leaseholders during construction activities; however, long-term improvements to existing routes would promote greater access within the Unit.<br>▪ Increased average annual daily traffic on Highway 133 (in Gunnison County) by less than 1% over a 3-year timeframe. Average annual daily trips associated with trucks could increase by up to 11%.<br>▪ Increased vehicle trips would affect long-term traffic movement on routes in Unit, especially on Highway 133. Short-term spikes in traffic volumes on CR 265 and access roads during construction.<br>▪ Safety on Highway 133 and other routes in the Unit decreased because of higher traffic volumes.<br>▪ Potential for road surface deterioration over time, including Highway 133 and CR 265; however, implementing a road maintenance plan may reduce deterioration. | ▪ Temporary and long-term impacts on access would be similar to Alternative A, but would apply to larger area within Unit.<br>▪ Increased average annual daily traffic on Highway 133 (in Gunnison County) by 1.35% over a 6-year timeframe. Average annual daily trips associated with trucks could increase by up to 21%.<br>▪ Increased vehicle trips would affect long-term traffic movement on routes in Unit, especially on Highway 133 and CR 265. Similar to Alternative A, short-term spikes in traffic volumes on CR 265 and access roads.<br>▪ Effects to safety from increased vehicle volume similar to Alternative A.<br>▪ Potential for road surface deterioration greater than Alternative A. Similar to Alternative A, implementing a road maintenance plan may reduce deterioration. | ▪ Temporary and long-term impacts on access similar to Alternative A, but would apply to larger area.<br>▪ Increased average annual daily traffic on Highway 133 (in Gunnison County) by 1% over a 6-year timeframe. Average annual daily trips associated with trucks could increase by up to 16%.<br>▪ Increased vehicle trips would affect traffic movement on routes in Unit, especially on Highway 133. Similar to Alternative A, short-term spikes in traffic volumes on CR 265 and access roads.<br>▪ Effects to safety from increased vehicle volume similar to Alternative A.<br>▪ Potential for road surface deterioration similar to Alternative B. |
| Hazardous and Solid Wastes | ▪ Potential impacts include human or animal contact to hazardous substances, contamination of waterbodies and aquifers, and effects to air quality from natural gas and drilling operations.<br>▪ No development on BLM-administered lands would likely result in fewer impacts from hazardous and solid wastes on lands overlaying BLM- | ▪ Potential impacts similar to Alternative A, but of greater magnitude based on the increase in proposed development.<br>▪ Because there would be more development on BLM-administered mineral estate, there are likely to be more impacts from hazardous and solid wastes on these lands, including potential contamination of groundwater. Impacts on surrounding | ▪ Potential impacts on human health and safety would be similar to Alternative B; however, SGI would propose to use a closed loop system, which would reduce potential impacts on health and safety.<br>▪ Design features 43 – 52 in Appendix C address hazardous substances and would reduce the risk of hazardous spills. |

**Table 2-13**
**Summary of Environmental Consequences by Alternative**

| Resource/Use | Alternative A, No Action | Alternative B, Proposed Action | Alternative C, Modified Action |
|---|---|---|---|
| | administered mineral estate, including potential contamination of groundwater. Development continuing on private land could impact the surrounding community.<br>▪ If a closed-loop system were implemented, there would be fewer impacts on health and safety from drilling waste and cuttings than if a reserve pit system is used. | community would be similar to Alternative A.<br>▪ Similar to Alternative A, a closed loop system that could reduce potential impacts on health and safety.<br>▪ Design features 43 – 52 in Appendix C address hazardous substances and would reduce the risk of hazardous spills. | |
| Socioeconomics | ▪ Employment would be approximately 80 percent from within the Rocky-Mountain region; however, a smaller portion would be from the immediate project area.<br>▪ Direct employment estimates are 263 people during the drilling phase; 25 people during the production.<br>▪ Development likely to result in increases to severance and ad valorum taxes<br>▪ Development is likely to result in an increase in Non-residential property, particular oil and gas property as well as ad-valorem tax on oil and gas production.<br>▪ Changes in residential property values may be mixed.<br>▪ Sales tax revenues would be increased<br>▪ Lodging tax revenues may be increased.<br>▪ Impacts on public services are likely to be restricted to the drilling phase and would be limited in nature.<br>▪ Increased heavy vehicle traffic would likely result in the need to increase | ▪ Employment would be approximately 80 percent from within the Rocky-Mountain region; however, a smaller portion would be from the immediate project area.<br>▪ Direct employment estimates are 285 people during the drilling phase; 94 people during the production.<br>▪ Development likely to result in higher increases to severance and ad valorum taxes than under Alternative A.<br>▪ Development is likely to result in larger increases in Non-residential property than under Alternative A.<br>▪ Changes in residential property values would be the same as Alternative A.<br>▪ Sales tax and lodging tax revenues would be increased more than under Alternative A.<br>▪ Alternative B is likely to have more extensive impacts on public services than under Alternative A.<br>▪ Road maintenance costs are expected to be higher than Alternative A due to higher levels of heavy vehicle traffic<br>▪ Even if project activities do not | ▪ Employment would be approximately 80 percent from within the Rocky-Mountain region; however, a smaller portion would be from the immediate project area.<br>▪ Direct employment estimates are 284 people during the drilling phase; 34 people during the production.<br>▪ Increases to severance and ad valorum taxes would be the same as Alternative B.<br>▪ Increase in Non-residential property revenue would be the same as Alternative B.<br>▪ Changes in residential property values would be the same as Alternative A.<br>▪ Sales tax and lodging tax revenues would be the same as Alternative B.<br>▪ Impacts on public services are likely to be the same as Alternative B.<br>▪ Road maintenance costs would be the same as Alternative B.<br>▪ Quality of life concerns would be same as Alternative B.<br>▪ Changes to residential property values would be the same as Alternative B |

**Table 2-13**
**Summary of Environmental Consequences by Alternative**

| Resource/Use | Alternative A, No Action | Alternative B, Proposed Action | Alternative C, Modified Action |
|---|---|---|---|
| | road maintenance.<br>▪ Even if project activities do not directly result in significant changes in air or water quality, residents and visitors perception of the air and water quality may be influenced by the presence of development activities.<br>▪ Changes to residential property values may occur but are likely to have impacts only on those properties immediately adjacent to the proposed development. | directly result in significant changes in air or water quality, residents' concerns about impacts on quality of life would be highest under Alternative B due to the higher degree of development.<br>▪ Changes to residential property values may occur and all 44 properties in the Unit would likely be affected. | |
| Environmental Justice | ▪ The actions are not likely to have disproportionate adverse effects on low income or minority populations. | ▪ Same as Alternative A | ▪ Same as Alternative A |

# Chapter 3
## Affected Environment

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# CHAPTER 3
# AFFECTED ENVIRONMENT

## 3.1 INTRODUCTION

The purpose of this chapter is to describe the existing biological, physical, and socioeconomic characteristics of the Bull Mountain Unit MDP project area, including human uses that could be affected by implementing the alternatives described in **Chapter 2**, Alternatives. This chapter includes a discussion of resources, resource uses, and social and economic conditions. Each topic area includes an introduction, followed by a description of current conditions and trends.

Information from the ongoing Uncompahgre RMP revision, scoping comments, the Preliminary Bull Mountain EA and public comments received on the environmental assessment, and other updated sources were used to help set the context for the project area. The level of information presented in this chapter is commensurate with and sufficient to assess potential effects discussed in **Chapter 4**, Environmental Consequences, based on the alternatives presented in **Chapter 2**.

Acreage figures and other numbers used are approximate projections. Readers should not infer that they reflect exact measurements or precise calculations. Acreages were calculated using GIS technology, and there may be slight variations in total acres between resources.

The project area is the geographic area within which the BLM will make decisions and includes all lands, regardless of jurisdiction, within the project area boundaries. However, the BLM makes decisions on only those lands and federal mineral estates that it administers (the decision area). Private mineral estate development is not included in Alternatives B or C; decisions in either of those alternatives may have impacts on private surface overlying private mineral leases (i.e., to accommodate access, or construct a stretch of pipeline both inside and directly adjacent to the Unit if the only reason impacts were to occur were due to the approval of a federal APD). The analysis area includes any lands, regardless of jurisdiction, for which the BLM synthesizes, analyzes, and interprets data and information that relates to the project area. The analysis areas can be any size, can vary according to resource, and can be located anywhere within, around, partially outside, or completely outside the project or decision areas. For example, air quality and socio-economics necessitate a broader analysis area in order to better disclose the extent and magnitude of the anticipated impacts. The analysis areas for resources and resource uses are defined in **Chapter 4**, Environmental Consequences.

### *Standards for Public Land Health*

In January 1997, Colorado BLM approved the Standards for Public Land Health. Standards describe conditions needed to sustain public land health and relate to all uses of the public lands. The approved standards presented in **Table 3-1**, Approved Standards for Public Land Health, are applicable to resources within the Unit and the current resource conformance to these standards is proved in **Section 3.2**, Resources.

**Table 3-1**
**Approved Standards for Public Land Health**

| Standard | Definition/Statement |
|---|---|
| #1 Upland Soils | Upland soils exhibit infiltration and permeability rates that are appropriate to soil type, climate, land form, and geologic processes. Adequate soil infiltration and permeability allow for the accumulation of soil moisture necessary for optimal plant growth and vigor, and minimizes surface runoff. |
| #2 Riparian Systems | Riparian systems associated with both running and standing water, function properly and have the ability to recover from major surface disturbances such as fire, severe grazing, or 100-year floods. Riparian vegetation captures sediment, and provides forage, habitat and biodiversity. Water quality is improved or maintained. Stable soils store and release water slowly. |
| #3 Plant and Animal Communities | Healthy, productive plant and animal communities of native and other desirable species are maintained at viable population levels commensurate with the species and habitat's potential. Plants and animals at both the community and population level are productive, resilient, diverse, vigorous, and able to reproduce and sustain natural fluctuations, and ecological processes. |
| #4 Threatened and Endangered Species | Special status, threatened and endangered species (federal and state), and other plants and animals officially designated by the BLM, and their habitats are maintained or enhanced by sustaining healthy, native plant and animal communities. |
| #5 Water Quality | The water quality of all water bodies, including ground water where applicable, located on or influenced by BLM-administered lands will achieve or exceed the Water Quality Standards established by the State of Colorado. Water Quality Standards for surface and ground waters include the designated beneficial uses, numeric criteria, narrative criteria, and anti-degradation requirements set forth under State law as found in (5 Code of Colorado Regulations 1002-8), as required by Section 303(c) of the Clean Water Act. |

Source: BLM 1997

### *Resources and Uses Not Addressed*

Certain types of resources that may be present in the Uncompahgre Field Office (UFO) are not addressed in this EIS because issues relating to these resources were not identified during scoping by the public or the BLM determined they do not occur within the analysis area. The noted resources below are not addressed in this chapter.

Areas of Critical Environmental Concern and Wild and Scenic Rivers do not occur in or within analysis area of the Unit, and will not be affected by the actions being considered in **Chapter 2**, Alternatives; therefore, they are not discussed.

Coal resources within the Unit are within the Piceance Deep coal field, located in the Uinta coal region. The coal development potential area identified in the 1989 Uncompahgre Basin RMP is based on a maximum development depth of about 2,000 feet; however, coal resources in the Unit have an overburden of more than 3,500 feet. Therefore, coal resources in the Unit are not considered to have economic or scientific interest and are not further discussed in this chapter.

Although locatable minerals such as uranium, vanadium, gypsum, and placer gold are known to exist throughout portions of the region, there has been no history of exploration, development, or production of any kind within or near (within 50 miles) the Unit. For this reason, locatable minerals are not further discussed in this chapter. Similarly, there are no mineral material operations and no free use permits in or near the Unit. While potential for mineral materials within the Unit may exist, lack of interest in and surrounding this area in developing mineral materials is an indication that development in this area is not likely to occur. For this reason, mineral materials are not discussed further in this chapter.

According to the Renewable Energy Potential Report (2010), the Unit has 19,670 acres (100 percent) with geothermal potential. This is shown in **Figure 2-2** of the Renewable Energy Potential Report (BLM 2010a). There are no hot springs, geothermal facilities, pending applications for geothermal facilities, leases, or lease nominations in or near the Unit. For this reason, geothermal resources are not further discussed in this chapter.

No congressionally designated Wilderness Areas, Wilderness Study Areas, or lands with wilderness characteristics have been identified within the project area (defined as the boundaries of the Unit). The nearby Raggeds Wilderness in the White River and Gunnison National Forests and the West Elk Wilderness Area in the Gunnison National Forest are managed by the US Department of Agriculture, Forest Service (Forest Service). Because they do not fall within the defined project area, theyse areas will not be analyzed as discrete units in the EIS. However, Raggeds Wilderness and West Elk Wilderness Area do fall within the defined analysis area for air resources. Therefore, these areas are discussed in the context of the air resources affected environment and impact analysis.

BLM-administered lands within the UFO were inventoried for wilderness characteristics between 2010 and 2011[1]. No lands possessing wilderness characteristics were found on BLM-administered lands occurring in or within the analysis area of the Unit and will not be affected by the actions being considered in **Chapter 2**, Alternatives; therefore, they are not discussed further.

Based on the current cultural resources surveys completed as part of the Bull Mountain Unit MDP EIS, there has been limited archaeological evidence of the historic presence of Native Americans within the Unit. However, only consultation with tribes that use resources in the Unit or live in the surrounding area will confirm whether there are sensitive heritage areas or religious concerns within the Unit. Consultation with the tribes is on-going and is described in **Chapter 5**, Consultation and Coordination.

[1] For additional details and information, please see the Uncompahgre Field Office's Lands With Wilderness Characteristics report which can be found on-line at http://www.blm.gov/co/st/en/fo/ufo/uncompahgre_rmp/lwc_inventory.html

## 3.2 RESOURCES

This section contains a description of the biological and physical resources of the project area and follows the order of topics addressed in Chapter 2, as follows:

- Air resources
- Noise
- Soil resources
- Water resources
- Geology
- Vegetation
- Invasive, non-native species
- Fish and wildlife
- Migratory birds
- Special status species (threatened, endangered, sensitive species)
- Wildland fire management
- Cultural resources
- Paleontological resources
- Visual resources

### 3.2.1 Air Resources

***Current Conditions***

The project area is located in Gunnison County and is within the Mountain Counties Region for air quality planning (CDPHE 2012). The Mountain Counties Region includes counties that generally are on or near the Continental Divide. Air quality concerns in this region are primarily impacts related to particulate pollution from wood burning and road sanding activities. Air quality for any area is generally influenced by the amount of pollutants that are released within the vicinity and up wind of that area, and can be highly dependent upon the contaminants chemical and physical properties. Additionally, an area’s topography or terrain (such as mountains and valleys) and weather (such as wind, temperature, air turbulence, air pressure, rainfall, and cloud cover) will have a direct bearing on how pollutants accumulate or disperse.

*Overview of Regulatory Environment*

Air quality impacts from pollutant emissions are limited by regulations, standards, and implementation plans established under the Clean Air Act (CAA), as administered by the

Colorado Department of Public Health and Environment (CDPHE) Air Pollution Control Division (APCD) under authorization of the EPA. The operator will comply with all applicable federal, state, and local air laws, regulations, and policies.

The APCD is the primary air quality regulatory agency responsible for determining potential impacts once detailed industrial development plans have been made, and those development plans are subject to applicable air quality laws, regulations, standards, control measures, and management practices. Unlike the conceptual "reasonable, but conservative" engineering designs used in NEPA analyses, any APCD air quality preconstruction permitting demonstrations required would be based on very site-specific, detailed engineering values, which would be assessed in the permit application review. Any proposed facility which meets the requirements set forth under division permit regulations is subject to the Colorado permitting and compliance processes.

Regulations and standards which limit permissible levels of air pollutant concentrations and air emissions and are relevant to the Project air impact analysis include:

- National Ambient Air Quality Standards (NAAQS) and Colorado Ambient Air Quality Standards (CAAQS)
- Prevention of Significant Deterioration
- New Source Performance Standards
- National Emission Standards for Hazardous Air Pollutants
- Non-Road Engine Tier Standards
- Colorado Oil and Gas Permitting Guidance

Each of these regulations is further described in the following sections.

*Ambient Air Quality Standards*
The NAAQS and CAAQS are health-based criteria for the maximum acceptable concentrations of air pollutants at all locations to which the public has access. Although specific air quality monitoring has not been conducted within the project area, all of Gunnison County is designated as "attainment" by the CDPHE for all criteria pollutants (CDPHE 2012). Criteria pollutants for which CAAQS and NAAQS exist include carbon monoxide (CO), nitrogen dioxide ($NO_2$), ozone ($O_3$), particulate matter less than 10 microns in effective diameter ($PM_{10}$), particulate matter less than 2.5 microns in effective diameter ($PM_{2.5}$), sulfur dioxide ($SO_2$), and lead (Pb). Lead emissions from project sources are negligible and therefore, the lead NAAQS is not addressed in this analysis. States typically adopt the NAAQS but may also develop state-specific ambient air quality standards for certain pollutants. The NAAQS and CAAQS are summarized in **Table 3-2,** Ambient Air Standards and PSD Increments**.** PSD Class I and Class II increments are also included in **Table 3-2**, and a discussion of PSD increments is provided later in this section.

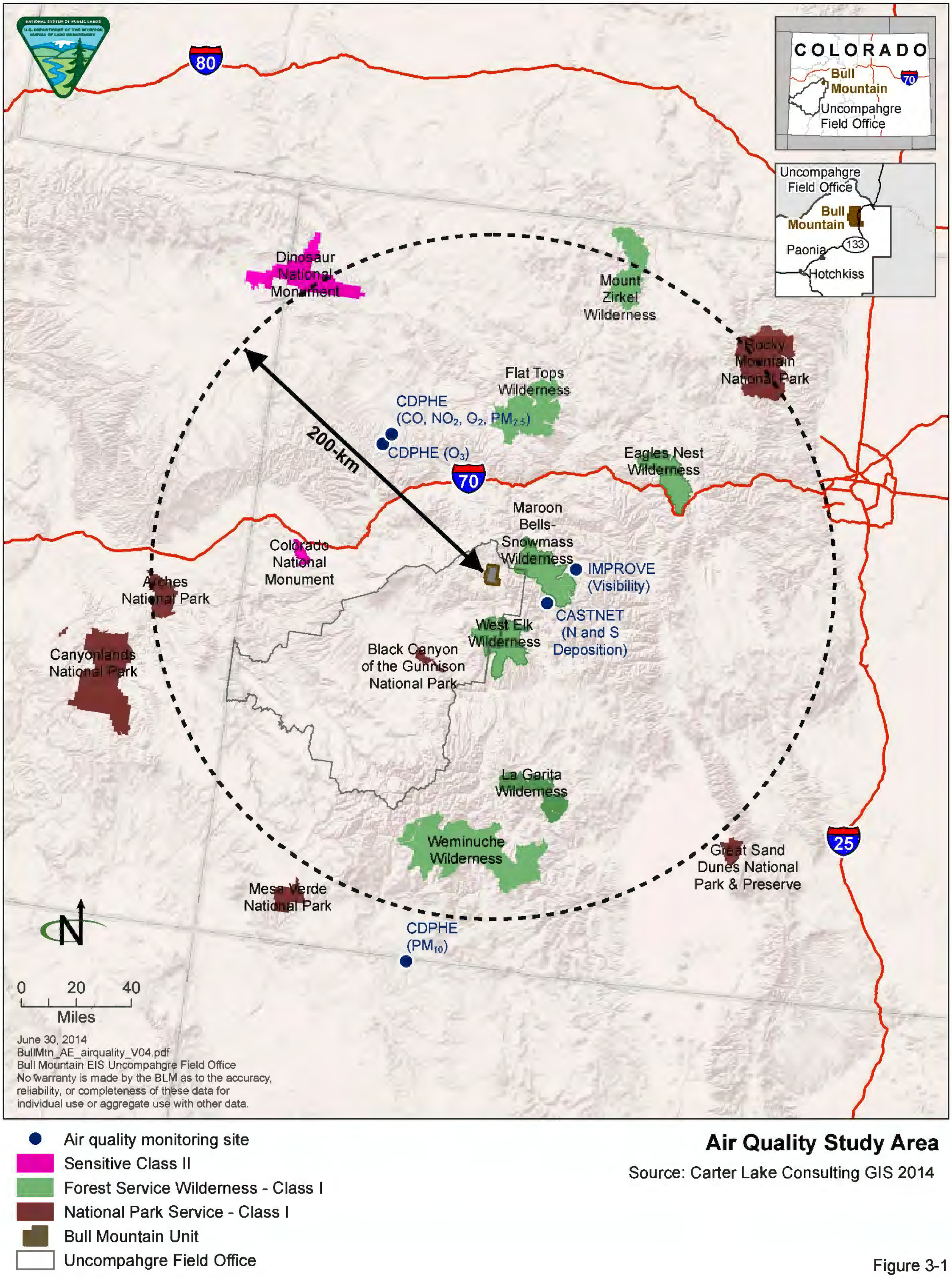
**Table 3-2**
**Ambient Air Standards and PSD Increments (µg/m³)**

| Pollutant | Averaging Time | Colorado and National Ambient Air Quality Standards | Incremental Increase Above Legal Baseline | |
|---|---|---|---|---|
| | | | PSD Class I[1] | PSD Class II[1] |
| Carbon Monoxide (CO) | 1-hour[2] | 40,000 | --[3] | --[3] |
| | 8-hour[2] | 10,000 | -- | -- |
| Nitrogen Dioxide ($NO_2$) | Annual[4] | 100 | 2.5 | 25 |
| | 1-hour[5] | 188 | n/a | n/a |
| Ozone ($O_3$) | 8-hour[6] | 157 | n/a | n/a |
| Particulate matter ($PM_{10}$) | 24-hour[2] | 150 | 8 | 30 |
| | Annual[4] | --[7] | 4 | 17 |
| Particulate matter ($PM_{2.5}$) | 24-hour[8] | 35 | n/a | n/a |
| | Annual[4] | 12 | n/a | n/a |
| Sulfur Dioxide ($SO_2$) | 1-hour[9] | 196 | n/a | n/a |
| | 3-hour[2] | 1,300 (NAAQS)<br>700 (CAAQS) | 25 | 512 |
| | 24-hour[2,10] | 365 | 5 | 91 |
| | Annual[4,10] | 80 | 2 | 20 |

CAAQS (CDPHE 2014), NAAQS (EPA 2014), PSD Increments (EPA 2010a)
[1]The PSD demonstrations serve information purposes only and do not constitute a regulatory PSD increment consumption analysis.
[2]No more than one exceedance per year.
[3]No PSD increments have been established for this pollutant.
[4]Annual arithmetic mean.
[5] An area is in compliance with the standard if the 98th percentile of daily maximum 1-hour nitrogen dioxide concentrations in a year, averaged over 3 years, is less than or equal to the level of the standard.
[6]An area is in compliance with the standard if the fourth-highest daily maximum 8-hour ozone concentrations in a year, averaged over 3 years, is less than or equal to the level of the standard.
[7] The NAAQS and CAAQS for this averaging time for this pollutant has been revoked by EPA and the CDPHE.
[8] An area is in compliance with the standard if the highest 24-hour $PM_{2.5}$ concentrations in a year, averaged over 3 years, is less than or equal to the level of the standard.
[9] An area is in compliance with the standard if the 99th percentile of daily maximum 1-hour sulfur dioxide concentrations in a year, averaged over 3 years, is less than or equal to the level of the standard
[10] In accordance with 40 CFR §50.4 *National Primary Ambient Air Quality Standards for Sulfur Oxides*, the $SO_2$ 24-hour and annual NAAQS remains in effect until 1 year after the effective date of the designation of that area, pursuant to section 107 of the Clean Air Act, for the $SO_2$ NAAQS set forth in §50. 17 ($SO_2$ 1-hour standard). Designations for the 1-hour $SO_2$ NAAQS in Colorado have not occurred.

*Air Pollutant Concentrations*

Monitoring of air pollutant concentrations has been conducted within the region, shown in **Figure 3-1**, Air Quality Study Area. These monitoring sites are part of several monitoring networks overseen by state and federal agencies, including: CDPHE (State of Colorado), Clean Air Status and Trends Network (CASTNET), Interagency Monitoring of Protected Visual Environments (IMPROVE), and National Acid Deposition Program National Trends Network (NADP/NTN).




**Air Quality Study Area**

Source: Carter Lake Consulting GIS 2014

Figure 3-1

Air pollutants monitored at these sites include carbon monoxide, nitrogen dioxide, ozone, particulate matter, and sulfur dioxide. Background concentrations of these pollutants define ambient air concentrations in the region and establish existing compliance with ambient air quality standards. The most representative monitored regional background concentrations available for criteria pollutants as identified by Air Pollution Control Division (2013) are shown in **Table 3-3,** Near-Field Analysis Background Ambient Air Quality Concentrations.

**Table 3-3**
**Near-Field Analysis Background Ambient Air Quality Concentrations**

| Pollutant | Averaging Period | Measured Background Concentration (μg/m3) |
|---|---|---|
| Carbon Monoxide (CO)[1] | 1-hour | 1150 |
| | 8-hour | 1150 |
| Nitrogen Dioxide ($NO_2$)[1] | Annual | 1.9 |
| | 1-hour | 21 |
| Ozone ($O_3$)[2] | 8-hour | 141 |
| Particulate matter ($PM_{10}$)[3] | 24-hour | 36 |
| | Annual | 15 |
| Particulate matter ($PM_{2.5}$)[1] | 24-hour | 14 |
| | Annual | 3 |
| Sulfur Dioxide ($SO_2$)[2] | 1-hour | 3 |
| | 3-hour | 3 |
| | 24-hour | 3 |
| | Annual | 3 |

[1] Data collected at Williams Willow Creek during 2012.
[2] Data from Greasewood Hub, collected during 2009-2010.
[3] Data from S. Ute, collected 1 mile NE of Ignacio during 2003-2005.
Source: CDPHE 2013

*Ozone*
Ozone is an important component of photochemical smog. Ozone is not emitted directly into the atmosphere, but is formed from photochemical reactions of precursor species in the presence of sunlight. The most important precursors are oxides of nitrogen ($NO_x$) and volatile organic compounds (VOCs). High ozone episodes occur most typically in urban areas during the summer during periods with high temperatures and abundant sunlight. However, high ozone episodes during the winter have been recently been recorded in Wyoming's Upper Green River basin and in Utah's Uinta Basin during periods with fresh snow cover, cold temperatures, and sunlight.

*Hazardous Air Pollutants*
Toxic air pollutants, also known as hazardous air pollutants, are those pollutants that are known or suspected to cause cancer or other serious health effects, such as reproductive effects or birth defects, or adverse environmental effects. No ambient air quality standards exist for hazardous air pollutants; instead emissions of these pollutants are regulated by a variety of regulations that target the specific source class and industrial sectors for stationary, mobile, and product use/formulations. Sources of hazardous air pollutants from project operations include well-site production emissions (benzene, toluene, ethyl benzene, xylene, n-hexane, and formaldehyde), and compressor station and gas plant combustion emissions (formaldehyde).

*Prevention of Significant Deterioration*

The PSD Program is designed to limit the incremental increase of specific air pollutant concentrations above a legally defined baseline level. All areas of the country are assigned a classification which describes the degree of degradation to the existing air quality that is allowed to occur within the area under the PSD permitting rules. PSD Class I areas are areas of special national or regional natural, scenic, recreational, or historic value, and very little degradation in air quality is allowed by strictly limiting industrial growth. Class I areas are protected by Federal Land Managers (FLMs) through management of air quality related values such as visibility, aquatic ecosystems, flora, and fauna (See section *Air Quality Related Values*, below). PSD Class II areas allow for reasonable industrial/economic expansion.

The FLMs can designate specific PSD Class II areas that they manage as “sensitive” Class II areas, based on their own criteria, and request that PSD Class I level air quality analyses are included for these areas.

The project area and surrounding areas are classified as PSD Class II. The PSD Class I area located closest to the Unit is the Maroon Bells – Snowmass Wilderness Area, which is approximately 5.6 miles to the east. Other PSD Class I and sensitive Class II areas located within 124 miles (200 kilometers) of the project area are shown in **Figure 3-1**, Air Quality Study Area, and include:

- Arches National Park, Utah (Class I);
- Black Canyon of the Gunnison National Park, Colorado (Class I);
- Colorado National Monument, Colorado, (Class II);
- Dinosaur National Monument, Colorado-Utah (Federal Class II, Colorado Class I ($SO_2$ only);
- Eagles Nest Wilderness Area, Colorado (Class I);
- Flat Tops Wilderness Area, Colorado (Class I);
- La Garita Wilderness Area, Colorado (Class I);
- Maroon Bells – Snowmass Wilderness Area, Colorado (Class I);
- Mount Zirkel Wilderness Area, Colorado (Class I);
- Rocky Mountain National Park, Colorado (Class I);
- Weminuche Wilderness Area , Colorado (Class I); and
- West Elk Wilderness Area, Colorado (Class I).

All NEPA analysis comparisons with PSD Class I and II increments are intended to evaluate a threshold of concern and do not represent a regulatory PSD increment consumption analysis. The determination of PSD increment consumption is an air quality regulatory agency responsibility and only applies to major sources of air pollution. Such an analysis is not likely to be required for this project because the field is not considered a major source of air pollution.

*Air Quality Related Values*

An air quality related value represents atmospheric effects to the landscape that may adversely impact sensitive resources. Landscape level resources may include visibility or a specific scenic, cultural, physical, biological, ecological, or recreational resource. The air quality related values of visibility, atmospheric deposition, and the change in water chemistry associated with atmospheric deposition at acid-sensitive lakes have been identified as a concern at several Class I and sensitive Class II areas within the study area. A discussion of the applicable background data and analysis thresholds is provided below.

*Visibility*

Visibility conditions can be measured as standard visual range, the farthest distance at which an observer can just see a black object viewed against the horizon sky; the larger the standard visual range, the cleaner the air. Visibility for the region is considered to be very good. Continuous visibility-related optical background data representative of the project area have been collected in the PSD Class II White River Wilderness (located approximately 30 miles east of the project area), as part of the Interagency Monitoring of Protected Visual Environments program. The average standard visual range at the White River Wilderness is over 125 miles (VIEWS 2013).

Another measure of visibility includes the concept of extinction (i.e., the absorption or scattering of light). Change in atmospheric light extinction relative to background conditions is used to measure regional haze. Analysis thresholds for atmospheric light extinction are set forth in The Federal Land Managers' Air Quality Related Values Work Group (FLAG) Report (FLAG 2010), with the results reported in percent change in light extinction and change in deciviews. A 5-percent change in light extinction (approximately equal to 0.5 deciview) is the threshold recommended in the 2010 FLAG Report and is considered to contribute to regional haze visibility impairment. A 10-percent change in light extinction (approximately equal to 1 deciview) is considered to represent a noticeable change in visibility when compared with background conditions.

Estimated visibility degradation at the Class I areas and sensitive Class II areas of concern are presented in terms of the number of days that exceed a threshold percent change in extinction, or deciview relative to background conditions. Although procedures and thresholds have not been established for sensitive Class II areas, the BLM is including these areas in its visibility analysis.

*Atmospheric Deposition and Lake Chemistry*

Atmospheric deposition refers to the processes by which air pollutants are removed from the atmosphere and deposited on terrestrial and aquatic ecosystems, and it is reported as the mass of material deposited on an area per year. Air pollutants are deposited by wet deposition (precipitation) and dry deposition (gravitational settling of pollutants). The chemical components of wet deposition include sulfate ($SO_4$), nitrate ($NO_3$), and ammonium ($NH_4$); the chemical components of dry deposition include sulfate, sulfur dioxide, nitrogen oxides, nitrate, ammonium, and nitric acid ($HNO_3$).

The effects of atmospheric deposition of nitrogen and sulfur compounds on terrestrial and aquatic ecosystems are well documented and have been shown to cause leaching of nutrients from soils, acidification of surface waters, injury to high-elevation vegetation, and changes in nutrient cycling and species composition. The 2010 FLAG Report recommends that applicable sources assess impacts of nitrogen and sulfur deposition at Class I areas.

This guidance recognizes the importance of establishing critical deposition loading values ("critical loads") for each specific Class I area as these critical loads are completely dependent on local atmospheric, aquatic, and terrestrial conditions and chemistry. Critical load thresholds are essentially a level of atmospheric pollutant deposition below which negative ecosystem effects are not likely to occur. The 2010 FLAG Report does not include any critical load levels for specific Class I areas and refers to site-specific critical load information on federal land management websites for each area of concern. This guidance does, however, recommend the use of deposition analysis thresholds developed by the National Park Service and the USFWS. The deposition analysis thresholds represent screening-level values for nitrogen and sulfur deposition from project emission sources below which estimated impacts are considered negligible. The deposition analysis threshold established for both nitrogen and sulfur in western Class I areas is 0.005 kilograms per hectare per year (kg/ha/yr).

In addition to the screening level analysis, project-specific and cumulative modeled results are compared to critical load thresholds established for the Rocky Mountain region to assess total deposition impacts. The BLM has compiled currently available research data on critical load values for Class I areas in the vicinity of the project area. Critical load thresholds published by Fox et al. (1989) established pollutant loadings for total nitrogen of 3 to 5 kg/ha/yr) and for total sulfur of 5 kg/ha/yr for Bob Marshall Wilderness Area in Montana and Bridger Wilderness Area in Wyoming. However, the National Park Service has recently stated that these pollutant loadings are not protective of sensitive resources and in its Technical Guidance on Assessing Impacts on Air Quality in NEPA and Planning Documents (NPS 2011) suggests that critical load values above 3 kg/ha/yr may result in moderate impacts. Research conducted by Jill Baron (Baron 2006) using hindcasting of diatom communities suggests 1.5 kg/ha/yr as a critical loading value for wet nitrogen deposition for high-elevation lakes in Rocky Mountain National Park, Colorado. Recent research conducted by Saros et al. (2010) using fossil diatom assemblages suggest that a critical load value of 1.4 kg/ha/yr for wet nitrogen is applicable to the eastern Sierra Nevada and Greater Yellowstone ecosystems. For the Bull Mountain MDP, both project-specific and cumulative nitrogen and sulfur deposition impacts are compared to the following critical load values: 1.5 kg/ha/yr as a surrogate for total nitrogen deposition and 3 kg/ha/yr for total sulfur deposition for the Class I and sensitive Class II areas evaluated.

The National Acid Deposition Program and the National Trends Network station monitors wet atmospheric deposition and the Clean Air Status and Trends Network station monitors dry atmospheric deposition at the Gothic site, located east of the project area, shown in **Figure 3-1**. The total annual deposition (wet and dry) reported as total nitrogen and total sulfur deposition for year 2010 is shown in **Table 3-4**, Background Nitrogen and Sulfur Deposition Values.

Analyses to assess the change in water chemistry associated with atmospheric deposition are performed following the procedures developed by the Forest Service Rocky Mountain Region

**Table 3-4**
**Background Nitrogen and Sulfur Deposition Values (kg/ha-yr)**

| Site Location | Nitrogen Disposition | | | Sulfur Deposition | | | Year of Monitoring |
|---|---|---|---|---|---|---|---|
| | **Wet** | **Dry** | **Total** | **Wet** | **Dry** | **Total** | |
| Gothic | 1.77 | 0.23 | 2.00 | 0.89 | 0.09 | 0.98 | 2010 |

Source: EPA 2013

(Forest Service 2000). The analysis assesses the change in the acid neutralizing capacity of the sensitive lakes within the study area (**Figure 3-1**). Predicted changes in acid neutralizing capacity are compared with the applicable threshold for each identified lake: 10-percent change in acid neutralizing capacity for lakes with background acid neutralizing capacity values greater than 25 microequivalents per liter, and less than a 1 microequivalents per liter change in acid neutralizing capacity for lakes with background acid neutralizing capacity values equal to or less than 25 microequivalents per liter.

**Table 3-5**, Background Acid Neutralizing Capacity Values for Acid-Sensitive Lakes, presents a list of 28 lakes in the Eagles Nest, Flat Tops, La Garita, Maroon Bells-Snowmass, Raggeds, Weminuche and West Elk Wilderness Areas that have been identified as acid sensitive. Analyses for potential changes to lake acidity from atmospheric deposition are based on the acid neutralizing capacity for the lake. The most recent lake chemistry background acid neutralizing capacity data are also shown in **Table 3-5**. The acid neutralizing capacity values shown are the 10th percentile lowest acid neutralizing capacity values which were calculated for each lake following procedures provided from the Forest Service. The years of monitoring data that were currently available, and the number of samples used in the calculation of the 10th percentile lowest acid neutralizing capacity values, are provided.

Of the 28 lakes listed in **Table 3-5**, 6 are considered by the Forest Service as extremely sensitive to atmospheric deposition since the background acid neutralizing capacity values are less than 25 microequivalents per liter (μeq/l), including four in the Weminuche Wilderness Area (White Dome Lake, Little Eldorado Lake, Ute Lake and Big Eldorado Lake), one in the Raggeds Wilderness (Deep Creek Lake), and one in the Flat Tops Wilderness Area (Upper Ned Wilson).

*New Source Performance Standards/National Emission Standards for Hazardous Pollutants*
Under Section 111 of the Clean Air Act, the EPA has promulgated technology-based emissions standards which apply to specific categories of stationary sources. These standards are referred to as New Source Performance Standards (40 CFR Part 60). The New Source Performance Standards potentially applicable to the Project include the following subparts of 40 CFR 60.

- Subpart A – General Provisions. Provisions of Subpart A apply to the owner or operator of any stationary source which contains an affected facility, the construction or modification of which is commenced after the date of publication in this part of any standard (or, if earlier, the date of publication of any proposed standard) applicable to that facility. Provisions of Subpart A could apply to proposed sources that are affected by New Source Performance Standards.

**Table 3-5**
**Background Acid Neutralizing Capacity Values for Acid-Sensitive Lakes**

| Wilderness Area | Lake | Latitude (Degs) | Longitude (Degs) | 10th Percentile Lowest Value (μeq/L)[1] | Number of Samples | Monitoring Period |
|---|---|---|---|---|---|---|
| Eagles Nest | Booth Lake | 39.6983 | -106.3044 | 86.8 | 49 | 1993-2010 |
| Eagles Nest | Upper Willow Lake | 39.6470 | -106.1735 | 133.9 | 50 | 1990-2010 |
| Flat Tops | Ned Wilson Lake | 39.9614 | -107.3239 | 39.0 | 191 | 1981-2007 |
| Flat Tops | Upper Ned Wilson Lake | 39.9628 | -107.3236 | 12.9 | 143 | 1983-2007 |
| Flat Tops | Lower Packtrail Pothole | 39.9682 | -107.3241 | 29.7 | 96 | 1987-2007 |
| Flat Tops | Upper Packtrail Pothole | 39.9656 | -107.3238 | 48.7 | 96 | 1987-2007 |
| La Garita | Small Lake Above U-Shaped Lake | 37.9436 | -106.8648 | 59.9 | 24 | 1992-2009 |
| La Garita | U-Shaped Lake | 37.9429 | -106.8618 | 81.4 | 23 | 1992-2009 |
| Maroon Bells | Avalanche Lake | 39.1439 | -107.0998 | 163.3 | 52 | 1991-2009 |
| Maroon Bells | Capitol Lake | 39.1630 | -107.0820 | 167.6 | 54 | 1991-2009 |
| Maroon Bells | Moon Lake | 39.1644 | -107.0589 | 52.2 | 51 | 1991-2009 |
| Mount Zirkel | Lake Elbert | 40.6342 | -106.7069 | 53.6 | 67 | 1985-2007 |
| Mount Zirkel | Seven Lakes (LG East) | 40.8958 | -106.6819 | 36.2 | 67.0 | 1985-2007 |
| Mount Zirkel | Summit Lake | 40.5453 | -106.6819 | 48.3 | 124 | 1985-2007 |
| Raggeds | Deep Creek Lake | 39.0089 | -107.2400 | 20.6 | 24 | 1995-2009 |
| Weminuche | Big Eldorado Lake | 37.7133 | -107.5433 | 7.8 | 55 | 1985-2007 |
| Weminuche | Four Mile Pothole | 37.4684 | -107.0525 | 123.4 | 19 | 2000-2009 |
| Weminuche | Lake Due South of Ute Lake | 37.6361 | -107.4428 | 13.2 | 24 | 1992-2009 |
| Weminuche | Little Eldorado | 37.7133 | -107.5458 | -3.3 | 54 | 1985-2007 |
| Weminuche | Little Granite Lake | 37.6205 | -107.3317 | 80.7 | 20 | 2000-2009 |
| Weminuche | Lower Sunlight Lake | 37.6331 | -107.5830 | 80.9 | 52 | 1985-2007 |
| Weminuche | Middle Ute Lake | 37.6483 | -107.4752 | 42.8 | 29 | 1985-2009 |
| Weminuche | Small Pond Above Trout Lake | 37.6519 | -107.1564 | 25.5 | 27 | 1992-2009 |
| Weminuche | Upper Grizzly Lake | 37.6200 | -107.5836 | 29.9 | 45 | 1985-2007 |
| Weminuche | Upper Sunlight Lake | 37.6278 | -107.5797 | 28.0 | 51 | 1985-2007 |
| Weminuche | West Snowdon Lake | 37.7103 | -107.6935 | 39.4 | 26 | 2000-2009 |
| Weminuche | White Dome Lake | 37.7089 | -107.5525 | 1.7 | 49 | 1985-2007 |
| West Elk | South Golden Lake | 38.7776 | -107.1828 | 111.4 | 25 | 1995-2008 |

Source: VIEWS, January 2014
[1]10th Percentile Lowest Acid Neutralizing Capacity Values Reported

- Subpart Kb – Standards of Performance for Volatile Organic Storage Vessels. Subpart Kb applies to storage vessels with a capacity greater than or equal to 75 cubic meters (m3) that are used to store volatile organic liquids for which construction, reconstruction, or modification is commenced after July 23, 1984. This subpart potentially would be applicable to storage tanks for natural gas liquids.

- Subpart JJJJ – Standards of Performance for Stationary Spark-Ignition Internal Combustion Engines. This subpart establishes emission standards and compliance schedules for the control of emissions from stationary combustion turbines that commenced construction, modification, or reconstruction after February 18, 2005. The pollutants regulated by this subpart are nitrogen oxides and sulfur dioxide. Subpart JJJJ applies to manufacturers, owners, and operators as well as new, modified, and reconstructed stationary spark-ignited internal combustion engines such as generators, pumps, and compressors. The applicable emissions standards are based on engine type, fuel type, and manufacturing date.

- Subpart OOOO – Standards of Performance for Crude Oil and Natural Gas Production. Subpart OOOO regulates volatile organic compound emissions from well completions, centrifugal compressors, reciprocating compressors, pneumatic controllers, storage vessels and leaking components in the natural gas production industry, as well as sulfur dioxide emissions from onshore natural gas processing plants.

- 40 CFR Part 63, Subpart HH – National Emissions Standards for Hazardous Air Pollutants from Oil and Natural Gas Production Facilities. Subpart HH establishes emissions standards for hazardous air pollutants from glycol dehydrator process vents and flash emissions from storage vessels, and sets requirements for equipment leaks at oil and natural gas production facilities.

*Non-Road Engine Tier Standards*

The EPA sets emissions standards for non-road diesel engines for hydrocarbons, nitrogen oxides, carbon monoxide, and particulate matter. The emissions standards are implemented in tiers by year, with different standards and start years for various engine power ratings. The new standards do not apply to existing non-road equipment. Only equipment built after the start date for an engine category (1999-2006, depending on the category) is affected by the rule. Over the life of the project, the fleet of non-road equipment will turn over and higher-emitting engines will be replaced with lower-emitting engines.

*Climate*

The nearest precipitation and temperature measurements were collected at Redstone, Colorado, (1979-1994), approximately 2.5 miles northeast of the project area at an elevation of 8,070 feet above mean sea level (WRCC 2013).

The annual average total precipitation at Redstone, Colorado, is 27.7 inches, with annual totals ranging from 20.2 inches in 1987 to 40.4 inches in 1985. Precipitation is greatest in the spring and fall months. Snowfall occurs from fall though spring with the greatest amount in March. The average annual snowfall is 169.4 inches.

The region has cool temperatures, with average daily temperature (in degrees Fahrenheit [˚F]) ranging between 8˚F and 33˚F in January to between 44˚F and 76˚F in July. Extreme temperatures have ranged from negative 29˚F in 1985 to 93˚F in 1991. **Table 3-6**, Mean Monthly Temperature Ranges and Total Precipitation Amounts, shows the mean monthly temperature ranges and total precipitation amounts.

**Table 3-6**
**Mean Monthly Temperature Ranges and Total Precipitation Amounts**

| Month | Average Temperature Range (ºF) | Total Precipitation (inches) | Total Snowfall (inches) |
|---|---|---|---|
| January | 8-33 | 1.8 | 26.0 |
| February | 12-36 | 2.4 | 29.9 |
| March | 17-43 | 3.1 | 32.4 |
| April | 25-51 | 2.0 | 12.1 |
| May | 32-61 | 2.3 | 5.3 |
| June | 39-72 | 1.5 | 0.5 |
| July | 44-76 | 2.2 | 0.0 |
| August | 44-75 | 1.7 | 0.0 |
| September | 37-67 | 3.0 | 0.5 |
| October | 28-55 | 3.0 | 6.9 |
| November | 18-39 | 2.6 | 26.4 |
| December | 9-32 | 2.0 | 29.5 |
| ANNUAL | 39.6 (mean) | 27.7 | 169.4 |

Source: WRCC 2013

Due to the absence of any available representative monitored meteorology data for the Bull Mountain project area, the 2008 Weather Research and Forecasting (WRF) meteorological model output produced as part of the Western Regional Air Partnership's (WRAP) West-wide Jump Start Air Quality Modeling Study (WestJumpAQMS) (ENVIRON et al., 2012) was used to characterize current meteorological conditions in the project area. Two WRF model 4-kilometer (2.4-mile) grid cells are within the project area boundary, a north site and a south site. The north site represents mountain top conditions, and the south site characterizes channeling in the project area valley. Windroses showing a diagram of the frequency of each wind direction for the north and south sites are shown on the next page. Wind direction is the direction from which the wind is blowing. For example, if the wind is blowing from the north to the south 1.8 percent of the time, the wind direction is north.

**Table 3-7**, Wind Direction Frequency Distribution, and **Table 3-8**, Wind Speed Distribution, below display the 2008 WRF model data in tabular format for wind direction frequency and speed distributions at the north and south project area sites. The annual mean wind speed at the north site is 4.2 miles per hour (mph), and 5.0 mph at the south site.

*Greenhouse Gases and Climate Change*

Greenhouse gases present in the earth's atmosphere trap outgoing longwave radiation and warm the earth's atmosphere. Higher concentrations of greenhouse gases in the atmosphere result in more heat being absorbed and cause higher global temperatures. Some greenhouse gases, such as water vapor, occur naturally in the atmosphere, and some, such as carbon dioxide ($CO_2$) and methane ($CH_4$), occur naturally and are also emitted by human activities. The global atmospheric concentration of carbon dioxide has increased by about 36 percent over the last 250 years, and

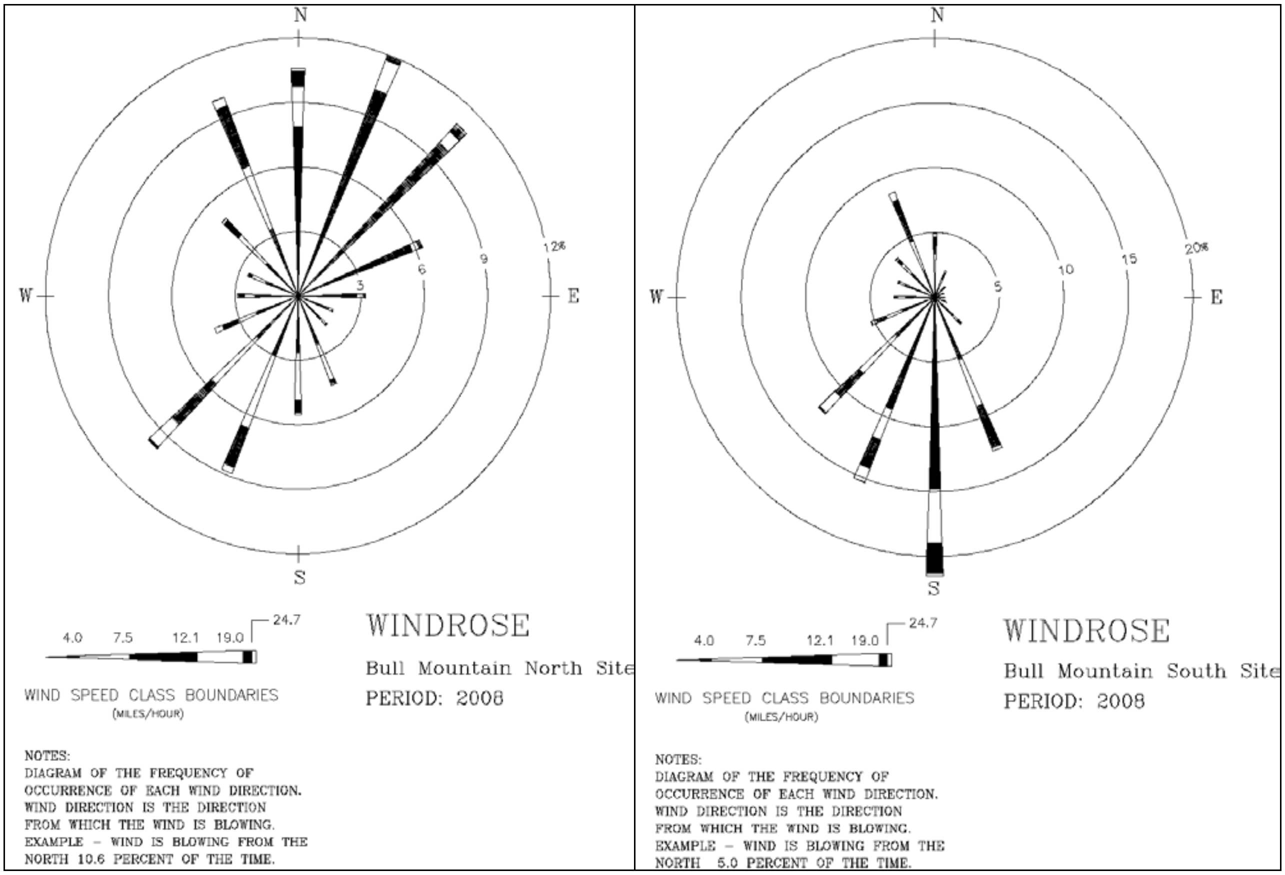



**Table 3-7**
**Wind Direction Frequency Distribution**

| North Site | | South Site | |
|---|---|---|---|
| **Wind Direction** | **Frequency (%)** | **Wind Direction** | **Frequency (%)** |
| North | 10.6 | South | 5.0 |
| North- Northeast | 12.0 | South Southwest | 2.2 |
| Northeast | 11.0 | Southwest | 1.1 |
| East Northeast | 6.3 | West Southwest | 0.8 |
| East | 3.2 | West | 0.8 |
| East Southeast | 1.8 | West Northwest | 1.0 |
| Southeast | 1.9 | Northwest | 2.9 |
| South Southeast | 4.5 | South Southeast | 12.7 |
| South | 5.5 | South | 21.6 |
| South Southwest | 8.8 | South Southwest | 15.3 |
| Southwest | 9.8 | Southwest | 12.4 |
| West Southwest | 4.2 | West Southwest | 5.3 |
| West | 2.9 | West | 3.2 |
| West Northwest | 2.6 | West Northwest | 3.1 |
| Northwest | 5.0 | Northwest | 4.2 |
| North Northwest | 9.9 | North Northwest | 8.7 |

Source: ENVIRON et al. 2012

**Table 3-8**
**Wind Speed Distribution**

| North Site | | South Site | |
|---|---|---|---|
| **Wind Speed (mph)** | **Frequency (%)** | **Wind Speed (mph)** | **Frequency (%)** |
| 0-4.0 | 61.7 | 0-4.0 | 52.1 |
| 4.0-7.5 | 22.8 | 4.0-7.5 | 23.9 |
| 7.5-12.1 | 12.2 | 7.5-12.1 | 18.6 |
| 12.1-19.0 | 3.1 | 12.1-19.0 | 5.0 |
| 19.0-24.7 | 0.2 | 19.0-24.7 | 0.3 |
| Greater than 24.7 | 0 | Greater than 24.7 | 0.02 |

Source: ENVIRON et al. 2012

far exceeds pre-industrial values determined from ice cores spanning many thousands of years (IPCC 2007). The anthropogenic greenhouse gases of primary concern are: carbon dioxide, methane, nitrous oxide ($N_2O$), and fluorinated gases. Ice core records extending back over thousands of years indicate that worldwide emissions of these anthropogenic greenhouse gases have increased dramatically during the industrial era with an increase of 70 percent between 1970 and 2004 alone (IPCC 2007).

The Intergovernmental Panel on Climate Change is the leading international body for the assessment of climate change. It was established by the United Nations Environment Programme and the World Meteorological Organization in 1988 to provide a clear scientific view on the current state of knowledge about climate change and its potential environmental and socioeconomic impacts. The main activity of the panel is to provide assessment reports of the state of knowledge on climate change at regular intervals. The latest report is the Intergovernmental Panel on Climate Change Fourth Assessment Report Climate Change 2007 (IPCC 2007). In report, the panel concluded that warming of the climate system is unequivocal and most of the observed increase in global average temperatures since the mid-20th century is very likely due to the observed increase in anthropogenic greenhouse gas concentrations. The panel further concluded that, “continued greenhouse gas emissions at or above current rates would cause further warming and induce many changes in the global climate system during the 21st century that would very likely be larger than those observed during the 20th century.”

The impacts of climate change are expected to vary by region, and there is significant uncertainty regarding the effects of climate change on any particular region. In particular, it is unknown how climate change will affect the project area or its surrounding environment. However, report identified specific risks for North America as a whole, and these are shown below:

- Warming in western mountains is projected to cause decreased snowpack, more winter flooding, and reduced summer flows, exacerbating competition for over-allocated water resources.

- In the early decades of the century, moderate climate change is projected to increase aggregate yields of rain-fed agriculture by 5 to 20 percent, but with important variability among regions. Major challenges are projected for crops that are near the warm end of their suitable range or which depend on highly utilized water resources.

- Cities that currently experience heat waves are expected to be further challenged by an increased number, intensity, and duration of heat waves during the course of the century, with potential for adverse health impacts.
- Coastal communities and habitats will be increasingly stressed by climate change impacts interacting with development and pollution.

The greenhouse gases projected to be emitted by the Project are carbon dioxide, methane, and nitrous oxide. The atmospheric lifetimes for carbon dioxide, methane, and nitrous oxide are on the order of years (IPCC 2007). Emissions of greenhouse gases from any particular source become well-mixed throughout the global atmosphere. Greenhouse gas emissions from all sources contribute to the global atmospheric burden of greenhouse gases, and it is not possible to attribute a particular climate impact in any given region to greenhouse gas emissions from a particular source. It is possible to state only that greenhouse gas emissions produced by the Proposed Action and action alternatives would add to the global burden of greenhouse gases and may therefore contribute to climate change impacts on the affected environment produced by world-wide emissions; these impacts may include those shown above.

In 2007, the US Supreme Court ruled in *Massachusetts v. EPA* that EPA has the authority to regulate greenhouse gases such as methane and carbon dioxide as air pollutants under the Clean Air Act. The ruling did not, however, require the EPA to create any emission control standards or ambient air quality standards for greenhouse gases. At present, there are no ambient air quality standards for greenhouse gases, and there are no emissions limits on greenhouse gases that would apply to the sources developed under the Proposed Action and the action alternatives. There are, however, applicable reporting requirements under the EPA's Greenhouse Gas Reporting Program. These greenhouse gas emission reporting requirements, finalized in 2010 under 40 CFR Part 98 (EPA 2010), require facility operators to develop and report annual methane and carbon dioxide emissions from equipment leaks and venting, and emissions of carbon dioxide, methane, and nitrous oxide from flaring, onshore production stationary and portable combustion emissions, and combustion emissions from stationary equipment. At present, there are no rules related to greenhouse gas emissions or impacts that would affect development of the Proposed Action or the action alternatives besides these greenhouse gas reporting requirements.

### 3.2.2 Noise

#### *Current Conditions*

Noise is defined as unwanted sound and can be intermittent or continuous, steady or impulsive. Human response to noise is extremely diverse and varies according to the type of noise source, the sensitivity and expectations of the receptor, the time of day, and the distance between the noise source and the receptor.

The decibel (dB) is the accepted unit of measurement for noise. Because human hearing is not equally sensitive to all sound frequencies, various frequency weighting schemes have been developed to approximate the way people hear sound. The A-weighted decibel scale (dBA) is normally used to approximate human hearing response to sound. Example sound noise levels are shown in **Table 3-9**, Common Sound Levels.

**Table 3-9**
**Common Sound Levels**

| Characterization | dBA | Example Noise Condition Or Event |
|---|---|---|
| Threshold of pain | 130 | Surface detonation, 30 pounds of TNT at 1,000 feet |
| | 125 | F/A-18 aircraft takeoff with afterburner at 470 feet |
| Possible building damage | 120 | Mach 1.1 sonic boom under aircraft at 12,000 feet |
| | 115 | F/A-18 aircraft takeoff with afterburner at 1,600 feet |
| | 110 | Peak crowd noise at a professional football game in an open stadium |
| | 105 | Emergency vehicle siren at 50 feet |
| | 100 | F/A-18 aircraft departure climb-out at 2,400 feet |
| Extremely noisy | 95 | Locomotive horn at 100 feet |
| 8-hour workplace limit | 90 | Heavy truck, 35 mph at 20 feet; leaf blower at 5 feet |
| Very noisy | 85 | Power lawn mower at 5 feet; city bus at 30 feet |
| | 80 | 2-Axle commercial truck, 35 mph at 20 feet |
| Noisy | 75 | Street sweeper at 30 feet; Idling locomotive, 50 feet |
| | 70 | Auto, 35 mph at 20 feet; 300 feet from busy 6-lane freeway |
| Moderately noisy | 65 | Typical daytime busy downtown background conditions |
| | 60 | Typical daytime urban mixed use area conditions |
| | 55 | Typical urban residential area away from major streets |
| | 50 | Typical daytime suburban background conditions |
| Quiet | 45 | Typical rural area daytime background conditions |
| | 40 | Quiet suburban area at night |
| Very quiet | 30 | Quiet rural area, winter night, no wind |
| | 20 | Empty recording studio |
| Barely audible | 10 | Audiometric testing booth |
| Threshold of Hearing | 0 | --- |

Source: Beranek 1988

In general, sound waves travel away from the noise source as an expanding spherical surface. The energy contained in a sound wave is spread over an increasing area as it travels away from the source. This results in a decrease in loudness at greater distances from the noise source. A doubling of distance results in an approximately 6-decibel reduction in sound pressure level for single point sources of noise and a 3-decibel reduction in sound pressure level for multiple point sources moving in a straight line such as a highway (Hedge 2011).

*Regulatory Considerations*

The Department of the Interior and the USDA have published surface operating standards and guidelines for oil and gas exploration and development, commonly referred to as The Gold Book (DOI and USDA 2007). This Gold Book contains noise control guidelines for well drilling and production operations. These guidelines state:

> Noise that has the potential to disturb wildlife, livestock, and private surface owners or neighbors should be controlled to reduce sound levels. Suitable mufflers should be installed on all internal combustion engines and certain compressor components. Other noise reduction techniques to consider include siting wells, production facilities, compressors, roads to take advantage of topography and distance, and constructing

engineered sound barriers or sound-insulated buildings. The placement of tank batteries and other facilities offsite and the use of remote well monitoring systems can reduce vehicle traffic in the field and the associated noise.

The COGCC has established noise abatement regulations for oil and gas operations (COGCC 2009). These regulations follow Colorado Noise Statute 25-12-103, Maximum Permissible Noise Levels. The COGCC guidelines state that the goal of the rule is to identify noise sources related to oil and gas operations that impact surrounding landowners and to implement cost-effective and technically feasible mitigation measures to bring oil and gas facilities into compliance with maximum permissible noise levels detailed in **Table 3-10**, Regulatory Limits for Noise Generated by Natural Gas Facilities, below.

The Gunnison County Board of County Commissioners passed Resolution No. 2012-25, A Resolution Amending the Gunnison County, Colorado Temporary Regulations for Oil and Gas Operations on August 28, 2012. These regulations do not contain specific standards for noise.

**Table 3-10**
**Regulatory Limits for Noise Generated by Natural Gas Facilities**

| Zone Area[1] | 7 AM to 7 PM[2] | 7 PM to 7 AM |
|---|---|---|
| Residential/Agricultural/Rural | 55 dBA | 50 dBA |
| Commercial | 60 dBA | 55 dBA |
| Light industrial | 70 dBA | 65 dBA |
| Industrial | 80 dBA | 75 dBA |

Source: COGCC 2009, Section 802(c)
[1] In remote areas with no nearby occupied structures, the light industrial standard may be applied.
[2] In the hours between 7:00 a.m. and the next 7:00 p.m., the noise levels permitted below may be increased 10 dbA for a period not to exceed 15 minutes in any 1 hour period. The allowable noise level for periodic, impulsive or shrill noises is reduced by 5 dbA from the levels shown.
[3] Sound levels shall be measured at a distance of 350 feet from the noise source. If an oil and gas well site, production facility, or gas facility is installed closer than 350 feet from an existing occupied structure, sound levels shall be measured at a point 25 feet from the structure towards the noise source.

*Existing Noise Environment*

The unit is within a rural agricultural area that includes a mix of farming and ranching properties, with dwellings located primarily along State Route 133 and county and private roads in the plan unit. Noise levels from human activity are mostly mechanical, consisting mainly of existing natural gas development, new exploration activities, ranching/farming activities, and travel on local roadways. Ambient levels are estimated to range from 35 to 40 dBA, increasing up to 60 dBA with traffic from local roads. The varied terrain and vegetation within the unit provide barriers and buffers for noise.

Noise from existing natural gas development within the unit comes from a number of sources, including truck traffic, drilling and completion activities, and well pumps. No compressor stations are present in the unit. **Table 3-11**, Noise Levels Associated with Typical Construction Equipment, summarizes noise levels of typical construction equipment.

**Table 3-11**
**Noise Levels Associated with Typical Construction Equipment (dBA)**

| Equipment | 50 feet | 500 feet | 1,000 feet |
|---|---|---|---|
| Tractor | 80 | 60 | 54 |
| Bulldozer | 89 | 69 | 63 |
| Motor grader | 85 | 65 | 59 |
| Mechanic truck | 88 | 68 | 62 |
| Backhoe | 85 | 65 | 59 |
| Crane | 88 | 68 | 62 |
| Air compressor | 82 | 62 | 56 |
| Dump truck | 88 | 68 | 62 |
| Average, nearest dBA | 86 | 66 | 60 |

Source: La Plata County 2002

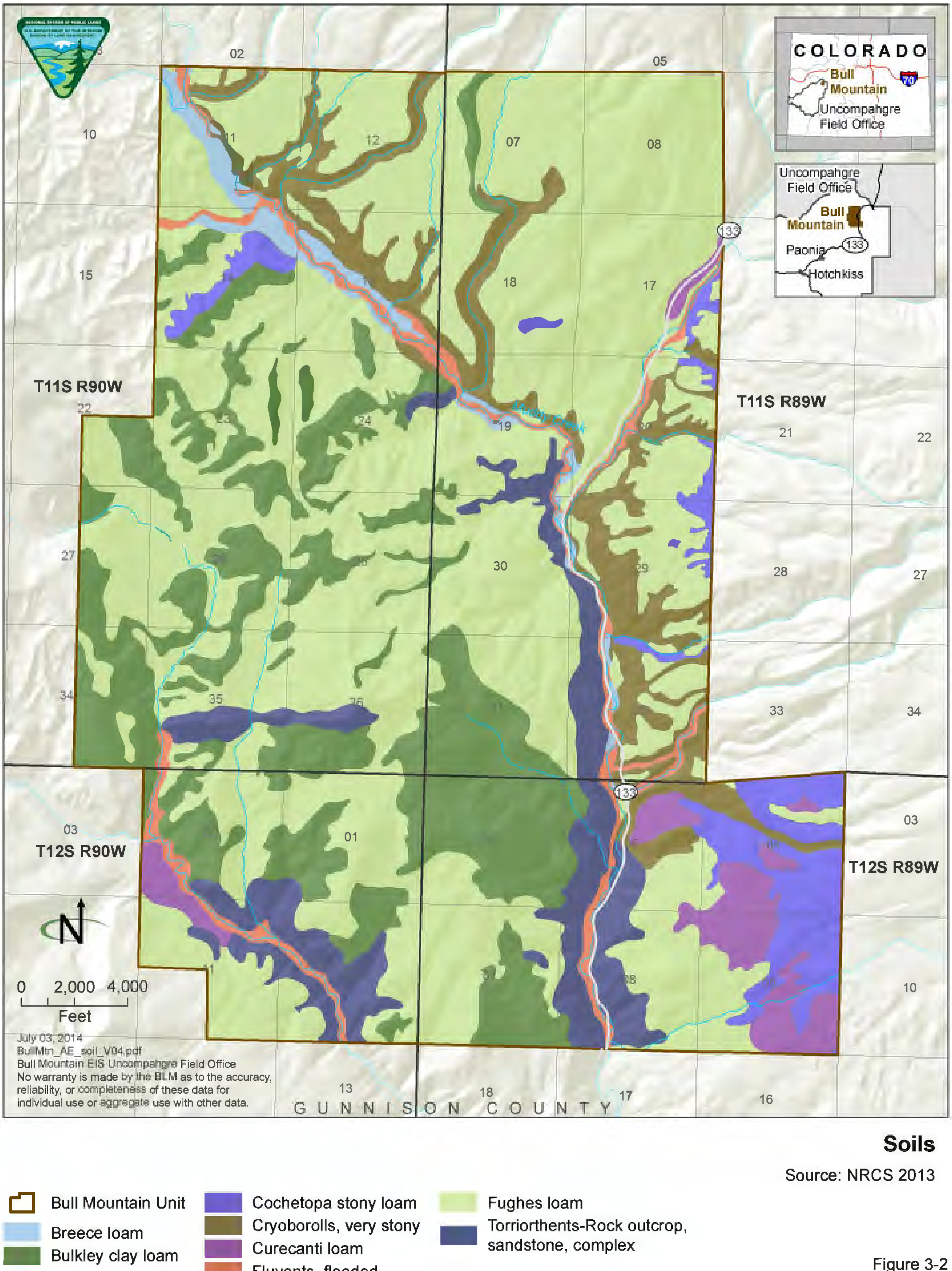
*Sensitive Resources*
Sensitive receptors include known residences, schools, churches, hospitals, libraries, camping areas, and parks. Any known cultural or sensitive wildlife area is also considered a sensitive noise receptor. Sensitive receptors in the project area include the residences discussed above, recreational users, and wildlife.

***Trends***
Noise level trends in the project area are expected to resemble baseline levels, with localized noise level increases as more natural gas wells are developed on private and potentially public lands.

### 3.2.3 Soil Resources

***Current Conditions***

*Soil Composition*
Soils are the product of weathering of rocks. They may reflect the mineral composition of the parent rock materials, but they are also highly dependent on vegetation, climate, and slope. There are 10 classified soil types with significant acreage (greater than 15 acres) found within the Unit per the USDA Natural Resource Conservation Service, as seen in **Figure 3-2**, Soils. Some of the soil series are differentiated based on percent of slope in the Unit as found in **Table 3-12**, Classified Soil Types in the Bull Mountain Unit. Many have similar characteristics, and the majority are within the Fughes Series, which has 10,880 acres (55 percent) of soils in the project area and Bulkley Series, which has 3,600 (18 percent) of soils in the project area. Soils in the Fughes series are derived principally from sedimentary rocks, mainly shale and interbedded sandstone, and typically form deep, well-drained soil deposits on alluvial fans, terraces, valley side-slopes, draws, and drainage ways (NRCS 2013). Their texture is heavy clay loam with 36 to 50 percent clay. The Bulkley soil series is derived from fine-textured alluvium eroded from shale and are found on alluvium fans and hills (NRCS 2013). Their texture is clay or silty clay loam with weathered shale, typically found at depths of approximately 3 to 6 feet.



COLORADO
Bull Mountain
Uncompahgre Field Office
Uncompahgre Field Office
Bull Mountain
Paonia
Hotchkiss
133
T11S R90W
T11S R89W
T12S R90W
T12S R89W
GUNNISON COUNTY
0 2,000 4,000
Feet
July 03, 2014
BullMtn_AE_soil_V04.pdf
Bull Mountain EIS Uncompahgre Field Office
No warranty is made by the BLM as to the accuracy, reliability, or completeness of these data for individual use or aggregate use with other data.
Soils
Source: NRCS 2013
Bull Mountain Unit
Breece loam
Bulkley clay loam
Cochetopa stony loam
Cryoborolls, very stony
Curecanti loam
Fluvents, flooded
Fughes loam
Torriorthents-Rock outcrop, sandstone, complex


Figure 3-2

**Table 3-12**
**Classified Soil Types in the Bull Mountain Unit**

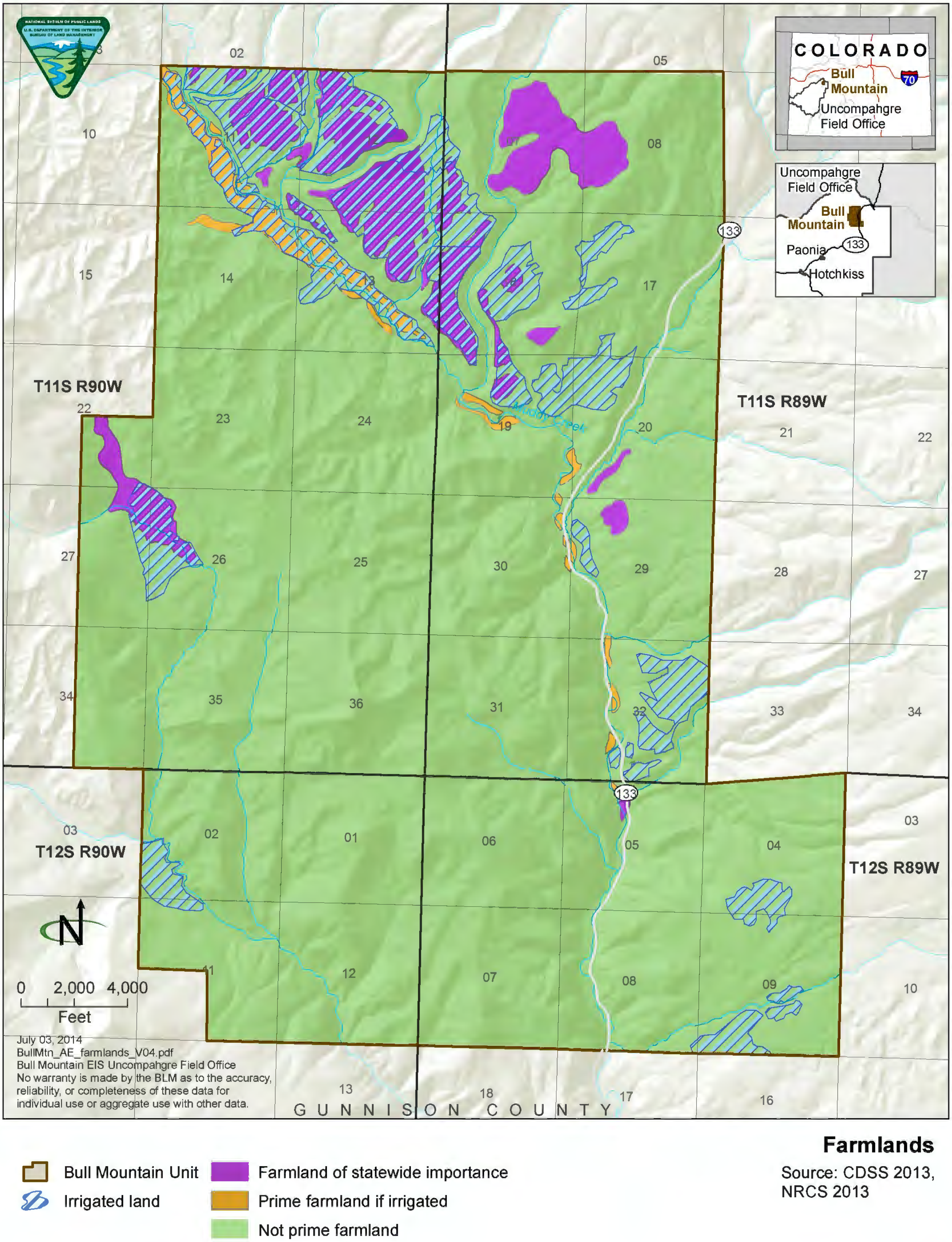
| Classified Soil Type | Acres |
|---|---|
| Herm-Fughes-Kolob family complex, 25 to 40 percent slopes | 10 |
| Wetopa-Wesdy complex, 5 to 65 percent slopes | 10 |
| Breece loam, 1 to 6 percent slopes | 280 |
| Bulkley clay loam, 12 to 25 percent slopes | 980 |
| Bulkley clay loam, 25 to 65 percent slopes | 2,620 |
| Cochetopa stony loam, 10 to 40 percent slopes | 850 |
| Cryoborolls, very stony | 1,540 |
| Curecanti loam, 3 to 15 percent slopes | 290 |
| Curecanti stony loam, 3 to 30 percent slopes | 300 |
| Fluvents, flooded | 560 |
| Fughes loam, 5 to 15 percent slopes | 1,240 |
| Fughes loam, 15 to 25 percent slopes | 3,700 |
| Fughes loam, 25 to 65 percent slopes | 4,180 |
| Fughes stony loam, 3 to 30 percent slopes | 880 |
| Fughes-Curecanti stony loams, 10 to 40 percent slopes | 880 |
| Torriorthents-Rock outcrop, sandstone, complex | 1,370 |

Source: NRCS 2013

Approximately 9 percent of the soils are within the Cryoborolls sub-order, and 7 percent of the soils are within the Torriorthents series. Cryoborolls are a sub-order of Mollisols, and are currently classified as Cryolls. Cryolls have similar soil characteristics as Mollisols, and are considered to be Mollisols in cold climates. Torriorthent soils are generally shallow silty clay or silty clay loam and are typically found in moderately steep to very steep areas with bedrock outcrops of sandstone, shale, and interbedded shale and sandstone. The remaining 11 percent of soils are within the Cochetopa series (4 percent), the Curecanti series (3 percent), the Fluvents series (3 percent), and the Breece series (1 percent). These soils are well drained and formed in colluvium and alluvium on mountain sides and slopes, from basalts, rhyolitic tuffs, or granitic outcrops and glacial outwash (NRCS 2013).

*Prime and Unique Farmlands*

Four categories of farmlands are federally regulated by the USDA under the Farmland Protection Policy Act: (1) prime farmlands, (2) unique farmlands, (3) farmlands of statewide importance, and (4) farmlands of local importance. In addition, the state makes designations of land that would be considered prime farmland if irrigated. Impacts from federal actions on BLM-administered lands on farmlands identified as prime or unique are required to be analyzed and disclosed to the public during development of an EIS. In addition, the USDA delineates important farmlands as those having soils that support the crops necessary for the preservation of the nation's domestic food and other supplies, specifically the capacity to preserve high yields of food, seed, forage, fiber, and oilseed with minimal agricultural amendment of the soil, adequate water, and a sufficient growing season. As seen in **Table 3-13**, Acres of Farmlands in the Bull Mountain Unit, and **Figure 3-3**, Farmlands, there are 1,240 acres of farmlands of statewide importance, and 280 acres of land that would be considered prime farmland if irrigated in the Unit. There are 18,150 acres in the Unit that do not have a farmland designation. Of these designations, 2,160 acres are irrigated, as shown in **Table 3-13**. There are 170 irrigated acres of prime farmland if irrigated, indicating that there are 170 acres of prime farmland within the Unit.




**Farmlands**

Source: CDSS 2013, NRCS 2013

Figure 3-3

**Table 3-13**
**Acres of Farmlands in the Bull Mountain Unit**

| Farmland Classification | Acres |
|---|---|
| Farmlands of statewide importance | 1,240 |
| Irrigated farmlands of statewide importance | 770 |
| Prime farmland if irrigated | 280 |
| Irrigated prime farmland if irrigated | 170 |
| Not prime farmland | 18,150 |
| Irrigated not prime farmland | 1,220 |

Source: NRCS 2013 and CDSS 2013

*Fragile Soils*

Fragile soils in the Unit consist of soils with a high wind and water erosion hazard and soils located on steep slopes. The Unit does contain soils high in sodium, selenium, soils affected by drought, or soils with a high potential to support biological soil crusts.

The NRCS has categorized slopes into five groups of steepness with overlapping lower and upper slope grade limit percentages. Moderately steep slopes have angles between 4 and 10 degrees, steep slopes have angles between 8 and 30 degrees, and very steep slopes have angles greater than 40 degrees. Soils located on steep slopes are generally subjected to high drainage densities, high relief, and high ruggedness, which results in increased erosion rates. Within the Unit, there are 1,730 acres of moderately steep slopes, 1,370 acres of steep slopes, and 8,340 acres of very steep slopes, as shown in **Table 3-14**, Acres of Slopes in the Bull Mountain Unit.

**Table 3-14**
**Acres of Slopes in the Bull Mountain Unit**

| Slope Classification | Acres |
|---|---|
| Gently sloping 1-10% | 2,360 |
| Strongly sloping 11-20% | 5,860 |
| Moderately steep 21-30% | 1,730 |
| Steep 31-40% | 1,370 |
| Very steep >40% | 8,340 |

Source: NRCS 2013

The erodibility of a soil, known as the K factor in soil surveys, represents both the susceptibility of soil to wind erosion, and water erosion through the rate of run-off. The Natural Resource Conservation Service surveys soils for their potential rate of erosion, or soil erosion hazard on a scale of slight to very severe The conditions of eroded soil are based on a comparison of the suitability for use and the management needs of the eroded soil with those of the uneroded soil of the same type or series (NRCS 2012).

The Natural Resource Conservation Service has classified soils in the project area based on their potential for erosion after disturbance in off-road and off-trail areas. The ratings in this interpretation indicate the hazard of soil loss from off-road and off-trail areas after disturbance activities that expose the soil surface. The ratings are based on slope and soil erosion factor K. The soil loss is caused by sheet or rill erosion in off-road or off-trail areas where 50 to 75 percent of the surface has been exposed by logging, grazing, mining, or other kinds of disturbance.

**Table 3-15**, Soil Erosion Ratings for the Bull Mountain Unit, shows acres of each soil hazard rating for the Unit.

**Table 3-15**
**Soil Erosion Ratings for the Bull Mountain Unit**

| Rating | Total Acres | Percent of the Unit |
|---|---|---|
| Slight | 2,360 | 12% |
| Moderate | 8,970 | 45% |
| Severe | 6,800 | 35% |
| Very Severe | 1,540 | 8% |
| Total | 19,670 | 100% |

Source: NRCS 2013

Soil erosion is also categorized into an erosion soil hazard for roads and trails, which is based on the soil erosion factor, K, slope, and content of rock fragments. This data has 3 categories (slight, moderate, and severe) and a numerical rating ranging from 0.01 to 1.00 which designates the soils as suitable or not suitable for road building, as seen in **Table 3-16**, Erosion Potential of Roads and Trials for the Bull Mountain Unit. A rating of slight indicates that little or no erosion is likely. A rating of moderate indicates that some erosion is likely and the road or trail may require additional maintenance and erosion-control measures. A rating of severe indicates that significant erosion is expected and the road or trail would require frequent maintenance and costly erosion control measures (NRCS 2012).

**Table 3-16**
**Erosion Potential of Roads and Trials for the Bull Mountain Unit**

| Rating | Total Acres | Percent of the Unit |
|---|---|---|
| Slight | 280 | 1% |
| Moderate | 2,010 | 10% |
| Severe | 17,370 | 89% |
| Total | 19,660 | 100% |

Source: BLM GIS 2014

***Trends***

Soil erodibility and low strength, combined with steep slopes and variable rates of runoff can lead to undesirable effects. Erosion is a natural process but human activities can speed up or increase the potential magnitude of these effects. Erosion rates may increase significantly when soil is disturbed. Undercutting slopes can activate or reactivate slides. Some of these effects have been observed in the site area. For example, construction of State Highway 133 may have directly undercut slopes, including landslide deposits, or constrained the natural ability of Muddy Creek to establish an optimal gradient, leaving some reaches vulnerable to erosion. Muddy Creek normally carries a high sediment load, and has resulted in significant loss of storage capacity in Paonia Reservoir since 1962 when the dam was constructed. There is some evidence that sedimentation rates have accelerated over the years.

A land health assessment was conducted on federal surface lands within the Unit in 2006-2007 as part of the North Fork Land Health Assessment. This assessment rates soil resources into 1 of 3 categories based upon BLM Colorado Public Land Health Standard: 1) meeting the standard, 2) meeting the standard with problems, or 3) not meeting the standard. Areas were classified as "unknown" if they were considered too small or minor to evaluate. Soils meeting the land health standard are healthy with respect to water absorption, erosion, organic matter, and groundcover. The BLM applies these standards to public lands on a landscape scale to help describe a landscape's potential, various uses, and the conditions needed to sustain land health. The soil rating for soil resources within the Unit is shown in **Table 3-17**, Land Health Assessment Results in the Bull Mountain Unit (BLM 2007).

**Table 3-17**
**Land Health Assessment Results in the Bull Mountain Unit**

| Land Health Assessment Rating | Federal Surface (acres) |
|---|---|
| Meeting Land Health Standard 1 | 310 (70%) |
| Not Meeting Land Health Standards 1 | 0 |
| Unknown or Data Not Available | 130 (30%) |
| Total | 440 |

Source: BLM 2007

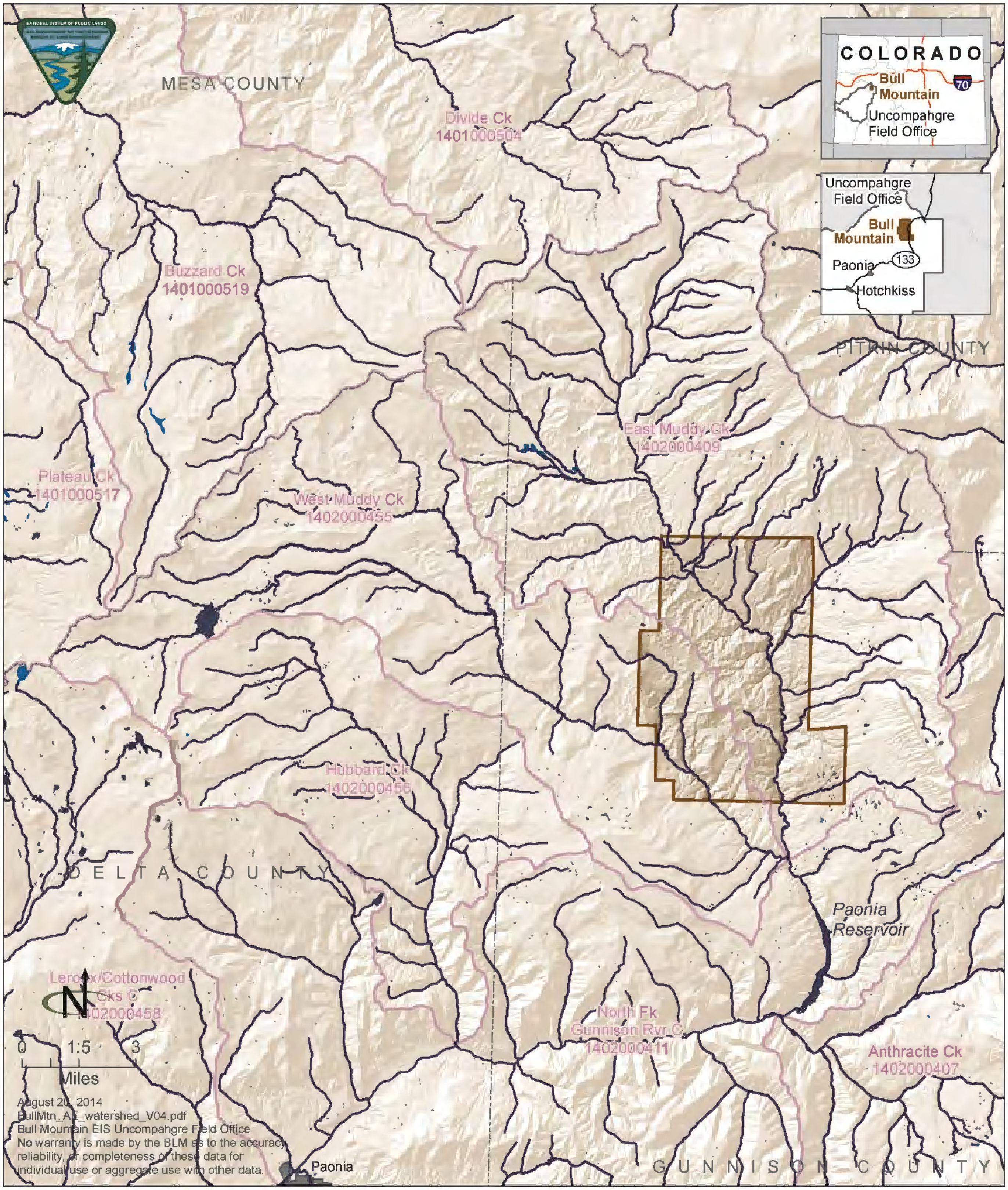
Recently, natural gas exploration and development activities have been creating surface disturbances which can lead to an increased rate of run off and erosion of soils. Over the last decade exploratory and development activities in and surrounding the Unit have focused on exploring for shale gas resources and developing coalbed natural gas resources, and these activities are expected to continue over the next 20 years (BLM 2012). Mineral and energy exploratory and development actives have BMPs in place to minimize soil surface disturbance, but the projected increases in natural gas extraction indicate that there is potential for additional soil disturbance and accelerated rates of erosion.

### 3.2.4 Water Resources

#### *Current Conditions*

*Surface Water*

The Unit is in the North Fork Gunnison River drainage basin, US Geological Service (USGS) Hydrologic Unit Code 14020004, and is part of the upper Colorado River Basin. The climate in the Unit is semi-arid and the North Fork Gunnison River basin has a drainage area of approximately 969 square miles. Hydrologic Unit Code numbers identify the hierarchical relationships of sub-watersheds. Hydrologic Unit Code 14, which represents the upper Colorado River basin, is 1 of 21 hydrologic regions in the US. The 10-digit Hydrologic Unit Codes 1402000409 and 1402000455 identify the watersheds of East Muddy Creek and West Muddy Creek, respectively. These are the two principal streams draining the Unit. As shown on **Figure 3-4**, Watersheds, the watersheds of both streams extend far beyond the Unit. The unit is entirely contained within these two watersheds, though the two streams converge a little more than a mile south of the Unit.




Bull Mountain Unit
Watershed: level 5 hydrologic unit code
Perennial stream or other stream
Lake or reservoir
Other water body
Town

**Watersheds**

Source: BLM GIS 2014, NHD 2013

Figure 3-4

On the east side of the Unit, the tributary streams to East Muddy Creek form a radial pattern from peaks that rise to more than 12,000 feet above mean sea level. The peaks are rocky outcrops, composed of the exposed remnants of igneous intrusions that once erupted lava onto the surface. Thousands of feet of overlying deposits have been eroded away, but the process still continues. Many of the lower slopes are landslide deposits which are continuously sliding into East Muddy Creek. East Muddy Creek flows along the toe of these deposits, sweeping them downstream as they are delivered by the radial stream channels and by episodic landslide activity. Lee Creek, which is a tributary to East Muddy Creek, extends north along the toe of the slope of Chair Mountain beyond the Unit, but the watershed of Lee Creek is much smaller than the watershed of East Muddy Creek, and more runoff is carried by East Muddy Creek than by Lee Creek. The channel of West Muddy Creek is similarly constrained by the north-facing slope of Buck Mesa, as it carries runoff from the upper watershed across the southwest corner of the Unit.

The lowest elevation within the Unit is approximately 6,500 feet above mean sea level at the southern boundary of the Unit just below the convergences of East Muddy Creek and Spring Creek. The elevation of East Muddy Creek where it enters the northeast corner of the Unit, near the convergence with Henderson Creek, is approximately 7,240 feet above mean sea level. This represents a fall of about 740 feet over a distance of about 10 miles, or an average stream gradient of about 75 feet per mile, or less than 1.5 percent. The gradient is relatively uniform over the entire reach and during normal flow conditions, the stream meanders through a relatively broad flood plain. The channel of West Muddy Creek is about twice as steep, with a drop of about 720 feet over a distance of about 5 miles within the Unit. Both streams have alluvial channels through the Unit. The tributaries to East Muddy Creek and West Muddy Creek are steeper and narrower.

The highest elevation within the Unit is on the northeast boundary, where the elevation reaches about 8,400 feet above mean sea level on the western slope of the Raggeds. On the western side of the Unit, the landscape is dominated by the relatively uniform regional uplift of the Colorado Plateau. The summit of Bull Mountain, near the center of the Unit, is 8,185 feet above mean sea level, but most of the ridges and promontories on the west side of the Unit rise to elevations in the range of approximately 7,000 to 7,500 feet above mean sea level. The tributaries to East and West Muddy Creek tend to drain small, rectangular watersheds, many of which contain broad terraces suitable for agriculture.

Due to the high elevation of the area, snow covers the ground from about November through March. Peak runoff within the area is a result of spring snowmelt (April through June) that originates from the higher peaks to the north and east of the Unit (**Table 3-18**, Typical Monthly Flows for USGS near the Unit). The gages on East and West Muddy Creek were only in use for limited periods of time, but provide an indication of the distribution of runoff during the year. The station descriptions are summarized below:

- **USGS Station 09131200, West Muddy Creek near Somerset, Colorado**. This site was maintained from 1961 through 1973 and was located on West Muddy Creek upstream of the confluence of West and East Muddy creeks, approximately 4 miles west of the Unit. The drainage area upstream of the gage is approximately 50 square miles. The mean

**Table 3-18**
**Typical Monthly Flows for USGS near the Unit (cfs[1])**

| USGS Gage | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 09131200 West Muddy Creek Near Somerset, CO | 5.0 | 5.1 | 9.9 | 64.7 | 166.8 | 74.7 | 14.5 | 6.3 | 8.7 | 8.5 | 7.4 | 5.7 |
| 09130500 East Muddy Creek Near Bardine, CO | 13.7 | 14.8 | 26.1 | 172.8 | 474.9 | 209.3 | 46.6 | 27.1 | 18.9 | 18.5 | 18.4 | 15.0 |
| 09131500 Muddy Creek at Bardine, CO | 21.0 | 22.4 | 29.9 | 302.3 | 642.1 | 268.7 | 48.7 | 36.0 | 22.4 | 24.0 | 24.0 | 21.0 |

Source: USGS 2013. National Water Information System (http://waterdata.usgs.gov/co/nwis/ )
[1] cubic feet per second

monthly discharge rates for the entire data record at this location ranged from 5 cubic feet per second (cfs; January) to 167 cfs (May). The mean annual discharge rates recorded at this location ranged from 11.0 cfs (1963) to 59.1 cfs (1962). Instantaneous peak discharge rates recorded at this site ranged from 120 cfs (1972) to 1,190 cfs (1973).

- **USGS Station 09130500, East Muddy Creek near Bardine, Colorado**. This site was maintained from October 1934 through September 1953 and was located on East Muddy Creek just south of the Unit. The drainage area upstream of the gage is 133 square miles. The mean monthly discharge rates for the entire data record at this location range from 14 cfs (January) to 475 cfs (May). The mean annual discharge rates recorded at this location ranged from 53.7 cfs (1940) to 135.0 cfs (1938). Instantaneous peak discharge rates recorded at this site ranged from 480 cfs (1951) to 2,190 cfs (1941).

- **USGS Station 09131500, Muddy Creek at Bardine, Colorado**. This site was maintained from October 1949 through September 1955 and was located on Muddy Creek below Paonia Reservoir, approximately 5 miles south of the Unit. The drainage area upstream of the gage is 257 square miles. The mean monthly discharge rates for the entire data record at this location ranged from 21 cfs (December and January) to 642 cfs (May). The mean annual discharge rates recorded at this location ranged from 48.9 cfs (1954) to 242.9 cfs (1952). Instantaneous peak discharge rates recorded at this site ranged from 382 cfs (1954) to 3,400 cfs (1952).

Muddy Creek is the principal source of inflow to Paonia Reservoir, which is operated by the Bureau of Reclamation for irrigation and flood control. As the name implies, Muddy Creek carries a high sediment load, especially during the period of peak annual runoff, which occurs in June, following the spring thaw. Paonia reservoir was designed with the expectation that it would receive about 100 acre-feet of sediment per year, but it has sometimes received much more, such as in 1986 when landslides activated by runoff on the west-facing slopes of Chair Mountain and the Raggeds delivered more than 600 acre-feet of sediment to Muddy Creek, which deposited it in the reservoir (Latousek 1995). The dam was built in 1962, but about one-quarter of its storage capacity has been lost to siltation (NFRIA 2010).

The area within the Unit receives relatively little precipitation during the summer despite the high runoff Snowmelt, overland flow after rainfall events, and perched groundwater likely contribute to the high runoff observed in the Unit. Surface water is the primary source of irrigation for the area, due to lack of a significant groundwater aquifer, and water storage has historically been a concern.

One hundred twelve (112) ponds and small reservoirs exist within the Unit, based on review of the Bull Mountain and Chair Mountain 7.5-minute topographic quadrangle maps (USGS 2001a, 2001b). Records indicate that 19 of these are permitted through the Colorado Division of Water Resources (CDWR). The permitted reservoirs are used for recreation, fishery, augmentation, fire, stock watering, wildlife, and other uses (CDWR 2010). Permitted reservoirs are discussed further in the Water Resources Technical Report (WWC 2011).

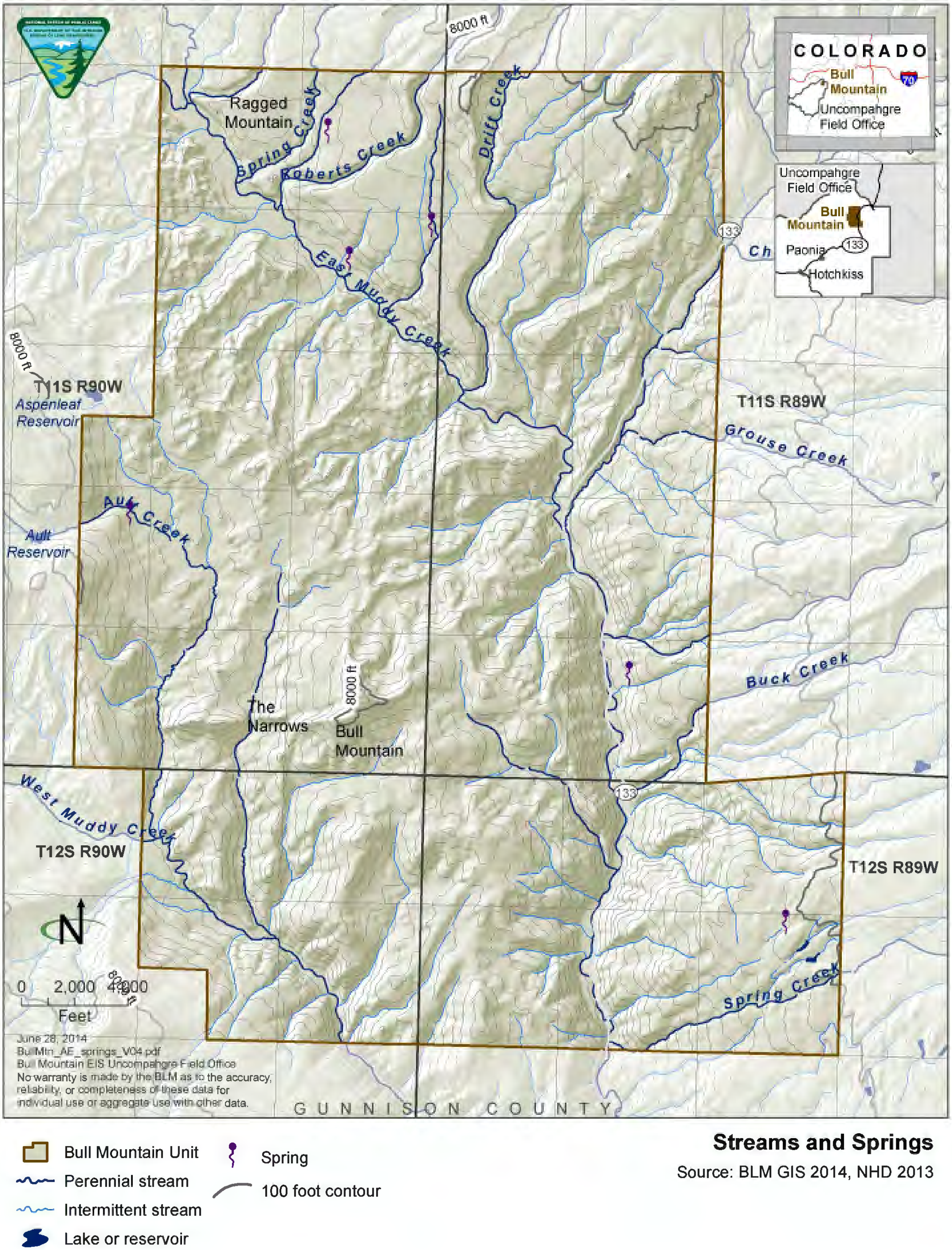
Six developed springs are listed in the National Water Information System database and 13 are recorded with surface water rights in the Colorado Division of Water Resources database, including two that were also in the USGS database (USGS 2010b). The spring water is evaluated as good quality with a moderate mineral content reflected in the specific conductance values. The approximate locations of the listed springs are shown on **Figure 3-5**, Streams and Springs. Available water quality data for the six springs listed in the database are resented in **Table 3-19**, General Water Quality of Springs within the Unit (one sample per station).

**Table 3-19**
**General Water Quality of Springs within the Unit (one sample per station)**

| | Parameters | | |
|---|---|---|---|
| **Gauging Station** | **Temperature (°F)** | **Specific Conductance (µmohs/cm)[1]** | **pH (standard units)** |
| USGS 390210107202001 SC01208909ABB1 | 57 | 70 | 6.9 |
| USGS 390340107213801 SC01108932BAD1 | 50 | 205 | 8.2 |
| USGS 390435107253801 SC01109027AAC1 | 82 | 285 | 7.5 |
| USGS 390611107235601 SC01109013BDB1 | 68 | 320 | 7.2 |
| USGS 390625107231701 SC01109013AAA1 | 61 | 270 | 7.0 |
| USGS 390659107240801 SC01109012BCA1 | 46 | 370 | 6.7 |

Source: USGS 2013. National Water Information System – Water Quality Samples for Colorado. http://nwis.waterdata.usgs.gov/co/nwis/
[1] µmohs/cm = micro mohs per centimeter

Colorado has adopted basic standards and antidegradation rules for surface waters. The CDPHE regulations governing the North Fork Gunnison River are contained within Water Quality Control Commission Regulation No. 35, which establishes classifications and numeric standards for the Gunnison and Lower Delores River Basins (CDPHE 2010a). Under these rules, the beneficial uses of all tributaries to the North Fork Gunnison River (including all lakes, reservoirs, and wetlands) are classified under five separate categories. The designated beneficial uses for




**Streams and Springs**

Source: BLM GIS 2014, NHD 2013

Figure 3-5

surface water are Aquatic Life; Recreation; Domestic Water Supply; Wetlands; and Agriculture (CDPHE 2009a).

Stream segment descriptions and water quality classifications within and downstream of the Unit, including the North Fork Gunnison River, are listed in **Table 3-20**, Stream Classifications and Water Quality Standards. A complete listing of numeric standards for physical, biological, inorganic, and metal constituents for Colorado surface water can be found in Basic Standards for Surface Water (CDPHE 2009a).

**Table 3-20**
**Stream Classifications and Water Quality Standards**

| Stream Segment Description | Classification |
|---|---|
| All tributaries to North Fork of the Gunnison River including all lakes, reservoirs, and wetlands within the West Elk and Raggeds Wilderness Areas. | Aquatic Life Cold 1<br>Recreation E<br>Water Supply<br>Agriculture |
| All tributaries to the North Fork of the Gunnison River including all lakes, reservoirs, and wetlands from the source of Muddy Creek to a point immediately below the confluence with Coal Creek; all tributaries to the North Fork of the Gunnison including all lakes, reservoirs, and wetlands, including the Grand Mesa Lakes which are on National Forest System lands, except for the specific listing in Segments 1 and 7. | Aquatic Life Cold 1<br>Recreation E<br>Water Supply<br>Agriculture |
| All tributaries to the North Fork of the Gunnison River including all lakes, reservoirs, and wetlands which are not on National Forest System lands, except for the specific listings in Segments 4, 5, 6b, and 7. | Aquatic Life Warm 2<br>Recreation P<br>Agriculture |
| Paonia Reservoir. | Aquatic Life Cold 1<br>Recreation E<br>Water Supply<br>Agriculture |

Source: CDPHE 2010a

Regulation No. 93 is Colorado's Section 303(d) list of water quality limited segments requiring total maximum daily loads (CDPHE 2010b). None of the stream segments above Paonia Reservoir is listed as impaired, although the segment of the Gunnison River below the reservoir is impaired for selenium, and it is possible that mineral sources of selenium are present in the watersheds above Paonia Reservoir.

One USGS surface water quality sampling station (390620107241900) is located within the Unit, and four other sampling stations (09129800, 390000107212700, 385918107205200, and 385903107210800) are located either above or below the Unit that provide relevant long-term water quality data, including temperature, specific conductance, pH, hardness, sodium absorption ratio, total dissolved solids, total suspended sediment, and sediment yield.

The USGS has collected water quality samples of various constituents at differing time intervals. Data are summarized in **Table 3-21**, General Water Quality of East Muddy/Muddy Creeks on/near the Unit. The data are not definitive since they were collected over a limited period of time and at only a few locations, but they indicate that the stream water quality is generally good.

**Table 3-21**
**General Water Quality of East Muddy/Muddy Creeks on/near the Unit**

| Parameter | No. of Samples | Range | Mean | Median |
|---|---|---|---|---|
| **USGS 385918107205200 Muddy Creek Above Paonia Res Site No 1 (1977 – 1978)** | | | | |
| Temperature (°C) | 2 | 6.5-20 | 0.2 | 0.2 |
| Specific Conductance (µmohs/cm) | 2 | 120-305 | 302.5 | 302.5 |
| pH (field - standard units) | 2 | 7.6-8.7 | 8.3 | 8.3 |
| Total Hardness (mg/L as $CaCO_3$) | - | - | - | - |
| Sodium Absorption Ratio (unitless) | 2 | 7.3-8.5 | 140.0 | 140.0 |
| Total Dissolved Solids at 180 °C (mg/L) | 2 | 60-140 | 0.4 | 0.4 |
| Total Suspended Solids (mg/L) | - | - | - | - |
| Sediment Yield (tons/day) | - | - | - | - |
| **USGS 385903107210800 Muddy Creek Above Paonia Reservoir, CO (1982 – 1983)** | | | | |
| Temperature (°C) | 15 | 6.5-20 | 13.5 | 13.0 |
| Specific Conductance (µmohs/cm) | 15 | 120-305 | 191.5 | 180.0 |
| pH (field - standard units) | 15 | 7.6-8.7 | 8.2 | 8.2 |
| Total Hardness (mg/L as $CaCO_3$) | 15 | 60-140 | 90.1 | 79.0 |
| Sodium Absorption Ratio (unitless) | 15 | 0.2-0.4 | 0.3 | 0.3 |
| Total Dissolved Solids at 180°C (mg/L) | 14 | 84-182 | 124.4 | 117.5 |
| Total Suspended Solids (mg/L) | 10 | 58-3,660 | 862.3 | 450.5 |
| Sediment Yield (tons/day) | 10 | 9.4-3,710 | 1395.1 | 905.0 |
| **USGS 385918107205200 Muddy Creek Above Paonia Res Site No 1 (1977 – 1978)** | | | | |
| Total Dissolved Solids at 180°C (mg/L) | 2 | 60-140 | 0.4 | 0.4 |
| Total Suspended Solids (mg/L) | - | - | - | - |
| Sediment Yield (tons/day) | - | - | - | - |
| **USGS 390000107212700 Lower West Muddy Creek Near Paonia Reservoir, CO (1982 – 1983)** | | | | |
| Sodium Absorption Ratio (unitless) | 12 | 0.2-0.4 | 0.3 | 0.3 |
| Total Dissolved Solids at 180°C (mg/L) | 12 | 96-210 | 152.8 | 155.5 |
| Total Suspended Solids (mg/L) | 11 | 10-271 | 96.6 | 48.0 |
| Sediment Yield (tons/day) | 11 | 0.15-653 | 110.5 | 6.4 |

Source: USGS 2010b
°C = degrees Celsius
µmohs/cm = µmohs per centimeter
mg/L = milligrams per liter

Given the geology of the region, it seems likely that most of the base flow in the perennial streams through the Unit is contributed by perched ground water, possibly within the alluvium near the stream channels, and by overland flow during periods of rainfall and runoff from snowmelt. No hydrologic studies have been performed to confirm the importance of perched groundwater, but most groundwater wells in the area are shallow wells located close to the channel of East Muddy Creek.

The North Fork Gunnison River is recognized as a major contributor of salt to the Colorado River System (NFRIA 2010). Salinity has become a major concern within the Colorado River drainage basin. The 1972 Clean Water Act required the establishment of numeric criteria for salinity for the Colorado River and in 1973, seven Colorado River Basin states created the Colorado River Basin Salinity Control Forum. The Forum developed water quality standards for salinity including numeric criteria and a basin-wide plan of implementation. The plan consists of a number of control measures to be implemented by State and Federal agencies. In 1974, Congress enacted the Colorado River Basin Salinity Control Act. The Act was amended in 1984, requiring the Secretary of the Interior to develop a comprehensive program to minimize contributions from BLM-administered. Salinity in Muddy Creek upstream of Paonia Reservoir is low, as demonstrated by the low total dissolved solids concentrations shown in **Table 3-21**.

*Regional Groundwater Occurrence*
An understanding of the regional aquifer system provides clues to the occurrence of groundwater within the Unit. However, conditions within the Unit may differ in important ways, due to the fact that the Unit is located on the margin of the Piceance Basin and is likely affected by several unusual features of that location, including the presence of volcanic intrusive rocks, proximity to the upwarped edge of Mesaverde strata, and because of the unusual juxtaposition of a source of recharge (East Muddy Creek) over this same area. Much remains to be discovered about the subsurface conditions in the vicinity of the Unit.

Alluvial aquifers in the region are thickest in valley bottoms (usually less than 100 feet thick) and are likely connected hydraulically with adjacent bedrock aquifers, meaning that groundwater is probably able to flow from the alluvial aquifer into the underlying bedrock formation, although the quantity of this flow would be dependent on the permeability of the underlying bedrock unit.

The primary bedrock aquifers in the North Fork Gunnison River Basin are the Dakota Sandstone and the Burro Canyon Formation of Early and Late Cretaceous age (Ackerman and Brooks 1986). The Dakota Sandstone varies from 30 to 150 feet in thickness and the Burro Canyon Formation varies from 50 to 180 feet thick (BLM 2010b). Wells completed in these formations typically yield more than 10 gallons per minute, although the depth and quality of water in these formations at the Unit is expected to make them unsuitable as a potable aquifer (Ackerman and Brooks 1986).

The Upper Cretaceous Mesaverde aquifer is regionally more extensive than the other bedrock aquifers in the area because none of the major river systems (i.e., the North Fork of the Gunnison, Colorado, or White Rivers) have eroded into it. Within the North Fork Gunnison River Basin, the Mesaverde aquifer includes the Lance Formation, the Fox Hills Sandstone (where it is present), the Lewis Shale, and the Mesaverde Group, which is composed of the Williams Fork Formation, the Trout Creek Sandstone Member, and the Iles Formation (Freethey 1991). The lithologic composition of the Mesaverde aquifer is highly variable from formation to formation and from location to location due to the complex nature in which the strata were deposited. Within the Piceance Basin, the Mesaverde aquifer is predominantly composed of sandstone with interbedded shale and coal beds. Within the North Fork of the Gunnison River Basin, the thickness of the Mesaverde aquifer varies between approximately 4,000 feet to 5,000 feet. Wells completed in the Mesaverde Formation have yields that are typically less than 10 gallons per minute, especially where the formation contains relatively little secondary permeability from joints and fractures (Ackerman and Brooks 1986).

Underlying the Mesaverde aquifer is the Mancos shale. Within the Unit, the Mancos Shale is approximately 4,500 feet thick. The Mancos Shale is primarily marine shale, mudstone, and claystone; therefore, permeability is very low. Because of the low permeability within the Mancos Shale, it is considered a major confining layer that essentially stops all groundwater flow (Ackerman and Brooks 1986).

*Local Groundwater Occurrence*

Alluvial deposits within the Unit primarily consist of sand, silt, and gravel of Quaternary age adjacent to the East Muddy Creek valley. Portions of the alluvial aquifer extends into the tributary valleys. Thin alluvial and eolian deposits are present on mesas near the site but none appear to be actually within the Unit (Ackerman and Brooks 1986). Wells completed in the alluvium have yields that can range from 1 to 150 gallons per minute but generally average about 20 gallons per minute (Ackerman and Brooks 1986).

Most domestic water wells in the Unit are completed in the Wasatch Formation or in alluvium near stream channels. In the Piceance Basin, alluvial aquifers are generally the most productive, but within the Unit, alluvial deposits are thin, except within the floodplains of the major streams, the water table is generally below the elevation of the alluvium.

Groundwater in the bedrock aquifers is expected to flow in the direction of the geologic dip, which is approximately 4 degrees from horizontal and in a northeastward direction (BLM 2007a). However, near the margins of the Piceance Basin, where outcrops of Mesaverde rocks have been folded upward and crop out at the surface or are found at shallow depth, recharge by runoff or rainwater can work its way down through fractures, and may yield good quality water to wells in these margin areas (EPA 2004). The situation is further complicated by the presence of the igneous intrusive rocks, such as the Raggeds, in the southeastern portion of the basin. Fractures in these rocks might be capable of conducting fresh water to greater depths. It is also possible that some fresh water recharge occurs through the alluvial channels of the principal streams, especially where the streams are in proximity to the upturned Mesaverde formation, such as along the south-trending reach of East Muddy Creek. However, no studies have been performed to support this hypothesis or to quantify the amount of recharge that may occur.

*Groundwater Quality*

Federal Safe Drinking Water Act regulations (40 CFR 144.3) define an Underground Source of Drinking Water as:

> an aquifer or portion thereof: (a)(1) which supplies any public water system; or (2) which contains a sufficient quantity of ground water to supply a public water system; and (i) currently supplies drinking water for human consumption; or (ii) contains fewer than 10,000 mg/L total dissolved solids; and (b) which is not an exempted aquifer.

Under 40 CFR 146.04, a Underground Source of Drinking Water can be exempted if it does not currently serve as a source of drinking water, and cannot now and will not in the future serve as a source of drinking water for one of four reasons:

- It is mineral, hydrocarbon, or geothermal energy producing, or can be demonstrated by a permit applicant as part of a permit application for a Class II or III operation to contain minerals or hydrocarbons that considering their quantity and location are expected to be commercially producible.

- It is situated at a depth or location that makes recovery of water for drinking water purposes economically or technologically impractical.

- It is so contaminated that it would be economically or technologically impractical to render that water fit for human consumption.
- It is located over a Class III well mining area subject to subsidence or catastrophic collapse; or the total dissolved solids content of the ground water is more than 3,000 and less than 10,000 milligrams/liter, and it is not reasonably expected to supply a public water system.

The EPA secondary drinking water standard for total dissolved solids (TDS) is 500 mg/L. Above a TDS of 500 mg/L, water has a noticeable salty taste, and at higher concentrations may have excessive hardness, or may contain harmful constituents. Secondary drinking water standards are guidelines rather than enforceable standards, though, and water with a high TDS can be blended with higher quality water to achieve acceptable TDS concentrations in the blended water.

A USGS investigation of groundwater resources in the North Fork watershed found that alluvial aquifers yield water with dissolved solids concentrations ranging from 110 to 2,300 mg/L. The higher cost of drilling deeper wells is usually not rewarded by higher yields or better quality water. The Mesaverde Group contains rocks that generally have low permeability and poor water quality. TDS concentrations of water samples from the Mesaverde Group, the Dakota Sandstone, and Burro Canyon Formation that were evaluated by the USGS ranged from 56 to 3,200 mg/L.

According to the North Fork River Watershed Plan, groundwater from bedrock aquifers in the upper watershed is generally of the sodium bicarbonate type that is neutral to alkaline (pH 7 to 9), with low metals content and a high methane content (NFRIA 2010). This suggests that methane continues to be generated in the underlying rocks, and that there may be a steady flux of methane into the overlying formations.

Below the depths normally explored for domestic water supplies, water quality tends to diminish. Most potable wells are less than 200 feet deep, though occasionally they extend deeper. But the deeper portions of the Piceance Basin, particularly in the central basin areas, contain evaporites (salts concentrated in stands of Lake Uinta, for example, which once covered portions of the Piceance Basin) that raise the TDS concentrations above levels that are normally acceptable for drinking water.

TDS concentrations of water samples from the Mancos Shale ranged from 1,800 to 8,200 mg/L in the USGS study (Ackerman and Brooks 1986); but the Mancos Shale has very low primary permeability associated with an aquitard rather than an aquifer. TDS in the overlying Rollins Sandstone reportedly ranges from 3,000 to 9,000 mg/L (NFRIA 2010). While poor in quality, the Rollins Sandstone would qualify as a Underground Source of Drinking Water.

Throughout the central parts of the Piceance Basin, coal-bearing strata are generally found at depths of more than 4,000 feet. Within the Unit, the depth to the base of the coal-bearing Cameo Group ranges from greater than 4,000 feet in the northwest to less than 2,000 feet along the east. These depths are generally too deep for economic drilling and pumping of groundwater, even if the groundwater were potable.

Knowledge about groundwater conditions at depths greater than several thousand feet comes almost entirely from wells drilled for gas production. The deepest permeable formations are commonly used for deep injection of production wastewater. SGI's existing disposal well (Federal 24-2 WDW) is a Class II disposal well located on fee lands in the NWSW Section 24, T11S, R90W and is used to dispose of produced water from current natural gas production in the area. The geological horizons for the primary disposal zones for the one existing and four proposed disposal wells are the sandstone formations below the Mancos Shale, including the Dakota Sandstone, Morrison Formation, Entrada Sandstone, and Maroon Formation at depths between 9,300 and 9,500 feet. The total dissolved solids concentration measured in the existing injection well, completed in the Unit in the Permian to Pennsylvanian age Maroon Formation, is 18,962 mg/L, which is about half the salinity of sea water. Produced-water quality sample lab test results from samples collected in 2007 from existing producing wells within the Unit are included in **Table 3-22**, Water Quality Lab Test Results from Produced Water from Existing Producing Natural Gas Wells within the Producing Formations in the Unit. Some of the waters encountered at these depths also contain dissolved petroleum hydrocarbons, including the volatile constituents benzene, toluene, ethylbenzene, and xylenes, which are found in light crude oil.

**Table 3-22**
**Water Quality Lab Test Results from Produced Water from Existing Producing Natural Gas Wells within the Producing Formations in the Unit**

| Parameter[1] | McIntyre 11-90-14-4 | Falcon Seaboard 11-90-12-1 | Henderson R1 | Federal 26-1 |
|---|---|---|---|---|
| pH (field) | 5.5 | 7.1 | 5.6 | 9.6 |
| Total Dissolved Solids | 10,557 | 8,775 | 18,445 | 4,495 |
| Potassium | 94 | 431 | 312 | 110 |
| Sodium | 2,961 | 2,531 | 5,462 | 1,493 |
| Calcium | 664 | 260 | 736 | 60 |
| Magnesium | 252 | 140 | 572 | 60 |
| Bicarbonate | 280 | 636 | 132 | 260 |
| Chloride | 6,400 | 4,800 | 11,600 | 2,400 |
| Sulfate | 0 | 4 | 4 | 19 |
| Total Iron | 0.9 | 5.4 | 1.6 | 0.1 |

[1] All units in mg/L except pH, which is in standard pH units

Water to be injected into the deep formations in which the disposal wells are completed is first piped into holding tanks to allow sediments to settle out by gravity. The water then passes through a series of filters to remove solids larger than 10 microns in diameter so that these sediments will not clog the pores of the sandstone aquifer in which they are injected.

Accumulated solids from the settling and filtration process are periodically removed from the holding tanks and trucked to an approved off-site disposal facility. Chemical treatment of water reduces scaling or deposition of minerals in the receiving formation, which, if unabated, could reduce the porosity in the recovery formation and otherwise shorten the life of the disposal wells.

*Current Water Quality Monitoring Program*

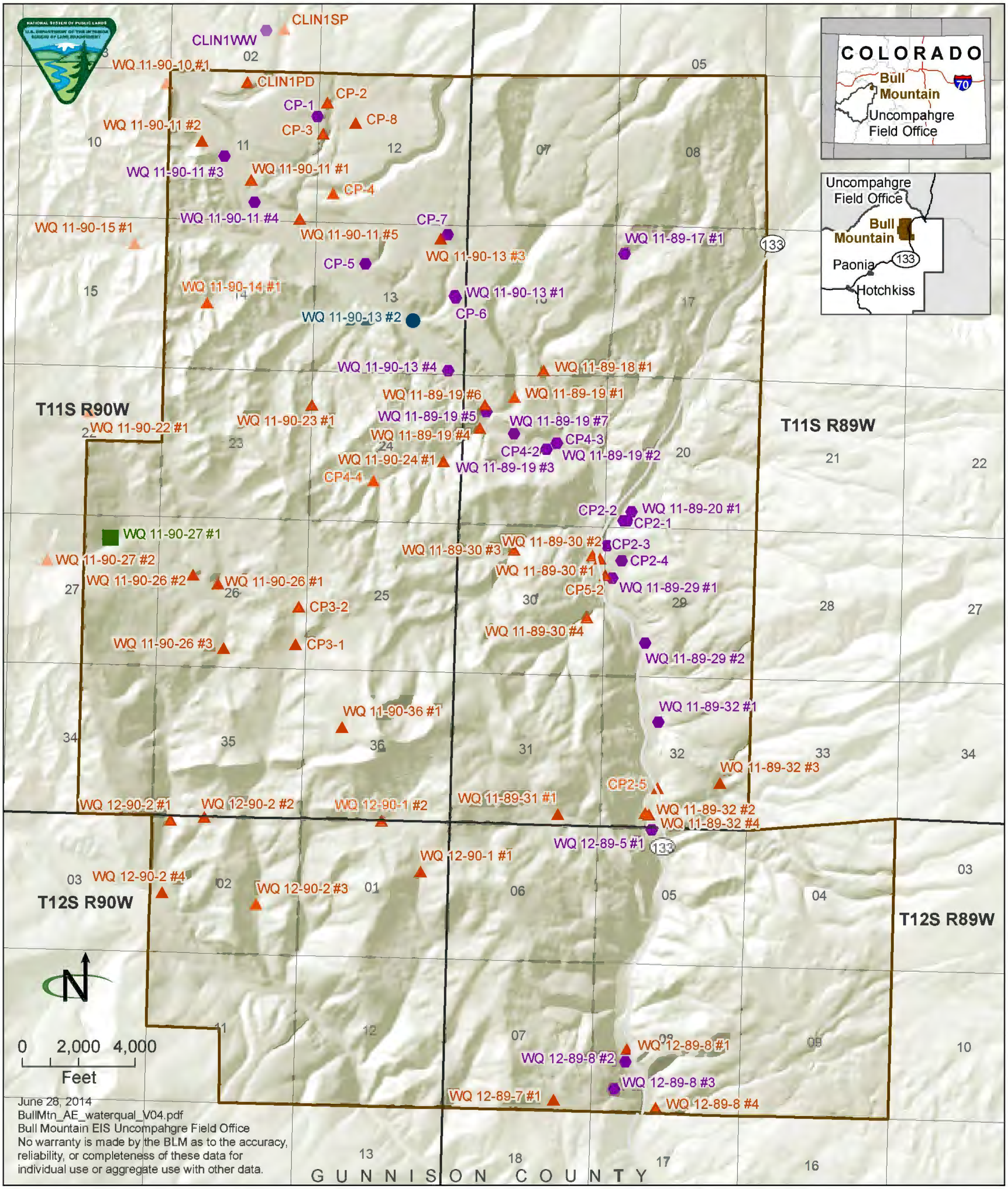
In compliance with Gunnison County and COGCC regulations (Gunnison County Board of County Commissioners 2003, COGCC 2009), and in anticipation of potential new development, SGI initiated baseline water quality monitoring of surface water monitoring locations near existing and proposed production wells within the Unit. Sites have been established to sample surface water along streams, ponds, and other water bodies to establish baseline conditions.

The requirements have changed during recent years, but as part of its current permitting requirements, COGCC Rules 608 (which covers coalbed methane wells) and 609 (which addresses all other oil and gas wells) require baseline monitoring of groundwater, and SGI has collected samples from available sources of groundwater within a 0.25 to 1-mile radius of proposed natural gas wells as part of its compliance with these rules.

Under Rule 609, the permittee is required to sample up to four sources of groundwater, including wells or springs (with preference given to well-maintained domestic wells), within a 0.5 mile radius of a new well pad. Initial sampling must be conducted within 12 months prior to setting conductor pipe in the first well of a multi-well site, or before commencement of drilling an injection well. Subsequent monitoring is required at the same locations between 6 and 12 months, and then again between 5 and 6 years after completion of the well. The testing program must include pH, specific conductance, TDS, dissolved gases (methane, ethane propane), alkalinity (total bicarbonate and carbonate as $CaCO_3$), major anions (bromide, chloride, fluoride, sulfate, nitrate and nitrite as N, phosphorus), major cations calcium, iron, magnesium, manganese, potassium, sodium), other elements barium, boron, selenium and strontium, presence of bacteria (iron related, sulfate reducing, slime forming), total petroleum hydrocarbons TPH), and BTEX compounds benzene, toluene, ethylbenzene and xylenes). Field observations of odor, color, sediment, bubbles, and effervescence must also be documented.

Rule 608 imposes additional requirements for monitoring in the vicinity of coalbed methane wells. The operator must perform a records search for plugged and abandoned wells within 0.25 mile of the proposed coalbed methane well, and must assess the risk that the plugged and abandoned wells may act as a conduit for gas or water leakage. Within 1 year, and then every 3 years after production from the coalbed methane well, the operator must perform a soil gas survey at all plugged and abandoned wells, and submit the result of the surveys to COGCC. In addition, the operator must sample existing water wells within a certain distance from the proposed coalbed methane well as part of a baseline sampling program. The method of selecting the wells to be sampled is specified in the rule, but generally requires sampling 2 wells within 0.25 mile of the coalbed methane well if they exist, or 1 well within 0.5 mile if closer wells do not exist. The initial testing program differs from Rule 609. Testing must include major cations and anions, TDS, iron, manganese, selenium, nitrates and nitrites, dissolved methane, field pH, sodium adsorption ratio, presence of bacteria (iron related, sulfate reducing, slime, and coliform), and specific conductance. Hydrogen sulfide must be measured in the field, and field observations of odor, color, sediment, bubbles, and effervescence must also be included.

The network of sampling points that has been monitored by SGI currently includes 23 wells, 1 cistern, and 51 surface water locations within the Unit. Additional sampling has also been conducted at locations outside the Unit. **Figure 3-6**, Water Quality Monitoring, shows the locations where baseline monitoring has been performed. Some of the available data were collected prior to 2010, including 6 wells and 8 surface water locations that were sampled between 2002 and 2008 but have not been sampled since; 8 wells that were sampled prior to 2010 and have been sampled again since 2010. Excluding the locations for which there are only




Bull Mountain Unit
Surface water
Well water
Shallow ground water
Water cistern

**Water Quality Monitoring**

Source: BLM GIS 2014, SG Interests 2013

Figure 3-6

pre-2010 data, there are currently 16 wells, 1 cistern, and 40 surface water locations in the water quality monitoring network within the Unit.

Baseline samples provide an indication of conditions prior to the initiation of oil and gas development activities. They can also provide an indication of the geographic variability of water quality throughout the Unit. Examination of baseline data could potentially reveal underlying geographic and temporal trends in water quality associated with natural conditions or with pre-oil and gas activities. More importantly, re-sampling over time and comparison to the baseline data can be used to identify changes in water quality, to monitor the effectiveness of controls designed to protect water resources, and to determine the need for corrective action.

The baseline monitoring program has evolved somewhat over the years since it was initiated, resulting in variations in the chemical and physical parameters measured at different locations and times. At most locations, water samples have been analyzed for presence of petroleum hydrocarbons, a class of compounds called polynuclear aromatic hydrocarbons, selected metals, general water quality indicators (such as pH, dissolved and suspended solids, nutrients, common anions and cations, and others), and methane. Since water quality can be affected by many factors other than project activities, data from multiple monitoring locations in the vicinity of existing and proposed production/exploration well platforms, preferably collected over time are needed to evaluate the causes of changes in water quality. The baseline monitoring results have indicated that existing surface and groundwater quality is generally good and typically meets regulatory standards to support the existing beneficial uses of the water. **Tables 3-23**, Summary of Results for Selected Analytes in Samples from 23 Wells, and **3-24**, Summary of Results for Selected Analytes in Samples from 51 Surface Water Locations, show the ranges of concentrations of selected analytes from monitoring of water wells and surface water sites within the Unit between 2007 and 2013. The results are from 59 samples analyzed from a network of 23 wells, and 84 samples analyzed from 51 surface water locations. (Note that not all analytical data are represented in the tables; not all wells or surface water samples were analyzed for the same compounds each time; and some wells and surface water locations have been sampled multiple times.) The similarity between the surface water and the well sample results in **Tables 3-23** and **3-24** probably reflects the fact that many of the wells included in the monitoring network are completed at shallow depths, within the alluvial aquifer, and near stream channels.

**Table 3-23**
**Summary of Results for Selected Analytes in Samples from 23 Wells**
**Collected between July 16, 2002 and June 12, 2013**

| Analyte | Units | No. of Samples | Average | Minimum | Maximum |
|---|---|---|---|---|---|
| pH | std units | 24 | 8.2 | 8 | 8.6 |
| Temperature | deg C | 23 | 21.4 | 19 | 23 |
| Conductivity @25C | umhos/cm$^2$ | 22 | 355 | 138 | 725 |
| Residue, Filterable (TDS) @180C | mg/L | 25 | 208 | 90 | 430 |
| Calcium (dissolved) | mg/L | 12 | 48.6 | 28.6 | 93.8 |
| Sodium (dissolved) | mg/L | 3 | 8.9 | 6.8 | 10.4 |
| Potassium (dissolved) | mg/L | 11 | 1.16 | 0.6 | 2.2 |
| Silica (dissolved) | mg/L | 9 | 13.7 | 6.2 | 19.1 |
| Total Alkalinity | mg/L | 25 | 164 | 60 | 304 |
| Bicarbonate as CaCO3 | mg/L | 25 | 163 | 59 | 304 |

**Table 3-23**
**Summary of Results for Selected Analytes in Samples from 23 Wells Collected between July 16, 2002 and June 12, 2013**

| Analyte | Units | No. of Samples | Average | Minimum | Maximum |
|---|---|---|---|---|---|
| Ortho phosphorus (dissolved) | mg/L | 8 | 0.019 | 0.01 | 0.04 |
| Bromide | mg/L | 4 | 0.10 | 0.03 | 0.25 |
| Chloride | mg/L | 24 | 9.8 | 1 | 70 |
| Fluoride | mg/L | 17 | 0.32 | 0.1 | 0.8 |
| Nitrate as nitrogen (dissoloved) | mg/L | 5 | 0.31 | 0.1 | 0.47 |
| Sulfate | mg/L | 18 | 8.8 | 3 | 31 |
| Boron (dissolved) | mg/L | 5 | 0.014 | 0.01 | 0.02 |
| Selenium (total) | mg/L | 10 | 0.0011 | 0.00010 | 0.0036 |
| Strontium (dissolved) | mg/L | 9 | 0.53 | 0.2 | 0.9 |
| Uranium (dissolved) | mg/L | 7 | 0.0019 | 0.0003 | 0.005 |
| Methane | mg/L | 2 | 4.995 | 0.39 | 9.6 |
| Benzene | µg/L | 1 | 1.0 | 1.0 | 1.0 |
| Ethylbenzene | µg/L | 2 | 0.6 | 0.2 | 1.0 |
| Toluene | µg/L | 3 | 0.23 | 0.2 | 0.3 |
| m,p-xylenes | µg/L | 1 | 0.4 | 0.4 | 0.4 |
| TPH C10 to C28 | mg/L | 2 | 0.35 | 0.2 | 0.5 |

**Table 3-24**
**Summary of Results for Selected Analytes in Samples from 51 Surface Water Locations Collected between July 16, 2002 and August 10, 2012**

| Analyte | Units | No. of Samples | Average | Minimum | Maximum |
|---|---|---|---|---|---|
| pH | std units | 42 | 8.4 | 7.8 | 9.7 |
| Temperature | deg C | 42 | 20.8 | 19 | 23 |
| Conductivity @25C | umhos/cm$^2$ | 42 | 362 | 70 | 602 |
| Residue, Filterable (TDS) @180C | mg/L | 45 | 223 | 40 | 370 |
| Calcium (dissolved) | mg/L | 5 | 60.22 | 46.3 | 70.1 |
| Sodium (dissolved) | mg/L | 3 | 21.6 | 12.5 | 38.9 |
| Potassium (dissolved) | mg/L | 5 | 1.9 | 1.2 | 2.5 |
| Silica (dissolved) | mg/L | 2 | 8.5 | 6.7 | 10.3 |
| Total Alkalinity | mg/L | 45 | 183 | 33 | 325 |
| Bicarbonate as CaCO3 | mg/L | 45 | 172 | 33 | 305 |
| Ortho phosphorus (dissolved) | mg/L | 2 | 0.03 | 0.02 | 0.04 |
| Bromide | mg/L | 2 | 0.045 | 0.03 | 0.06 |
| Chloride | mg/L | 41 | 6.5 | 1 | 23 |
| Fluoride | mg/L | 37 | 0.24 | 0.1 | 0.5 |
| Nitrate as nitrogen (dissoloved) | mg/L | NA | NA | NA | NA |
| Sulfate | mg/L | 35 | 6.9 | 1 | 39 |
| Boron (dissolved) | mg/L | 2 | 0.015 | 0.01 | 0.02 |
| Selenium (total) | mg/L | 36 | 0.00031 | 0.0001 | 0.0008 |
| Strontium (dissolved) | mg/L | 2 | 0.7 | 0.55 | 0.85 |
| Uranium (dissolved) | mg/L | 2 | 0.0012 | 0.0009 | 0.0014 |
| Methane | mg/L | 1 | 0.17 | 0.17 | 0.17 |
| Benzene | µg/L | NA | NA | NA | NA |
| Ethylbenzene | µg/L | 1 | 0.2 | 0.2 | 0.2 |
| Toluene | µg/L | 6 | 0.33 | 0.2 | 0.7 |
| m,p-xylenes | µg/L | 2 | 0.65 | 0.5 | 0.8 |
| TPH C10 to C28 | mg/L | 9 | 0.24 | 0.1 | 0.6 |

***Hydrology and Water Rights***

There are a number of irrigation diversions from the larger creeks, especially on the eastern side of the Unit (BLM 2010a). Stock ponds are abundant in the area and, in general, contain water throughout the year.

Expansive irrigated hay meadows are generally found in the bottomlands of the East Muddy Creek drainage. Irrigated meadows are also found in the Ault Creek drainage at the far western side of the Unit (BLM 2010a). Natural flows of streams are likely affected by diversions for irrigation and there are numerous water rights for both reservoirs and irrigation diversions on North Fork Gunnison River (NFRIA 2010). Based on USGS estimates, approximately 3,000 acres of irrigated lands occur upstream of USGS gauging station 09132500 (North Fork Gunnison River near Somerset, Colorado; USGS 2010a). Irrigation diversions affect the intensity, quantity, and timing of streamflows within the North Fork Gunnison River, and may have a similar effect in the Unit. For example, in June when runoff is highest, irrigation diversions attenuate peak flows by diverting some of the flow onto irrigated lands. Irrigation withdrawals sometimes reduce discharge in the North Fork Gunnison River to low volumes. During drought years, surface flow sometimes disappears entirely from segments of the channel (NFRIA 2010).

According to the Colorado Division of Water Resources, there are 35 ditch-type water rights within the Unit. All but three of these ditches list Muddy Creek as the source. Permitted surface water rights on the Unit are summarized in the Water Resources Technical Report (WWC 2011).

Surface Water Rights. Based on a review of the Colorado Division of Water Resources' surface water rights database, there are 75 permitted surface water rights within the Unit. The majority of the water rights (33) have a designated use that is (or includes) irrigation. Other uses include stock (19), fishery (18), domestic (14), recreation (12), wildlife (5), fire (5), federal reserve (4), storage (2), other (2), industrial (1), and augmentation (1). The sum of water rights uses is greater than 75 as some of the individual rights list multiple uses. Sources for these surface water rights within the Unit are as follows: Muddy Creek is the water source for 71, North Fork Gunnison River is the source for 3, and Gunnison River is the source for 1. Existing surface water rights within the Unit are tabulated in the Water Resources Technical Report.

Groundwater Rights. A CDWR records review revealed 66 current groundwater permits within the Unit. All of these groundwater permits are filed on water wells apportioned as follows: 20 domestic use; 15 domestic/stock use; 12 other use; 11 household use only; and 8 industrial use. Of the 66 permitted wells, 50 wells are developed, no records of completion are available for 14 wells, and 2 permits were extended. Of the 66 permitted wells, 48 report positive yields. Details on the permitted wells within the Unit are tabulated in Water Resources Technical Report (WWC 2011).

***Trends***

Several trends related to water resources are important in the region and may affect the Unit.

The Unit provides very favorable conditions for agriculture in terms of climate and soils. However, a reliable water supply has long been a limiting factor for agricultural development of the area. Most of the water use in the area is from surface water or from shallow groundwater that is probably in direct connection to surface water. Surface storage is limited, and groundwater storage capacity is inadequate to meet most needs. Any reduction in surface water availability is likely to impact agriculture. Similarly, water quality is critical to the viability of agriculture and, with limited supplies of potable surface water and groundwater to meet demand, any reduction in water quality could have severe impacts on landowners.

Development of the gas resources in the southeastern margin of the Piceance Basin is in its early stages. The economic viability of gas production in this portion of the basin remains to be tested. The exploration and initial development phase will likely bring significant changes to the region, including additional demands on water resources. There is strong demand for development of domestic gas resources throughout the country that could also contribute to lower prices as the demand is filled, and to reduced economic feasibility in marginally productive areas. In the event that the gas resources in the Unit do not prove as economically viable as initially hoped, it would be important to ensure that the region is not abandoned in such a way that agriculture activity could continue with minimal long-term impact.

The rate of erosion from the vicinity of the Unit, and particularly the west slope of the Raggeds, has an important effect on the rate of sedimentation of the Paonia Reservoir, and therefore its effective life. The project, along with other potential consequent development of the area could lead to increased erosion rates and faster sedimentation of the reservoir. This would have an indirect effect on irrigation and on agriculture that is dependent on water storage in the reservoir.

The 2006-2007 land health assessment of federal lands within the Unit included a water quality assessment (standard 5) on nearly 60 miles of streams. This standard was met for a majority of streams (74 percent) in the Unit and the watersheds they drain into. The remaining waters assessed within the Unit were meeting standard 5 with problem areas (23 percent) or were not meeting the water quality standard (3 percent). Stream segments that were not meeting standard 5 in the Unit were attributed to soil erosion, exposed soil, and poor vegetation cover in the surrounding watersheds. These watersheds are more susceptible to erosion and subsequent sedimentation within adjacent streams.

### 3.2.5 Geology

#### *Current Conditions*

*Physiography*

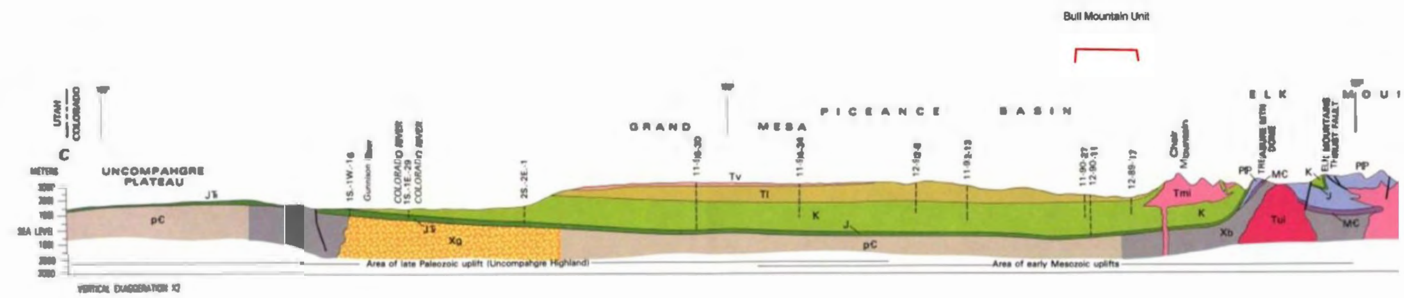
Physiography refers to the physical appearance of the surface of the earth, which reflects its geologic and tectonic history. The Unit is located on the boundary between the Western Section of the Southern Rocky Mountains physiographic province, and the Uinta Basin Section of the Colorado Plateau physiographic province (Lobeck 1975; Fenneman 1946; CGS 2011). It lies west of the Sawatch Range, the White River Uplift, and the Continental Divide which belong to the Southern Rocky Mountains; and east of the Uncompahgre uplift, on the southeastern margin of the Piceance Basin, which are part of the eastern edge of the Colorado Plateau. State Highway 133 roughly marks the boundary between the 2 provinces. Streams west of the Continental Divide drain to the west, toward the Colorado River, but follow a circuitous route to get there: first the tributaries of Muddy Creek flow to the southeast across the Unit and converge near the southeast corner of the Unit. Then Muddy Creek turns south and flows along State Highway 133 to Peonia Reservoir on the North Fork of the Gunnison River. The North Fork Gunnison flows southwest and then turns northwest to join the Colorado River at Grand Junction. Streams on the east side of State Highway 133 drain to the west, to Muddy Creek.

As indicated on the USGS 7.5 minute topographic quadrangles that depict the site area, topographic relief ranges widely in the nearby region of the Unit (USGS 2001a, 2001b, 2001c, 2011). Chair Mountain, about 3 miles east of the Unit, rises to 12,723 feet, and nearby Ragged Peak is 12,641 feet. There is about 1,500 feet of relief within the Unit. The lowest point is in the channel of East Muddy Creek near the confluence of Spring Creek, where the elevation is about 6,690 feet. At 8,185 feet, Bull Mountain is the highest point within the Unit.

The stream drainage pattern on the west side of the Unit, west of State Highway 133, is rectangular, with small straight stream segments generally oriented perpendicular to the principal drainages, West Muddy Creek, and East Muddy Creek. The trunk streams are moderately incised, with relatively wide channels and steep side slopes, which have the appearance of being antecedent to the terrain. Meanders have developed within the channels of East and West Muddy Creeks. Some of the side slopes are relatively flat, while others are very steep. The stream channel gradients of the trunk streams are relatively gradual. For example, the slope of the channel of East Muddy Creek is about 3 feet per 1,000 feet. The drainage pattern on the east side of State Highway 133 is radial, with streams issuing in every direction out from peaks such as Chair Peak.

The Unit is at the southeastern margin of the Piceance Basin, a large structural basin covering approximately 1,000 square miles, which extends northwest to the area near Rangely, Colorado. It is bounded by the Uinta uplift to the north, the White River uplift and the Grand Hogback on the northeast, and the Uncompahgre uplift on the southwest. To the southeast, it butts up against Chair Mountain and the Raggeds. It is separated from the Uinta Basin, which extends westward into Utah, by the Douglas Creek Arch, a topographic rise that roughly parallels the western border of Colorado. The Piceance Basin is cut approximately in half by the Colorado River, which enters the Piceance Basin near Rifle Creek at the south end of the White River uplift, and exits the Piceance Basin at Grand Junction. Water drains from the each end of the Basin toward the Colorado River. The Piceance Basin lies almost entirely within the Colorado Plateau physiographic province.

North of the Colorado River, the Piceance Basin contains abundant oil shale deposits (up to 2,000 feet thick, some of it very near the surface) in the Middle Tertiary Green River formation (Taylor 1987). Coal and gas are found below the depth of the oil shale, at depths of 6,000 to 10,000 feet, in the Mesaverde formation. The southern portion of the basin contains mainly coal and gas. In the southern portion of the basin, there is no structural or stratigraphic trap for the gas deposits. The gas is trapped in the primary porosity of the low permeability rocks. The low permeability of these rocks presents the primary challenge for exploiting these abundant gas deposits. The most effective way of releasing and extracting the gas is to increase the secondary porosity of the reservoir rock using a technique called hydraulic fracturing. See **Figure 3-7**, Geology Cross Section.




Geology Cross Section

Figure 3-7

*Geologic History*

The Piceance Basin formed during the Laramide orogeny, a period of mountain building that began in the late Cretaceous Period (more than 65 million years ago) and continued for more than 30 million years, extending into the Oligocene Period. Before the Laramide, the area that was to become the Piceance Basin was part of a broad, shallow inland sea, the western shoreline of which lay along the edge of the Sevier thrust belt, a north-trending mountain range created as the oceanic plate was pushed up against the continent by plate tectonic forces. This westward compressional movement deformed the crust inland, creating large folds in the sedimentary rocks that had been deposited in the continental interior. Sediments eroded from the eastern slopes of the Sevier thrust belt were deposited in the sea that covered the Piceance Basin, gradually filling it and causing the shoreline to migrate eastward. It was these sediments, deposited during the late Cretaceous Period, which became the Mesaverde formation. The fact that the same rocks lie deep under the Piceance Basin and form the principal gas reservoir in the south part of the basin, and also crop out along its margins, forming the steep cliffs of the Grand Hogback, is proof of the intense forces that deformed the landscape during the Laramide orogeny. The exposed Mesaverde rocks also act as a conduit to conduct groundwater to great depths within the basin.

The Laramide orogeny, which was powered by subduction of oceanic crust deep under the continent formed vast quantities of molten rock (magma) that, along with the compressional forces associated with plate subduction, intruded under and pushed up the sedimentary rocks that had once filled the inland sea, creating the Rocky Mountains. But rocks that are above sea level tend to erode and are transported to lower areas by water. The period of the later Cretaceous to the middle Paleocene is missing from the geologic record of the Piceance Basin because the area was gradually elevated above sea level during this time. However, by the middle of the Paleocene, the Piceance Basin was subsiding, and filled with thousands of feet of sediments eroded from the adjacent uplifted mountains.

Heat from the subducting crust helped to “cook” the organic matter that was contained in the shallow marine sediments that had been deposited in the inland basins and subsequently buried by basin filling sediments during the Laramide. The combination of heat from the pressure of burial, and the heat from the underlying magma, transformed the organic matter over time into oil, coal, and methane gas, depending on the combination of temperature and pressure and the abundance of the organic matter prevailing in each part of the basin. In some areas, such as to the area southeast of the Unit, magma rose nearer to the surface, and even erupted onto the surface during the middle Oligocene to early Miocene Periods.

The primary gas source rocks in the southern Piceance Basin are the Mancos Shale and certain members of the Mesaverde Group. The Mesaverde Group is also considered to be a gas reservoir, largely because of its low permeability. The stratigraphic and structural context of these formations is discussed below.

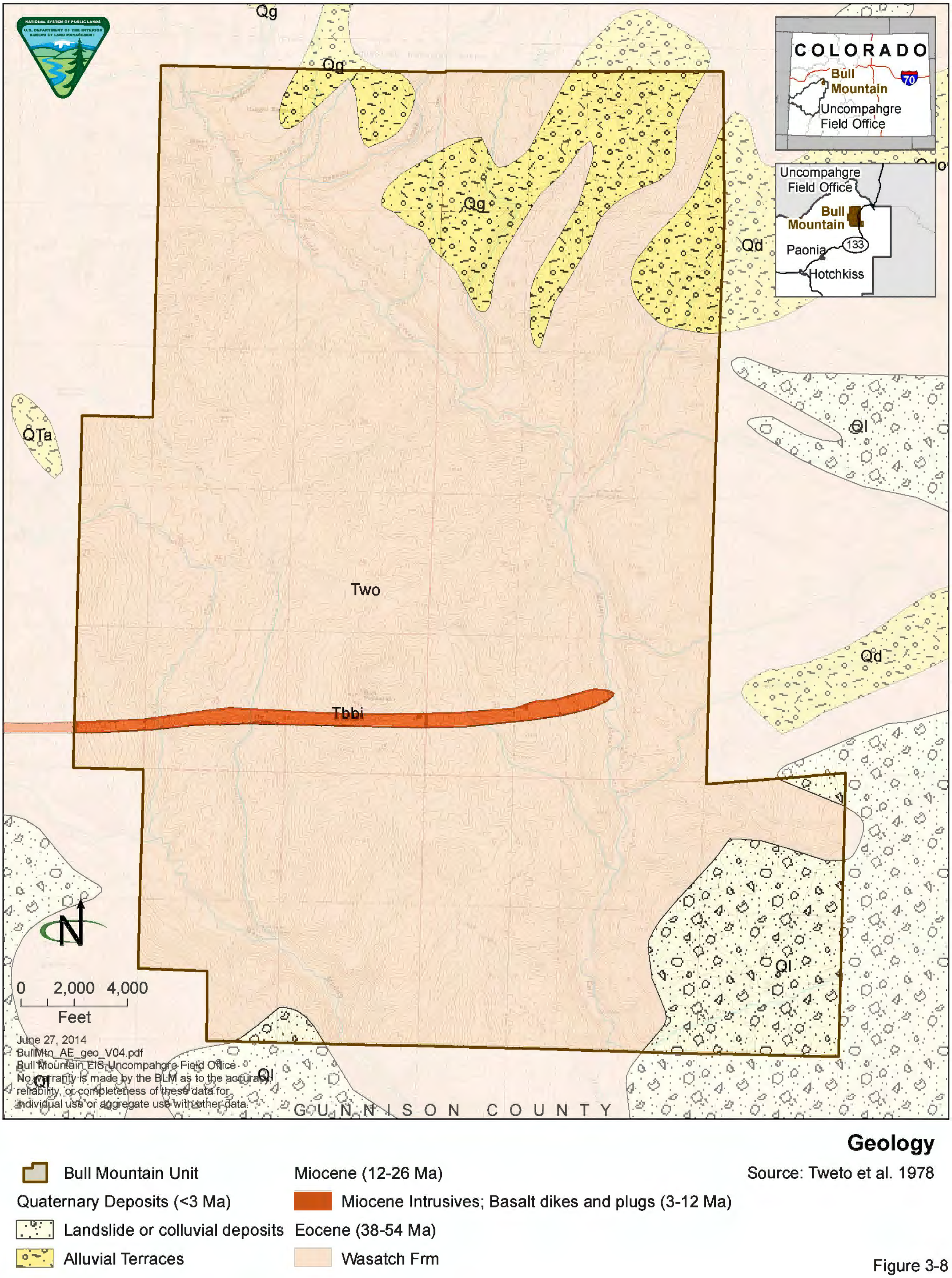
*Hydrocarbon Source Rocks*

The Mancos Shale formed from the deposition of fine-grained silts and clays in the shallow inland sea that prevailed at the beginning of the late Cretaceous Period a little more than 90 million years ago. The Mancos Shale, in addition to carbonaceous strata in the overlying

Mesaverde Group, is considered a likely source of some of the methane gas now present in the Mesaverde Group (Johnson 1988). Methane is generated when oil or coal is sufficiently heated, and in some areas the Mancos Shale is known to contain up to 4 percent organic carbon, and it may have been a significant source of gas due to its great thickness. The top of the Mancos Shale is reported to be about 4,500 feet below the surface at the southern end of the Unit, and may be several thousand feet thick (Hettinger and Kirshbaum 2002). The Mancos Shale rests on the Cretaceous Dakota Sandstone. Below these are additional Mesozoic rocks, which may lie unconformably on pre-Cambrian crystalline rocks. Tweto (1983) indicates that in one cross-sections that happens to pass through the Unit the pre-Cambrian basement is about 9,000 feet below the surface at the southern boundary of the Unit.

The relatively steady conditions that accompanied the deposition of the Mancos Shale were gradually superseded about 65 to 70 million years ago by a period of more rapid deposition and regional uplift. Sediments eroded from the Sevier Thrust Belt to the west were deposited during a period of changing sea depths, so that shale deposits (away from the shore) alternated with sandstones (near the shore). The Upper Cretaceous Mesaverde Group, which is exposed on nearly all of the margins of the Piceance Basin, including along the eastern side of the Unit, is important as both a source and a reservoir for natural gas throughout the region (Tweto 1979). The Mesaverde Group (labeled Kmv on **Figure 3-8**, Geology) includes several formations or members, among which are two highly carbonaceous sequences: the Corcoran and Cozzette Members. These are the deepest significant coal-bearing strata in the basin. Towards the end of the Cretaceous, uplift and shallowing of the depositional environment caused by an eastward migrating shoreline resulted in deposition of coarser sediments. Although the sediments of the Mesaverde Formation are generally coarser, the pores between the grains have been filled with various precipitated minerals, including clay minerals that tend to swell when moisture is present, and these fillings reduce the porosity and permeability of the formation. Most of the natural porosity in the gas-bearing formations results from subsequent dissolution of the precipitated material filling the pores, though most of the pores are not well connected to each other (Pitman et al 1988). Hence, although gas is stored within the porosity of the formation, it is difficult to recover it. Throughout the basin, gas production has had to be enhanced by hydraulic fracturing (Johnson 1988).

According to Johnson (1988), most of the gas produced from the southern part of the Piceance Basin has been from the Corcoran and Cozzette Members of the Mesaverde Group, or from stratigraphic units that contain coarser grained sediments, and most has been from depths of less than 5,000 feet. The Unit lies at approximately the southern limit of occurrence of the Cozzette Member, and therefore the Cozzette is relatively thin in this area (Johnson 1988). It was at the base of the Mesaverde Group, and near the top of the Mancos Shale. The top of the Mesaverde Group is reportedly found at a depth of about 800 below the surface at the southern end of the Unit, making the Mesaverde Group more than 3,000 feet thick in this area. Thin coal beds are reportedly present in the Bowie Shale Member, a member of the Williams Fork Formation, which is found in the lower half of the Mesaverde Group (Hettinger and Kirshbaum 2002). The top of the Mesaverde Group dips toward the center of the Piceance Basin, more steeply along the margins of the basin, such as in the vicinity of the Unit (Tweto 1983). Mesaverde Group rocks are exposed along Muddy Creek according to mapping by Ellis and Freeman (1984), and are


Qg
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Bull Mountain EIS Uncompahgre Field Office
No warranty is made by the BLM as to the accuracy, reliability, or completeness of these data for individual use or aggregate use with other data.
GUNNISON COUNTY
Geology
Bull Mountain Unit
Quaternary Deposits (<3 Ma)
Landslide or colluvial deposits
Alluvial Terraces
Miocene (12-26 Ma)
Miocene Intrusives; Basalt dikes and plugs (3-12 Ma)
Eocene (38-54 Ma)
Wasatch Frm
Source: Tweto et al. 1978

Figure 3-8

prominently exposed in the Grand Hogback north of the Unit. This exposure at the surface demonstrates that, if gas were not trapped in the tight porosity of the formation, it would have leaked to the surface.

Similarly, the exposed, shallow portions of the Mesaverde Group provide a potential conduit for surface and groundwater to enter the Mesaverde rocks. Indeed, seepage of groundwater from above may be one of the factors that prevents gas from escaping from the porosity of the Mesaverde rocks. Drill stem tests have reportedly indicated that gas within the porosity of the formation is under higher pressure than expected due to formation pressure alone. It has been suggested that water-filled porosity under hydrostatic pressure may be a significant factor in sealing the formation and trapping the gas under pressure. Understanding the dynamic forces involved may provide insights regarding the effects of the use of hydraulic fracturing to extract gas from the formation.

The Wasatch Formation is the principal formation exposed at the surface throughout the Piceance Basin, and on most of the western half of the Unit (Tweto 1979). The Wasatch Formation (and underlying Ohio Creek Formation) was deposited on the erosional surface of the Mesaverde Group at the end of the Cretaceous and beginning of the Paleocene Period. In some parts of the basin, the Wasatch Formation contains significant gas deposits. Wasatch Formation deposits (labeled Tw on **Figure 3-8**) is exposed across most of the western side of the Unit, and is covered by various types of Quaternary deposits on the eastern side of the Unit. These include landslide deposits (Ql), alluvium (Qa), colluvium (Qc), gravel (Qg), and glacial deposits (Qr). The Wasatch Formation consists of consolidated materials eroded from the slopes of the young Rocky Mountains and includes claystone, mudstone, shale, sandstone, and conglomerate. When exposed to weathering at the ground surface, these rocks tend to break down to their component sediments. They contain a high percentage of fine grained materials that are highly erodible. The Ohio Creek Formation (Toc) has been mapped along the valley walls and bottoms of East Muddy Creek. It forms steep canyons in areas of stream erosion and is known as a source of landslide hazards. Sandstone outcrops of the Ohio Creek Formation are visible along the valley of East Muddy Creek (Godwin 1968). Erosion of the soils that develop on the exposed Wasatch and Ohio Creek Formations is a source of sediment that is transported downstream by Muddy Creek (Stover 1986). The sediment load carried by Muddy Creek is the primary cause of rapid sedimentation and loss of storage capacity in Paonia Reservoir (Appel and Butler 1991; Latousek 1995).

*Geologic Hazards*

Potential geological hazards within the Unit include (Trautner 2011):

- Avalanches: A few limited areas within the Unit have slopes steeper than 30 degrees, generally considered the minimum angle for avalanche initiation in Colorado’s snow climate. Avalanches may occur during periods of intensive snowfall (greater than 1 inch of snow per hour for 12 hours or more); however, the area has not historically had significant avalanche hazards.

- Landslides: Existing landslide areas within the Unit comprise 1,163 acres, primarily on the east side of State Highway 133 in the southeast corner of the Unit. An existing landslide area near Spring Creek was active in 1986, during a period of above-average precipitation and rapid snowmelt (Appel and Butler 1991). Evidence of recent landslide movement was found along the proposed pipeline route leading from State Highway 133 to the proposed FED 12-89-9 #1, with scarps ranging from 2 to 5 feet high (Trautner 2011).

- Rockfall: Most rockfall hazards within the Unit occur along the west side of the State Highway 133 corridor. Colorado Department of Transportation has conducted extensive mitigation in the form of rockfall fences and scaling of existing hazards. Some small areas occur near the top of slopes with slopes greater than 30 percent. One such area, which has a small outcrop of sandstone, is located north of the proposed access road and pipeline to the proposed FED 11-90-35 #1.

- Mudflows and debris fans: Mud or debris flows occur when soils become saturated, usually during an intense rain event, and begin to flow down-slope, often carrying rocks or boulders and building up sediment channels. A debris fan is created when the mud or debris flow spreads into a fan-like shape at the bottom of a gully. The landslides that occurred on the east and west sides of East Muddy Creek were a combination of rotation landslides and debris flows.

- Seismic activity: Landslides can be triggered by earthquakes under some circumstances. The site is in an area that has very low seismic activity, where only very low magnitude earthquakes are likely (USGS 2008). State of Colorado/USGS database shows one minor earthquake recorded in the area of the Unit in 1988, which does not appear to have triggered any landslide events. There are no significant active faults in the region of the site (Morgan 2008).

***Trends***

Exploration and extraction of gas and other hydrocarbons from tight formations are receiving increased interest as more easily extractable resources are depleted and technological improvements combined with increased demand for fuel make extraction from tight formations more economically feasible.

The Unit is located in an area of active erosion and many unstable slopes. These conditions present a continuing concern in the area because of the economic and safety challenges they present. Global climate changes may lead to more extreme ranges in rainfall and runoff and reducing the reliability of past records as predictors of future hazards.

### 3.2.6 Vegetation

Information in this section is based on the Biological Evaluation (Petterson 2012) conducted for the Bull Mountain Unit EA, interpretation of high resolution aerial photography, and site visits conducted in 2009 to ground-truth the vegetation community types.

***Current Conditions***

The Unit is within the Southern Rockies EPA Level III ecoregion (EPA 2011d). This ecoregion is composed of steep, rugged mountains with high elevations. Although coniferous forests cover much of the region, as in most of the mountainous regions in the western United States, vegetation, as well as soil and land use, follows a pattern of elevational banding. The lowest elevations are generally grass or shrub-covered. Low to middle elevations are also grazed and covered by a variety of vegetation types including Douglas-fir, ponderosa pine, aspen, and juniper-oak woodlands. Middle to high elevations are largely covered by coniferous forests. The highest elevations have alpine characteristics (EPA 2010).

Vegetation communities found within the Unit are listed in **Table 3-25**, Existing Vegetation Communities in Bull Mountain Unit, and shown on **Figure 3-9**, Vegetation.

**Table 3-25**
**Existing Vegetation Communities in Bull Mountain Unit**

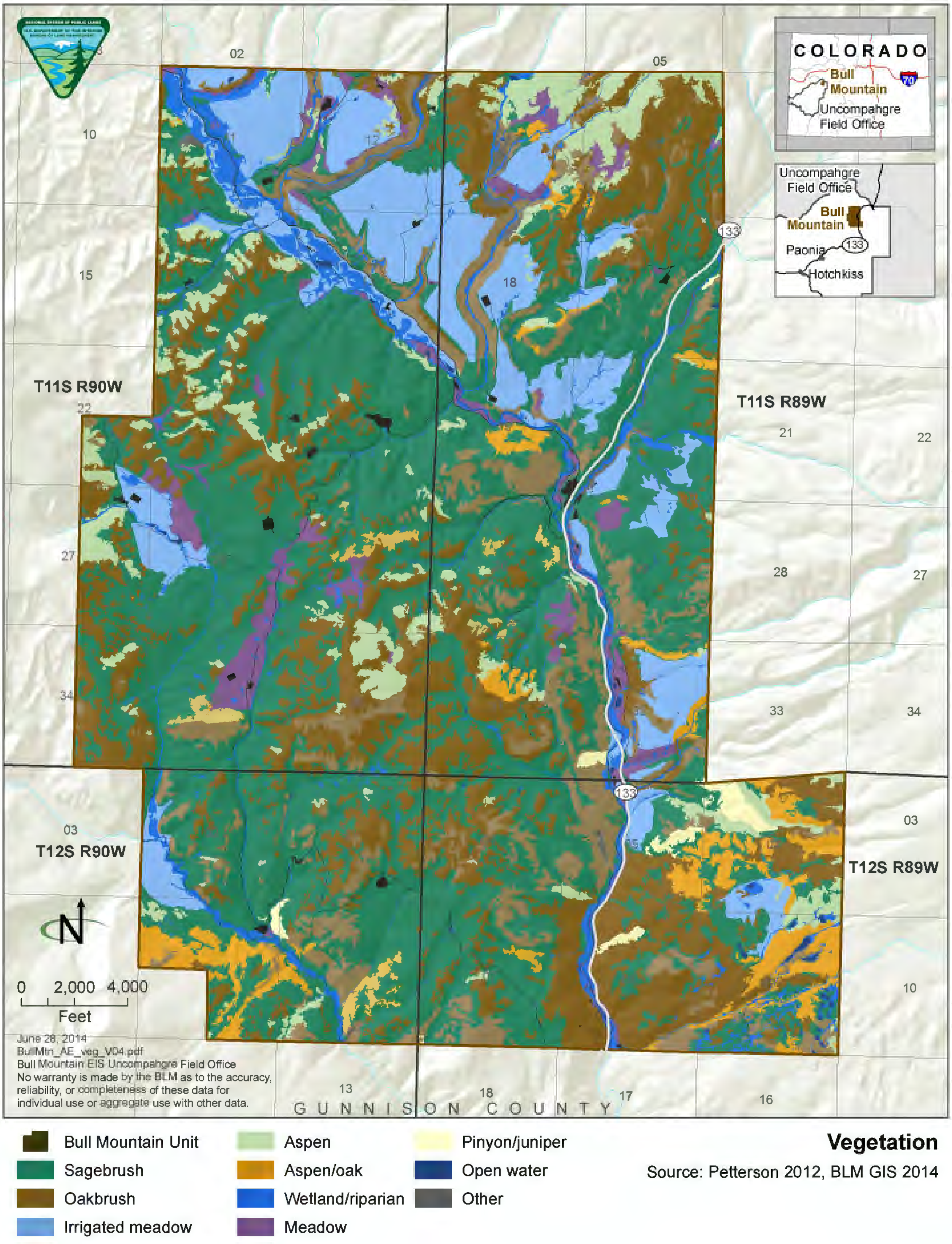
| Vegetation Type | Federal Surface/ Federal Minerals (acres) | Private Surface/ Federal Minerals (acres) | Private Surface/ Private Minerals (acres) |
|---|---|---|---|
| Aspen | 0 | 829 | 292 |
| Aspen/Conifer | 0 | 3 | 9 |
| Aspen/Oak | 95 | 486 | 188 |
| Disturbed Area | 4 | 78 | 93 |
| Irrigated Meadow | 3 | 297 | 1,681 |
| Mixed Conifer | 0 | 5 | 58 |
| Mixed Mountain Shrub | 50 | 1,048 | 655 |
| Oakbrush | 162 | 3,156 | 667 |
| Pinyon/Juniper | 6 | 80 | 43 |
| Riparian Woodland | 3 | 28 | 56 |
| Rocky Outcrop | 0 | 1 | 0 |
| Sagebrush | 81 | 6,337 | 1,838 |
| Wetland/Riparian Area | 28 | 213 | 431 |
| Willow | 0 | 15 | 1 |
| Open Water | 9 | 33 | 47 |
| Total | 440 | 12,609 | 6,485 |

Source: Petterson 2012; BLM GIS 2014

The following are descriptions of the major community types:

Sagebrush. Vegetation is dominated by mountain sagebrush (*Artemisia tridentata* var. *vaseyana*), with Douglas rabbitbrush (*Chrysothamnus viscidiflorus*) and snowberry (*Symphorocarpos rotundifolius*) also present. Dominant grasses include Kentucky bluegrass (*Poa pratensis*) and Thurber's fescue (*Festuca thurberi*), with western yarrow (*Achillea lanulosa*), lupine (*Lupinus argenteus*), and sandwort (*Arenaria kingii*) as the dominant forb species. There are a few invasive and noxious plant species in the area, including musk thistle (*Carduus nutans*) and Japanese brome (*Bromus japonicus*).

Oakbrush (Gambel's Oak Shrubland). This diverse community type is found at middle elevations of the project area. The amount of Gambel's oak (*Quercus gambelii*; also called oakbrush) varies, depending primarily on elevation and aspect. In some areas, the type consists almost entirely of dense, tall oakbrush with few associated shrubs and a sparse herbaceous understory due to extreme shading by the oak canopy and competition for light, moisture, and space. In areas of elevated soil moisture, another tall shrub, chokecherry (*Prunus virginiana*), is sometimes present and locally co-dominant. On slightly drier exposures, the oakbrush shares




**Vegetation**

Source: Petterson 2012, BLM GIS 2014

Figure 3-9

dominance with Saskatoon serviceberry (*Amelanchier alnifolia*). More open stands may include snowberry in the understory, occasionally accompanied by wax currant (*Ribes cereum*).

Irrigated meadow. A major community type in the Unit is irrigated hay meadows. These pasturelands occur mostly towards the northern end of the Unit. Dominant vegetation includes timothy (*Phleum pratense*), orchardgrass (*Dactylis glomerata*), red clover (*Trifolium pratense*), Kentucky bluegrass, and smooth brome (*Bromus inermus*). The noxious weed Canada thistle (*Cirsium arvense*) is common in wetter areas and in ditches. Some native wetland graminoids, including beaked sedge (*Carex utriculata*) and meadow sedge (*C. praegracilis*), are found in the irrigation ditch laterals. Almost the entire irrigated meadow community is dominated by non-native vegetation.

Mixed Mountain Shrubland. On drier slopes at lower elevations or on sunnier aspects, the habitat is dominated by Utah serviceberry (*Amelanchier utahensis*) and some Saskatoon serviceberry and varying amounts of chokecherry, sagebrush, snowberry, and Gambel's oak. Because of the more open canopies of these shrubs, the herbaceous layer is denser and more diverse. Associated forbs vary with elevation, site moisture, and shrub density but commonly include tailcup lupine (*Lupinus caudatus*), Rocky Mountain penstemon (*Penstemon strictus*), Watson's penstemon (*Penstemon watsonii*), aspen daisy (*Erigeron speciosus*), running fleabane (*Erigeron flagellaris*), Drummond's rockcress (*Boechera drummondii*), Nuttall's larkspur (*Delphinium nuttallianum*), small-leaf pussytoes (*Antennaria parviflora*), lambs-tongue groundsel (*Senecio integerrimus*), longleaf phlox (*Phlox longifolia*), sticky false starwort (*Pseudostellaria jamesii*), and narrowleaf mountain trumpet (*Collomia linearis*). Native perennial graminoids include elk sedge (*Carex geyeri*) and a variety of grasses such as slender wheatgrass (*Elymus trachycaulus*) and junegrass (*Koeleria macrantha*).

Grasses. Common grasses include Indian ricegrass (*Achnatherum hymenoides*), slender wheatgrass, western wheatgrass (*Pascopyrum smithii*), bottlebrush squirreltail (*Elymus elymoides*), junegrass, and muttongrass (*Poa fendleriana*). Common forbs include tapertip onion (*Allium acuminatum*), running fleabane, lobeleaf groundsel (*Packera multilobata*), tailcup lupine, death camas (*Toxicoscordion venenosum*), coppermallow (*Sphaeralcea coccinea*), balsamroot (*Balsamorhiza sagittata*), and Indian paintbrush (*Castilleja* sp.).

Aspen Forest. At the higher elevations in the Unit, and on north facing slopes at mid-elevations stands of quaking aspen (*Populus tremuloides*) occur. In the lower elevation aspen stands, understory vegetation is dominated by chokecherry and Saskatoon serviceberry. The understory in this system can also include low-growing shrubs such as common juniper (*Juniperus communis*), Woods' rose (*Rosa woodsii*), and snowberry as well as a diverse grass/forb understory. Perennial grasses in the herbaceous layer include the native mountain brome (*Bromopsis marginatus*) as well as the non-native smooth brome. Many dead and dying aspen trees were observed, likely from sudden aspen decline or possibly old age.

Pinyon/Juniper Woodland. Stands of pinyon pine (*Pinus edulis*) and Utah juniper (*Juniperus osteosperma*)—generally consisting almost entirely of the latter—occur at lower elevations of the project area, often interspersed within sagebrush shrublands or drier types of mixed mountain shrubland. This habitat type is best developed at the southern end of the Unit on south and west facing slopes. Associated shrubs include bitterbrush (*Purshia tridentata*), Utah serviceberry, broom snakeweed (*Gutierrezia sarothrae*), and skunkbrush (three-leaf sumac) (*Rhus trilobata*). In general, the sparse herbaceous layer consists of graminoids such as cheatgrass (*Bromus tectorum*), western wheatgrass, Indian ricegrass, bottlebrush squirreltail, muttongrass, and Sandberg bluegrass (*Poa secunda*). Forbs are a minor component.

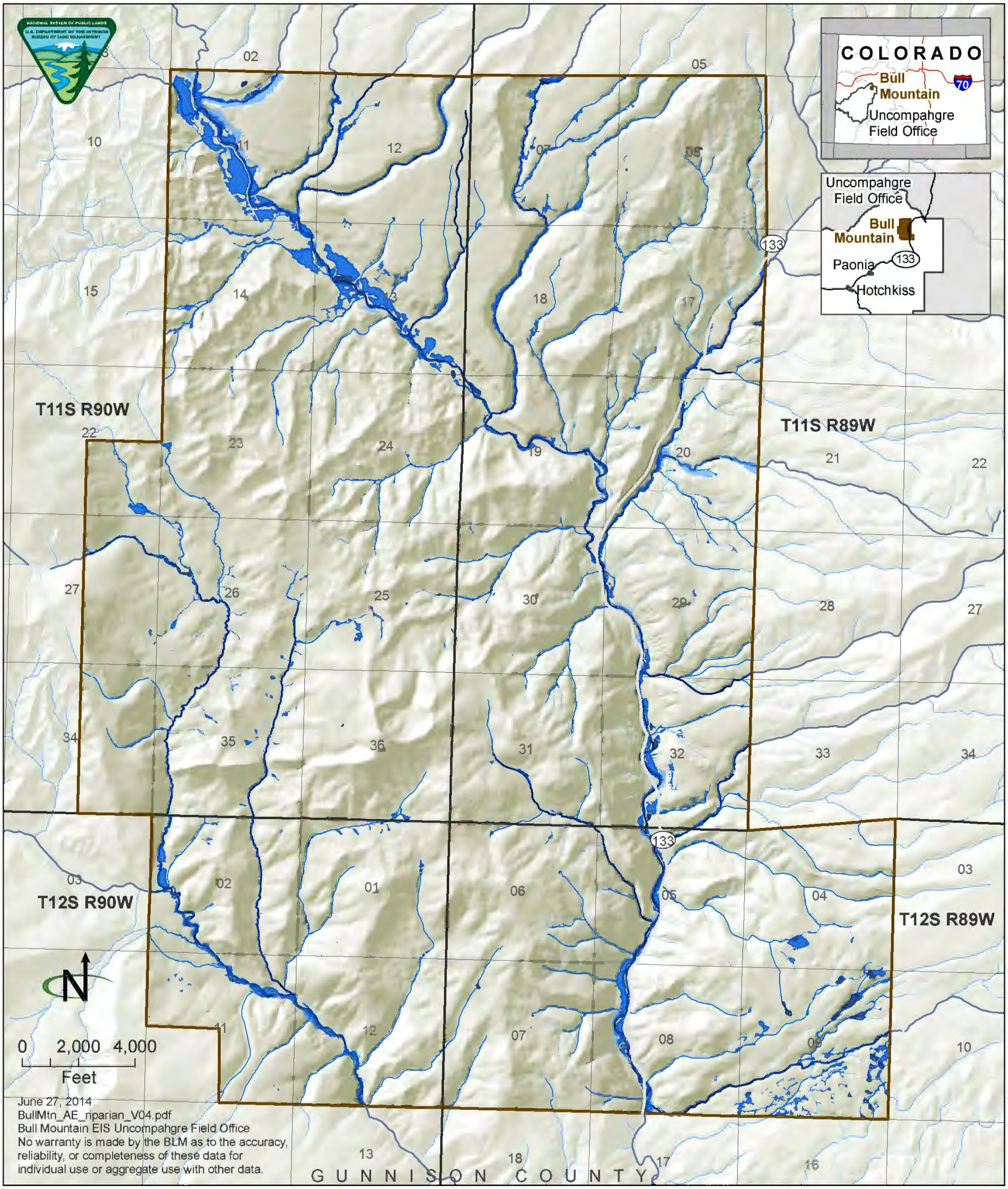
*Wetlands and Riparian Zones*
Jurisdictional wetlands, which are hydrologically connected to Waters of the US, are found throughout the Unit (**Figure 3-10**, Riparian and Wetland Vegetation). Major drainages include Lee Creek and East and West Muddy Creeks. Wetlands in the Unit are dominated by beaked sedge, woolly sedge (*Carex lanuginosa*), meadow sedge, swordleaf rush (*Juncus ensifolius*), Baltic rush (*Juncus balticus*) and other graminoids. Rocky Mountain willow (*Salix monticola*), Bebb's willow (*S. bebbiana*), and Drummonds willow (*S. drummondiana*) occur in these wetlands. Most wetlands retain moisture well into the summer, and the widespread irrigation at the northern end of the Unit has expanded the surface area of wetlands. Subsequently, many irrigation ditches and laterals move waters across the private ranches, utilizing waters from Lee, Henderson, Spring, Drift, Little Henderson, Grouse, Buck, East and West Muddy, and Ault creeks.

No fens (peat-forming wetlands fed by groundwater; EPA 2014c) have been identified within the Unit.

Within the broad category of riparian vegetation are many distinct, interwoven plant communities. Among the most widespread are communities dominated by narrowleaf cottonwood (*Populus angustifolia*) and distinguished by various associated shrubs and trees including thinleaf alder (*Alnus tenuifolia*), blue spruce (*Picea pungens*), Douglas-fir (*Pseudotsuga menziesii*), river hawthorn (*Crataegus rivularis*), box elder maple (*Acer negundo*), sandbar willow (*Salix exigua*), skunkbrush, and red osier dogwood (*Cornus sericea*). Some willow dominated communities may also be present, with sandbar willow occurring alone or in combination with strapleaf willow (*Salix ligulifolia*) or Pacific willow (*Salix lucida*). Tamarisk (*Tamarix chinensis*; BLM 2007a) occurs in ephemeral and lower elevation drainages.

*Colorado Natural Heritage Program Natural Communities*
There are no natural communities considered to be rare or pristine associations by the Colorado Natural Heritage Program within the Unit. A blue spruce/thinleaf alder (*Alnus tenuifolia*) woodland occurs within the West Muddy Creek watershed, one of the watersheds that overlaps with the Unit. This woodland type is considered a rare and pristine association and is located nearly 4 miles west of the westernmost boundary of the Unit, in T11S, R91W.

***Trends***
<u>Sagebrush</u>. Most of the sagebrush communities within the Unit generally support very good understory grass and forb diversity, despite evidence of high grazing pressure and mechanical damage to plants. Thousands of acres of sagebrush on the Hotchkiss Ranch were mowed in the mid-2000s to reduce sagebrush cover and increase grass production for livestock grazing. In these areas, sagebrush is beginning to recover.




## Riparian and Wetland Vegetation

Source: Peterson 2012, BLM GIS 2014, NHD 2013

- Bull Mountain Unit
- Open water
- Wetland/riparian
- Riparian woodland
- Perennial stream
- Intermittent stream
- Ephermal stream
- Ditch/other

Figure 3-10

Meadow. There is persistent and heavy grazing on the majority of the meadow communities, likely favoring the persistence and cover of species more tolerant to grazing, such as Kentucky bluegrass and tarweed.

Wetlands and Riparian Zones. Widespread summertime cattle and sheep grazing has impacted the wetlands in the Unit; hoof action on soft soils is evident and extensive grazing of wetland vegetation was observed during 2008 to 2011 site visits. Hedging of willows was also evident.

Aspen Forest. Aspen trees have been impacted by sudden aspen decline. Aging stands and many dead aspen trees are observable at mid- and high elevations in the Unit.

Conifers. Spruce and pine trees in coniferous forests have suffered from bark beetle infestations.

Trends for the other vegetation communities within the Unit are unknown.

A land health assessment was conducted on federal surface lands within the Unit in 2006-2007 as part of the North Fork Land Health Assessment. Most lands were found to be meeting Land Health Standard 3 (healthy vegetation communities; **Table 3-26**, Land Health Assessment Results in the Bull Mountain Unit). Areas were classified as “unknown” if they were considered too small or minor to evaluate (BLM 2007a).

**Table 3-26**
**Land Health Assessment Results in the Bull Mountain Unit**

| Land Health Assessment Rating | | Federal Surface (acres and percentage) |
|---|---|---|
| Meeting Land Health Standards 3 | | 315 (72%) |
| Not Meeting Land Health Standards 3 | | 0 |
| Unknown or Data Not Available | | 125 (28%) |
| | Total | 440 |

Source: BLM 2007

### 3.2.7 Invasive, Non-Native Species

#### *Regulatory Background*

*Federal Noxious Weed Act of 1974*
This law provides for the control and management of nonindigenous weeds that injure or have the potential to injure the interests of agriculture and commerce, wildlife resources, or the public health. The Federal Noxious Weed Act prohibits importing or moving any noxious weeds identified by the regulation and allows for inspection and quarantine to prevent the spread of noxious weeds.

*Executive Order 13112, Invasive Species*
Signed in 1999, this Executive Order directs federal agencies to prevent the introduction of invasive species and provide for their control and to minimize the economic, ecological, and human health impacts that invasive species cause. To do this, the Executive Order established the

National Invasive Species Council; there are currently 13 departments and agencies on the Council.

*Colorado Noxious Weed Act*
Passed in 1996, the Colorado Noxious Weed Act ensures protection for all Colorado lands from noxious weeds and creates a duty to control these plants on the part of all landowners, both public and private. It characterizes noxious weeds into three lists: A, B, and C. List A species require mandatory eradication by local governing agencies; List B species are mandated for eradication in some parts of the state, and recommended for suppression or containment in other areas depending on distribution and densities around the state; and List C species are widespread and established.

***Current Conditions***
Noxious and invasive weeds compete with native vegetation for water, space, and nutrients. Invasive plants include those species that are not native to the US, and the BLM considers plants invasive if they have been introduced into an environment where they did not evolve. As a result, they usually have no natural enemies to limit their reproduction and spread (Westbrooks 1998).

Noxious weeds are a subset of invasive plants that are state or federally listed as harmful to public health, agriculture, recreation, wildlife and any private or public property. These weeds are regulated by the Animal and Plant Health Inspection Service and/or the Colorado Department of Agriculture. The Colorado state noxious weeds that occur within Gunnison County are presented in **Table 3-27**, Colorado Noxious Weeds in Gunnison County and Noxious Weeds Observed in Bull Mountain Unit.

**Table 3-27**
**Colorado Noxious Weeds in Gunnison County and Noxious Weeds Observed in Bull Mountain Unit**

| Common Name | Scientific Name | Colorado Weed List | Observed in Bull Mountain Unit |
|---|---|---|---|
| Absinth wormwood | *Artemisia absinthium* | B | |
| Black henbane | *Hyoscyamus niger* | B | |
| Canada thistle | *Cirsium arvense* | B | X |
| Cheatgrass | *Bromus tectorum* | C | X |
| Dalmatian toadflax | *Linaria dalmatica* | B | |
| Dame's rocket | *Hesperis matronalis* | B | |
| Diffuse knapweed | *Centaurea diffusa* | B | X |
| Field bindweed | *Convolvulus arvensis* | C | |
| Hoary cress | *Cardaria draba* | A | |
| Houndstongue | *Cynoglossum officinale* | B | X |
| Leafy spurge | *Euphorbia esula* | B | |
| Musk thistle | *Carduus nutans* | B | X |
| Orange hawkweed | *Hieracium aurantiacum* | A | |
| Oxeye daisy | *Chrysanthemum luecanthemum* | B | X |
| Plumeless thistle | *Carduus acanthoides* | B | |
| Purple loosestrife | *Lythrum salicaria* | A | |
| Russian knapweed | *Acroptilon repens* | B | |
| Saltcedar | *Tamarix* spp. | B | |
| Scentless chamomile | *Matricaria perforate* | B | X |
| Scotch thistle | *Onopordum acanthium* or *O. tauricum* | B | |
| Spotted knapweed | *Centaurea maculosa* | B | X |

**Table 3-27**
**Colorado Noxious Weeds in Gunnison County and Noxious Weeds Observed in Bull Mountain Unit**

| Common Name | Scientific Name | Colorado Weed List | Observed in Bull Mountain Unit |
|---|---|---|---|
| Yellow toadflax | *Linaria vulgaris* | B | X |
| Whitetop | *Cardaria draba* | B | X |

Source: Colorado State University Extension 2013; Petterson 2012

Musk thistle is widely scattered across the Unit and becomes quite noticeable on private property at the southwestern side of the Unit. Scattered Japanese brome (invasive, but not noxious) and houndstongue (*Cynoglossum officinale*) are also common. Canada thistle occurs in more mesic (moist) sites. Other noxious weeds in the vicinity of the project area and potentially becoming problematic in areas of surface disturbance include the non-native annual cheatgrass and limited patches of the non-native biennial forbs spotted knapweed (*Centaurea stoebe* ssp. *micranthos*) and diffuse knapweed (*Centaurea diffusa*), which currently infests the Colorado Department of Transportation yard at the junction of County Road 265 and State Highway 133. Other noxious weeds minimally occurring in the general area include oxeye daisy (*Chrysanthemum leucanthemum*), scentless chamomile (*Matriciaria perforata*), whitetop (*Cardaria draba*), and yellow toadflax (*Linaria vulgaris*). Vegetative cover by noxious weeds in the general area is estimated at less than 1 percent of the total plant cover. For the past 8 years, SGI has annually treated noxious weeds on their pads, access roads, and pipeline corridors. Noxious weeds in these areas are relatively infrequent.

***Trends***

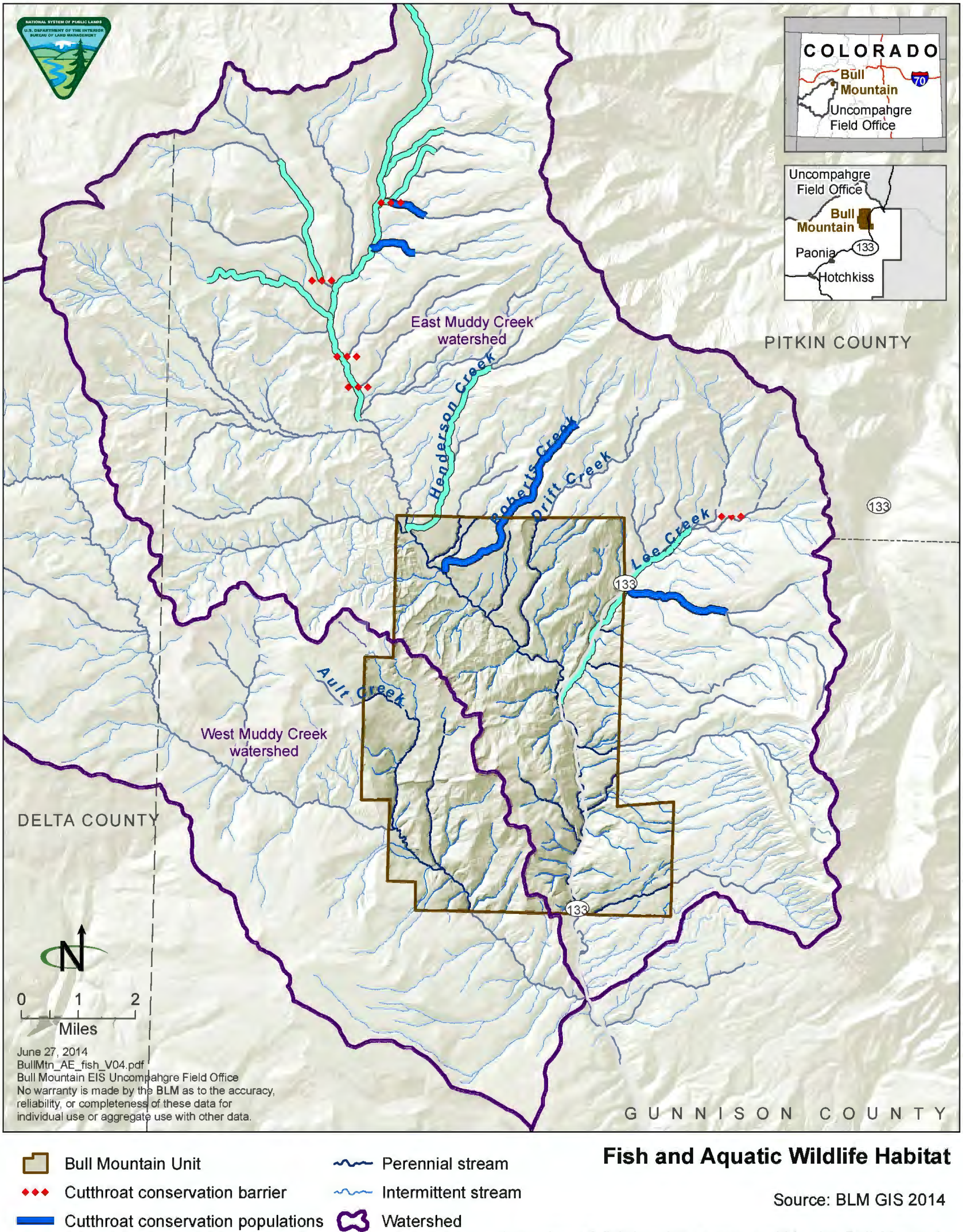
The Unit is covered by a mixed mountain shrubland community type that has seen various agricultural uses and surface disturbances over the last 100 years. Recently, natural gas exploration and development activities have also been creating surface disturbances, which remove native vegetation and increase the potential for noxious or invasive weed introduction and spread. For most of the landscape, noxious weeds are not yet a dominant part of the plant community. However, although few infestations are present in undisturbed lands, infestations tend to be distributed frequently enough across the landscape to pose a threat to undisturbed lands, especially with some of the more invasive species (BLM 2007a).

### 3.2.8 Fish and Wildlife

***Current Conditions***

*Aquatic Wildlife*

The Unit contains a number of fish-bearing streams, including Henderson, Roberts, Drift, Lee, East and West Muddy, and Ault Creeks (**Figure 3-11**, Fish and Aquatic Wildlife Habitat). However, East Muddy Creek can only support fish during the late summer and fall months, the rest of the year it is too silty and is likely ineffective for any significant fish use (Petterson 2012). A multitude of smaller tributaries contribute perennial and ephemeral flows to these creeks.




**Fish and Aquatic Wildlife Habitat**

Source: BLM GIS 2014

A number of fish-bearing streams within the Bull Mountain Unit have the potential to provide habitat for threatened and endangered fish species.

Figure 3-11

In terms of aquatic life, all of these streams are limited primarily by flows, which are flashy and seasonally very low, and by heavy sediment loads in East Muddy Creek. Other limiting factors include the type of substrate and the presence, density, and width of riparian plant communities. For more information regarding riparian conditions within the Unit refer to **Section 3.2.6**, Vegetation. These streams are sourced both directly and indirectly from snowpack at higher elevations on the flanks of Huntsman Ridge, the Ragged Mountains, and Spruce Mountain to the north of the Unit, but some of these creeks are sourced by lower-elevation hills, and these creeks (mainly on the western side of the Unit) tend to be ephemeral. Much of the recharge from snowpack enters the streams as groundwater inflow from colluvium and shallow bedrock. Refer to **Section 3.2.4**, Water Resources, for flow and water quality descriptions within the Unit. Substrates vary longitudinally along the streams and include reaches dominated by cobbles and finer sediments.

Fish surveys by CPW have documented the presence of greenback cutthroat trout (*Onchorhynchus clarkia stomias*) lineage fish, a federally listed threatened subspecies, in upper reaches of Roberts and Henderson Creeks located north of the Unit (**Figure 3-11**). Other creeks in the Unit may have suitable greenback cutthroat trout habitat, including Lee Creek, Drift Creek, and Ault Creek, however no greenback cutthroat trout have been identified within the Unit. Further discussion of greenback cutthroat trout is provided in **Section 3.2.10**, Special Status Species (Threatened, Endangered, and Sensitive Species).

Non-native brook trout is a sport fish that occupies lower reaches of Lee Creek. This eastern North American trout has been widely introduced in mountainous areas of Colorado because of its ability to tolerate slightly warmer waters than the cutthroat trout and its ability to reproduce successfully in streams with very low flows. Brook trout may also occur in other creeks within the Unit. Brook trout can competitively displace cutthroat trout.

Aquatic macroinvertebrates inhabit perennial streams such as Lee Creek during a portion of their lifecycles. These species include larvae of stoneflies, mayflies, and some caddisflies in fast-flowing reaches with rocky or detrital substrates. The aquatic larvae and winged adults of stoneflies, mayflies, and caddisflies are probably the main prey for trout in Lee, Roberts, and Henderson Creeks, and other creeks with low-sediment loading. Other terrestrial invertebrates that land or fall onto the surface or are carried into the stream in runoff from adjacent uplands can also be prey for trout. In slow-flowing portions of area wetlands with fine substrates, and in East and West Muddy Creeks, aquatic macroinvertebrates probably include the larvae of midges, mosquitoes, and some caddisflies. These species are able to tolerate relatively warm, turbid, and poorly oxygenated waters, and their more abbreviated larval stages allow them to reproduce in intermittent streams and in seasonally inundated overbank areas.

*Terrestrial Wildlife*

<u>General Wildlife</u>. General wildlife species of interest that have habitat on or adjacent to the project area include mammals, birds, and herptiles. A detailed description of wildlife species observed within the Unit is provided in the Biological Evaluation for the Bull Mountain Unit (Petterson 2012). Big game species that inhabit the Unit include mule deer, elk, black bear, and moose. Refer to **Section 3.2.9**, Migratory Birds, and **Section 3.2.10**, Special Status Species (Threatened, Endangered, and Sensitive Species), for additional information on other specific

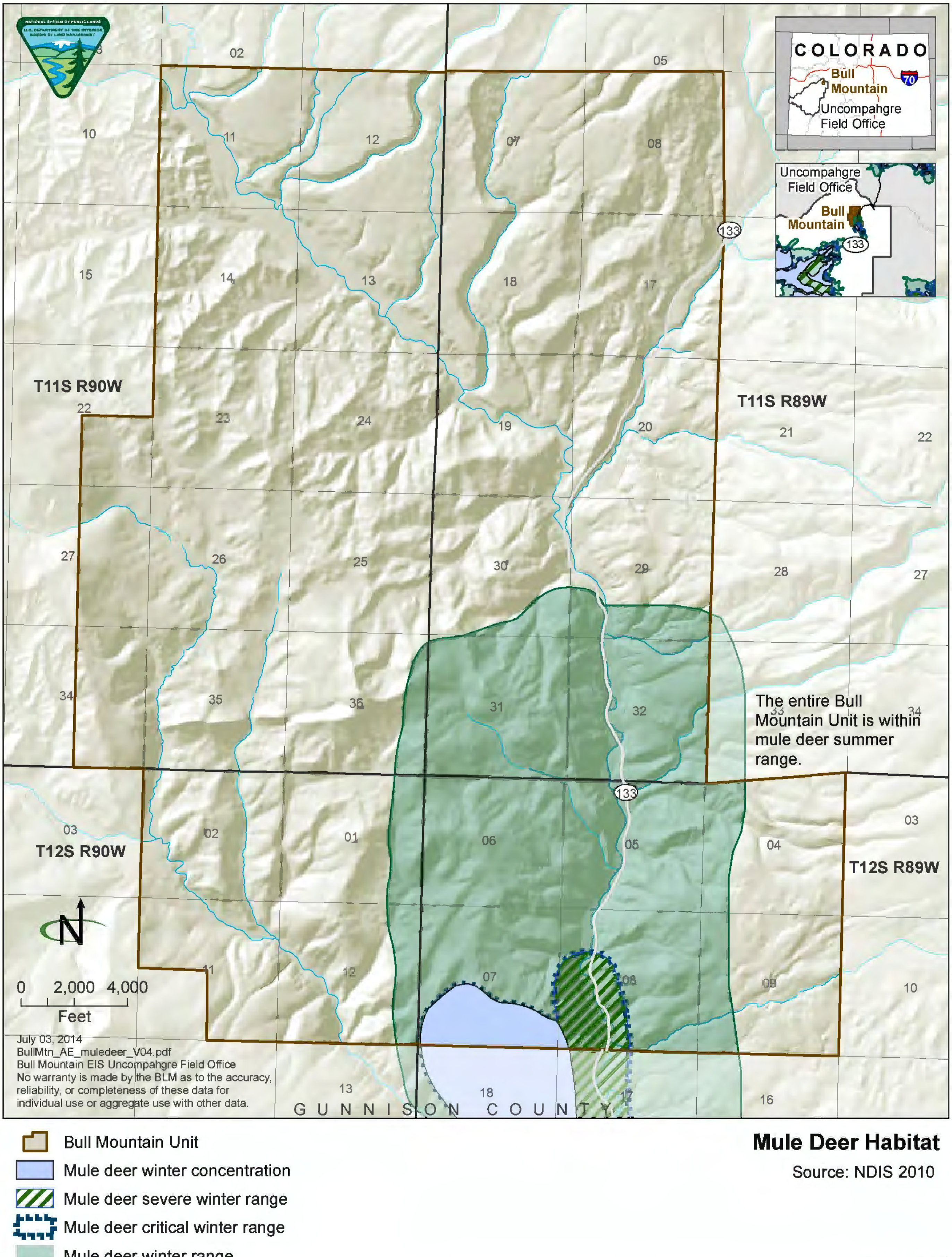
species. For a complete description of the various habitat types within the Unit refer to **Section 3.2.6**, Vegetation, which provides acres of habitat that could be impacted under the alternatives.

CPW was consulted regarding the development of the Unit through the scoping process. CPW raised concerns over direct and indirect impacts on deer and elk habitats and habitat connectivity. Per their request, CPW was provided a copy of the Biological Evaluation.

Big game species were chosen for impacts analysis because of the high biological importance and public interest of these species, for economic value, and for regulatory concern. Individual wildlife species and groups not specifically mentioned in this assessment are not insignificant; rather, they are not presently at issue because the limited extent of the proposed project would avoid or minimally impact these species and their habitats.

Mule Deer (*Odocoileus hemionus*). Throughout the State of Colorado, mule deer are abundant and browse on shrubs and trees. Mule deer breed in mid- to late fall (October to December; CPW 2012a). The Unit is located at the northern end of a larger area of mule deer Winter Range, Severe Winter Range and a Winter Concentration Area as mapped by CPW Natural Diversity Information Source data (**Figure 3-12**, Mule Deer Habitat). The northern and western portions of the Unit, as well as larger areas to the west, north, and east outside of the Unit, do not provide mule deer limiting habitats. The CPW manage mule deer in the Bull Mountain area under game management units 52 and 521, south Grand Mesa. Deer use of the Unit occurs throughout the summer months, and the entire Unit is shown as Mule Deer Summer Range by CPW Natural Diversity Information Source mapping. Fawning occurs in the general area, given the suitable aspen and mixed mountain shrubland habitats (which provide good cover), and abundant water sources from frequent stock tanks and creeks (which is important for nursing does). During the winter, deer mainly use pinyon-juniper habitats towards the southern end of the Unit in lower elevations and on south facing slopes, but some winter use may still occur in the northern areas of the Unit during mild winters. The southern and western facing slopes are very important for deer during the winter months due to shallower snow depths and more frequent melting, and northern and eastern slopes are less utilized due to deep and persistent snows. Deer will mobilize throughout the winter to find more desirable foraging areas, and habitat connectivity is important throughout the winter months. CPW maps approximately 4,616 acres of mule deer Winter Range, 196 acres of mule deer Severe Winter Range, and 207 acres of mule deer Winter Concentration Areas within the Unit.

During the fall months and during hunting seasons, deer congregate in the Unit and likely use some of the area as a “hunting refuge” as the Unit is mostly private land. Management of deer herd sizes by CPW is difficult when deer utilize sizable hunting refuges. However, during the fall hunters are known to be legally guided and permitted to hunt on the Falcon Seaboard, Jacobs, Aspen Leaf, Rock Creek, Buck Creek, Hughes, Hotchkiss, and other ranches within the Unit. Continued hunting of the area will be important to keep deer herds from congregating and will help with managing deer herd sizes. At this time, mule deer continue to pass through the greater area but are likely modifying movement patterns around some of the more active wells and roads to avoid human activities and traffic.


COLORADO
Bull Mountain
Uncompahgre Field Office
70
Uncompahgre Field Office
Bull Mountain
133
T11S R90W
T11S R89W
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T12S R89W
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The entire Bull Mountain Unit is within mule deer summer range.
0 2,000 4,000
Feet
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BullMtn_AE_muledeer_V04.pdf
Bull Mountain EIS Uncompahgre Field Office
No warranty is made by the BLM as to the accuracy, reliability, or completeness of these data for individual use or aggregate use with other data.
GUNNISON COUNTY
Bull Mountain Unit
Mule deer winter concentration
Mule deer severe winter range
Mule deer critical winter range
Mule deer winter range
Mule Deer Habitat
Source: NDIS 2010

Figure 3-12

Elk (*Cervus elaphus*). Elk mostly graze on grasses in summer months and they will also consume twigs from trees and shrubs during the winter (CPW 2012b).The Unit is located at the northern end of a larger area of elk Winter Range, Severe Winter Range, and Winter Concentration Area as mapped by CPW (Figure 3-13). The Unit itself contains elk Winter Range, Severe Winter Range, Winter Concentration Area, and Summer Range by CPW (**Figure 3-13**, Elk Habitat), and is located in Data Analysis Unit E-14. The data analysis unit covers 2,477 square miles. The majority of the unit is located on private lands, BLM- administered lands, and the Grand Mesa Uncompahgre and Gunnison National Forest and White River National Forests.

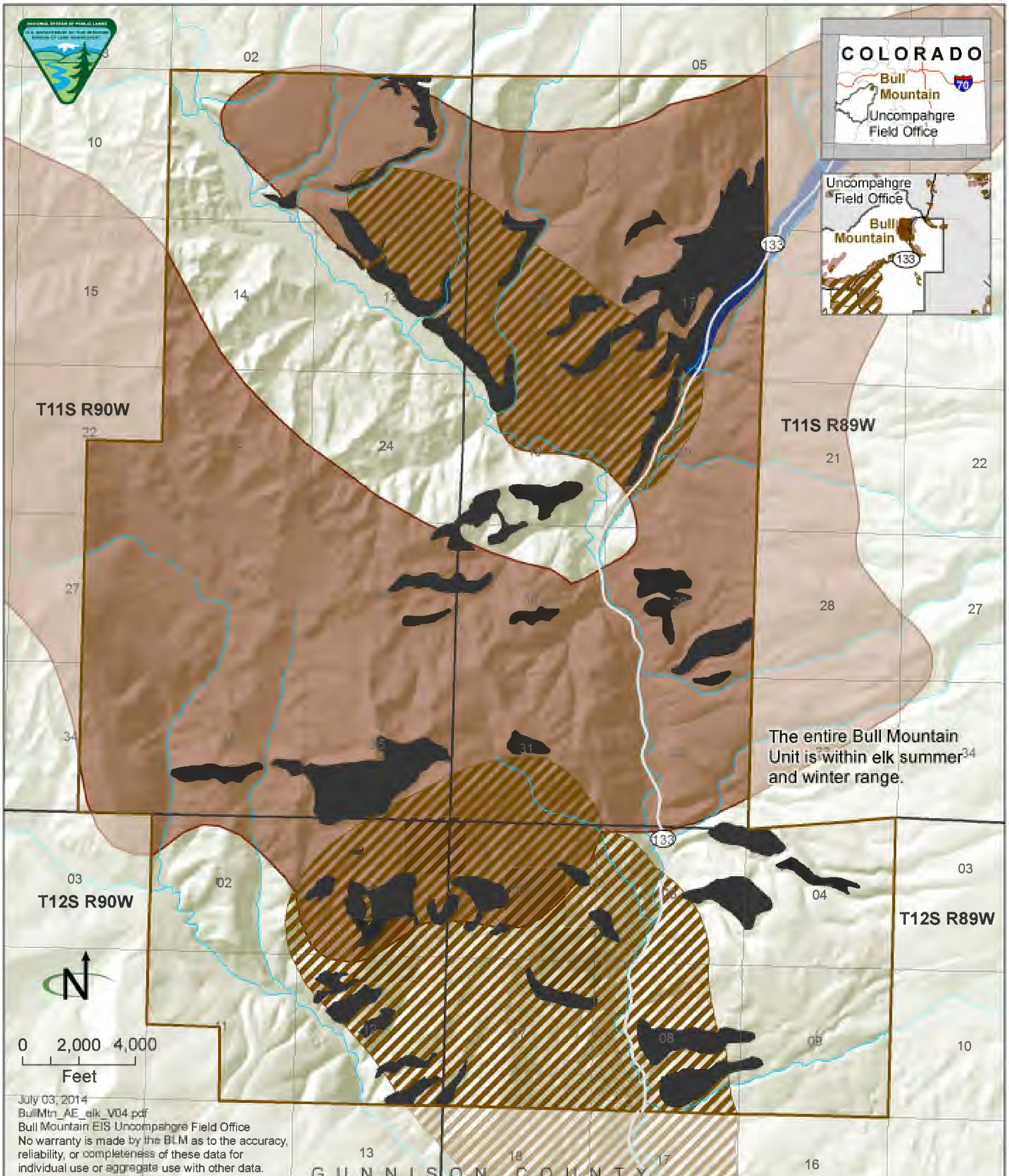
Elk can be found in the Unit year-round, but most significant elk use of the Unit occurs generally during the spring, fall, and winter months, with some low-density summertime use. It is assumed that many elk may spend most of the spring, summer, and fall in the aspen stands at the upper elevations outside of the Unit, and along both the extreme eastern and western sides of the Unit. Hunting pressure in the area is likely light to moderate. Most, if not all, of the larger ranches within the Unit provide access for hunting, as this helps keep elk from congregating on private property, but also provides an important supplemental source of income for these ranches and helps with herd size management.

Most observed elk use of the Unit area begins in late October and becomes more localized as winter range occupancy in small but important yards where elk tend to linger through the deepest snow months. As the snows melt in late winter and early spring elk are more widespread. During the most severe of winters (such as in 2008-2009), elk may be forced toward the more southern end of the Unit and along the Muddy Creek corridor, commonly lingering and utilizing hay spread for wintering cattle.

Elk activities through the winter months vary depending on snowfall depths and subsequent melting events. Elk scat on lower-elevation, steep, south-facing slopes in the Unit are observed to be very common, and browsing levels of brush are indicative of heavy winter utilization. However, the north-facing slopes and more level terrain do not see intense wintertime utilization. Some of the elk yards on south- and west-facing slopes are very small but are likely critical habitats for wintering elk.

CPW maps the entire Unit as Winter Range; lower elevations of the Unit are also considered Severe Winter Range totaling approximately 5,000 acres, and Winter Concentration Areas totaling nearly 12,000 acres within the Unit. There are approximately 77 acres of elk highway crossings in the Unit. There are no mapped elk calving grounds, but some elk do calve in the Unit, especially during cool, wet springs. Most cows and calves move to higher elevations outside of the Unit as summer progresses.

Black Bear (*Ursus americanus*). Colorado Black bears tend to live near open areas of chokecherry and serviceberry brush in stands of Gamble’s oak and aspen. Black bears within the Unit are managed by CPW as Grand Mesa Data Analysis Unit B-17 in west-central Colorado. Bear densities are considered high within the Grand Mesa Data Analysis Unit. Their natural diet consists of berries, nuts, and insects (CPW 2012c). Bears commonly supplement their diets by raiding garbage cans, breaking into homes, and becoming a hazard and a nuisance. Habitat in the Unit is suitable for bear use.




Bull Mountain Unit

Elk highway crossings: where elk movements traditionally cross roads, presenting potential conflicts between elk and motorists.

Elk severe winter range: where 90% of the individuals are located when the annual snowpack is at its maximum and/or temperatures are at a minimum in the two worst winters out of ten.

Elk winter concentration: verified by Petterson 2012

Elk winter concentration: where densities are 200% greater than the surrounding winter range density during the average five winters out of ten from the first heavy snowfall to spring green-up.

**Elk Habitat**

Source: NDIS 2010, Petterson 2012

Figure 3-13

Moose (*Alces alces*). Moose were introduced by CPW onto the Grand Mesa from Utah between 2005 and 2007 and are managed by CPW Data Analysis Unit M-5. Since that time, moose have expanded their range towards areas around the Unit. Moose in general utilize coniferous habitats and wetland complexes, but can also heavily utilize oakbrush and mixed mountain shrubland habitats in the area. During the winter moose browse mainly on willows; in summer they graze on grasses and forbs. Additionally, moose wade into lakes and streams to feed on aquatic vegetation (CPW 2013a). CPW has mapped the Unit as Overall Range, which covers most of the Grand Mesa and Muddy Creek basin.

***Trends***

In the 2006-2007 North Fork Land Health Assessment, which included federal lands within the Unit, found that most of the Land Health Standards were being met for standard 1 (soils), standard 3 (plant and animal communities), and standard 4 (threatened and endangered species). Nearly 90 percent of the stream miles included in the 2006-2007 North Fork Land Health Assessment were meeting standards 2 (riparian systems) and 5 (water quality).

Current population data are lacking for fish, amphibians, and other aquatic species; therefore current trends are largely unknown. Other non-game populations, including furbearers, small mammals, and reptiles, are expected to be stable. Those wildlife species or populations thought to be at risk or declining are monitored and tracked as special status species (**Section 3.2.10**, Special Status Species [Threatened, Endangered, Sensitive Species]).

Mule Deer. The mule deer herds which occur within the Unit are managed by CPW under Data Analysis Unit D-51, South Grand Mesa and consist of game management units 411, 52, and 521. The D-51 herd management plan from 2007 is outdated but reports that the mule deer populations exceeded population objectives from the early 1980s with a peak in 1982 of nearly 20,000 deer. Since the population peak, mule deer in D-51 have declined to at or below the population objective of 12,500 deer , possibly due to such factors as limited winter range habitat availability and human development on transition and winter ranges (CPW 2007). The post-hunt 2012 population estimate was approximately 9,200 animals, with a 3-year average sex ratio of 27:100; the D-51 population is essentially stable (B. Diamond, CPW pers. comm. June 21, 2013).

Elk. Computer modeling data as well as other information, including harvest and aerial surveys, show that the Data Analysis Unit E-14 elk herd has increased significantly since the 1950s (CPW 2009; Giezentanner 2008). The overall population of this herd increased from approximately 2,500 animals in the early 1950s to an estimated high of over 21,000 in 1990 and 1991. The 10-year average from 1998 to 2007 is approximately 16,000. In 2008, the post-hunt population was estimated at approximately 18,600 individuals, which exceeds the population objective of 9,000 – 11,000 individuals (CPW 2010).

Black Bear. Current black bear numbers in Data Analysis Unit B-17 are considered stable. In 2011, population models estimated the presumptive post-hunt population at 1,600 individual black bears in Data Analysis Unit B-17 (CPW 2013b). Total mortality objectives for population suppression have been set at 15 to 20 percent (240 to 320 bears) annually; this plan was approved by the CPW Commission in January 2013.

<u>Moose.</u> In 2008, CPW estimated that approximately 125 moose inhabit Data Analysis Unit M-5 consisting of approximately 60 bulls: 100 cows. The current herd management objectives include increasing the population size to 200-300 moose (CPW 2009).

### 3.2.9 Migratory Birds

***Current Conditions***

The Migratory Bird Treaty Act, established in 1918, made it unlawful to pursue, hunt, kill, capture, possess, sell, purchase, or barter any migratory bird, including the feathers or other parts, nests, eggs, or migratory bird products. In addition, Executive Order 13186 set forth the responsibilities of federal agencies to implement further the provisions of the Act by integrating bird conservation principles and practices into agency activities and by ensuring that federal actions evaluate the effects of actions and agency plans on migratory birds.

As used in the Act, "migratory birds" include native resident species that remain in an area throughout the year as well as migrant species that move from northern to southern latitudes and from higher to lower elevations to avoid winter conditions and a seasonal shortage of suitable food.

For most migrant and native resident species, nesting habitat is of special importance because it is critical for supporting reproduction in terms of both nesting sites and food. Also, because birds are generally territorial during the nesting season, their ability to access and utilize sufficient food is limited by the quality of the territory occupied. During non-breeding seasons, birds are generally non-territorial and able to feed across a larger area and wider range of habitats.

Among the wide variety of species protected by the Act, special concern is usually given to the following groups:

- Species that migrate across long distances
- Birds of prey, which require large areas of suitable habitat for finding sufficient prey
- Species that have narrow habitat tolerances and hence are vulnerable to extirpation from an area as a result of a relatively minor habitat loss
- Species that nest colonially and hence are vulnerable to extirpation from an area as a result of minor habitat loss

BLM Instruction Memorandum No. 2008-050 provides guidance toward meeting the agency's responsibilities under the Migratory Bird Treaty Act. This guidance directs field offices to promote the maintenance and improvement of habitat quantity and quality for migratory birds of conservation concern to avoid, reduce, or mitigate adverse impacts on their habitats to the extent feasible and in a manner consistent with regional or statewide bird conservation priorities. Because of the many species of migratory birds potentially present within field office boundaries, the BLM has focused its protection on species listed by the USFWS as Birds of Conservation Concern. This listing resulted from the 1988 amendment to the Fish and Wildlife Conservation Act, which mandates USFWS to "identify species, subspecies, and populations of all migratory nongame birds that, without additional conservation actions, are likely to become candidates for listing under the Endangered Species Act of 1973." **Table 3-28**, Birds of Conservation Concern of the Uncompahgre Field Office, lists those species that occur or have a potential to occur within the field office.

*Neotropical Species*
The Unit is dominated by sagebrush communities, with nearby Gambel's oak and mixed shrubs. A variety of migratory birds fulfill nesting requirements within these vegetation communities from late May to mid-July and/or during spring and fall migrations.

Approximately 42 percent of the Unit is dominated by sagebrush shrublands, and provides potential habitat for Brewer's sparrow, See **Section 3.2.10**, Special Status Species (Threatened, Endangered, Sensitive Species) for a discussion on impacts on this species. Other species associated with sagebrush shrublands that occur, but are not Birds of Conservation Concern species, include the western meadowlark (*Sturnella neglecta*), vesper sparrow (*Pooecetes gramineus*), and lark sparrow (*Chondestes grammacus*).

None of the Birds of Conservation Concern species in the UFO area are commonly associated with mixed mountain shrub and oakbrush habitats in the Unit. Migratory birds commonly associated with these habitat types but not included on the Birds of Conservation Concern list include migrants such as the Cordilleran flycatcher (*Empidonax occidentalis*), western scrub-jay (*Aphelocoma californica*), blue-gray gnatcatcher (*Polioptila caerulea*), Virginia's warbler (*Vermivora virginiae*), MacGillivray's warbler (*Oporornis tolmiei*), lesser goldfinch (*Carduelis psaltria*), black-headed grosbeak *(Pheucticus melanocephalus*), spotted towhee (*Pipilo maculatus*), and green-tailed towhee (*P. chlorurus*).

Areas of quaking aspen or other deciduous trees (including along drainages), occupy approximately 6 percent of the project area, and provide potential habitat for the house wren (*Troglodytes aedon*) and warbling vireo (*Vireo gilvus*). Also, migrants may use these habitats periodically such as the cordilleran flycatcher, western wood-pewee (*Contopus sordidulus)*, tree swallow (*Tachycineta bicolor*), and violet-green swallow (*Tachycineta thalassina*). A Birds of Conservation Concern species of riparian habitats, the willow flycatcher, is an obligate in lower-elevation riparian shrublands dominated by tall willows or structurally similar species.

The small area of mixed conifer forests on north-facing slopes in some of the deeper drainages supports limited numbers of coniferous forest species, including Cassin's finch. The area is generally below the elevational range of Cassin's finch for nesting, but use during winter is possible when individuals or flocks move to lower areas in search of food. Other species potentially nesting in the scattered coniferous forest stands include migrants such as Hammond's flycatcher (*Empidonax hammondii*), western tanager (*Piranga ludoviciana*), plumbeous vireo (*Vireo plumbeus*), yellow-rumped warbler (*Dendroica coronata*), chipping sparrow (*Spizella passerina*), darkeyed junco (*Junco hyemalis*), and pine siskin (*Carduelis pinus*).

Stands or scattered individuals of pinyon pine and Utah juniper provide some habitat for three pinyon-juniper obligates on the Birds of Conservation Concern list: the pinyon jay, juniper titmouse, and gray vireo. The gray vireo is unlikely to occur because the location of the project area is outside the known nesting range, which is located farther to the west. Other migrants

**Table 3-28**
**Birds of Conservation Concern of the Uncompahgre Field Office**

| Common Name | Scientific Name | Habitat Description | Range/Status | Potential and/or Occurrence in Project Area |
|---|---|---|---|---|
| American bittern | *Botaurus lentiginosus* | Marshes and wetlands; ground nester | Spring/ summer resident, breeding confirmed in the region but not within the UFO | Suitable habitat is limited, not likely occurring |
| Bald eagle[1] | *Haliaeetus leucocephalus* | Nests in forested rivers and lakes; winters in upland areas, often with rivers or lakes nearby | Fall/winter resident, no confirmed breeding | See assessment under Sensitive Species |
| Bendire's thrasher | *Toxostoma bendirei* | Desert, especially areas of tall vegetation, cholla cactus, creosote bush and yucca, and in juniper woodland | UFO is outside known range | No |
| Black rosy-finch | *Leucosticte atrata* | Open country including mountain meadows, high deserts, valleys, and plains; breeds and nests in alpine areas near rock piles and cliffs | Winter resident, non-breeding | No |
| Brewer's sparrow | *Spizella breweri* | Sagebrush-grass stands; less often in pinyon-juniper woodlands | Summer resident, breeding | Summer resident, breeding, see Sensitive Species assessment |
| Brown-capped rosy-finch | *Leucosticte australis* | Alpine meadows, cliffs, and talus and high-elevation parks and valleys | Summer residents, breeding | No |
| Burrowing owl | *Athene cunicularia* | Open grasslands and low shrublands often in association with prairie dog colonies; nests in abandoned burrows created by mammals; short vegetation | Summer/ fall resident, breeding | No, see assessment under Sensitive Species Section |
| Cassin's finch | *Haemorhous cassinii* | Open montane coniferous forests; breeds and nests in coniferous forests | Year-round resident, breeding | Yes |
| Chestnut-collared longspur | *Calcarius ornatus* | Open grasslands and cultivated fields | Spring migrant, non-breeding | No |
| Ferruginous hawk | *Buteo regalis* | Open, rolling, and rugged terrain in grasslands and shrubsteppe communities; also grasslands and cultivated fields; nests on cliffs and rocky outcrops | Fall/ winter resident, non-breeding | Possible migrant through area. See assessment under Sensitive Species Section |

**Table 3-28**
**Birds of Conservation Concern of the Uncompahgre Field Office**

| Common Name | Scientific Name | Habitat Description | Range/Status | Potential and/or Occurrence in Project Area |
|---|---|---|---|---|
| Flammulated owl | *Otus flammeolus* | Montane forest, usually open and mature conifer forests; prefers ponderosa pine and Jeffrey pine | Summer resident, breeding | Yes |
| Golden eagle | *Aquila chrysaetos* | Open country, grasslands, woodlands, and barren areas in hilly or mountainous terrain; nests on rocky outcrops or large trees | Year-round resident, breeding | Common in Unit, unknown nest site |
| Grace's warbler | *Dendroica graciae* | Mature coniferous forests | Summer resident, breeding | No |
| Grasshopper sparrow | *Ammodramus savannarum* | Open grasslands and cultivated fields | UFO is outside known range | No |
| Gray vireo | *Vireo vicinior* | Pinyon-juniper and open juniper-grassland | Summer resident, breeding | Possibly at southern end of Unit |
| Gunnison sage grouse | *Centrocercus minimus* | Sagebrush communities (especially big sagebrush) for hiding and thermal cover, food, and nesting; open areas with sagebrush stands for leks; sagebrush-grass-forb mix for nesting; wet meadows for rearing chicks | Year-round resident, breeding. | No, see assessment under Sensitive Species Section |
| Juniper titmouse | *Baeolophus griseus* | Pinyon-juniper woodlands, especially juniper; nests in tree cavities | Year-round resident, breeding | Possibly at southern end of Unit |
| Lewis's woodpecker | *Melanerpes lewis* | Open forest and woodland, often logged or burned, including oak, coniferous forest (often ponderosa), riparian woodland, and orchards, less often in pinyon-juniper | Year-round resident, breeding | No |
| Long-billed curlew | *Numenius americanus* | Lakes and wetlands and adjacent grassland and shrub communities | Spring/ fall migrant, non-breeding | Unlikely migrant through area. See assessment under Sensitive Species Section |

**Table 3-28**
**Birds of Conservation Concern of the Uncompahgre Field Office**

| Common Name | Scientific Name | Habitat Description | Range/Status | Potential and/or Occurrence in Project Area |
|---|---|---|---|---|
| Mountain plover | *Charadrius montanus* | High plain, cultivated fields, desert scrublands, and sagebrush habitats, often in association with heavy grazing, sometimes in association with prairie dog colonies; short vegetation | Spring/ fall migrant, non-breeding | No |
| Peregrine falcon[1] | *Falco peregrinus* | Open country near cliff habitat, often near water such as rivers, lakes, and marshes; nests on ledges or holes on cliff faces and crags | Spring/summer resident, breeding | Possibly foraging during summer. See assessment under Sensitive Species Section |
| Pinyon jay | *Gymnorhinus cyanocephalus* | Pinyon-juniper woodland | Year-round resident, breeding | Possibly at southern end of Unit |
| Prairie falcon | *Falco mexicanus* | Open country in mountains, steppe, or prairie; winters in cultivated fields; nests in holes or on ledges on rocky cliffs or embankments | Year-round resident, breeding | Observed as migrant through area |
| Snowy plover [2] | *Charadrius alexandrines* | Sparsely vegetated sand flats associated with pickleweed, greasewood, and saltgrass | Spring migrant, non-breeding | No |
| Veery | *Catharus fuscescens* | Deciduous forests, riparian, shrubs | Possible summer resident, observed recently in Gunnison County, possible breeding | No |
| Willow flycatcher [2] | *Empidonax traillii* | Riparian and moist, shrubby areas; winters in shrubby openings with short vegetation | Summer resident, breeding | No |
| Yellow-billed cuckoo[3] | *Coccyzus americanus* | Riparian, deciduous woodlands with dense undergrowth; nests in tall cottonwood and mature willow riparian, moist thickets, orchards, abandoned pastures | Summer resident, breeding | No, see assessment under Sensitive Species Section |

Source: USFWS 2008; Cornell Lab of Ornithology 2009; San Juan Institute of Natural and Cultural Resources 2009; Petterson 2012
[1] Endangered Species Act delisted species.
[2] Non-listed subspecies/ population
[3] Endangered Species Act candidate species

occurring in the limited pinyon-juniper include migrants such as the gray flycatcher (*Empidonax wrightii*), Say's phoebe (*Sayornis saya*), mountain bluebird (*Sialia sialis*), blue-gray gnatcatcher, and black-throated gray warbler (*Dendroica nigrescens*).

During winter, three additional species—Clark's nutcracker (*Nucifraga Columbiana*), Townsend's solitaire (*Myadestes townsendi*), and the cedar waxwing (*Bombycilla cedrorum*)—may congregate in pinyon-juniper habitats in search of pine nuts (the nutcracker) or juniper berries (the solitaire and waxwing).

The purple martin (*Progne subis*), although not a Bird of Conservation Concern, is a migratory bird that winters in South America and arrives in Colorado in early June then departs the area by late August (CPIF 2013). This swallow is recognized as a Forest Service sensitive species and is a Management Indicator Species in the Rocky Mountain Region (Region 2). Additionally, this species is listed as a Priority Species by the Colorado Partners in Flight plan (Wiggins 2005). The purple martin is an obligate secondary cavity nester and in Colorado it prefers to breed in stands of old growth aspen nesting in cavities excavated by woodpeckers or flickers (CPIF 2013). Due to the presence of suitable habitat and sightings of purple martin within and adjacent to the Unit (**Figure 3-14**, Purple Martin Habitat), as well as current management considerations of this species, effects of the proposed action on the purple martin will be addressed.

*Raptor Species*

Suitable bald eagle winter habitat occurs in the south central region of the Unit along East Muddy Creek (**Figure 3-15**, Bald Eagle Habitat). The golden eagle (*Aquila chrysaetos*) and prairie falcon (*Falco mexicanus*) are more likely to hunt across sagebrush areas than in the other habitat types in the Unit, all of which contain taller and denser woody vegetation. The irrigated meadows occupying 10 percent of the Unit provide potential habitat for the golden eagle and potentially for prairie falcon, when this species migrates through the project area.

Also, stands of quaking aspen and other deciduous trees provide suitable habitat for the flammulated owl. Intact stands of aspen within the Unit that are not affected by sudden aspen decline may also provide suitable nesting habitat for raptors and could require further surveys to address potential impacts on nesting raptors in the Unit. The north-facing slopes of mixed conifer forests in some of the drainages have the potential to support the flammulated owl.

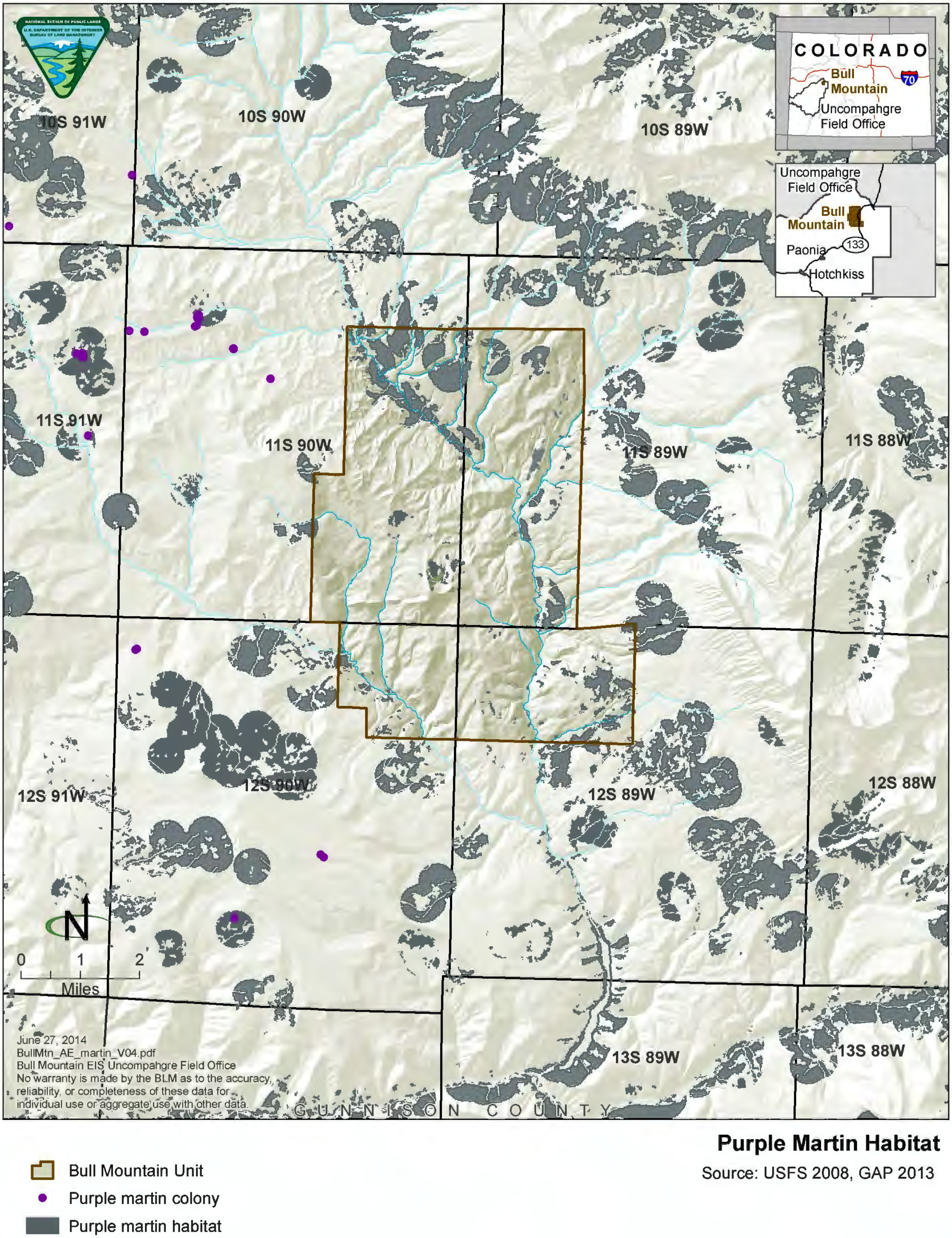
***Trends***

Habitat throughout the UFO supports a diversity of migratory bird species, including neotropical migrants. Recent studies and monitoring suggest that some of these populations are declining, due in part to land use and management practices and habitat loss and degradation (USFWS 2008). With the limited wildlife data available, most raptor populations appear to be stable.

### 3.2.10 Special Status Species (Threatened, Endangered, Sensitive Species)

***Current Conditions***

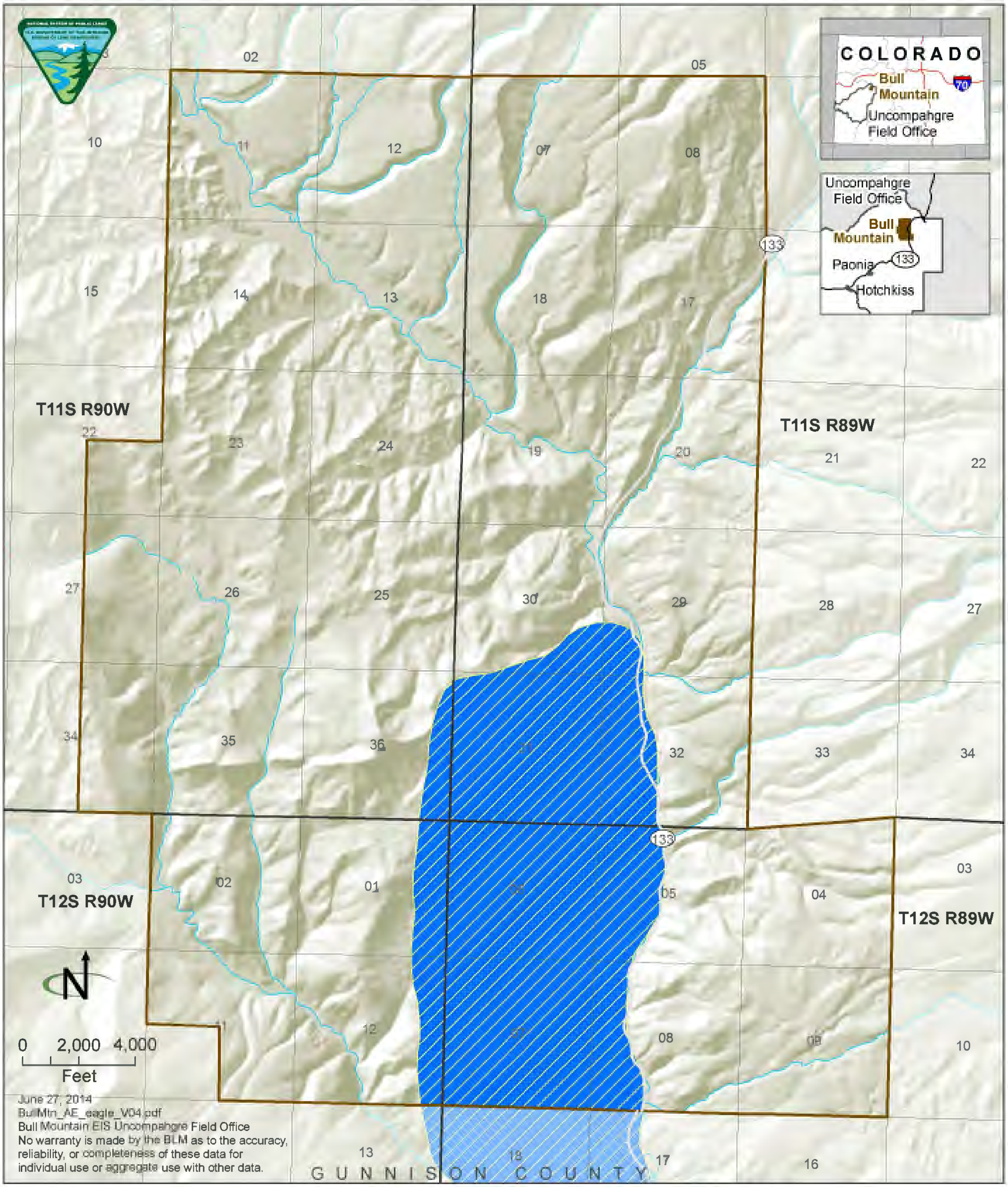
Listed or candidate wildlife, fish, and plant species that were considered and evaluated for this assessment include those identified by the UFO and the USFWS as potentially occurring in Gunnison County (accessed December 2011).




**Purple Martin Habitat**

Source: USFS 2008, GAP 2013

Figure 3-14




**Bald Eagle Habitat**

Source: NDIS 2010

- Bull Mountain Unit
- Bald eagle winter forage: frequented by wintering bald eagles between November 15 and March 15.
- Bald eagle winter range: bald eagles have been observed between November 15 and April 1.

Figure 3-15

The following habitats dominate the project area: sagebrush, mixed shrublands, oakbrush, riparian/emergent wetlands, aspen, irrigated hay meadows, and upland grass meadows. While all species were considered, only species which occur in the area, have suitable habitat, or for which the Unit is within the range of the species were selected for additional evaluation due to direct, indirect, and/or cumulative impacts. No critical habitat occurs in the Unit.

Information on species status, distribution, and ecology was derived from USFWS recovery plans, Colorado Natural Heritage Program database maps and reports, CPW habitat mapping (CPW 2011), personal knowledge of the consultant and reviewing BLM biologists, various scientific studies and reports, and correspondence with USFWS biologists.

Habitat surveys were conducted in the fall of 2007 through spring of 2011 (Petterson 2012).

*Federally Listed, Proposed, or Candidate Threatened or Endangered Animal Species*
**Table 3-29**, Threatened and Endangered Species of the Uncompahgre Field Office, is a complete list of federally protected listed, proposed, or candidate threatened or endangered animal species considered and evaluated.

Canada Lynx (*Lynx canadensis*), Federally Threatened Species: In Colorado, Canada lynx occupy high elevation coniferous forests characterized by cold, snowy winters and an adequate prey base (Ruggiero et al. 1999). The preferred prey of Canada lynx throughout their range is the snowshoe hare (*Lepus americanus*). In the western United States, lynx are associated with mesic forests of lodgepole pine, subalpine fir, Engelmann spruce, and quaking aspen in the upper montane and subalpine zones, generally between 8,000 and 12,000 feet in elevation. Although snowshoe hares are the preferred prey, lynx also feed on other species such as pine squirrel (*Tamiasciurus hudsonicus*), and blue (dusky) grouse (*Dendragapus obscurus*).

The Canada Lynx Conservation Assessment and Strategy (Ruediger et al. 2000, revised 2003) was developed to provide a consistent and effective approach to conserve Canada lynx on federal lands in the conterminous United States. The Lynx Conservation Assessment and Strategy indicates that project planning should evaluate the effects on lynx habitat within designated Lynx Analysis Units that are generally greater than 25,000 acres in the southern Rocky Mountain Geographic Area. Lynx Analysis Units do not represent actual lynx home ranges, but their scale should approximate the size of an area used by an individual lynx. A major transportation route to the Unit is State Highway 133, which passes through the Ragged Mountain Lynx Analysis Unit and McClure Pass Lynx Linkage Area. As such, the USFWS (Broderdorp 2011) has suggested that indirect effects from development of the Unit be investigated for potential effects on Canada lynx.

The Ragged Mountain Lynx Analysis Unit comprises 20,174.5 acres or 31.5 square miles (Forest Service 2008a). Mapped lynx habitat in Lynx Analysis Unit statistics only includes lands in federal ownership (**Figure 3-16**, Canada Lynx Habitat). Environmental baseline statistics of lynx habitat in the Ragged Mountain Lynx Analysis Unit are summarized in **Table 3-30**, Existing Habitats within the Ragged Mountain Lynx Analysis Unit, and **Table 3-31**, Existing Habitats within the Crystal West Ragged Mountain Lynx Analysis Unit.

**Table 3-29**
**Threatened and Endangered Species of the Uncompahgre Field Office**

| Species | Status | Habitat Description | Critical Habitat (Y/N?) | Known?[1] | Range (Y/N)? [2] | Habitat (Y/N)? [3] | No Effect (X)? [4] | Menlae (X) [5] | Melae (X) [6] |
|---|---|---|---|---|---|---|---|---|---|
| **Fish** | | | | | | | | | |
| Bonytail *Gila elegans* | E | Warm-waters of the Colorado River mainstem and tributaries, some reservoirs; flooded bottomlands for nurseries; pools and eddies over rocky substrates with silt-boulder mixtures for spawning | N | N | Y | N | | | X |
| Humpback chub *Gila cypha* | E | Warm-water, canyon-bound reaches of Colorado River mainstem and larger tributaries; turbid waters with fluctuating hydrology; young require low-velocity, shoreline habitats such as eddies and backwaters | N | N | N | N | | | X |
| Razorback sucker *Xyrauchen texanus* | E | Warm-water reaches of the Colorado River mainstem and larger tributaries; some reservoirs; low velocity, deep runs, eddies, backwaters, side canyons, pools, eddies; cobble, gravel, and sand bars for spawning; tributaries, backwaters, floodplain for nurseries | N | N | N | N | | | X |
| Colorado pikeminnow *Ptychocheilus lucius* | E | Warm-waters of the Colorado River mainstem and tributaries; deep, low velocity eddies, pools, runs, and nearshore features; uninterrupted streams for spawning migration and young dispersal; also floodplains, tributary mouths, and side canyons; highly complex systems | N | N | N | N | | | X |

**Table 3-29**
**Threatened and Endangered Species of the Uncompahgre Field Office**

| Species | Status | Habitat Description | Critical Habitat (Y/N?) | Known?[1] | Range (Y/N)? [2] | Habitat (Y/N)? [3] | No Effect (X)? [4] | Menlae (X) [5] | Melae (X) [6] |
|---|---|---|---|---|---|---|---|---|---|
| Greenback cutthroat trout *Oncorhynchus clarki stomias* | T | Cold water streams and lakes with adequate spawning habitat (riffles), often with shading cover; young shelter in shallow backwaters | N | Y | Y | N | X | | |
| **Mammals** | | | | | | | | | |
| Black-footed ferret[7] *Mustela nigripes* | E | Prairie dog colonies for shelter and food; greater than 200 acres of habitat with at least 8 burrows per acre | N | N | N | N | X | | |
| Canada lynx *Lynx canadensis* | T | Spruce-fir, lodgepole pine, willow carrs, and adjacent aspen and mountain shrub communities that support snowshoe hare and other prey | N | N | Y | Y | | X | |
| North American Wolverine *Gulo gulo luscus* | C | Alpine and arctic tundra, boreal and mountain forests (primarily coniferous); limited to mountains in the south, especially large wilderness areas. | N | N | N | N | X | | |
| Gunnison's prairie dog *Cynomys gunnisoni* | C | Level to gently sloping grasslands, semi-desert shrublands, and montane shrublands, from 6,000 to 12,000 feet in elevation | N | N | N | N | X | | |
| **Birds** | | | | | | | | | |
| Mexican spotted owl[8] *Strix occidentalis* | T | Mixed-conifer forests and steep-walled canyons with minimal human disturbance | N | N | Y | N | X | | |

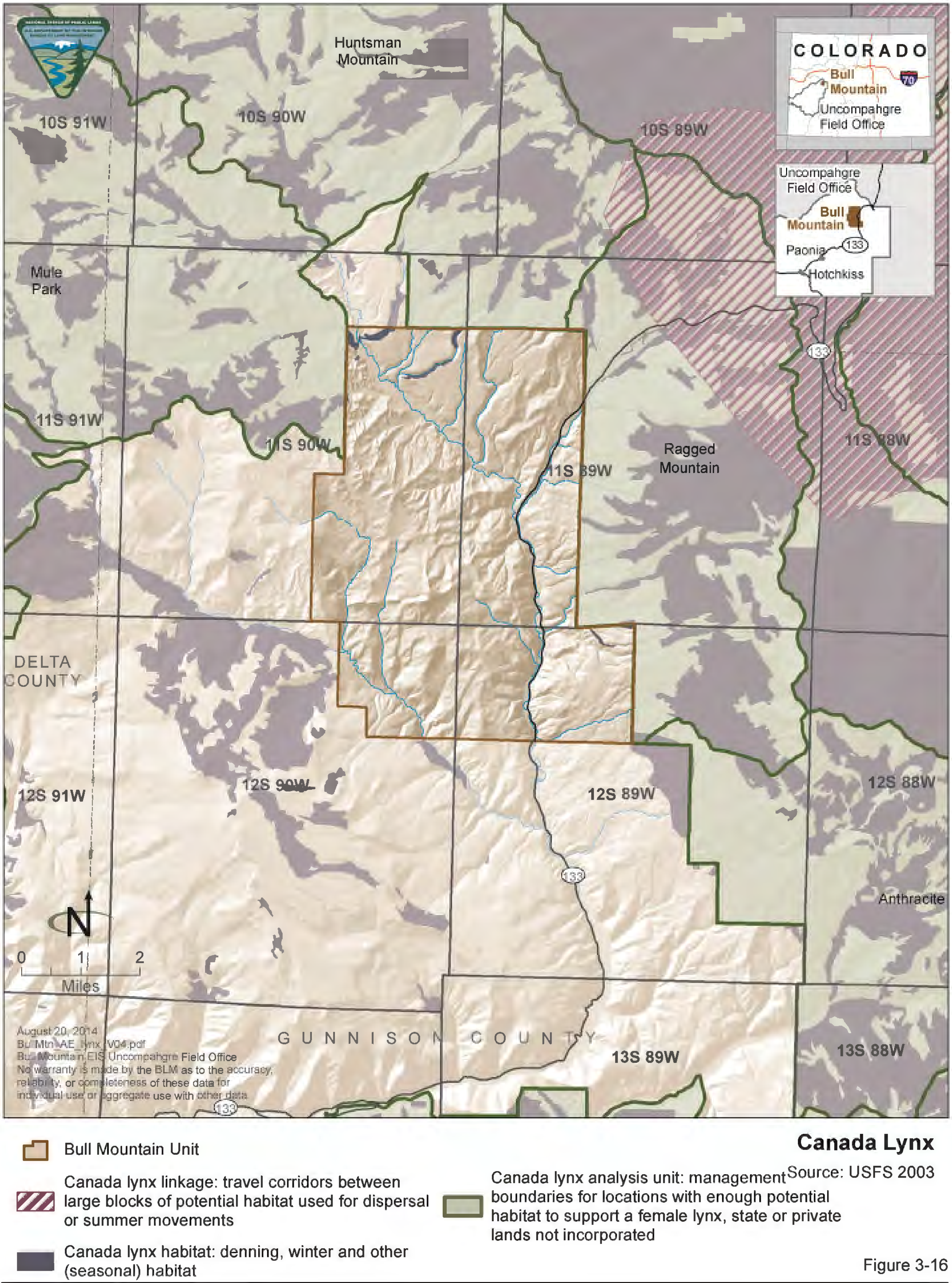
**Table 3-29**
**Threatened and Endangered Species of the Uncompahgre Field Office**

| Species | Status | Habitat Description | Critical Habitat (Y/N?) | Known?[1] | Range (Y/N)? [2] | Habitat (Y/N)? [3] | No Effect (X)? [4] | Menlae (X) [5] | Melae (X) [6] |
|---|---|---|---|---|---|---|---|---|---|
| Southwestern willow flycatcher[8] *Empidonax traillii extimus* | E | For breeding, riparian tree and shrub communities along rivers, wetlands, and lakes; for wintering, brushy grasslands, shrubby clearings or pastures, and woodlands near water | N | N | N | N | X | | |
| Gunnison sage grouse *Centrocercus minimus* | C | Sagebrush communities (especially big sagebrush) for hiding and thermal cover, food, and nesting; open areas with sagebrush stands for leks; sagebrush-grass-forb mix for nesting; wet meadows for rearing chicks | N | N | N | Y | X | | |
| Western yellow-billed cuckoo *Coccyzus americanus* | C | Riparian, deciduous woodlands with dense undergrowth; nests in tall cottonwood and mature willow riparian, moist thickets, orchards, abandoned pastures | N | N | Y | N | X | | |
| **Plants** | | | | | | | | | |
| Clay-loving wild buckwheat *Eriogonum pelinophilum* | E | Mancos shale badlands in salt desert shrub communities, often with shadscale, black sagebrush, and mat saltbush; 5,200 to 6,400 feet in elevation | N | N | N | N | X | | |
| Colorado hookless cactus *Sclerocactus glaucus* | T | Salt-desert shrub communities in clay soils on alluvial benches and breaks, toe slopes, and deposits often with cobbled, rocky, or graveled surfaces; 4,500 to 6,000 feet in elevation | N | N | N | N | X | | |

**Table 3-29**
**Threatened and Endangered Species of the Uncompahgre Field Office**

| Species | Status | Habitat Description | Critical Habitat (Y/N?) | Known?[1] | Range (Y/N)? [2] | Habitat (Y/N)? [3] | No Effect (X)? [4] | Menlae (X) [5] | Melae (X) [6] |
|---|---|---|---|---|---|---|---|---|---|
| **Invertebrates** | | | | | | | | | |
| Uncompahgre fritillary butterfly[8] *Boloria acrocnema* | E | Restricted to moist, alpine slopes above 12,000 feet in elevation with extensive snow willow patches; restricted to San Juan Mountains | N | N | N | N | X | | |

Source: USFWS 2009; Van Reyper 2006
[1] Potential and/or known occurrences in Project Area? Assessment based on UFO files and GIS data, partner data, and local knowledge.
[2] Project area is within the current known range of the species?
[3] Project area contains suitable habitat for the species?
[4] Project activities will have "No Effect" to the species or its habitat
[5] Project activities "May Effect, Not Likely to Adversely Affect" to the species or its habitat
[6] Project activities "May Effect, Likely to Adversely Affect" to the species or its habitat
[7] Black-footed ferret are believed to be extirpated from this portion of its range.
[8] Species not known to occur within UFO boundaries, but known to occur in close proximity.




**Canada Lynx**

Source: USFS 2003

Figure 3-16

**Table 3-30**
**Existing Habitats within the Ragged Mountain Lynx Analysis Unit**

| Habitat Type | Acres | Percent of the Unit |
|---|---|---|
| Primary Suitable | 8,638 | 43% |
| Secondary Suitable | 3,166 | 16% |
| Unclassified | 8,370 | 41% |
| Total | 20,174 | 100% |

Source: Forest Service 2008

**Table 3-31**
**Existing Habitats within the Crystal West Lynx Analysis Units**

| Habitat Type | Acres | Percent of the Unit |
|---|---|---|
| Winter Foraging | 20,790 | 21% |
| Denning | 14,603 | 15% |
| Other | 10,884 | 11% |
| Non-Habitat | 40,294 | 41% |
| Private | 10,963 | 11% |
| Total | 97,534 | 100% |

Source: Forest Service 2008

The Ragged Mountain Lynx Analysis Unit overlaps a small portion of the 27,034-acre McClure Pass Lynx Linkage Area at the northern end of the Lynx Analysis Unit, linking the Huntsman Ridge area with habitats in the Crystal West, Crystal East, and Huntsman Mountain Lynx Analysis Units on the White River and Grand Mesa Uncompahgre and Gunnison National Forests. The McClure Pass Lynx Linkage Area links suitable lynx habitats in the Elk Mountains to potential habitats on Huntsman Ridge and the Grand Mesa. State Highway 133 is within the McClure Pass Lynx Linkage Area.

The Crystal West Lynx Analysis Unit is a relatively large Lynx Analysis Unit at 97,534 acres, and is located on the White River National Forest. At this time the White River National Forest still utilizes habitat definitions previously described under the Lynx Conservation Assessment and Strategy. The Lynx Conservation Assessment and Strategy provides guidelines for the management of lynx habitat within Lynx Analysis Units, and recommends that at least 10 percent of a Lynx Analysis Unit be suitable Denning habitat, and the Crystal West Lynx Analysis Unit is at 15 percent Denning habitat. The Lynx Conservation Assessment and Strategy also recommends that at least 6,500 acres of primary lynx habitat (Denning and Winter Foraging habitats) be available for lynx use; the Crystal West Lynx Analysis Unit is at 35,393 acres.

Major existing land uses that may influence lynx habitat use within the Ragged Mountain Lynx Analysis Unit and McClure Pass Lynx Linkage Area is generally limited to widespread livestock grazing, dispersed camping and infrequent trail use, relatively active fall big game hunting, and some limited winter-time snowmobile activities.

Colorado River Endangered Fish, Federally Endangered Species. The USFWS lists the humpback chub (*Gila cypha*), bonytail chub (*G. elegans*), Colorado pikeminnow (*Ptychocheilus* *lucius*), and razorback sucker (*Xyrauchen texanus*) as occurring in downstream waters in the Colorado River. Colorado pikeminnow and razorback sucker also occur in lower reaches of the Gunnison River, near the City of Delta down to the confluence with the Colorado River.

The Unit is approximately 60 river miles upstream of the nearest designated critical habitat for the Colorado pikeminnow and razorback sucker and even further away for designated critical habitats for the humpback chub and bonytail in the mainstem of the Colorado River.

Water depletions in the Colorado River Basin and the potential effects on federally listed Colorado River fish as a result of fluid mineral development were addressed in the Programmatic Biological Assessment for the BLM's Fluid Minerals Program in Western Colorado (May 2008). In response to BLM's Programmatic Biological Assessment, the USFWS issued a Programmatic Biological Opinion (ES/GJ-6-CO-08-F-0006) on December 19, 2008, which determined that BLM water depletions associated with BLM approved projects in the Colorado River Basin are not likely to jeopardize the continued existence the Colorado pikeminnow, razorback sucker, bonytail chub, and humpback chub. Likewise, the project is also not likely to destroy or adversely modify designated critical habitats for these endangered fish along the Green, Yampa, White, Colorado, and Gunnison Rivers. Water depletions analyzed under the Programmatic Biological Opinion include water used for dust abatement, hydrostatic testing, well drilling and completion, and water associated with federal actions. The Programmatic Biological Opinion requires the BLM and SGI to report the entire quantity of fresh water actually used to develop a federal well in that year to update water use estimates. Water depletion reports will be submitted to the USFWS on October 31 of each year. These reports will be used to track compliance with the threshold depletion amount.

<u>Greenback cutthroat trout (*Onchorhynchus clarkii stomias*), Federally Threatened Species</u>. Genetic testing through the amplified fragment length polymorphism process has determined that populations of cutthroat trout in Roberts Creek and Dyke Creek (both creeks are tributaries in the Muddy Creek basin) are not Colorado River cutthroat trout (*Onchorhynchus clarkii pleuriticus*) lineages, but are actually greenback cutthroat trout lineages (Speas 2010; Kowalski 2010). The Roberts Creek population is 96 percent genetically pure greenback cutthroat trout and the Dyke Creek population is 98 percent genetically pure. Any population that shows at least 80 percent genetic purity would be subject to the requirements of the Endangered Species Act (Speas 2010; USFWS 2010). Fish sampling in Ault Creek revealed that there are no cutthroat trout within that creek (Petterson 2012). Cutthroat trout populations in Henderson Creek have not undergone the amplified fragment length polymorphism genetic testing process, but mitochondrial DNA testing has shown those trout to have greenback cutthroat trout lineage. Greenback cutthroat trout occur in clear, cold, high-gradient streams and creeks. They are extremely vulnerable to competition by non-native trout (e.g., brook trout [*Salvelinus fontinalis*]), which were accidentally released in the Clear Fork. Trout are also vulnerable to water depletions.

*Federally Listed, Proposed, or Candidate Threatened or Endangered Plant Species*
Habitat necessary for life requirements of federally listed, proposed, or candidate threatened or endangered plant species are not found within the Unit.

*BLM Sensitive Species*

**Table 3-32**, BLM Sensitive Species of the Uncompahgre Field Office lists the species considered and evaluated. Of the 31 UFO-listed sensitive animal species known or likely to occur in or adjacent to the Unit, most do not occur in the area on a regular basis and are listed as unlikely based on project location and habitat types. However, eight species are considered to possibly occur, indicating a greater likelihood of occurrence, or present, in that they are known to occur. These species are addressed below.

Northern Goshawk (*Accipiter gentilis*). This raptor nests in subalpine spruce-fir, Ponderosa pine, aspen forests, and infrequently in mature pinyon-juniper woodlands, but may move to lower-elevation woodlands during winter in search of prey. The Unit provides suitable nesting and foraging habitat for this species.

Bald Eagle (*Haliaeetus leucocephalus*). Removed from the federal list of threatened or endangered species in August 2007, this large raptor is now considered a sensitive species and remains protected by the Bald and Golden Eagle Protection Act as well as the Migratory Bird Treaty Act. Bald eagles roost during the winter months along Muddy Creek at the southern end of the Unit, but may scavenge on winter-killed big game species in upland areas in the Unit. Bald eagle winter forage areas and winter range are mapped on approximately 2,976 acres of the Unit. Bald eagles are not known to occur in the area during the summer months.

Brewer's Sparrow (*Spizella breweri*). This migrant is essentially a sagebrush obligate, although it may occasionally nest in other semi-desert shrublands. Sagebrush is a significant component of the habitat in the Unit, and this species is known to nest in the project area (Petterson 2012). This species does not occur in the area during the winter months (see **Section 3.2.9**, Migratory Birds).

Bat Species. Bats potentially found in the Unit include Townsend's big-eared bat (*Corynorhinus townsendii pallescens*), spotted bat (*Euderma maculatum*), and fringed myotis (*Myotis thysanodes*). All of these bat species may forage over shrublands typified by the sagebrush and pinyon-juniper woodlands occurring within the lower elevations and south-facing slopes in the Unit. However, these bat species require nearby rock outcrops, caves or mines (abandoned or active) for shelter; for fringed myotis and spotted bat, old buildings and larger trees with cavities will suffice. Rock outcrops occur at the southern end of the Unit, near the West Muddy Creek and East Muddy Creek canyons, but no direct or indirect impacts on these outcrops would occur.

Leopard Frog (*Lithobates pipiens*). This species occurs in the Unit in irrigated meadows, riparian areas and creeks, and prefers sunny, grassy wetlands. It requires abundant aquatic vegetation for breeding and adjacent semi-aquatic vegetation for cover when adults disperse short distances to feed. Leopard frogs feed primarily on emergent adults of aquatic insects or on terrestrial insects attracted to the water.

*BLM Sensitive Plant Species*

During field surveys for special status plant species, no sensitive plants species were observed, nor was suitable habitat present in the project area for any of these species.

**Table 3-32**
**BLM Sensitive Species of the Uncompahgre Field Office[1]**

| Species | Habitat Description | Known[1] | Range?[2] | Habitat?[3] | No Effect[4] | MAI[5] | LFL[6] |
|---|---|---|---|---|---|---|---|
| **Fish** | | | | | | | |
| Roundtail chub *Gila robusta* | Warm-water rocky runs, rapids, and pools of creeks and small to large rivers; also large reservoirs in the upper Colorado River system; generally prefers cobble-rubble, sand-cobble, or sand-gravel substrate | None | N | N | | X | |
| Bluehead sucker *Catostomus discobolus* | Large rivers and mountain streams, rarely in lakes; variable, from cold, clear mountain streams to warm, turbid streams; moderate to fast flowing water above rubble-rock substrate; young prefer quiet shallow areas near shoreline | None | N | N | | X | |
| Flannelmouth sucker *Catostomus latipinnis* | Warm moderate- to large-sized rivers, seldom in small creeks, absent from impoundments; pools and deeper runs often near tributary mouths; also riffles and backwaters; young usually in shallower water than are adults | None | N | N | | X | |
| Colorado River cutthroat trout *Oncorhynchus clarki pleuriticus* | Cool, clear streams or lakes with well-vegetated streambanks for shading cover and bank stability; deep pools, boulders, and logs; thrives at high elevations | None | Y | N | X | | |
| **Mammals** | | | | | | | |
| Desert bighorn sheep *Ovis canadensis nelsoni* | Steep, mountainous or hilly terrain dominated by grass, low shrubs, rock cover, and areas near open escape and cliff retreats; in the resource area, concentrated along major river corridors and canyons | None | N | N | X | | |
| White-tailed prairie dog [7] *Cynomys leucurus* | Level to gently sloping grasslands and semi-desert grasslands from 5,000 to 10,000 feet in elevation | None | N | N | X | | |
| Kit fox *Vulpes macrotis* | Semi-desert shrublands of saltbrush, shadscale and greasewood often in association with prairie dog towns | None | N | N | X | | |

**Table 3-32**
**BLM Sensitive Species of the Uncompahgre Field Office[1]**

| Species | Habitat Description | Known[1] | Range?[2] | Habitat?[3] | No Effect[4] | MAI[5] | LFL[6] |
|---|---|---|---|---|---|---|---|
| Allen's (Mexican) big-eared bat *Idionycteris phyllotis* | Ponderosa pine, pinyon-juniper woodland, oak brush, riparian woodland (cottonwood); typically found near rocky outcrops, cliffs, and boulders; often forages near streams and ponds. Thought to be in the West End of Montrose County. | None | Y | N | X | | |
| Big free-tailed bat *Nyctinomops macrotis* | Rocky areas and rugged terrain in desert and woodland habitats; roosts in rock crevices in cliffs and in buildings caves, and occasionally tree holes | None | Y | Y | | X | |
| Spotted bat *Euderma maculatum* | Desert shrub, ponderosa pine, pinyon-juniper woodland, canyon bottoms, open pasture, and hayfields; roost in crevices in cliffs with surface water nearby | None | Y | Y | | X | |
| Townsend's big-eared bat *Corynorhinus townsendii* | Mesic habitats including coniferous forests, deciduous forests, sagebrush steppe, juniper woodlands, and mountain; maternity roosts and hibernation in caves and mines; does not use crevices or cracks; caves, buildings, and tree cavities for night roosts | None | Y | Y | | X | |
| Fringed myotis *Myotis thysanodes* | Desert, grassland, and woodland habitats including ponderosa pine, pinyon/juniper, greasewood, saltbush, and scrub oak; roosts in caves, mines, rock crevices, and buildings | None | Y | Y | | X | |
| **Birds** | | | | | | | |
| Bald eagle[5] *Haliaeetus leucocephalus* | Nests in forested rivers and lakes; winters in upland areas, often with rivers or lakes nearby | None | Y | Y | | X | |
| American peregrine falcon[5] *Falco peregrines anatum* | Open country near cliff habitat, often near water such as rivers, lakes, and marshes; nests on ledges or holes on cliff faces and crags | None | Y | N | X | | |

**Table 3-32**
**BLM Sensitive Species of the Uncompahgre Field Office[1]**

| Species | Habitat Description | Known[1] | Range?[2] | Habitat?[3] | No Effect[4] | MAI[5] | LFL[6] |
|---|---|---|---|---|---|---|---|
| Northern goshawk *Accipiter gentilis* | Nests in a variety of forest types including deciduous, coniferous, and mixed forests including ponderosa pine, lodgepole pine, or in mixed-forests with fir and spruce; also nest in aspen or willow forests; migrants and wintering individuals can be observed in all coniferous forest types | None | Y | Y | | X | |
| Ferruginous hawk *Buteo regalis* | Open, rolling and/or rugged terrain in grasslands and shrubsteppe communities; also grasslands and cultivated fields; nests on cliffs and rocky outcrops; winter migrant. | None | Y | N | X | | |
| Burrowing owl[8] *Athene cunicularia* | Level to gently sloping grasslands and semi-desert grasslands; Prairie dog colonies for shelter and food | None | Y | N | X | | |
| Columbian sharp-tailed grouse *Tympanuchus phasianellus columbian* | Native bunchgrass and shrub-steppe communities for nesting; mountain shrubs including serviceberry are critical for winter food and escape cover; thought to be extirpated from UFO. | None | N | Y | X | | |
| Long-billed curlew *Numenius americanus* | Lakes and wetlands and adjacent grassland and shrub communities; rare occurrence | None | Rare | N | X | | |
| White-faced ibis *Plegadis chihi* | Marshes, swamps, ponds and rivers | None | Y | N | X | | |
| American white pelican *Pelecanus erythrorhynchos* | Typically large reservoirs but also observed on smaller water bodies including ponds; nests on islands | None | Y | N | X | | |
| Brewer's sparrow *Spizella breweri* | Breeds primarily in sagebrush shrublands, but also in other shrublands such as mountain mahogany or rabbitbrush; migrants seen in wooded, brushy, and weedy riparian, agricultural, and urban areas; occasionally observed in pinyon-juniper | None | Y | Y | | Y | |
| Black swift[8] *Cypseloides niger* | Nests on precipitous cliffs near or behind high waterfalls; forages from montane to adjacent lowland habitats; rare | None | Y | N | X | | |

**Table 3-32**
**BLM Sensitive Species of the Uncompahgre Field Office[1]**

| Species | Habitat Description | Known[1] | Range?[2] | Habitat?[3] | No Effect[4] | MAI[5] | LFL[6] |
|---|---|---|---|---|---|---|---|
| **Reptiles and Amphibians** | | | | | | | |
| Longnose leopard lizard *Gambelia wislizenii* | Desert and semidesert areas with scattered shrubs or other low plants; e.g., sagebrush; areas with abundant rodent burrows, typically below 5,000 feet in elevation | None | N | N | X | | |
| Midget faded rattlesnake[9] *Crotalus oreganus concolor* | Rocky outcrops for refuge and hibernacula, often near riparian; upper limit of 7,500 to 9,500 feet in elevation | None | Y | N | X | | |
| Milk snake *Lampropeltis triangulum taylori* | Variable types including shrubby hillsides, canyons, open ponderosa pine stands and pinyon-juniper woodlands, arid river valleys and canyons, animal burrows, and abandoned mines; hibernates in rock crevices | None | Y | N | N | | |
| Northern leopard frog[7] *Lithobates pipiens* | Springs, slow-moving streams, marshes, bogs, ponds, canals, flood plains, reservoirs, and lakes; in summer, commonly inhabits wet meadows and fields; may forage along water's edge or in nearby meadows or fields | Yes | Y | Y | | X | |
| Canyon treefrog *Hyla arenicolor* | Rocky canyon bottoms along intermittent or perennial streams in temporary or permanent pools or arroyos ; semi-arid grassland, pinyon-juniper, pine-oak woodland, scrubland, and montane zones; elevation 1,000 to 10,000 feet | None | Y | N | X | | |
| Boreal toad *Anaxyrus boreas boreas* | Mountain lakes, ponds, meadows, and wetlands in subalpine forest (e.g., spruce, fir, lodgepole pine, and aspen); feed in meadows and forest openings near water but sometimes in drier forest habitats | None | N | N | X | | |
| **Plants** | | | | | | | |
| Debeque milkvetch *Astragalus debequaeus* | Varicolored, fine-textured, seleniferous, saline soils of the Wasatch Formation-Atwell Gulch Member; elevation 5,100 to 6,400 feet | None | N | N | X | | |

**Table 3-32**
**BLM Sensitive Species of the Uncompahgre Field Office[1]**

| Species | Habitat Description | Known[1] | Range?[2] | Habitat?[3] | No Effect[4] | MAI[5] | LFL[6] |
|---|---|---|---|---|---|---|---|
| Grand Junction milkvetch *Astragalus linifolius* | Sparsely vegetated habitats in pinyon-juniper and sagebrush communities, often within Chinle and Morrison Formation and selenium-bearing soils; elevation 4,800 to 6,200 feet | None | Y | N | X | | |
| Naturita milkvetch *Astragalus naturitenis* | Cracks and ledges of sandstone cliffs and flat bedrock area typically with shallow soils, within pinyon-juniper woodland; elevation 5,400 to 6,700 feet | None | Y | N | X | | |
| San Rafael milkvetch *Astragalus rafaelensis* | Banks of sandy clay gulches and hills, at the foot of sandstone outcrops, or among boulders along dry watercourses in seleniferous soils derived from shale or sandstone formations; elevation 4,500 to 5,300 feet | None | Y | N | X | | |
| Sandstone milkvetch *Astragalus sesquiflorus* | Sandstone rock ledges (Entrada formation), domed slickrock fissures, talus under cliffs, sometimes in sandy washes; elevation 5,000 to 5,500 feet | None | N | N | X | | |
| Gypsum Valley cateye *Cryptantha gypsophila* | Confined to scattered gypsum outcrop and grayish-white, often lichen-covered, soils of the Paradox Member of the Hermosa Formation; often the dominant plant at these sites; elevation 5,200 to 6,500 feet | None | N | N | X | | |
| Fragile (slender) rockbrake *Cryptogramma stelleri* | Cool, moist, sheltered calcareous cliff crevices and rock ledges | None | Y | N | X | | |
| Kachina daisy (fleabane)[8] *Erigeron kachinensis* | Saline soils in alcoves and seeps in canyon walls; elevation 4,800 feet 5,600 feet | None | N | N | X | | |
| Montrose (Uncompahgre) bladderpod *Lesquerella vicina* | Sandy-gravel soil mostly of sandstone fragments over Mancos Shale (heavy clays) mainly in pinyon-juniper woodlands or in the ecotone between it and salt desert scrub; also in sandy soils derived from Jurassic sandstones and in sagebrush steppe communities; elevation 5,800 to 7,500 feet | None | N | N | X | | |

**Table 3-32**
**BLM Sensitive Species of the Uncompahgre Field Office[1]**

| Species | Habitat Description | Known[1] | Range?[2] | Habitat?[3] | No Effect[4] | MAI[5] | LFL[6] |
|---|---|---|---|---|---|---|---|
| Colorado (Adobe) desert parsley *Lomatium concinnum* | Adobe hills and plains on rocky soils derived from Mancos Formation shale; shrub communities dominated by sagebrush, shadscale, greasewood, or scrub oak; elevation 5,500 to 7,000 feet | None | N | N | X | | |
| Paradox Valley (Payson's) lupine *Lupinus crassus* | Pinyon-juniper woodlands, or clay barrens derived from Chinle or Mancos Formation shales, often in draws and washes with sparse vegetation; elevation 5,000 to 5,800 feet | None | Y | N | X | | |
| Dolores skeleton plant[8] *Lygodesmia doloresenis* | Reddish purple, sandy alluvium and colluviums of the Cutler Formation between the canyon walls and the river in juniper, shadscale, and sagebrush communities; elevation 4,000 to 5,500 feet | None | N | N | X | | |
| Eastwood's monkey-flower *Mimulus eastwoodiae* | Shallow caves and seeps on steep canyon walls; elevation 4,700 to 5,800 feet | None | Y | N | X | | |
| Paradox (Aromatic Indian) breadroot *Pediomelum aromaticum* | Open pinyon-juniper woodlands in sandy soils or adobe hills; elevation 4,800 to 5,700 feet | None | Y | N | X | | |
| **Invertebrates** | | | | | | | |
| Great Basin silverspot butterfly *Speyeria nokomis nokomis* | Found in streamside meadows and open seepage areas with an abundance of violets | None | N | | X | | |

Source:BLM 2011; Van Reyper 2006; Spackman et al. 1997
[1] Potential and/or known occurrences in Project Area? Assessment based on UFO files and GIS data, partner data, and local knowledge.
[2] Project area is within the current known range of the species?
[3] Project area contains suitable habitat for the species?
[4] Project activities will have no effect on the species or its habitat
[5] Project activities may affect individuals of the species or its habitat, but not likely to result in a trend toward federal listing
[6] Project activities are likely to result in a trend toward federal listing for the species
[7] Species was petitioned for listing and is currently under status review by USFWS, and a 12-month finding is pending; i.e., listing of the species throughout all or a significant portion of its range may be warranted.
[8] Species not on BLM Colorado State Director's Sensitive List; included at the Field Office level to account for recent sightings, proximate occurrences, and/or potential habitat
[9] Validity of subspecies designation is in question by taxonomists.

***Trends***

By definition, the populations, and often habitats, of all special status wildlife species have historically suffered downward trends. However, due to protection and recovery efforts, some populations, such as peregrine falcon and bald eagle, are stabilizing. Management efforts by USFWS, CPW, the BLM, and others have reversed the downward trend for a number of these populations. Nevertheless, none of the populations are thought to be near their historic levels, and most remain biologically insecure, regardless of their legal status.

Current and future threats include habitat loss and fragmentation, poaching, predation, disease, invasive species, and others. Habitat degradation and loss are caused by, or exacerbated by, historic overgrazing, oil and gas development, mining, water diversions, recreation, agriculture, residential development, and other human activities. Natural processes such as fire, drought, vegetation type conversions, and climate change may also contribute to landscape changes over time. It is not known which species will be able to adapt to these changes and persist over time. Pinyon-juniper, riparian, sagebrush, and salt-desert shrub have been determined to be at-risk habitats and harbor many of our special status and rare species.

Beginning in 1997, the Colorado Division of Wildlife (now CPW) initiated a Canada lynx reintroduction program to establish a self-sustaining population in suitable habitat throughout Colorado (CPW 2010). All of the benchmarks established by CPW used in measuring the success of the reintroduction program for Canada lynx were met as of 2010. Observations of lynx reproduction in Colorado first documented litters in the spring of 2003; as of 2010, reintroduced lynx that have established territories also produced litters (CPW 2010). At present, the Canada lynx population is estimated at 200 to 300 throughout Colorado and the reintroduction program is considered a success by the USFWS (USFWS 2013).

The greenback cutthroat trout recovery plan (USFWS 1998) identified hybridization and resource competition with other trout species as key limiting factors that affect greenback cutthroat trout success. Colorado greenback cutthroat trout populations were believed to be exceeding population recovery goals set in the USFWS recovery plan (USFWS 1998, 2009). Intensive data collection efforts within the Grand Mesa Uncompahgre and Gunnison National Forest have not produced rigorous trend data for greenback cutthroat trout near the Unit due to a lack of standardized sampling methods. Despite the lack of population trend data, the USFWS concluded that populations within the Grand Mesa Uncompahgre and Gunnison National Forest including Dyke and Roberts Creeks have increased between 2002 and 2010 (Dare et al. 2011). However, recent genetic studies have concluded that the only true greenback cutthroat trout population exists in Bear Creek, a tributary of the Arkansas River west of Colorado Springs (USFWS 2012). These recent findings will require the USFWS to reevaluate the taxonomy and status of the species.

The goals of the Upper Colorado River Endangered Fish Recovery Program is to downlist the Colorado pikeminnow from endangered to threatened by 2018, and to downlist the humpback chub, razorback sucker, and bonytail from endangered to threatened by 2020 (Upper Colorado River Endangered Fish Recovery Program 2013). Current estimates for Colorado pikeminnow indicate that the Colorado River populations are stable and the program is meeting or exceeding stocking goals for bonytail and razorback sucker (Upper Colorado River Endangered Fish

Recovery Program 2013). Upper Colorado River humpback chub populations below the confluence of the Gunnison River near Black Rocks, Colorado, have remained stable since a decline 13 years ago (Upper Colorado River Endangered Fish Recovery Program 2013).

### 3.2.11 Wildland Fire Management

Wildland fire management on public lands is governed by the Federal Wildland Fire Management Policy was developed by the secretaries of the Department of the Interior and the USDA. The 2001 Federal Wildland Fire Management Policy provides guiding principles, policy statements, and implementation actions. Under the plan, every unit within a federal land management agency, such as a BLM field office, that has vegetation capable of sustaining wildland fire is required to prepare a fire management plan, a strategic plan that outlines a program for managing wildland and prescriptive vegetation treatments. Fire management plans are dynamic documents that are reviewed annually and updated whenever better information is available. The plan is supplemented by operational plans, such as preparedness plans, dispatch plans, prescribed fire plans, and prevention plans.

The UFO Fire Management Plan (FMP) was originally written and approved in 1998, and has undergone three revisions in order to incorporate national policy changes, as well as minor changes gained through experience. In the next few years, an effort will be made to integrate the UFO FMP and other local agencies' fire management plans.

#### *Current Conditions*

The Unit is located within the Ragged Mountain Fire Protection District. It is geographically located within Management Unit 16 as defined in the RMP (BLM 1989). The RMP calls for intensive suppression of fire on federally managed lands within this unit. Surface fuels in the Unit are dominated by generally continuous sagebrush fuels, with patches of decadent Gambel's oak and mixed-shrub fuel types. Should they occur, fires within these fuel types would be generally difficult to stop with hand-crews and Type 6 brush trucks, unless natural and man-made fuel breaks (e.g., roads and irrigated meadows) were utilized. Wildfire risk assessment mapping from 2012 quantifies potential fire intensity in the project area as moderate to high (Colorado State Forest Service 2012).

Gunnison County regulations state that natural gas operations "shall not cause a significant risk of wildfire hazard." As a result, measures are put in place to minimize risk on natural gas operations and other energy development in the project area and surrounding area.

#### *Trends*

Large fires have been uncommon in the area. Within 10 miles of the Bull Mountain Management Unit, only two large fires have been documented since 1960, the most recent of which occurred in 1981 (BLM 2013a).

Changes to vegetation, climate, as well as development in the wild land-urban interface zone could all impact fire risk in and around the project area. Changes to these factors are difficult to quantify, but it is likely that fire risk will remain static or slightly increase over the life of the plan.

### 3.2.12 Cultural Resources

Cultural resources are defined as fragile and nonrenewable remains of prehistoric and historic human activity, occupation, or endeavor as reflected in districts, sites, structures, buildings, objects, artifacts, ruins, works of art, architecture, and natural features that were important to human history. Cultural resources comprise the physical remains themselves, the areas where significant human events occurred even if evidence of the event no longer remains, and the environment surrounding the actual resource.

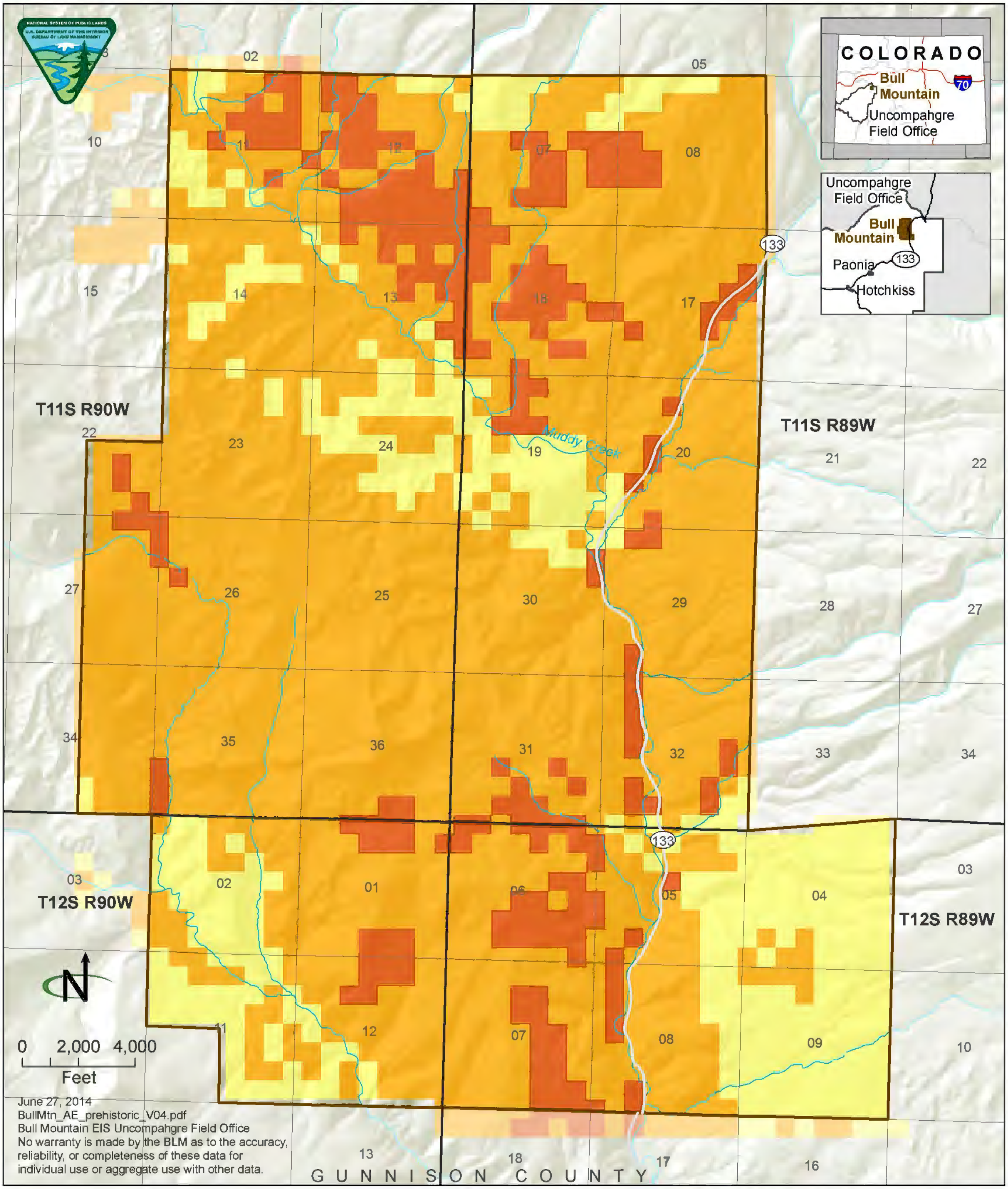
Significant cultural resources are defined as those listed in, or eligible for listing in, the National Register of Historic Places. Significant cultural resources are generally at least 50 years old and meet one or more of the criteria presented in 36 CFR Part 60, which specifies that the quality of significance in American history, architecture, archaeology, and culture is present in districts, sites, buildings, structures, and objects of national, state and local importance that possess integrity of location, design, setting, materials, workmanship, feeling, and association, and that are associated with events that have made a significant contribution to the broad patterns of our history; are associated with the lives of persons significant in our past; embody the distinctive characteristics of a type, period, or method of construction, or that represent the work of a master, or that possess high artistic values, or that represent a significant and distinguishable entity whose components may lack individual distinction; or have yielded, or may be likely to yield, information important in prehistory or history.

***Current Conditions***

The area has been inhabited by humans for approximately 10,000 to 12,000 years. Early inhabitants are characterized as Paleo-Indian hunters of big game, followed by small-game hunters and gatherers, Ute, and eventually Euroamerican settlement. Detailed summaries of the Units prehistoric and historic past can be found in the UFO Class I Cultural Resource Overview (Greubel et al. 2010), the Northern Colorado River Basin regional prehistoric archaeological context (Reed and Metcalf 1999), and the Colorado historical archaeology context (Church et al. 2007). Current land uses within the Unit include cattle and sheep grazing, oil and gas exploration, and residential development.

As of May 14, 2013, 25 cultural resource investigations have been conducted within the Unit covering 600 acres (less than 1 percent) of the Unit. Of these, 20 were related to the oil and gas development in the area, 4 were related to federal management or exchange, and 1 was related to Natural Resource Conservation Service funding. These inventories resulted in the identification of five archaeological sites and five isolated artifacts. The archeological sites include a historic ranch, three historic roads, and one historic trash dump with a prehistoric lithic scatter. Of these, only the ranch and one historic road are considered significant resources. Although very few previous surveys have been conducted in the Unit, those inventories show that cultural resources are limited.

As part of a larger UFO RMP, a cultural resource sensitivity model of the North Forth Land Unit of the UFO Management area was developed (**Figure 3-17**, North Fork Landscape Unit Prehistoric Site Sensitivity Model; Greubel et al. 2010). The model used existing environmental and cultural data across the UFO management area to extrapolate the potentiality of cultural resources in areas not yet inventoried. The Unit is within this model area, and the analysis can be




Bull Mountain Unit
Low-medium
Low
Very low

**North Fork Landscape Unit Prehistoric Sensitivity Model**

Source: Alpine Archaeological Consultants, Inc. 2013

Figure 3-17

used to characterize the likely cultural resources within the Unit as a whole. Based on mathematical probabilities used in the model, 88 percent of the Unit has very low to low potential for prehistoric cultural sites. None of the Unit has a medium or high likelihood of prehistoric cultural resources, but 12 percent of the Unit is characterized as Low-Medium sensitivity.

In order to gain further insight into prehistoric site distributions and densities within the Unit more specifically, a Class II cultural resource inventory was conducted by Alpine Archaeological Consultants, Inc. in the spring of 2013 (Millward 2013). Of the 840 acres inventoried, roughly half were in Low-Medium sensitivity areas, with the remainder in Low and Very Low areas. The sample-oriented inventory resulted in the recordation of one new site and three isolated finds, all found within the Low-Medium areas. This inventory validated the model expectations; few to no prehistoric sites are expected to exist in the vast majority of the Unit. It is likely that travel in the area was restricted by the geographic features and thick vegetation, thus limiting prehistoric human use to ephemeral activities and resulting in fewer artifacts and features than might typically be expected.

Historic use of the area appears to be more common and includes roads and small ranch settings. Historic research shows that the Unit was homesteaded from 1916 to 1936, with stock raising as a clear focus. There is most certainly evidence of small, historic homesteading efforts in the Unit; based on available records, there were likely approximately 50 residential areas with structures within the entire Unit in the 1920s and 1930s. A few of those homesteads grew and consolidated into larger ranches, with some complexes still occupied today. Most were isolated structures that were abandoned and lie in ruins. Although historic homestead and ranch activities are likely still evident on the landscape, the relative frequency of homesteads, transportation corridors, ditches, and trash dumps are low.

Although the Unit has been occupied for more than 10,000 years, the evidence of those occupations occurs at a very low frequency. The relatively ephemeral occupations coupled with dense vegetation and rugged terrain result in very few cultural resources in the Unit.

***Trends***

Factors influencing cultural resource trends include the presence and condition of cultural sites, which are very difficult to evaluate. In general, downward trends in cultural resources directly relate to impacts, which alter the integrity and physical condition of the resource, while upward trends relate to the identification or creation of new sites.

In general, site conditions are considered to be declining due to natural erosional processes, increased casual use, increased development, and a general lack of protection. Exposed sites and associated artifacts, features, and structures are easily disturbed by natural elements such as wind and water erosion, deterioration, decay, animal and human intrusion, and development and maintenance activities. Vandalism of sites and cultural artifacts, such as illicit surface collecting, unauthorized digging, and pot hunting, is also a factor. Archaeological and historic sites are also known to be deteriorating from a variety of causes.

As time passes, additional cultural resources are being discovered, which appears as a positive trend. As development increases, more Section 106 studies are required. The results of those studies are the likely discovery of previously unknown sites. However, these new discoveries do not constitute newly created resources, merely newly discovered ones. The discoveries add to the knowledge base but are not truly additions to the body of resources in existence.

Cultural resources are defined as objects or locations more than 50 years old. As long as the definition remains based on the age of the items, as time passes the trend is toward increasing numbers of (relatively recent) cultural resources.

### 3.2.13 Paleontological Resources

Paleontology is the study of prehistoric life, its evolution, and its interaction with the environment (paleoecology). The term paleontological resources, as used by the BLM, includes any fossilized remains or traces of organisms that are preserved in or on Earth's crust, are of scientific interest, and provide information about the history of life. Paleontological resources, whether invertebrate, plant, trace, or vertebrate fossils, constitute a fragile and nonrenewable record of the history of life on our planet. The BLM's policy is to manage paleontological resources for scientific, educational, and recreational values (e.g., hobby collecting of invertebrate fossils and petrified wood) and to protect these resources from adverse impacts. To accomplish this goal, paleontological resources must be professionally identified and evaluated, and paleontological data should be considered as early as possible any decision-making process.

Paleontological resources are integrally associated with the geologic rock units (formations, members, or beds) in which they are preserved, and the probability for finding paleontological resources can be broadly predicted from the geologic units present at or near the surface. Therefore, geologic mapping paired with the BLM's Potential Fossil Yield Classification (PFYC) system can be used for assessing the occurrence potential of paleontological resources.

Paleontological resources are managed according to the BLM Manual Section 8270, Paleontological Resource Management, BLM Handbook H-8270-1, General Procedural Guidance for Paleontological Resource Management, and applicable BLM instructional memoranda and bulletins. It should be noted that additional protection measures have now been enacted under the Omnibus Public Lands Act of 2009 (123 Stat. 1174 Public Law 111–11, Subtitle D), giving paleontological resources protection under law. The BLM is currently developing regulations to implement the requirements of this law.

Recent BLM guidance (Instruction Memorandum 2008-009, PFYC system for Paleontological Resources on Public Lands [BLM 2007b]) defines a new classification system for the classification of paleontological resources, the PFYC system. This system is intended to provide a uniform tool to assess potential occurrences of paleontological resources and to allow evaluation of potential impacts on these resources. It is intended to be applied in broad approach for programmatic efforts and as an intermediate step in evaluating specific projects.

#### *Potential Fossil Yield Classification System*

The potential for paleontological resources is currently identified using two indicators: The BLM Fossil Class Condition system, and the newer PFYC system. While the older BLM Fossil Class Condition system has been used extensively in the past, recent BLM guidelines encourage use of the more precise PFYC system.

In the PFYC system, geologic units are classified from 1 (no potential for significant fossils) to 5 (very high occurrence of significant fossils) based on the relative abundance of vertebrate fossils or significant invertebrate or plant fossils and their sensitivity to adverse impacts.[2] This classification is applied to the geologic formation, member, or other distinguishable unit, preferably at the most detailed mappable level. It is not applicable to specific paleontological localities or small areas within units. While widely scattered fossils or localities may occur within a geologic unit, the relative abundance of significant localities determines the class assignment. The BLM in Colorado has classified rock units both statewide and by BLM region (Trujillo 2010).

The PFYC system is meant to provide baseline guidance for predicting, assessing, and mitigating paleontological resources. The classification should be considered at an intermediate point in the analysis, and should be used to assist in determining the need for further assessment and/or mitigation actions. Descriptions of the PFYC classes can be found in BLM Instruction Memorandum 2008-009 (BLM 2007b).

***Current Conditions***

Surface exposures of potentially fossil-bearing rock within the project area consist of a large number of lithologic types and ages, and they range in age from Pennsylvanian (318 to 299 million years ago) to Quaternary (2.6 million years ago to present; Green 1992). The majority of this rock was deposited during the Mesozoic Era, though older (e.g., Pennsylvanian) and younger (e.g., Tertiary) rocks are exposed.

**Table 3-33**, Sedimentary Rock Units, Their Fossil-bearing Potential, and Known Fossil Resources, lists the potentially fossil-bearing rock units in the project area in stratigraphic order (from oldest at bottom to youngest at top), their PFYC category, and the known fossil resources from each unit both in general and specifically in the project area. The distribution of PFYC categories across the project area is displayed in **Figure 3-18**, Potential Fossil Yield Classification. However, there are few areas of exposed rock outcrops or strata and no known localities within the project area.

***Trends***

Qualitative observation indicates that the condition has remained stable for paleontological resources protected or mitigated through the permitting process and other standard operating procedures, such as pre-disturbance clearance, associated with federal management actions. In these cases, the trend has been toward conservation. For resources not associated with direct management actions, the trend has been slightly downward. The primary contributors to this trend include unauthorized collection of fossils, limited law enforcement resources, and ground disturbance associated with recreational activities.

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[2] PFYC 1 – very low potential for recognizable fossil remains; PFYC 2 – low potential for vertebrate fossils or scientifically significant nonvertebrate fossils; PFYC 3 – moderate potential where fossil content varies in significance, abundance, and predictable occurrence, or unknown fossil potential; PFYC 4 – high occurrence of significant fossils; PFYC 5 – very high occurrence that consistently and predictably produce fossils. Source: BLM WO Instruction Memorandum 2008-009 (http://www.blm.gov/wo/st/en/prog/more/CRM/paleontology/paleontological_regulations.html)

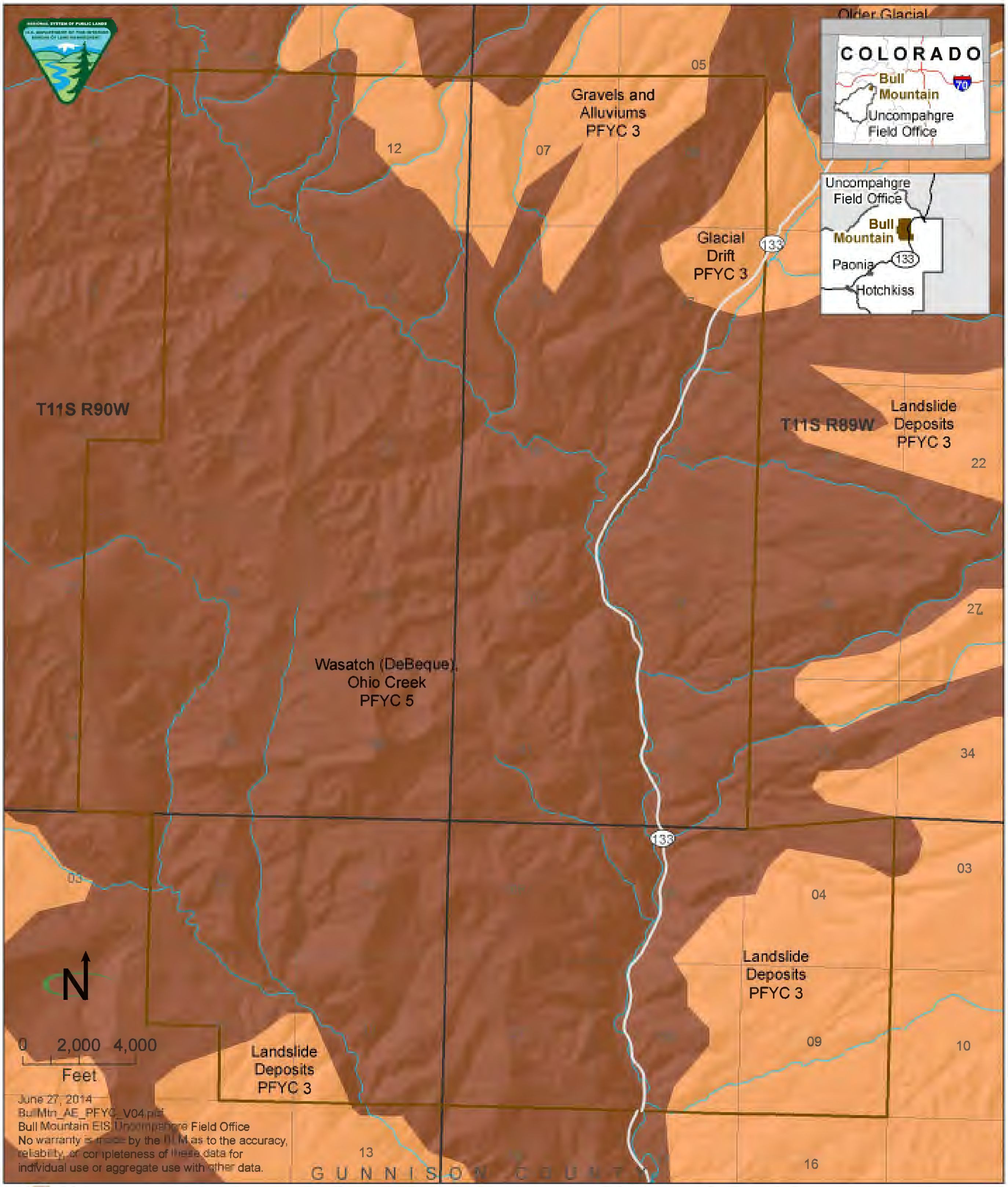
**Table 3-33**
**Sedimentary Rock Units, Their Fossil-bearing Potential, and Known Fossil Resources**

| Geologic Age | Group | Formation | Member | PFYC Rating | Known Fossil Resources | Known Fossil Resources in Project Area |
|---|---|---|---|---|---|---|
| Quaternary | | unconsolidated sediments | | 3 | Pleistocene mammals | Mammoth teeth, camel, horse, rodents |
| Eocene | | Uinta Formation | | 3 | mammals | none known |
| Eocene | | Green River Formation | Parachute Creek Member | 3 | fish, bats, birds, mammals | none known |
| Paleocene-Eocene | | Wasatch Formation | | 3 | mammals, reptiles, invertebrates | none known |
| Upper Cretaceous | Mesa Verde | Hunter Canyon Formation<br>Mt. Garfield Formation<br>Sego Sandstone | | 3 | dinosaurs, mammals, reptiles, fish | none known |
| Upper Cretaceous | | Mancos Shelf | | 3 | marine reptiles, invertebrates, shark teeth, wood | mosasaur, invertebrates, wood |
| Lower Cretaceous | | Dakota Formation | | 3 | invertebrates, plants, tracks, mammals | none known |
| Lower Cretaceous | | Burro Canyon Formation | | 3 | dinosaurs, tracks, plants | theropod dinosaur, fish scales, plants, invertebrates |
| Upper Jurassic | | Morrison Formation | Brushy Basin Member | 4-5 | dinosaurs, mammals, pterosaurs, lizards, amphibians, sphenodonts, crocodiles, turtles, fish, invertebrates | dinosaurs, mammals, pterosaurs, lizards, amphibians, crocodiles, turtles, fish, invertebrates |
| Middle Jurassic | San Rafael | Wanakah Formation | | 4-5 | fish, plants, trace fossils, invertebrates | Hadrodon (bivalve) |
| | | | Salt Wash Member | 4-5 | dinosaurs, crocodiles, turtles, invertebrates | dinosaurs, crocodiles, turtles, invertebrates |
| | | Entrada Sandstone | | 3 | dinosaur tracks | none known |
| Lower Jurassic | Glen Canyon | Navajo Sandstone | | 3 | dinosaur tracks, rare dinosaur skeleton | none known |
| | | Kayenta Formation | | 3 | dinosaurs, dinosaur tracks | none known |
| | | Wingate Sandstone | | 3 | dinosaur tracks | theropod tracks |

**Table 3-33**
**Sedimentary Rock Units, Their Fossil-bearing Potential, and Known Fossil Resources**

| Geologic Age | Group | Formation | Member | PFYC Rating | Known Fossil Resources | Known Fossil Resources in Project Area |
|---|---|---|---|---|---|---|
| Lower Triassic | | Chinle Formation | | 5 | Phytosaurs, aetosaurs, dinosaurs, lizards, lungfish, invertebrates | none known |
| Lower Triassic | | Moenkopi Formation | | 3 | tracks, invertebrates | plants |
| Pennsylvanian-Permian | | Cutler Formation | | 3-4-5 | amphibians, synapsids, reptiles, invertebrates | Fish, large amphibians, microsaurian amphibians, various reptiles, plants |
| Pennsylvanian | | Hermosa Formation | | | none known | none known |

Sources: Trujillo 2010; Batten and Stokes 1986; Breithaupt 1985; Foster 2007; Irmis 2005; Kass 1999; Kurten and Anderson 1980; Lillegraven and McKenna 1986; Lockley and Hunt 1995; Merewether et al. 2006; O’Sullivan et al. 2006; Roehler 1992; Schoch 1986; Sertich and Loewen 2010; Turner and Peterson 1999; Untermann and Untermann 1964; Vaughn 1962, 1964; Weiscampel 1990




Bull Mountain Unit

PFYC 5 very high fossil occurrence that consistently and predictably produce fossils

PFYC 4 high occurrence of significant fossils (none)

PFYC 3 moderate potential where fossil content varies in significance, abundance, and predictable occurrence, or unknown fossil potential

**Potential Fossil Yield Classification**

Source: BLM GIS 2014

PFYC 2 low potential for vertebrate fossils or scientifically significant nonvertebrate fossils (none)

PFYC 1 very low potential for recognizable fossil remains (none)

Figure 3-18

### 3.2.14 Visual Resources

Visual resources refer to the visible features (e.g., land, water, vegetation, animals, and structures) on a landscape. These features contribute to the scenic or visual quality and appeal of the landscape. Visual impact is the creation of an intrusion or perceptible contrast that affects the scenic quality of a landscape. A visual impact can be perceived by an individual or group as either positive or negative, depending on a variety of factors or conditions (e.g., personal experience, time of day, and weather or seasonal conditions; BLM 1984).

*Visual Resource Management System*

The BLM Visual Resource Management (VRM) system is a way to identify and evaluate these scenic values in order to determine appropriate levels of management. VRM is a tool to identify and map essential landscape settings to meet public preferences and recreational experiences today and into the future. The VRM system helps to ensure that actions taken on BLM-administered lands today will benefit the visual qualities associated with the landscapes, while protecting these visual resources for years to come.

*Visual Resource Inventory*

Visual resource inventory (VRI) involves identifying the visual resources of an area and assigning them to inventory classes using the BLM's resource inventory process. The process involves rating the visual appeal of a tract of land (Scenic Quality Evaluation), measuring public concern for scenic quality (Sensitivity Level Analysis), and determining whether the tract of land is visible from travel routes or observation points (Delineation of Distance Zones). Based on these three inventory components, lands are placed into one of four VRI classes. These class assignments are informational and provide the basis for considering visual values during the RMP process. They do not establish management direction and are not used as a basis for constraining or limiting surface-disturbing activities but are considered a baseline for existing conditions. This process is described in detail in BLM Handbook H-8410-1, Visual Resource Inventory (BLM 1986a).

*Visual Resource Management*

The assignment of VRM classes is ultimately based on management decisions made during the RMP process, which must take into consideration the value of visual resources. During the process, inventory class boundaries can be adjusted as necessary to reflect these resource allocation decisions. The goal of VRM is to minimize the visual impacts of all surface-disturbing activities, regardless of the class to which an area is assigned. Objectives for each of the four Visual Resource Classes are as follows:

Class I. The objective of this class is to preserve the existing character of the landscape. This class provides for natural ecological changes; however, it does not preclude very limited management activity. The level of change to the characteristic landscape should be very low and must not attract attention.

Class II. The objective of this class is to retain the existing character of the landscape. The level of change to the characteristic landscape should be low. Any changes must repeat the basic elements of form, line, color, and texture found in the predominant natural features of the characteristic landscape.

Class III. The objective of this class is to partially retain the existing character of the landscape. The level of change to the characteristic landscape should be moderate. Management activities may attract attention but should not dominate the view of the casual observer. Changes should repeat the basic elements found in the predominant natural features of the characteristic landscape.

Class IV. The objective of this class is to provide for management activities that require major modification of the existing character of the landscape. The level of change to the characteristic landscape can be high. These management activities may dominate the view and be the major focus of viewer attention. However, every attempt should be made to minimize the impact of these activities through careful location, minimal disturbance, and repeating the basic elements.

The analysis of a visual contrast rating process is used to resolve visual impacts. The process of a visual contrast rating, which involves comparing the project features with the existing landscape features using basic elements of form, line, color, and texture, is described in detail in BLM Handbook H-8431-1, Visual Resource Contrast Rating (BLM 1986b).

***Current Conditions***

The project area encompasses the rolling foothills to the northwest of the Ragged Mountain range, which holds a highly diverse landscape with a high amount of visual variety. Vertical relief is present, with high, rolling hills and fairly steep slopes. It is substantially natural in character, with few human intrusions creating a visual imprint on the land. The vegetation is vibrant and healthy, displaying as much or more diversity than seen in comparable areas in the west, resulting in brilliant seasonal color variation. Numerous shrub species thrive with open meadows weaving in between large stands of woodlands comprised of aspen, juniper, and oak, along with a few groups of coniferous trees. The viewshed is mostly open and exposed as the traveler comes down McClure Pass, moving west along State Highway 133. As the highway begins to drop, the viewshed begins to narrow and is limited by the valley walls of Muddy Creek and the North Fork of the Gunnison River.

State Highway 133 and County Road 265 serve as the two primary travel routes in the project area. The West Elk Loop Scenic Byway passes through the project area on State Highway 133 and connects the towns of Carbondale, Hotchkiss, Crawford, Gunnison, Crested Butte, among others. This route also provides access to the White River and Gunnison National Forests, the Black Canyon of the Gunnison National Park, Gunnison Gorge National Conservation Area, Curecanti National Recreation Area, and Crawford and Paonia State Parks. County Road 265 has less traffic and is primarily used for local use with some regional access. This road follows a drainage, which limits its viewshed to the immediate foreground due to the topography.

The proposed facilities in the project area occur on a mixture of private surface/private minerals, private surface/federal minerals (split-estate), and federal surface/federal minerals. While VRM objectives do not apply to non-BLM-administered lands, visual concerns may be addressed on split-estate where federal minerals occur.

A VRI of the UFO was completed in September 2009 according to guidelines in BLM Manual Handbook H-8410-1, Visual Resource Inventory (BLM 1986a) and the project area was included as part of that inventory. While not yet incorporated into the current RMP, this data is the most recent and comprehensive data available for visual resources within the project area.

Information for each of the three VRI components, as they pertain to the project area, is as follows:

Scenic Quality Evaluation: The project area is within the Bull Mountain, Paonia Reservoir, and Deep Creek Scenic Quality Rating Units of the VRI. Landform, water, vegetation, and structures were reviewed and described in the context of form, line, color, and texture as part of the VRI. In addition, landform, vegetation, water, color, adjacent scenery, scarcity, and cultural modifications were rated. The three Scenic Quality Rating Units received a Class A scenic quality rating, indicating a high and unique scenery value. The Scenic Quality Rating Units were given this rating due to the variety and seasonal color variation of vegetation, the adjacent scenery provided by the Ragged Mountain Range as well as the presence of flowing water. The rating documentation also notes that these Scenic Quality Rating Units provide a very diverse and vibrant vegetative community, considerable visual variety in terms of color, and that it is a very scenic landscape.

Sensitivity Level Analysis: The project area is within the Bull Mountain, Paonia Reservoir, and Deep Creek Sensitivity Level Rating Units. Although the Deep Creek Sensitivity Level Rating Unit received a rating of medium for sensitivity, the Bull Mountain and Paonia Reservoir Sensitivity Level Rating Units (97 percent of the project area) received a rating of high for sensitivity. During the VRI, it was noted that a high sensitivity rating involved a high public sensitivity to preserving the rural character and open space of the area, as well as the presence of the West Elk Loop Scenic Byway, and the volume of tourist traffic and visitor use. The area attracts the notice of conservation groups concerned about energy development.

Delineation of Distance Zones: The project area is all within the foreground/middleground distance zone (0 to 5 miles), which means the landscape can readily be seen and experienced from a major travel route or point. The primary travel routes are State Highway 133 and County Road 265.

The scenic quality evaluation, sensitivity level analysis, and distance zone delineation combine to rate the project area as VRI Class II. Under the RMP, however, all BLM-administered land within the project area is rated as VRM Class III.

*State and Local Plans*

The Delta County Master Plan. This plan notes the presence of the West Elk Loop Scenic Byway and the protection and interpretation of the cultural heritage and natural resources in the area. The Delta County Master Plan states the following goal:

> The preservation of the rural lifestyle and landscape, which includes the natural environment and unique physical characteristics of Delta County. Natural resources associated with the rural landscape include open space and scenic viewsheds, and includes a desired strategy to map the significant physical features and environmental characteristics of the County, such as important scenic viewsheds.

The Town of Paonia State Highway 133 Corridor Master Plan. This plan states as a goal that, "The open scenic character of the West Elk Scenic Byway shall be protected." It states that new development should not detract from the rural qualities of the highway corridor and Paonia's small-town character.

***Trends***

The landscape in the Unit is experiencing a high degree of human modification due to energy development occurring on private lands. This type of development includes strips of land lacking vegetation for access roads, artificial structures associated with energy development and transmission infrastructure, and commotion from operating and maintaining energy development sites.

## 3.3 RESOURCE USES

This section contains a description of the human uses of resources in the project area and follows the order of topics addressed in **Chapter 2**:

- Livestock grazing
- Minerals (leasable, locatable, salable)
- Recreation
- Lands and realty
- Transportation and access

### 3.3.1 Livestock Grazing

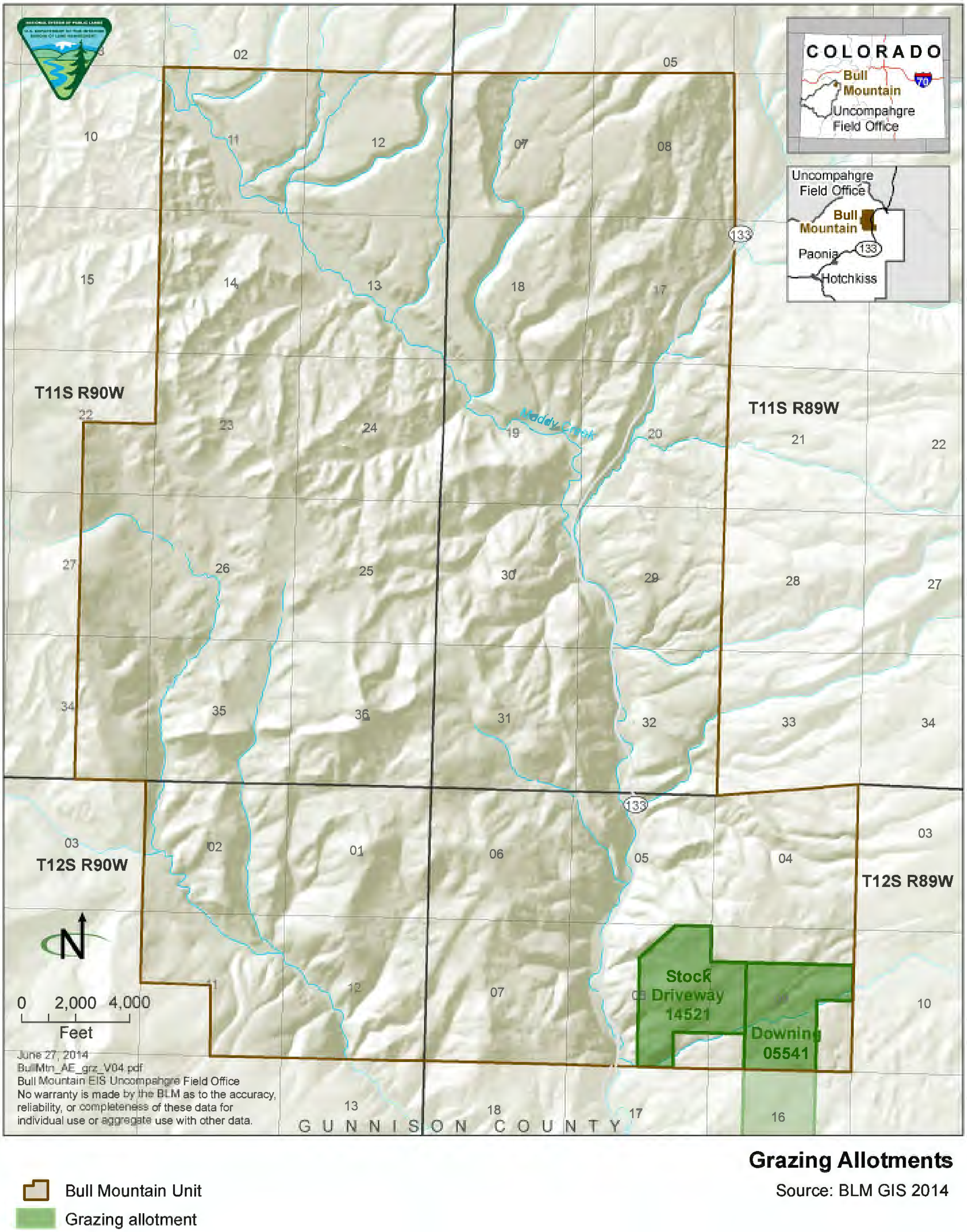
***Regulatory Environment***

The BLM manages grazing under the authority of the Taylor Grazing Act of 1934, the FLPMA, and the Public Rangelands Improvement Act of 1978. Under this management, ranchers may obtain permits for an allotment of public land on which a specified number of livestock may graze. The number of permitted livestock on a particular allotment is determined by how many animal unit months that land will support.

The BLM operates a program to stabilize or improve the ecological condition of the allotments in compliance with the Colorado Standards for Public Land Health and Guidelines for Livestock Grazing Management. Standards are expressions of physical and biological condition or the degree of function required for healthy land, and they define minimum resource conditions that must be achieved or maintained.

***Current Conditions***

Until recently, this area sustained very high levels of both sheep and cattle grazing. Larger ranches within the Unit still host both cattle and sheep grazing, but sheep grazing is mostly limited to ranches at the northern end of the Unit (**Figure 3-19**, Grazing Allotments). **Table 3-34,** Ranches and Allotments within the Bull Mountain Unit, below lists private landholdings and BLM grazing allotments within the Unit.




**Grazing Allotments**

Source: BLM GIS 2014

Figure 3-19

**Table 3-34**
**Ranches and Allotments within the Bull Mountain Unit**

| Name | Acreage *(if available)* | AUMs | Class of Livestock | Season of Use |
|---|---|---|---|---|
| **BLM Allotments** | | | | |
| Stock Driveway | 340 | 32 | Cattle | Summer |
| Downing | 280 | 27 | Cattle | Summer |
| McIntyre Livestock Co. | na | 200 | Sheep | Spring/Fall |
| **Private Ranches** | | | | |
| Sperry | na | 200 | Sheep | Spring/Fall |
| Rock Creek Ranch (McIntyre) | na | 315 | Cattle | Summer/Fall |
| Jacobs Ranch | 2,000 | 225 | Cattle | Summer/Fall |
| Falcon Seaboard Ranch | na | na | Cattle | Summer |
| Aspen Leaf | na | na | Sheep and Cattle | Spring/Summer/Fall |
| Hotchkiss | na | na | Sheep and Cattle | Spring/Summer/Fall |

Source: BLM GIS 2014, needs source for AUMs
AUM = animal unit month
na = not available

Federal landholdings are limited in the Unit and only two grazing allotments are present in the southeast corner of the unit, Stock Driveway and Downing. These allotments are partially on BLM-administered and partially on private land (BLM 2007 - North Fork Land Health Assessment). The allotment portions on BLM-administered land are generally meeting land health standards (BLM 2007).

The McIntyre Livestock Company (which previously owned Rock Creek Ranch) once ran 20 bands of sheep (a band is 1,000 sheep) in this area. Currently, McIntyre Livestock runs one band, and another rancher (Sperry) runs one band northeast of this area. In addition, seasonal cattle grazing occurs in this area, and a grazing permit is leased back to McIntyre Livestock for grazing on the Rock Creek Ranch. On the Rock Creek Ranch, McIntyre Livestock runs 173 cow-calf pairs in one area and 134 pairs in another, plus 10 heifers. The grazing season is highly variable depending on weather, but in general is from June through early December. Rock Creek Ranch itself does not own cattle at this time.

The Jacobs Ranch is located at the eastern side of the Unit and is a working cattle ranch. This ranch supports a cow-calf operation, with grazing occurring from May 15th through December. A maximum of 225 cow-calf pairs graze on 2,000 acres of pasture. Cattle start the early season on south-facing slopes north of State Highway 133, and in mid-July are moved south of State Highway 133. No cattle are grazed during the winter and spring months on the ranch. Irrigation starts around the end April or early May, and ends in late August to early September. Meadows are hayed for grass-hay production.

The Falcon Seaboard Ranch was consolidated from several smaller ranches in 1990 and was purchased by Falcon Seaboard in its current configuration in 1996. Prior to 1996 the ranch was used for both cattle and sheep grazing, but currently only sees cattle grazing. The ranch supports both a cow/calf and yearling calf operation. Yearlings are brought on (via stock trucks) in early May and grazed through the summer to early September. Cows and nursing calves are trucked to the ranch in early June and come off in early October. No cattle are grazed during the winter and spring months on the ranch. Irrigation of meadows starts around the end of April or early May, and ends in late August to early September. Meadows are hayed for grass-hay production.

Other large ranches in the Unit include the Sperry, Aspen Leaf, and Hotchkiss ranches, all of which support cow/calf and yearling calf operations as well as sheep grazing. Sheep generally graze the ranches in the spring, and are moved onto summertime allotments on National Forest System lands on the Grand Mesa Uncompahgre and Gunnison and White River National Forests. They are trailed back down onto the ranches in the late fall, where they graze on upland meadows, and on irrigated hay fields post-haying. All sheep are generally trucked out of the Muddy Creek basin by early November for market. On the Hotchkiss Ranch, a small herd of sheep (around 30) persists through the summer on the ranch.

Along the State Highway 133 corridor, from the intersection of State Road 265 and south, there is a lack of widespread large ranches, but cattle are often wintered on the lower-elevation meadows near Muddy Creek. Subdivisions and smaller lot sizes have decreased the connectivity of larger ranches, and less cattle grazing occurs. Further, the steeper topography and drier climate reduce grazing opportunities at the southern end of the Unit.

Despite the extremely high grazing pressure in the past, the area has a very good distribution of grasses and forbs in the understory of the sagebrush and Gambel's oak habitat types. Within the general area, aspen stands and various increaser species of plants indicate high long-term grazing pressure. These increasers include skunk cabbage (*Veratrum tenuipetalum*), tall larkspur (*Delphinium barbeyi*), tarweed (*Madia glomerata*), and sneezeweed (*Helenium autumnale*). Notable evidence of habitat degradation from past and current grazing was not apparent during a site visit. The dense stands of Gambel's oak are too thick to be greatly utilized by livestock.

Substantial elk wintering activity can also occur on ranches with elk winter ranges (e.g., lower-elevation, south- and west-facing slopes), such as the Jacobs Ranch. Some mule deer wintering range is also present in the project area.

***Trends***

Past livestock grazing on the Unit was heavier than currently practiced, with use levels up to 20 times higher than current use maintained in the area. Currently, 7 private ranches and 2 BLM grazing allotments operate in the unit at a capacity of approximately 1,000 animal unit months. Livestock grazing trends in the project area appear stable at the present time, though with increasing human population and associated development, grazing may experience some decline in the near future.

### 3.3.2 Minerals (Leasable, Locatable, Salable)

Except for gas and coal resources, no fluid or solid leasable minerals or locatable minerals are known to exist within the Unit. As discussed under Section 3.2.5, Geology, coal can be found at depths of 6,000 to 10,000 feet. In the Uncompahgre RMP (1989), coal potential is based on a maximum development depth of about 2,000 feet, and the revised RMP (ROD expected in 2015) is proposing to expand that depth to 3,000 feet. As such, coal resources are not considered a viable resource in the Unit and no impact on coal is expected from the proposed project. There is potential for minor occurrences of mineral materials; however, there are no operations and no county free use permits within the Unit. No impact on mineral materials is expected from the proposed project.

***Fluid Leasable Minerals – Gas***

In the Unit, the Mesa Verde Group in the Piceance Basin has gas potential for conventional gas in sandstone units, coal bed methane gas within its coal seams, and shale gas resources in sedimentary strata associated with the Mancos Shale. The hydrocarbon production in this area has been natural gas with very little condensate[3] and no associated oil. For this reason, only natural gas production will be discussed in the remainder of this section.

As of 2010, wells in the North Fork area had produced over 3 billion cubic feet of gas. The bulk of the gas production in this area is from upper Cretaceous sandstone reservoirs in the Mesa Verde Group within the greater Piceance Basin. Primary targets for drilling in the Mesa Verde group include the Cozzette and Corcoran Sandstone members found within the Mount Garfield (or Iles) Formation.

In addition, a high potential exists for the occurrence of coalbed natural gas in the Mesa Verde Group. The South Canyon Coal and Cameo Coal units within the Williams Fork Formation are targets within this group. Producers are also exploring potential sources of shale gas within the Mancos shale (BLM 2012).

Additional formations within the Cenozoic zone contain natural gas production potential but have not yet been productive (BLM 2012). According to Colorado State historic records, 116 gas wells have been drilled in the North Fork area on federally managed oil and gas leases, including split-estate lands. Of these wells, 15 are currently producing, 29 are shut-in but capable of production, and 72 have been drilled, abandoned, and plugged (BLM 2011).

*Current Conditions*

Oil and gas leasing in the Unit is guided by the Uncompahgre RMP (1989), which is currently being revised (ROD expected in 2015). According to the RFD prepared in support of the ongoing RMP revision, the Unit is located in an area identified as having High occurrence potential (BLM 2012). Mineral production within the Unit is limited to natural gas wells developed by SGI and one natural gas well developed by Gunnison Energy Corporation. SGI owns and operates 11 fee/fee and 5 federal natural gas wells on 13 well pads, and one additional well pad housing a water-disposal well. Gunnison Energy Corporation owns and operates 1 fee/fee natural gas well within the Unit project area. **Table 2-5**, Bull Mountain Unit Annual Production Rates, provides annual gas and water production data. Additionally, **Table 3-35**, Bull Mountain Unit Existing Facilities, presents the existing facilities in the Unit.

[3] Of SGI's 13 producing wells, 6 made condensate. Of these 6 wells, 2 produce salable quantities and the remaining 4 produce between 0 and 6 barrels per month. The 2 wells that produce condensate have had average sales of 98 and 20 barrels of condensate per month.

**Table 3-35**
**Bull Mountain Unit Existing Facilities**

| Facility Type | Facility Name/Number | Operator Name/Number | Status | Field Name/Number | Location |
|---|---|---|---|---|---|
| Well | McIntyre 11-90-11 #3 | SG Interests I LTD 77330 | Abandoned Location | Wildcat 99999 | Gunnison Co. T.11S, R. 90W, 11, NWSW |
| Location | McIntyre-611S90W 11NWSW | SG Interests I LTD 77330 | Abandoned Location | Wildcat 99999 | Gunnison Co. T.11S, R. 90W, 11, NWSW |
| Well | McIntyre 11-90-11 1 | SG Interests I LTD 77330 | Abandoned Location | Wildcat 99999 | Gunnison Co. T.11S, R. 90W, 11, SENW |
| Location | McIntyre 11-90-11-611S90W 11SENW | SG Interests I LTD 77330 | Abandoned Location | Wildcat 99999 | Gunnison Co. T.11S, R. 90W, 11, SENW |
| Location | Falcon Seaboard 11-90-11-611S90W 11SESE | SG Interests I LTD 77330 | Active | Wildcat 99999 | Gunnison Co. T.11S, R. 90W, 11, SESE |
| Well | Falcon Seaboard 11-90-11 2 | SG Interests I LTD 77330 | Producing | Bull Mountain 7815 | Gunnison Co. T.11S, R. 90W, 11, SESE |
| Well | Falcon Seaboard 11-90-12 2 | SG Interests I LTD 77330 | Producing | Ragged Mountain 71430 | Gunnison Co. T.11S, R. 90W, 12, NWNE |
| Location | Falcon Seaboard 11-90-12-611S90W 12NWNE | SG Interests I LTD 77330 | Active | Ragged Mountain 71430 | Gunnison Co. T.11S, R. 90W, 12, NWNE |
| Location | Falcon Seaboard 11-90-12-N11S90W 12SWNW | SG Interests I LTD 77330 | Active | Ragged Mountain 71430 | Gunnison Co. T.11S, R. 90W, 12, SWNW |
| Location | Falcon Seaboard - 611S90W 12SWNW | SG Interests I LTD 77330 | Active | Wildcat 99999 | Gunnison Co. T.11S, R. 90W, 12, SWNW |
| Well | Falcon Seaboard 11-90-12 #1A | SG Interests I LTD 77330 | Shut in | Bull Mountain 7815 | Gunnison Co. T.11S, R. 90W, 12, SWNW |
| Well | Falcon Seaboard 11-90-12 1 | SG Interests I LTD 77330 | Producing | Ragged Mountain 71430 | Gunnison Co. T.11S, R. 90W, 12, SWNW |

**Table 3-35**
**Bull Mountain Unit Existing Facilities**

| Facility Type | Facility Name/Number | Operator Name/Number | Status | Field Name/Number | Location |
|---|---|---|---|---|---|
| Well | Falcon Seaboard 11-90-12 4 | SG Interests I LTD 77330 | Abandoned Location | Wildcat 99999 | Gunnison Co. T.11S, R. 90W, 12, SWNW |
| Lease | Falcon Seaboard 11-90-12 1 | SG Interests I LTD 77330 | Shut in | Wildcat 99999 | Gunnison Co. T.11S, R. 90W, 12, SWNW |
| Well | McIntyre 11-90-14 1 | SG Interests I LTD 77330 | Producing | Ragged Mountain 71430 | Gunnison Co. T.11S, R. 90W, 14, NWSW |
| Location | McIntyre 11-90-14-611S90W 14NWSW | SG Interests I LTD 77330 | Active | Ragged Mountain 71430 | Gunnison Co. T.11S, R. 90W, 14, NWSW |
| Pit | McIntyre Flowback Pits 2 | SG Interests I LTD 77330 | | Ragged Mountain 71430 | Gunnison Co. T.11S, R. 90W, 23, NESE |
| Location | McIntyre Flowback Pits 1 & 2 | SG Interests I LTD 77330 | Active | | Gunnison Co. T.11S, R. 90W, 23, NESW |
| Well | RC Fed 11-90-23 2 | SG Interests I LTD 77330 | XX (Location) | Bull Mountain 7815 | Gunnison Co. T.11S, R. 90W, 23, SESW |
| Location | Rock Creek 11-90-23 1 | SG Interests I LTD 77330 | Active | | Gunnison Co. T.11S, R. 90W, 23, SESW |
| Well | Rock Creek 11-90-23 1 | SG Interests I LTD 77330 | XX (Location) | Bull Mountain 7815 | Gunnison Co. T.11S, R. 90W, 23, SESW |
| Location | Federal 11-90-24 #3 | SG Interests I LTD 77330 | Active | | Gunnison Co. T.11S, R. 90W, 24, Lot 4 |
| Well | Federal 11-90-24 3 | SG Interests I LTD 77330 | XX (Location) | Bull Mountain 7815 | Gunnison Co. T.11S, R. 90W, 24, Lot 4 |
| Location | Federal 11-90-24-11S90W 24NWSE | SG Interests I LTD 77330 | Active | Ragged Mountain 71430 | Gunnison Co. T.11S, R. 90W, 24, NWSE |
| Well | Federal 11-90-24 1 | SG Interests I LTD 77330 | Producing | Bull Mountain 7815 | Gunnison Co. T.11S, R. 90W, 24, NWSE |

**Table 3-35**
**Bull Mountain Unit Existing Facilities**

| Facility Type | Facility Name/Number | Operator Name/Number | Status | Field Name/Number | Location |
|---|---|---|---|---|---|
| UIC Disposal | Federal 24-2 WDW | SG Interests I LTD 77330 | Active | Wildcat 99999 | Gunnison Co. T.11S, R. 90W, 24, NWSW |
| Well | Federal 24-2 WDW | SG Interests I LTD 77330 | Injecting | Bull Mountain 7815 | Gunnison Co. T.11S, R. 90W, 24, NWSW |
| Location | Federal -611S90W 24NWSW | SG Interests I LTD 77330 | Active | Wildcat 99999 | Gunnison Co. T.11S, R. 90W, 24, NWSW |
| Location | Federal 24SWNE | SG Interests I LTD 77330 | Active | Bull Mountain 7815 | Gunnison Co. T.11S, R. 90W, 24, SWNE |
| Well | Federal 11-90-24 #1A | SG Interests I LTD 77330 | Producing | Bull Mountain 7815 | Gunnison Co. T.11S, R. 90W, 24, SWNE |
| Pit | McIntyre Flowback 1 | SG Interests I LTD 77330 | | Ragged Mountain 71430 | Gunnison Co. T.11S, R. 90W, 24, SWNW |
| Centralized EP Waste Management Facility | McIntyre Flowback Pits #1 and #2 421065 | SG Interests I LTD 77330 | XX (Location) | Ragged Mountain 71430 | Gunnison Co. T.11S, R. 90W, 24, SWNW |
| Well | Hughes 11-90-26 2 | SG Interests I LTD 77330 | Waiting on Completion | Bull Mountain 7815 | Gunnison Co. T.11S, R. 90W, 26, Lot 6 |
| Location | Hughes 11-90-26 2 | SG Interests I LTD 77330 | Active | | Gunnison Co. T.11S, R. 90W, 26, Lot 6 |
| Well | Federal 11-90-26 #1 | SG Interests I LTD 77330 | Producing | Bull Mountain 7815 | Gunnison Co. T.11S, R. 90W, 26, NENE |
| Location | Federal 26NENE | SG Interests I LTD 77330 | Active | Wildcat 99999 | Gunnison Co. T.11S, R. 90W, 26, NENE |
| Location | McIntyre Flowback Pits 3 & 4 | SG Interests I LTD 77330 | Active | Ragged Mountain 71430 | Gunnison Co. T.11S, R. 90W, 26, NWNE |
| Centralized EP Waste Management Facility | McIntyre Flowback Pits #3 and #4 421066 | SG Interests I LTD 77330 | XX (Location) | Ragged Mountain 71430 | Gunnison Co. T.11S, R. 90W, 26, NWNE |

**Table 3-35**
**Bull Mountain Unit Existing Facilities**

| Facility Type | Facility Name/Number | Operator Name/Number | Status | Field Name/Number | Location |
|---|---|---|---|---|---|
| Pit | McIntyre Flowback 4 | SG Interests I LTD 77330 | | Ragged Mountain 71430 | Gunnison Co. T.11S, R. 90W, 26, NWNE |
| Pit | McIntyre Flowback 3 | SG Interests I LTD 77330 | | Ragged Mountain 71430 | Gunnison Co. T.11S, R. 90W, 26, NWNE |
| Well | Pasco Spadafora 3 | SG Interests I LTD 77330 | Producing | Wildcat 99999 | Gunnison Co. T.11S, R. 90W, 27, NENE |
| Well | Pasco Spadafora 2 | SG Interests I LTD 77330 | Waiting on Completion | Wildcat 99999 | Gunnison Co. T.11S, R. 90W, 27, NENE |
| Location | Pasco Spadafora #2 413893 | SG Interests I LTD 77330 | Active | Wildcat 99999 | Gunnison Co. T.11S, R. 90W, 27, NENE |
| Location | Pasco (Spadafora)-611S90W 27NENE | Delhi Taylor Oil Corp 23430 | Closed | Wildcat 99999 | Gunnison Co. T.11S, R. 90W, 27, NENE |
| Well | Pasco (Spadafora) 1 | Delhi Taylor Oil Corp 23430 | Dry and Abandoned | Wildcat 99999 | Gunnison Co. T.11S, R. 90W, 27, NENE |
| Well | Federal 11-90-35#1 | SG Interests I LTD 77330 | Producing | Bull Mountain 7815 | Gunnison Co. T.11S, R. 90W35, SWNE |
| Location | Federal -611S90W 35SWNE | SG Interests I LTD 77330 | Active | Wildcat 99999 | Gunnison Co. T.11S, R. 90W, 35, SWNE |
| Location | Falcon Seaboard 11-89-7-611S89W 7SESE | SG Interests I LTD 77330 | Abandoned Location | Wildcat 99999 | Gunnison Co. T.11S, R. 89W, 7, SESE |
| Well | Falcon Seaboard 11-89-7 1 | SG Interests I LTD 77330 | Abandoned Location | Wildcat 99999 | Gunnison Co. T.11S, R. 89W, 7, SESE |
| Well | Federal 11-89-17 1 | SG Interests I LTD 77330 | Producing | Wildcat 99999 | Gunnison Co. T.11S, R. 89W, 17, SWNE |
| Well | Muddy Creek Federal 10-17-11-89 | Tamarack Energy Inc. 85545 | Abandoned Location | Wildcat 99999 | Gunnison Co. T.11S, R. 89W, 17, SWNE |

**Table 3-35**
**Bull Mountain Unit Existing Facilities**

| Facility Type | Facility Name/Number | Operator Name/Number | Status | Field Name/Number | Location |
|---|---|---|---|---|---|
| Location | Federal 11-89-17-11S89W 17SWNE | SG Interests I LTD 77330 | Active | Wildcat 99999 | Gunnison Co. T.11S, R. 89W, 17, SWNE |
| Location | Muddy Creek Federal-611S89W17SWNE | Tamarack Energy Inc. 85545 | Abandoned Location | Wildcat 99999 | Gunnison Co. T.11S, R. 89W, 17, SWNE |
| Well | Cow Skull 11-89-18 1 | SG Interests I LTD 77330 | Waiting on Completion | Wildcat 99999 | Gunnison Co. T.11S, R. 89W, 18, NESW |
| Location | Cow Skull 11-89-18 #1 414132 | SG Interests I LTD 77330 | Active | Wildcat 99999 | Gunnison Co. T.11S, R. 89W, 18, NESW |
| Well | Cow Skull 11-89-18 2 | SG Interests I LTD 77330 | Producing | Bull Mountain 7815 | Gunnison Co. T.11S, R. 89W, 18, NESW |
| Location | HL 11-89-19 #1 | SG Interests I LTD 77330 | Active | Wildcat 99999 | Gunnison Co. T.11S, R. 89W,19, SENW |
| Well | HL 11-89-19 1 | SG Interests I LTD 77330 | XX (Location) | Wildcat 99999 | Gunnison Co. T.11S, R. 89W,19, SENW |
| Pit | Jacobs 29-1 | Loch Exploration Inc. 51058 | | Wildcat 99999 | Gunnison Co. T.11S, R. 89W, 29 |
| Well | Jacobs 29-1 | SG Interests I LTD 77330 | Producing | Bull Mountain 7815 | Gunnison Co. T.11S, R. 89W, 29, NWNW |
| Location | Jacobs-611S89W 29NWNW | SG Interests I LTD 77330 | Active | Wildcat 99999 | Gunnison Co. T.11S, R. 89W, 29, NWNW |
| Location | Borich 11-89-32 #1 | SG Interests I LTD 77330 | Active | | Gunnison Co. T.11S, R. 89W, 32, NWSE |
| Well | Borich 11-89-32 1 | SG Interests I LTD 77330 | XX (Location) | Wildcat 99999 | Gunnison Co. T.11S, R. 89W, 32, NWSE |
| Location | Buck Creek 12-89-5 1 | SG Interests I LTD 77330 | Active | | Gunnison Co. T.12S, R. 89W, 5, SWNE |

**Table 3-35**
**Bull Mountain Unit Existing Facilities**

| Facility Type | Facility Name/Number | Operator Name/Number | Status | Field Name/Number | Location |
|---|---|---|---|---|---|
| Well | Medved 12-89-5 1 | SG Interests I LTD 77330 | XX (Location) | Wildcat 99999 | Gunnison Co. T.12S, R. 89W, 5, SWNE |
| Location | Federal 12-89-7 #1 | SG Interests I LTD 77330 | Active | | Gunnison Co. T.12S, R. 89W, 7, NESE |
| Well | Federal 12-89-7 #1 | SG Interests I LTD 77330 | XX (Location) | West Muddy Creek 91970 | Gunnison Co. T.12S, R. 89W, 7, NESE |
| Location | Eck 12-90-1 428197 | SG Interests I LTD 77330 | Active | | Gunnison Co. T.12S, R. 90W, 1, Lot 1 |
| Well | Eck WDW 2 | SG Interests I LTD 77330 | XX (Location) | West Muddy Creek 91970 | Gunnison Co. T.12S, R. 90W, 1, Lot 1 |
| Well | Eck 12-90-1 #3 | SG Interests I LTD 77330 | XX (Location) | West Muddy Creek 91970 | Gunnison Co. T.12S, R. 90W, 1, Lot 1 |
| Well | Eck 12-90-1 1 | SG Interests I LTD 77330 | Waiting on Completion | West Muddy Creek 91970 | Gunnison Co. T.12S, R. 90W, 1, Lot 1 |
| Well | Hotchkiss 12-90 1-34 | Gunnison Energy Corp. 100122 | Producing | West Muddy Creek 91970 | Gunnison Co. T.12S, R. 90W, 1, SWSE |
| Pit | Hotchkiss 1290 1-34 | Gunnison Energy Corp. 100122 | Closed | Wildcat 99999 | Gunnison Co. T.12S, R. 90W, 1, SWSE |
| Location | Hotchkiss 12-90-612S90W 1SWSE | Gunnison Energy Corp. 100122 | Active | West Muddy Creek 91970 | Gunnison Co. T.12S, R. 90W, 1, SWSE |
| Well | Hotchkiss Ranch 3-11 | Petro-Lewis Corp. 68900 | Dry and Abandoned | Wildcat 99999 | Gunnison Co. T.12S, R. 90W, 11, NENW |
| Location | Hotchkiss Ranch - 12S90W 11NENW | Petro-Lewis Corp. 68900 | Closed | Wildcat 99999 | Gunnison Co. T.12S, R. 90W, 11, NENW |

Source: COGCC 2013

*Trends*

The US oil and gas industry is drilling fewer dry holes and recovering more oil and gas reserves per well due to innovative drilling and completion techniques. The Energy Information Administration estimates that over the next 20 years successfully drilled US energy wells will increase 0.2 percent per year through 2030. According to the Annual Energy Outlook 2011, shale gas production is expected to steadily increase, growing almost fourfold from 2009 to 2034; natural gas in power generation will grow due to low natural gas prices and the relatively low capital costs for new natural gas plants that make it more attractive than coal; and reliance on petroleum imports as a share of total liquids consumption is expected to decrease (EIA 2011; BLM 2012).

Over the last decade, exploratory and development activities in and surrounding the Unit have focused on exploring for and developing coalbed natural gas resources and other Cretaceous aged sediments. Although the risk of failure is higher for these types of exploratory activities (in comparison to drilling for tight sands gas and shale gas types of reservoirs), the BLM expects that exploratory and development activities in this area will continue over the next 20 years (BLM 2012).

Increases in future natural gas production to accommodate projected increased demand is anticipated to come partly from the Rocky Mountain area, in particular shale gas resources. It is difficult to predict how much new gas production is expected to come from reservoirs in and surrounding the Unit.

### 3.3.3 Recreation

***Current Conditions***

The Unit is accessed from State Highway 133, along the West Elk Loop Scenic Byway, and County Road 265. The West Elk Loop Scenic Byway passes through the proposed project area on State Highway 133 and connects the town of Carbondale, Hotchkiss, Crawford, Gunnison, Crested Butte, and other towns. In addition to attracting tourists, State Highway 133 provides access to hiking, mountain biking, dispersed camping, viewing of seasonal colors, cross-country skiing, and snowmobiling. The byway is known for its history, showcasing towns of varied lifestyles, and natural beauty. This route also provides access to the White River and Gunnison National Forests, the Black Canyon of the Gunnison National Park, Gunnison Gorge National Conservation Area, Curecanti National Recreation Area, and Crawford and Paonia State Parks.

County Road 265 provides access to the Grand Mesa, Uncompahgre, and Gunnison National Forest, which is extensively utilized for fall big game hunting, summer camping, viewing of seasonal colors, and snowmobiling.

Paonia State Park is located in close proximity to State Highway 133 and provides developed campsites, picnic sites, and a boat ramp surrounding Paonia Reservoir. McClure Pass is also in the vicinity and provides access to hiking, horseback riding, fishing, viewing of seasonal colors and scenic viewing, skiing, and snowshoeing and is a popular area with locals seeking nearby recreation opportunities.

The project area consists primarily of private surface that has historically been used for agriculture and grazing, with seasonal hunting. Hunting on private lands is permitted through local outfitter-guide services located in Crested Butte, Paonia, and Hotchkiss as well as with landowner permission requested by individual hunters. Most of the larger private ranches in the Unit allow hunting with a ranch-approved guide or through the payment of a fee to the landowner. SGI negotiates with landowners on a case-by-case basis if drilling or construction activities need to continue into the hunting season; landowners are sometimes compensated for lost hunting revenue by payment of a fee, based on the period of time and amount of area impacted.

***Trends***

Recreation near the project area is expected to continue to increase as the local population increases. Recreation in the project area itself is likely to stay at current levels if private landowners continue to limit the number of hunters allowed on their property.

### 3.3.4 Lands and Realty

***Current Conditions***

The analysis area includes all land ownerships in the project area. The boundaries of the Unit encompass federal and private oil and gas mineral estate which covers approximately 19,670 acres located in Gunnison County, Colorado. As shown in **Figure 1-1**, Bull Mountain Unit, the majority of the surface lands in the project area are privately owned. Over 90 percent of the subsurface minerals, both federal and fee within the geographic area of the Unit, are committed to the Unit at this time. The total project area consists of 440 surface acres of federal surface underlain by federal mineral estate administered by the BLM; 6,330 acres of split-estate lands consisting of private surface and federal minerals also administered by BLM; and 12,900 acres of fee land consisting of private surface and private minerals regulated by the COGCC.

The primary land uses within and adjacent to the project area include oil and gas development, livestock grazing, and seasonal hunting. See **Sections 3.3.1**, Livestock Grazing; **3.3.2**, Minerals; and **3.3.3**, Recreation, for details on these specific land uses. Expansive irrigated hay meadows are generally found in the bottomlands of the East Muddy Creek basin. Irrigated meadows are also found in the Ault Creek basin at the far western side of the Unit. A few residential subdivisions are located within the Unit, generally near the State Highway 133 corridor.

SGI began leasing minerals in the Unit in 2000 and has periodically purchased additional mineral interests within the Unit. The company currently owns and operates 11 fee/fee and 5 federal natural gas wells on 13 well pads and 1 water-disposal well occupying approximately 21.8 acres in the Unit. The wells were developed at an average of 2 per year for the past 6 years. To date, SGI and Gunnison Energy Corporation (the other existing operator within the Unit boundary) have developed 16.8 miles of gathering pipelines (4.5 miles co-located with roads, and 12.3 miles cross-country) and improved approximately 13.7 miles of roads within the Unit for pad site access (not including Gunnison County Road 265, which has also been improved by Gunnison County Road and Bridge and by the operators according to various road use agreements). Natural gas is currently delivered to the Bull Mountain Pipeline and the Ragged Mountain Pipeline north of the Unit for delivery to local and national markets.

*Relevant Regulations and Guidelines*

Land use regulations applicable to this project include federal and local. The primary entities responsible for land use planning within the study area are the BLM and Gunnison County. The proposed project is located mainly in rural areas. The nearest communities are Paonia and Marble. Paonia is approximately 30 miles southwest of the Unit and Marble is approximately 20 miles east of the Unit. Land use plans for these communities will not inform the land use and realty analysis. These locations are provided for reference only.

Overarching policy and procedural guidance is found in the FLPMA, Mineral Leasing Act, and the BLM NEPA Handbook (H-1790-1). These documents direct BLM activities related to ROW authorizations and preparation of environmental impact documentation. The BLM does not require the Unit Operator to obtain an authorization in circumstances where actions are tied to leases that are part of a unit. For example, SGI is not required to obtain a BLM ROW authorization, provided the facility (e.g., road or pipeline) is contained within the unit and its use is specific to the unit. If the facility also serves off-unit use, then a ROW authorization would be required. For example a pipeline carrying off-unit gas from development outside of the unit.

The proposed project is located on surface lands and federal mineral estate administered by the UFO. The UFO RMP guides the management of lands and resources on BLM-administered land in the project area. County-level land use planning criteria applicable to this project are found within the Gunnison County Regulations for Oil & Gas Operations. The Gunnison County, Colorado Regulations for Oil and Gas Operations were adopted by the Gunnison County Board of County Commissioners on August 28, 2012, via Resolution #2012-25. The purpose of these Regulations is to establish "processes" that provide reasonable limitations and safeguards for the exploration and production of oil and gas resources in the County. All oil and gas operations in the unincorporated areas on private land within the County shall comply with these regulations.

*Land Use Authorizations*

BLM-administered lands throughout the project area are generally made available for land use authorizations, which are analyzed and issued on a case-by-case basis. A ROW is an authorization to use a specific parcel of BLM-administered land for a specific project, such as roads, pipelines, and power lines. A ROW authorizes nonexclusive rights and privileges for a specific use of the land for a designated time. A ROW is granted for a term appropriate to the life of a project. A ROW authorizes the holder to construct, operate, maintain, and terminate a facility over, under, upon, or through BLM-administered lands. Such authorizations are issued for commercial and non-commercial purposes such as roads and utilities, and may be for energy or non-energy-related uses. Land use authorizations are also issued to other federal, state, and local agencies and governments.

Existing land use authorizations within the Unit include ROWs for State Highway 133, Delta-Montrose Electric Association power lines, a Delta County Tele-Com telephone line, the Volk Ditch, and private access ROWs.

***Trends***

Demand for land use authorizations in the project area is anticipated to increase in correlation with future residential and commercial development, increasing population, and energy demand. Based on review of LR 2000 database, there has only been one new ROW authorized (access road to a private property) since the Draft Environmental Assessment was released in 2012.

### 3.3.5 Transportation and Access

***Current Conditions***

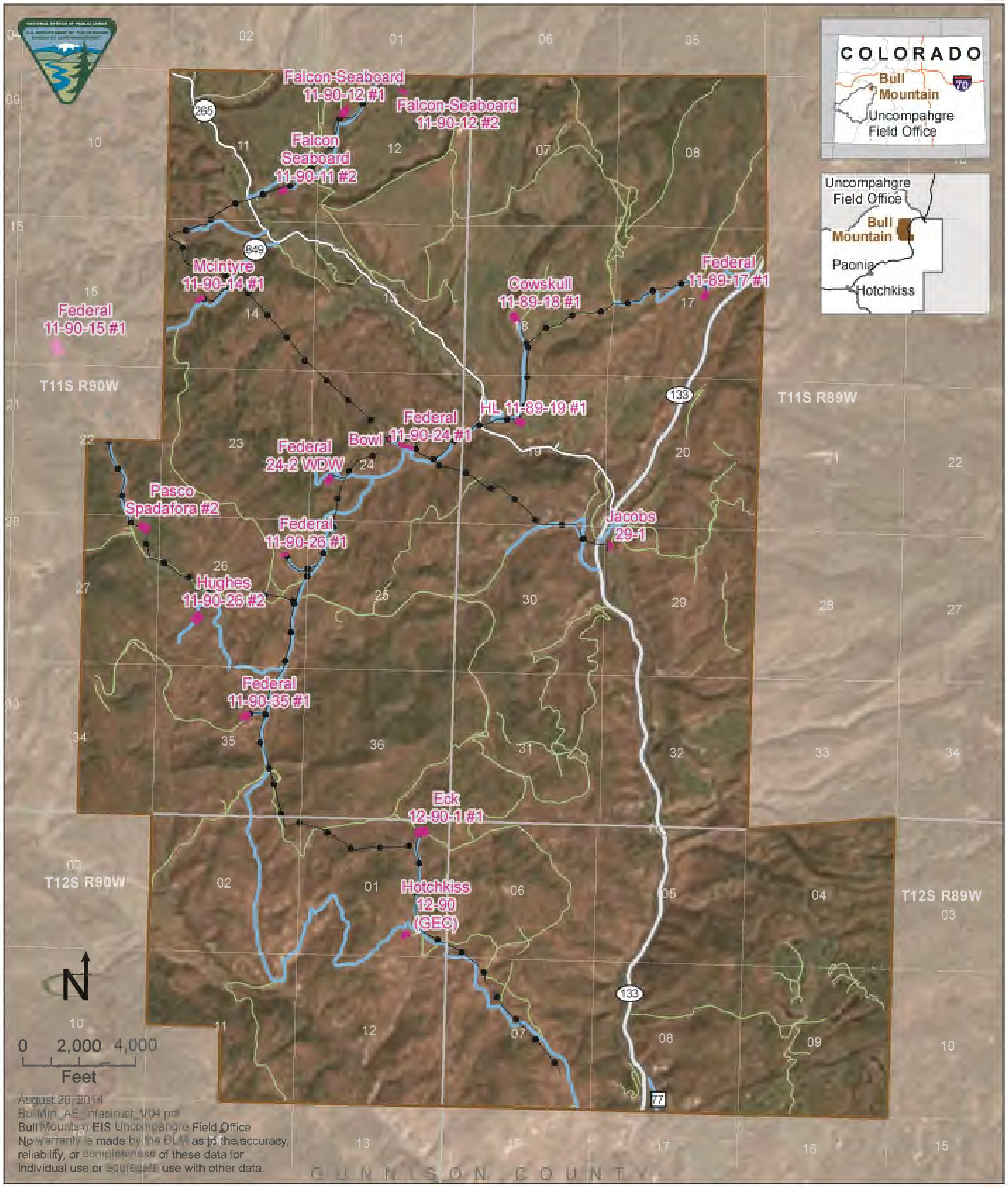
Travel and access are central to many activities on BLM-administered lands. Comprehensive Travel and Transportation Management, which is the BLM's program for managing transportation, takes into consideration motorized (e.g. cars, trucks, and motorcycles) and nonmotorized (e.g. bicycles, foot, and horseback) access for resource management, recreation, and other resource uses such as energy and mineral development. The primary goal of Comprehensive Travel and Transportation Management is to provide a network of routes for which access is available to designated uses. Executive Order 11644 and CFR (43 CFR Part 8340) both require the BLM to designate all BLM-administered lands as open, closed, or limited to off-highway vehicle use. Further, Colorado Instruction Memorandum 2007-20 restricts off-highway vehicle use within limited areas to designated routes. Accordingly, motorized vehicle access on the 440 acres of BLM-administered surface estate in the Unit is limited to existing routes until further route planning can be conducted for the area.

*Access*

Within the project area, State Highway 133 is the only paved roadway; it bisects the eastern portion of the Unit from north to south for approximately 6.4 miles. There are an additional 84.4 miles of gravel access roads and other unpaved routes throughout the project area. Gunnison County Road 265, which is an upgraded unpaved public road, crosses the project area for approximately 4.8 miles. There are an additional 20.2 miles of gravel access roads and 49.3 miles of unimproved 2-track routes throughout the project area. Primary access to the Unit is from State Highway 133 and Gunnison County Road 265 (**Figure 3-20**, Existing Infrastructure).

State Highway 133 is an undivided 2-lane road with a typical lane width of 12 feet and overall paved width, including shoulders, of between 30 and 40 feet, depending on location in the Unit. State Highway 133 provides an arterial connection for regional car and truck travel between Hotchkiss and Paonia in Delta County through Gunnison County to the town of Carbondale in Garfield County. In Gunnison County, County Roads 265 and 77 intersect State Highway 133 as well as several private roads. Where these roads intersect State Highway 133, the intersecting roadway is typically paved for the first 100 to 200 feet before becoming gravel or dirt. The posted speed limit for the segment of State Highway 133 within the project area ranges from 45 to 50 mph. Paved and unpaved emergency and slow vehicle turnouts are located intermittently along the route.

County Road 265 intersects with State Highway 133 approximately 2 miles south of the point where State Highway 133 enters the Unit from the northeast. The road is graveled except for a paved 120-foot segment where the road intersects with State Highway 133. The road runs northwest through the Unit providing access to private homes and ranches, as well as National Forest System lands. Private roads used for oil and gas development and other private residential, agricultural, and industrial uses also intersect County Road 265 periodically throughout the roadway length in the project area. The roadway width varies depending on location, but is typically between 15 and 30 feet with periodic turnouts. Within the Unit, County Road 265 crosses two small streams. The bridge width for each stream crossing is approximately 28 feet. Gunnison County provides limited plow service on this road during the winter months (Gunnison County 2013).Two additional gravel-surfaced county roads, County Road 849 and County Road 77, provide access in the northwestern and southeastern portions of the Unit, respectively. County Road 849 intersects with County Road 265 and provides access to private agricultural and industrial uses. Each road has similar design characteristics as County Road 265. Other routes within the Unit are single lane gravel-surfaced roads and two-track routes used for private




## Existing Infrastructure

Source: BLM GIS 2014, Gunnison County 2012, SG Interests GIS 2013, US Census 2012

- Bull Mountain Unit
- Existing well pad
- Existing pipeline
- Existing paved road
- Existing upgraded public road
- Existing road currently suitable for use
- Existing road requires upgrades for use

Figure 3-20

access to ranches, agricultural lands, and existing well sites. Several of the private access roads are gated with access limited to administrative uses only.

*Transportation*

Existing regional traffic on State Highway 133 consists primarily of local residents, regional travelers, and commercial vehicles, including light and heavy trucks from nearby mineral extraction activities. Based on 2012 data from the Colorado Department of Transportation, the annual average daily traffic, which is a measurement of total traffic volume for a full year for a given location, as counted by a traffic counter, divided by 365 days, is 1,400 for a 22.3 mile segment of State Highway 133 between the intersection with County Road 12 approximately 6.75 miles south of the project area boundary and the intersection with County Road 3 north of the Gunnison County line in Pitkin County approximately 6 miles north of the project area boundary. The peak truck traffic for this segment is 6.3 percent of the total recorded volume. On an average day, there are 30 single trucks and 60 combined trucks traveling on this segment of State Highway 133 (CDOT 2012a).

Between 2008 and 2010 (the years for which data is available), there were three traffic-related fatalities on State Highway 133 in Gunnison County. Two of the fatalities involved motorcycle riders, while the other involved the driver of a passenger vehicle (CDOT 2012b).

Traffic on the 4.8 mile segment of County Road 265 within the Unit consists primarily of local residents, farmers and ranchers, and commercial vehicles, including light and heavy trucks from the mineral extraction industries. The county road is also used to access recreation and hunting opportunities on adjacent National Forest System Lands. For the period July 31 through October 15, 2007 (the latest period for which data are available), the average daily traffic count for the entire roadway was 205 vehicles (102 northbound and 103 southbound).

SGI executed Gunnison County Road Improvement Agreement on September 13, 2005, and the First Amendment to Road Improvement Agreement on July 11, 2006, for improvements to County Road 265. Gunnison County holds Performance/Utilization Bond No. RLB0004678 in the amount of $10,000 to warrant against road damage to County Road 265. On November 5, 2010, SGI and Gunnison Energy entered an agreement with Gunnison County (Gunnison County 2010) under which SGI and Gunnison Energy agreed to purchase magnesium chloride so that the Gunnison County Public Works Department can apply it to County Road 265 for dust suppression twice each year through 2015. Per the agreement, the first of each annual application would be for the entire length of County Road 265, while the second application would be at residential driveway entrances adjacent to County Road 265. Gunnison County would grade County Road 265 each year in preparation for the magnesium chloride application and would have full responsibility for the product’s application.

In addition, SGI and Gunnison Energy have executed an agreement with Gunnison County under which they pay the county to install magnesium chloride product on County Road 265 twice each year.

***Trends***

On the 22.3 mile segment of State Highway 133 between the intersection with County Road 12 and the intersection with County Road 3, Colorado Department of Transportation projects an increase in annual average daily traffic from a current level of 1,400 to 2,500 by 2033. Over the next 20 years, the number of single trucks traveling on this segment on an average day is expected to increase from 30 to 54, while the daily number of combined trucks is expected to increase from 60 to 107 (CDOT 2012c).

While no quantitative forecast is available for County Road 265, annual average daily traffic on this road would increase only if the local population increases or non-residential uses in the Unit, such as access to adjacent National Forest System Lands for recreation and hunting, create additional vehicle trips.

## 3.4 Social and Economic Conditions

This section is a description of the support conditions in the project area and follows the order of topics addressed in **Chapter 2**:

- Hazardous and solid waste
- Socioeconomics
- Environmental Justice

### 3.4.1 Hazardous and Solid Wastes

The affected environment for hazardous materials includes air, water, soil, and biological resources that may potentially be affected by an accidental release of hazardous materials during transportation to and from the Unit, storage, and use in construction, drilling, and operations. Additionally, hazardous wastes from abandoned mines or other past activities in the project area could affect air, water, soil, and biological resources. Sensitive areas for hazardous materials releases include areas adjacent to water bodies, above aquifers, and areas where humans or wildlife would be directly impacted.

The most pertinent of the federal laws dealing with hazardous materials contamination are as follows:

- The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA, Public Law 96-510 of 1980) provides for liability, compensation, cleanup, and emergency response for hazardous substances released into the environment. It also provides national, regional, and local contingency plans. Applicable emergency operations plans in place include the National Contingency Plan (40 CFR 300, required by Section 105 of CERCLA), the Region VIII Regional Contingency Plan, and the Gunnison County Emergency Operations Plan (developed by the Gunnison County Office of Emergency Management).

- The Resource Conservation and Recovery Act (Public Law 94-580, October 21, 1976) regulates the use of hazardous substances and strictly regulates the management and disposal of hazardous as well as ordinary solid wastes. Oil and gas lessees are exempt from certain parts of the Act, including Subtitle C (hazardous waste regulations); however, they are not exempt from Subtitle D (solid waste regulations). Oil and gas lessees should know which of their wastes are exempt and nonexempt from Resource Conservation and Recovery Act subtitles.

In addition, the EPA and CDPHE require a Spill Prevention, Countermeasure, and Control Plan to be developed and implemented by SGI and its subcontractors as applicable and appropriate. The plan is intended to preclude the release of oils such as diesel fuel, gasoline, crude oil, or condensate, into the waters of the United States. The plan must also provide response actions to be taken, and notifications to be made, in the event a release occurs.

According to 29 CFR 1910.1200(g), SGI is required to maintain a file containing Material Safety Data Sheets for all chemicals, compounds, and/or substances utilized during the course of construction, drilling, completion, and production operations of the project. This file is to be available at all times when employees are present at the site. The BLM Instruction Memoranda numbers WO-93-344 and CO-97-023 require that all NEPA documents list and describe any hazardous and extremely hazardous materials that would be produced, used, stored, transported, or disposed of as a result of a proposed project.

On December 13, 2011, the State of Colorado enacted Code of Colorado Regulations 404-1:205A, a new rule requiring vendors and providers of hydraulic fracturing services to provide the operator of a natural gas well with the identity of each additive and each chemical intentionally added to the hydraulic fracturing fluid, within 30 days following the conclusion of the hydraulic fracturing treatment (Nettles et al. 2012 CCR 404-01:205A). The operator must then complete a chemical disclosure registry form and post the form to a national public website, fracfocus.org, within 60 to 120 days. The operator must disclose the concentration of the chemical or additive but is not required to disclose the brand name of the product or additive to which the disclosed chemical or chemical concentration is a component. A vendor, service provider, or operator may claim that the specific identity and concentration of a chemical is entitled to trade secret protection and may withhold disclosure of this information on that basis. However, the identity and amount of any chemicals claimed to be a trade secret must be identified to any health professional who requests such information in writing (and who agrees to keep the information confidential) for the purpose of diagnosing or treating an individual who may have been exposed to such chemicals. Likewise, this information must be provided to the COGCC upon receipt of a letter stating that such information is necessary to respond to a spill or release, or a complaint from a person who may have been directly and “adversely affected or aggrieved” by a spill or release.

The EPA conducted a study in 2004 and concluded hydraulic fracturing presents little or no threat to underground sources of drinking water (EPA 2004). However, this study was highly criticized as politically motivated and scientifically unsound by former EPA scientists and others (Wilson 2004). In 2010, Congress mandated the EPA conduct a new study on the impacts of hydraulic fracturing on drinking water. This study is scheduled to be released by the EPA in 2014, though it is rumored that its release may be delayed until 2016 (EPA 2013g). In the meantime, many citizen groups, environmentalists, and scientists believe hydraulic fracturing poses a great threat to air and water quality. Concerns are typically about the use of toxic chemicals and diesel fuel in fracturing fluid and the detrimental impacts on the environment and on human health that would result if these chemicals were to contaminate underground drinking water sources (EPA 2004).

Typical hazardous materials present or likely to be present in the project area during development and production are listed in **Appendix G**, Hazardous Materials Management Summary, and include:

- drilling mud and cementing products, which are primarily inhalation hazards
- flammable or combustible motor fuels
- proprietary materials necessary for well completion and stimulation, such as acids and gels (corrosives)
- fluids such as ethylene glycol that may be used in dehydration units, and are known to be toxic to wildlife and cattle
- human solid and liquid wastes, generated primarily during the construction and drilling phases of the project

Use of any substances classified as Extremely Hazardous by the Superfund Amendments and Reauthorization Act of 1986 would be limited to treating chemicals, should they be necessary. Materials generated during drilling include drill cuttings, combined with drilling fluids and additives used to maintain circulation and reduce borehole caving and accomplish cementing of the borehole annulus. These fluids are normally confined to the borehole, reserve pit, and/or storage tanks.

***General Project Area***

A search of EPA records indicates no presence of present or past hazardous waste generation or management facilities in the area, nor any accidents, spills, leaks, or improper disposal of hazardous materials resulting in brownfields (EPA 2013a). As of 2011 there were no Superfund sites in the area, nor any indication in the EPA Hazardous Waste Report of any past or present hazardous waste treatment, storage, or disposal facilities (EPA 2013b).

The interactive EPA database *EnviroMapper for Envirofacts* identified two points of interest for hazards to human health within the project area. The Gunnison Energy Corp 1-34 Well Site was identified in the Air Facility System as a stationary source of volatile organic compound emissions, and the Aspen Leaf Lateral Pipeline was identified in the EPA Integrated Compliance System for having been issued a permit to discharge waste water into rivers (EPA 2013c, 2013d) Both facilities are operating in compliance with procedure (EPA 2013c, 2013e).

Other nearby points of interest include the Gunnison Energy Corporation and three Gunnison Energy Corp well sites, all of which lie just south of the project area and are operating in compliance with procedure (EPA 2013a, 2013f).

***Trends***

Over the last decade exploratory and development activities in and surrounding the Unit have focused on exploring for and developing coalbed natural gas resources, and these activities are expected to continue over the next 20 years (BLM 2012b). As these activities continue and potentially increase in the future, the risk of an accidental release of hazardous materials increases. Increased gas operations would likely result in increased transportation, storage, and use of hazardous material in construction, drilling, and operations, which would increase the risk of air, water, soil, and biological resources being affected by hazardous materials.

### 3.4.2 Socioeconomics

***Current Conditions and Trends***

Local and regional demographic characteristics, economic factors, and social structure have the potential to be affected by management decisions in the Bull Mountain Unit MDP EIS planning area. Economic and demographic statistics are primarily reported by county. While the project is located within Gunnison County, it is likely that the local workforce may be drawn from Delta, and project construction and operation has the potential to impact Delta County, in particular North Fork Valley. For these reasons, demographic, economic, and social data are presented for Gunnison and Delta Counties. A state context is provided for comparison where appropriate. It should be noted that much of the population of Gunnison County is located in the Gunnison and Crested Butte area, which is not likely to be impacted by the proposed project and has little influence on the current conditions of the planning area. A summary of current social and economic conditions for the area is included below, additional information, including complete data tables, is available in the Bull Mountain MDP EIS Socioeconomic Baseline Report (BLM 2013b).

*Demographics and Economic Conditions*

<u>Population:</u> As of 2010, total population in Delta and Gunnison Counties was 30,952 and 15,324 respectively. Total population in the two-county region has increased since 1980, but at a slower rate than that of the State. From 1980 to 1990, population declined in both Delta and Gunnison Counties. In the 1990s, growth for both Counties was slightly higher than the state average (30.6 percent) at 32.7 percent for Delta County and 35.9 percent for Gunnison County. Since 2000, population growth has slowed and was lower than the state average of 16.9 percent (11.2 percent for Delta County and 9.8 percent for Gunnison County) (US Census Bureau 2010, Headwaters Economic 2013). It should be noted that, despite growth, total population density remains low in the study area.

Population growth in the area is expected to continue over the next few decades with approximately 14 percent increase by 2020 and 62 percent increase by 2040 for the two-county study area (Colorado Division of Local Government, State Demography Office 2012). In-migration of people from other Colorado regions and throughout the West is the likely source of much of the anticipated population growth. For Delta, and in particular, Gunnison County, a growing percentage of the population is originally from other states, with 44.9 percent and 56.5 percent respectively born in other states based on 2010 data (US Census Bureau 2010).

Income and Employment: Median household incomes for Delta County ($41,856) and Gunnison County ($50,073) remained below the state average of $52,762 in 2010. Per capita income in Delta County ($23,495) was lower than the state average of $27,915, while the per capita income in Gunnison County ($28,862) was slightly higher than the state average (US Census Bureau 2010).

Income is derived from two major sources: (1) labor earnings or income from the workplace; and (2) non-labor income including dividends, interest, and rent and transfer payments (payments from governments to individuals; age-related, including Medicare, disability insurance payments, and retirements). Labor income is the main source of income in Delta and Gunnison County, however non labor income contributes an important source of income; from 1970 to 2011, non-labor income in Delta County grew from $50 million to $187 million, an increase of 275 percent (Headwater Economics 2013). Percent of personal income contributed by non-labor income in Delta County (44.6 percent) and Gunnison County (40.8 percent) are well above the state average of 29.8 percent (Headwater Economics 2013). Based on input from the community assessment and economic workshops, the large level of non-labor income is likely related to high numbers of retirees in the area (BLM 2009, 2010).

As of 2011 data, key industries in Delta County include retail trade (11 percent of total employment), health care and social assistance (9 percent), farm employment (9.3 percent), construction (7 percent), and government (16 percent). In Gunnison County, retail trade (9.1 percent), construction (8.7 percent), arts entertainment and recreation (8.2 percent) and accommodation and food services (11.7 percent), and government (16.9 percent) employed the most people (US Department of Commerce, Bureau of Economic Analysis 2012). Mining data is non-disclosed for Gunnison County and for certain mining sectors in Delta County, however, estimates from the Headwaters Economics' Economic Profile System indicate that mining represents an important industry in the area, with approximately 7.9 percent of employment in Delta County and 10.4 percent in Gunnison County related to mining (Headwaters Economics 2013). It should be noted that data from the US Department of Commerce, Bureau of Economic Analysis are not directly comparable with the data from Headwaters Economics due to different sources of data and different industry coverage.

A significant portion of the tourism base economy in Gunnison County is located in the towns of Gunnison and Crested Butte. The Bull Mountain area's economic conditions are, therefore, not comparable with the rest of Gunnison County. Specifically, agriculture and natural resource development are more dominant in the project area than tourism. Fall big game hunting is also a popular activity in this area. Delta County's economy is similar to the project area, but also features a significant healthcare and nursing home industry in and around the town of Delta.

It should be noted that for some industries average annual wages are higher than others. Highest average annual wages are typically seen in the government sector and natural resources extraction, particularly in mining. Average wage per job numbers are typically lower in the hospitality sector and in agriculture. The average annual wage for the natural resources and mining sector was significantly higher than average annual wage for both Gunnison and Delta Counties (116 percent and 63 percent higher than average wage) (Headwater Economics 2013). see **Table 3-36**, Annual Wages by Industry, 2012.

**Table 3-36**
**Annual Wages by Industry, 2012**

| | Avg. Annual Wages | | % Above or Below Avg. | |
|---|---|---|---|---|
| | **Delta** | **Gunnison** | **Delta** | **Gunnison** |
| **Total** | $33,870 | $36,202 | | |
| **Private** | $32,231 | $35,342 | -4.8% | -2.4% |
| **Non-Services Related** | $47,354 | $58,853 | 39.8% | 62.6% |
| Natural Resources and Mining | $55,410 | $78,183 | 63.6% | 116.0% |
| Agriculture, forestry, fishing & hunting | $28,202 | na | -16.7% | na |
| Mining (incl. fossil fuels) | $69,873 | na | 106.3% | na |
| Construction | $37,210 | $36,393 | 9.9% | 0.5% |
| Manufacturing (Incl. forest products) | $35,312 | $21,806 | 4.3% | -39.8% |
| **Services Related** | $25,619 | $27,781 | -24.4% | -23.3% |
| Trade, Transportation, and Utilities | 28,270 | $27,329 | -16.5% | -24.5% |
| Information | $28,515 | $35,688 | -15.8% | -1.4% |
| Financial Activities | $33,642 | $37,726 | -0.7% | 4.2% |
| Professional and Business Services | $34,538 | $60,954 | 2.0% | 68.4% |
| Education and Health Services | $24,378 | $34,314 | -28.0% | -5.2% |
| Leisure and Hospitality | $12,961 | $17,041 | -61.7% | -52.9% |
| Other Services | $29,350 | $22,942 | -13.3% | -36.6% |
| Unclassified | $6,246 | $56,047 | -81.6% | 54.8% |
| **Government** | $38,217 | $38,970 | 12.8% | 7.6% |
| Federal Government | $61,600 | $52,914 | 81.9% | 46.2% |
| State Government | $50,796 | $44,794 | 50.0% | 23.7% |
| Local Government | $35,087 | $34,801 | 3.6% | -3.9% |

Source: Headwaters Economics 2013. Based on BLS 2012 data.

Unemployment levels in the two-county area are decreasing from peaks in 2010 and remain lower in Gunnison County than Delta County. Estimated annual unemployment rates were 5.9 percent and 7.5 percent in Delta and Gunnison County respectively in 2013, compared to the Colorado annual unemployment rate of 6.8 percent (US Department of Commerce, Bureau of Labor Statistics 2014).

Housing Resources: As of 2010, approximately 14,572 and 11,412 housing units were available in Delta and Gunnison counties respectively (US Census Bureau 2010). The number of housing units in the two-county area increased since 2000, with the rate of increase higher than the state average in Gunnison County (20.0 percent) and lower than the average in Delta County (15 percent). Housing vacancy rates in the study area are notably high in Gunnison County (42.9 percent), with the majority of the vacant housing units second homes used for seasonal, recreational, or occasional use.

Temporary housing availability in the area includes 2 RV parks and 16 hotels with in a 25 mile radius of Delta, the largest town in the vicinity of the project area (tripadvisor.com 2014). Glenwood Springs is approximately 50 miles and contains approximately 24 hotels. The regional hub of Grand Junction is approximately 100 miles away contains over 25 hotels.

Median home value has increased since 2000, with a 32 percent increase in Delta County (a median value of $198,000) and a 37 percent increase in Gunnison County (a median value of $338,100), based on 2007-2011 data (US Census Bureau 2000, 2011). Both Counties had higher rates of change than the Colorado average of 9 percent. Based on 2007-2011 data, median monthly rental rates were $721 and $858 in 2011 for Delta and Gunnison Counties, respectively (US Census Bureau 2000, 2011). Median rental rates increased at a lower rate than housing prices, at 10 percent for Delta County and 11 percent for Gunnison County, but at a higher rate than the Colorado average of 1 percent.

*Fiscal Conditions*

Property Taxes: Property taxes are determined by multiplying the assessed (taxable) value of the property by the tax rate. The tax rates are set by local government entities and vary by location. Assessed values are derived by multiplying the actual value of the property by 7.96 percent for residential property and by 29 percent for other property, including improvements for oil and gas production. Ad-valorum property taxes are also applied to oil and gas production in Colorado based on prior year production. The assessed value is either 87.5 percent or 75 percent depending on whether the production is classified as primary or secondary.

Approximately half of property tax revenues go towards County school districts with the remainder distributed to other Gunnison County entities. Gunnison County's total taxable assessed value for 2012 was $689,286,200, with oil and gas property representing $4,264,210 (0.62 percent) of total County-assessed value. Gunnison County reported $35,413,810 in property tax revenue for 2012 (Gunnison County 2012). Property taxes in Delta County would not be directly affected by project activities but could be impacted by any related change in property values.

Severance Taxes: Tax revenue related to natural gas production comes from two main sources: the Colorado state severance tax and the state's share of federal mineral lease royalties. Colorado Severance Tax is a tax imposed upon nonrenewable natural resources that are removed from the earth. The severance tax is graduated, ranging from 2 percent for income under $25,000 to 5 percent for income of $300,000 and over. Very small operations are exempt. Producers may also deduct ad- valorum property taxes paid from severance taxes. Severance tax revenues are distributed with 50 percent to the Colorado Department of Natural Resources to fund water conservation, wildlife, and environmental programs and the remaining 50 percent to Local Impact Fund Department of Local Affairs. Of the amount that goes to the Local Impact Fund Department of Local Affairs, 70 percent goes to local government projects and 30 percent is directly distributed to local communities. The direct payments from Department of Local Affairs to Colorado communities are often used to offset the impacts of drilling on roads, schools and public services. Gunnison County received $833,006 in severance taxes in 2012.

Federal Mineral Royalties: Additional revenue is collected for bonus, rent and royalties on federal mineral leases. Federal royalty rates are generally 12.5 percent of production value. Approximately 50 percent of revenues go to the US Treasury and 49 percent of these revenues are transferred to the Colorado State Treasurer. This portion, in turn, is distributed to counties, cities, and school districts based on senate bill 08-218. In 2012 approximately $2.5 million was distributed to Delta County, Gunnison county, and area communities (Colorado Division of Local Government 2012).

<u>Other Taxes:</u> Additional taxes on oil and gas activities include contributions to the Oil & Gas Conservation Fund Levy (approximately 12 percent of net revenue) and the Oil & Gas Environmental Response Fund (approximately 2 percent of net revenue).

Contributions also occur from corporate income tax (4.63 percent), sales tax would be paid on supplies purchased in state ( average rate for Colorado is 4.3 percent).

Lodging taxes in Delta county provide additional revenue for local communities, approximately $80,000 in Delta County in 2011 (Delta County 2012). County lodging tax is 1.9 percent, but may vary by municipality (Colorado Department of Revenue 2014). Gunnison County has no county imposed lodging tax.

*Social Services*

<u>Law Enforcement and Emergency Response:</u> Law enforcement services in the Bull Mountain area are provided by the Gunnison County Sheriff's Office. Sheriff's deputies provide routine patrol services, First Responder medical care, and 24-hour on-call coverage for the area. The Sheriff's Office provides dispatch services for all emergency service agencies in the county. Emergency management is also provided under the jurisdiction of the Sheriff's Office through the County's emergency manager. Ambulance service is provided by the Gunnison Valley Hospital in Gunnison. Delta County Hospital in Delta also offers ambulance service with advanced life support and is a certified Level IV trauma center. Montrose Memorial Hospital is a Level III trauma center. Fire-suppression services are provided by the Ragged Mountain Fire District.

<u>Schools:</u> The project area is located within Delta County Joint District. The average teacher/student ratio is 1:17.8. The district has four high schools, three middle schools, five elementary schools, one K-8 school, and three K-12 schools (Delta County 2013).

<u>Domestic Water and Wastewater Treatment:</u> The incorporated areas of Delta County and Gunnison counties, including much of the two-county region, are not served by domestic water suppliers or municipal waste water treatment plants and generally utilize wells for potable water and private septic systems. Scarcity of domestic water as well as water quality has historically been important issues in the region. The town of Paonia is in the process of upgrading the existing water treatment facility to 2 million gallons in order to provide additional finished water storage and the ability to divert the Old Original Town Spring and the Upper Reynolds Creek Spring to the Lamborn Plant, therefore added flexibility in operations and redundancy in the water system. Federal and state funding is being sought to support this effort. Recent water rate increases also occurred in in anticipation of the State of Colorado requiring upgrades and the need for additional water capacity (Delta County Independent 2012).

*Local Economic Activity Affected By Project Area Land Uses*

Local economies are directly and indirectly impacted by expenditures and revenues generated by a variety of activities in planning area. Activities that tend to have the greatest economic influence in the area include recreation, mining and energy resource development, and livestock grazing, as discussed in detail below.

Hunting and Recreational Use: Recreational activity has important economic value both in terms of the satisfaction it provides local residents and the economic activity it generates for the regional economy. In terms of economic activity, recreation generates additional spending in the local economy that supports jobs and income. Recreational use contributes to the local economy through expenditures of visitors and employment of local residents in the service sectors. A 2008 study by Colorado Parks and Wildlife found that hunters and anglers spent an estimated $1 billion on trip expenses and sporting equipment in Colorado in 2007 (CPW 2008). Expenditures per visitor for multiple activities can also be estimated by applying the average visitor spending levels developed by the US Forest Service for its National Visitor Use Monitoring Reports, which were $57.15 for the average overnight visitor and $19.02 for the average day-use visitor (USDA Forest Service 2008). In the planning area recreational activity includes hunting on private lands through local outfitter-guide services as well as hiking, biking and other recreational activities along the State Highway 133 corridor as described in **Section 3.3.3**, Recreation.

Agriculture and Livestock Grazing: Agriculture is a traditional use of lands in the project region and continues to be important today. There were 1,494 farms totaling 441,004 acres in the two-county region in 2012 (USDA NASS 2014). The North Fork Valley has become known for its rural character and organic farms; approximately 40 farms in Delta County were certified organic or transitioning to organic in 2012; Delta County has the largest concentration of organic farms and orchards of any Colorado County (USDA NASS 2014). The area has become a premier agri-tourism destination in the Rocky Mountains for visitors to organic farms and vineyards; based on the 2012 agricultural census, approximately 21 farms had established agri-tourism opportunities in Delta County, generating $293,000, and 17 farms in Gunnison County generated $243,000 through agri-tourism (USDA NASS 2014).Livestock grazing of cattle and sheep is also a traditional use on public and private lands in the area as discussed in **Section 3.3.1**, Livestock Grazing.

Tourism: Tourism in the North Fork Valley Area includes those seeking recreational experiences and agri-tourism, as discussed above. Employment in tourism is not considered a separate industry category; therefore, data on jobs generated are estimates only. In 2011, travel and tourism-related jobs accounted for approximately 11.8 percent of the jobs in Delta County and 48.5 percent of jobs in Gunnison County compared the state average of 17.5 percent of jobs (Headwater Economics 2013). As previously noted, the majority of the tourism in Gunnison County is located outside of the project area in the towns of Gunnison and Crested Butte. Travel spending has been classified by county in Colorado in a recent report. In 2011, it is estimated that travel spending in Delta County resulted in an estimated 33.8 million dollars, brought in 9.5 million in earnings, resulted in 530 jobs, and generated nearly 1 million in local taxes (Colorado Tourism Office 2011).

Mineral and Energy Resources: Leasable minerals play an important economic role in both Delta and Gunnison Counties. As discussed in **Section 3.3.2**, Minerals, while the potential for development may exist, locatable minerals, mineral materials, and renewable energy have not been developed in notable amounts in the project area and are unlikely to be developed over the life of the MDP and therefore do not significantly contribute to the local area economy or social structure.

Coal mining is a historical industry in the area and is primarily related to three mines in the North Fork Valley near Paonia in an area known as the Somerset coal field. Production varies based on market conditions, but in 2012, approximately 13.4 million tons were produced overall for the three mines combined and employment totaled 948 miners (Colorado Division of Reclamation Mining and Safety 2013). However, Elk Creek Mine was closed in late 2013 after an underground fire closed off much of the coal-mining operation, resulting in a 257-person reduction in workforce in 2013 (Denver Post 2013). Coal resources within the Unit are not considered economically feasible for extraction. Therefore, while coal mining is a traditional land use in the area, coal resources in the Unit are not considered to have economic interest and do not likely contribute a significant economic contribution or influence on social values.

In the past 10 years, oil, and in particular and natural gas development, has increased steadily in Gunnison County, as described in detail in **Section 3.3.2**, Minerals. As of 2010, wells on private and federal minerals in the North Fork area had produced over 3 billion cubic feet of gas. Similarly, within the Unit, existing wells have seen steady increases in production since initial production year of 2010, with approximately 359,165 mcf sold in 2012, including all producing wells (see **Table 2-5**, Bull Mountain Unit Annual Production Rates).

County employment figures for oil, gas, and coal extraction are included within the mining and mining and mining related industries category of BLS and contributes approximately 7.9 percent of county employment in Delta County in 2011, and an estimated 10.4 percent in Gunnison County (Headwater Economics 2013). Additional jobs for this industry are also reflected in construction numbers and other fields that are connected to the exploration and development of resources. It should be noted, however, that these figures include portions of the Counties located outside of the planning area and include estimates for non-disclosed data.

Estimates can be made for economic contributions from natural gas based on the production levels reported. At an average well-head price of $2.66 per mcf and 1,944,599 mcf sold, total gas sales from all wells in the two-county area would have been approximately $5.17 million in 2012 (EIA 2013; Colorado Oil and Gas Conservation Commission 2013). As previously noted, this figure includes all production in Delta and Gunnison Counties, including lands outside of the planning area. Using the same average well-head price and the estimated 359,165 mcf sold from all existing Unit wells (private and BLM minerals) in 2012, it can be estimated that sales from the Unit totaled $955 thousand in 2012.

*Quality of Life and Non-Market Values*

The planning area an surrounding North Fork Valley region consist of a largely rural setting with small towns. Meetings were held with local community leaders in advance of the UFO RMP revision which collected information about local residents' values and desired conditions for community in the planning area. In meetings held for a Community Assessment in November-December of 2008 and in economic workshops in March of 2010, local residents sited small community feeling, slower pace of life, and outdoor lifestyle as important factors in local communities, particularly in Hotchkiss and Paonia. Local community leaders also stressed the importance of health lands and environment as well as municipal watershed protection as important factors. Some representatives, particularly from Delta County, also recognized the importance of mining jobs for the local economy. All communities desired moderate controlled growth (BLM 2009 and BLM 2010) .

Many of the quality of life components brought forward in community meetings can be discussed in terms of non-market values. Non-market values are the benefits derived by society from the uses or experiences that are not dispensed through markets and do not require payment. Non-market values can be broken down into two categories, use and non-use values. The use-value of a non-market good is the value to society from the direct use of the asset; through recreational activities such as hiking, bird watching and OHV use. The use of non-market goods often requires consumption of associated market goods, such as lodging and gas. Non-use, or passive use, values of a non-market good reflect the value of an asset beyond its current use, due to willingness to preserve a resource for potential future use and for the benefit of preserving an asset for future generations to enjoy. This can include values such as scenic views and preservation of plant and animal habitat that are not currently providing economic benefits . Non-use values are typically measures in surveys of individual's willingness to pay for preservation of a resource.

Open space in the region has an important non-market function in the use category through area recreational activities, including fishing and hunting. These uses provide opportunities for recreation local residents and may also attract area visitors. Undeveloped open space in the area may also play a role in the non-use category by preserving the visual landscape as well as the historic pastoral setting for future generations' enjoyment. Ranchlands and farmlands themselves may be important for heritage value, both culturally and naturally (Rosenberger and Walsh 1997).

Some of the value of undeveloped areas can also be determined by examining ecosystem services, including clean air and water. BLM Instruction Memorandum (IM 2013-131) explains that "Ecosystem goods and services include a range of human benefits resulting from appropriate ecosystem structure and function, such as flood control from intact wetlands and carbon sequestration from healthy forests. Some involve commodities sold in markets, for example, natural gas. Others, such as wetlands protection and carbon sequestration, do not commonly involve markets, and thus reflect nonmarket values" (BLM 2013c).

Both use and non-use non-market values of open space can play a role in attracting new residents who in turn bring new sources of income to the area. Communities adjacent to public lands offer a high level of natural amenities that often attract retirees and others with non-labor sources of income, as well as sole proprietors and telecommuters who bring income from other regions into the local economy (Haefele et al. 2007). Undeveloped open space may also influence property value of local homes (Fausold and Lilieholm 1996, Western Governors' Association 1998, Crompton 2000).

### 3.4.3 Environmental Justice

***Current Conditions***

A summary of low income populations and racial and ethnic minorities in the socioeconomic planning areas is provided below. Additional information, including complete data tables, is available in the Bull Mountain MDP EIS Socioeconomic Baseline Report (BLM 2013b).

Executive Order 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low-income Populations, requires that federal agencies identify and address any disproportionately high and adverse human health or environmental effects of their programs, policies, and activities on minority and low-income populations. 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 effects on minority and low-income populations. Low-income populations are defined as persons living below the poverty level based on total income of $11,484 for an individual and $22,811 for a family household of four for 2011 data (US Census Bureau 2010b). Black/African American, Hispanic, Asian and Pacific Islander, American Indian, Eskimo, Aleut, and other non-White persons are defined as minority populations. For environmental justice compliance, the relevant minority population is defined as the total of all persons of a minority racial identity plus persons of Hispanic-origin ethnic identity (Council on Environmental Quality 1997).

Populations are identified for further analysis of environmental justice impacts when one of two factors is present: (1) the minority and/or low income population of the affected area exceeds 50 percent or (2) the minority and/or population percentage of the affected area is “meaningfully greater” than the minority population percentage in the general population or other appropriate unit of geographic analysis, identified here as 20 percentage points or greater difference from the state level.

*Low-income Populations*

Based on 2007-2011 data, Delta County had a low-income population of 14.1 percent, near the state poverty rate of 14.3, while Gunnison County was estimated to be slightly lower than the state rate at 13.8 percent of persons below poverty. The census tracts encompassing the proposed project area (Gunnison Valley tract 9639) and those in the North Fork Valley south of the project area along State Highway 133 (Delta County tracts 9646 and 9650) were also examined. Poverty rate for these geographic areas ranged from 7.0 in Gunnison County in the regions surrounding the project area, and 16.9 and 9.5 percent for the 2 relevant census tracts in Delta County. All areas had an increase in poverty compared to 2000 data due to the 2008 economic downturn (US Census Bureau 2011).

*Minority Populations*

Based on 2007-2011 data, approximately 71 percent of Colorado’s population was identified as White and not of Hispanic or Latino origin. The remaining 29 percent identified as an ethnic and/or racial minorities. People of Hispanic or Latino descent (of any race) were the largest minority group and accounted for 20.7 percent of the total state population (US Census Bureau 2011).

The project area and the two-county region examined are less diverse than that of the state. In Delta County, approximately 83 percent of the total population was identified as White of non-Hispanic/Latino origin in 2010 and the remaining 17 percent as ethnic and/or racial minority, while in Gunnison County approximately 89 percent were identified as White of non-Hispanic/Latino origin and the remaining 11 percent identifying as an ethnic and/or racial minority. The largest minority groups in both counties included those of Hispanic/Latino descent. The racial and ethnic background of the census tract containing the project area (Gunnison County tract 9639) as well as those along State Highway 133 in the North Fork Valley south of the project area (Delta County tracts 9646 and 9650) were also examined. For these census tracts, the percentage of the population who identified themselves as being of Hispanic/Latino origin or from a minority racial group were 1.8, 6.1 and 7.8 percent receptivity, while the remainder of the population classified themselves as White of non-Hispanic/Latino origin (US Census Bureau 2011).

# Chapter 4

## Environmental Consequences

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# CHAPTER 4
# ENVIRONMENTAL CONSEQUENCES

## 4.1 INTRODUCTION

This chapter presents the likely direct, indirect, and cumulative environmental impacts that could result from implementing the alternatives presented in **Chapter 2**, Alternatives. This chapter is organized by topic, similar to **Chapter 3**, Affected Environment. Each topic area includes a method of analysis section that identifies indicators of impacts, methods, and assumptions; a summary of effects common to all alternatives; and an analysis of impacts for each of the alternatives.

This impact analysis identifies impacts that may result in some level of change to the resource, regardless of whether that change is beneficial or adverse. The impact analysis will not include a subjective qualifier (beneficial or adverse) to the impact; instead, it will state the nature, magnitude, and context for the change (see **Section 4.1.1**, General Methodology for Analyzing Impacts, for more detail). The evaluations presented in this section are confined to the actions that have more prominent, immediate, or direct effects. Some of the proposed management actions and potential future development may affect only certain resources and alternatives. If an activity or action is not addressed in a given section, no impacts are expected, or the impact is expected to be negligible.

Impact analysis is a cause-and-effect inquiry. The detailed impact analyses and conclusions are based on the interdisciplinary team's knowledge of resources and the project area, reviews of existing literature, and information provided by experts in the BLM and other agencies. The baseline used for the impact analysis is the current condition or situation, as described in **Chapter 3**, Affected Environment. Impacts on resources and resource uses are analyzed and discussed in detail commensurate with resources issues and concerns identified throughout the process. At times, impacts are described using ranges of potential impacts or in qualitative terms.

### 4.1.1 General Methodology for Analyzing Impacts

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

- Type of Impact – Because types of impacts can be interpreted differently by different people, this chapter 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 programmatic issues is intended to provide the BLM decision maker and reader with an understanding of the multiple-use tradeoffs associated with each alternative.

- Context – Context describes the area or location (site-specific, local, Unit-wide, or regional) in which the impact would occur. Site-specific impacts would occur at the location of the action, local impacts would occur within the general vicinity of the action area, Unit-wide impacts would affect a greater portion of the state, and regional impacts would extend beyond the Unit (state) boundaries.

- Duration – Duration 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 within the first 5 years after the action is implemented. Long term is defined as lasting beyond 5 years to the end of or beyond a 50-year project horizon.

- Intensity – This analysis discusses impacts using quantitative data wherever possible. If quantitative analysis is not possible, qualitative statements are used.

- 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 at the end of each resource section. Cumulative impacts are the direct and indirect effects 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 CFR Part 1508.7). The list of actions used for cumulative impact analysis is provided in **Section 4.1.3**, Cumulative Effects, Past, Present, and Reasonably Foreseeable Future Actions.

Analysis shown under an alternative may be referenced in the other alternatives with such statements as "impacts would be the same as, or similar to, Alternative A" or "impacts would be the same as Alternative B, except for…" as applicable.

Irreversible and irretrievable commitment of resources, unavoidable adverse impacts, and the relationship of short-term uses of the environment to long-term productivity are discussed in **Section 4.5**, Irreversible and Irretrievable Commitment of Resources and Relationship of Short-term Uses of the Environment to Long-term Productivity. Each of these impacts discussions is required by the regulations at 40 CFR 1502.16 and summarizes information for resources and resources uses that may be affected.

The scope of the analysis focuses on impacts on resources and uses on BLM-administered lands or mineral estate, as the decisions being made by the BLM apply only to BLM-administered resources and uses. However, the type of impacts anticipated from energy development may be useful to other agencies and/or private landowners in understanding project development.

### 4.1.2 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 within the project area and timeframe. These assumptions should not be interpreted as constraining or redefining the management objectives and actions proposed for each alternative, as described in **Chapter 2**, Alternatives. The following general assumptions apply to all resource categories. Any specific resource assumptions are provided in the methods of analysis section for that resource.

- Sufficient funding and personnel will be available for implementing the final decision.
- Implementing actions from any of the alternatives will be in compliance with all valid existing rights, federal regulations, BLM policies, and other requirements such as state, county, and local government regulations.
- Additional site-specific NEPA documentation will be completed on PODs or individual APDs as appropriate.
- Appropriate maintenance will be carried out to maintain the functional capability of all developments.
- The discussion of impacts is based on the best available data. Knowledge of the Unit and professional judgment, based on observation and analysis of conditions and responses in similar areas, are used to infer environmental impacts where data are limited.
- Acreage figures and other numbers used in the analyses are approximate projections for comparison and analytic purposes only. Readers should not infer that they reflect exact measurements or precise calculations. Acreage calculations are rounded to the nearest 10 acres. All alternatives assume a standard area of disturbance that will be used for calculations. Due to the uncertainty of the number of wells per pad and alignments for roads and pipelines, the disturbance areas used are estimates only and were developed based on the assumption that the disturbance area would need to be large enough to reasonably accommodate future permitted construction or realignments. Actual and specific well pad size, pipeline width or road width will be determined in future APDs and/or PODs and analyzed in subsequent NEPA actions.
- Cumulative actions within in the Unit were calculated as all of Alternative A actions plus all of Alternative B or Alternative C actions. For example, the cumulative actions under Alternative A includes all of the private wells and well pads as described in Alternative A, plus all of the federal wells and well pads as described in Alternative B. These numbers are the same for cumulative Actions under Alternative B. For Alternative C, the cumulative effects include all of Alternative A actions plus all actions accounted for in Alternative C. **Tables 4-1**, Summary of Cumulative Actions within the Unit by Alternative, and **4-2**, Summary Cumulative Surface Disturbance Acres within the Unit by Alternative, below present action quantities in terms of well and well pad numbers as well as miles of roads and acreage of disturbance.

### 4.1.3 Cumulative Effects

Cumulative impacts are effects on the environment that result from the impact of implementing any one of the alternatives in combination with other actions outside the scope of this plan, either within the Unit or adjacent to it. Cumulative impact analysis is required by CEQ regulations because environmental conditions result from many different factors that act together. The total effect of any single action cannot be determined by considering it in isolation. Total effect must be determined by considering the likely result of that action in conjunction with many others. Evaluation of 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 Unit boundary; therefore, assessment data and information could span multiple scales, land ownerships, and jurisdictions. These assessments involve determinations that often are complex and, to some degree, subjective.

***Cumulative Analysis Methodology***

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 Unit. Resources not discussed in detail include Areas of Critical Environmental Concern and Wild and Scenic Rivers, coal resources, locatable minerals, mineral materials, geothermal resources, Wilderness Study Areas,  or lands with wilderness characteristics (see Chapter 3, Resources and Uses Not Addressed for more information). Wilderness areas are only discussed in the context of potential air quality and visibility impacts on wilderness in **Section 4.2.1**, Air Quality.

Because of the programmatic nature of the Bull Mountain Unit MDP EIS and cumulative assessment, the analysis tends to be broad and generalized to address potential effects 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 lack of detailed information that would result from site specific 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 (see **Chapter 3**, Affected Environment) or the long-term sustainability of a resource or social system.

The following factors were considered in this cumulative impact assessment:

- Federal, state, and private actions
- Potential for synergistic effects or synergistic interaction among or between effects
- Potential for effects across 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 date for the cumulative impacts analysis is 2013. The temporal scope of this analysis is a 50-year planning horizon.

Spatial boundaries vary and are larger for resources that are mobile or migrate (e.g., deer populations) compared with stationary resources (e.g. vegetation). Occasionally, spatial boundaries could be contained within the Unit boundaries or expand beyond the Unit. Spatial boundaries were developed to facilitate the analysis and are included under the appropriate resource section heading.

***Past, Present, and Reasonably Foreseeable Future Actions***

Past, present, and reasonably foreseeable future actions are considered in the analysis to identify whether and to what extent the environment has been degraded or enhanced, whether ongoing activities are causing impacts, and trends for activities in and impacts on the area. Projects and activities are evaluated on the basis of proximity, connection to the same environmental systems, potential for subsequent impacts or activity, similar impacts, the likelihood a project will occur, and whether the project is reasonably foreseeable.

The general cumulative impacts analysis area was defined as the Bull Mountain Unit plus a 10-mile buffer around the unit; however, each resource topic defines the area based on the specific issues and resources being addressed. For example, the air resources cumulative impacts analysis provides for an airshed cumulative analysis area which extends well beyond the general cumulative analysis area. For those projects that fall within the general cumulative analysis area, projects and activities considered in the cumulative analysis were identified by cooperators and BLM employees with local knowledge of the area. Each was asked to provide information on the most influential past, present, or reasonably foreseeable future actions. Additional information was obtained through discussions with agency officials and review of publicly available materials and websites.

Effects of past actions and activities are manifested in the current condition of the resources, as described in the affected environment (see **Chapter 3**, Affected Environment). Reasonably foreseeable future actions are actions that have been committed to or known proposals that would take place within a 50-year planning period. **Table 4-1**, Summary of Cumulative Actions within the Unit by Alternative; **Table 4-2**, Summary Cumulative Surface Disturbance Acres within the Unit by Alternative; **Figure 4-1,** Alternatives A and B Cumulative; and **Figure 4-2**, Alternative C Cumulative, present summaries of the existing and current actions within the Bull Mountain Unit as a starting point for cumulative effects analysis.

Reasonably foreseeable future action scenarios are projections made to predict future impacts – they are not actual planning decisions or resource commitments. Projections, which have been developed for analytical purposes only, are based on current conditions and trends and represent a best professional estimate. Unforeseen changes in factors such as economics, demand, and federal, state, and local laws and policies could result in different outcomes than those projected in this analysis.

**Table 4-1**
**Summary of Cumulative Actions within the Unit by Alternative**

| Phase | Action | Alternative A, No Action | Alternative B Proposed Action | Alternative C Modified Action |
|---|---|---|---|---|
| Construction | Well Pads | 17 existing pads on Private mineral estate<br>11 new pads on Private mineral estate<br>36 new pads on Federal mineral estate | 17 existing pads on Private mineral estate<br>11 new pads on Private mineral estate<br>36 new pads on Federal mineral estate | 17 existing pads on Private mineral estate<br>11 new pads on Private mineral estate<br>35 new pads on Federal mineral estate |
| | Access Roads | 21 miles existing suitable roads<br>79 miles upgrades to existing roads<br>21 miles new road construction | 21 miles existing suitable roads<br>79 miles upgrades to existing roads<br>21 miles new road construction | 21 miles existing suitable roads<br>39 miles upgrades to existing roads<br>16 miles new road construction |
| | | Construction Rate: 600-800 yards per day | | |
| | Pipelines | 6 miles existing co-located with roads<br>12 miles existing cross-country<br>17 miles new co-located with roads<br>15 miles new cross-country | 6 miles existing co-located with roads<br>12 miles existing cross-country<br>17 miles new co-located with roads<br>15 miles new cross-country | 6 miles existing co-located with roads<br>12 miles existing cross-country<br>24 miles new co-located with roads<br>8 miles new cross-country |
| | Electrical Lines | 5 new overhead electrical lines (20 power poles) + 1 existing overhead electrical line | | 5 new buried electrical lines + 1 existing overhead electrical line |
| | Storage Areas | 1 new storage yard developed on land owned by SGI within the Unit | | |
| Drilling | Gas Wells | 17 existing gas wells<br>201 new gas wells | | |
| | | Timeframe<br>Coalbed Methane Natural Gas – 60 days<br>Shale and Sandstone – 85 days | | |
| | Water-Disposal Wells | 5 new water disposal wells<br>1 existing water disposal well | | |
| | | Timeframe: 60 – 120 days | | |
| | Drilling Rate | 3 Tier-2 or cleaner rigs drilling 27 wells per year | | |
| | Drilling Duration | 10 years | 6 years | |

**Table 4-1**
**Summary of Cumulative Actions within the Unit by Alternative**

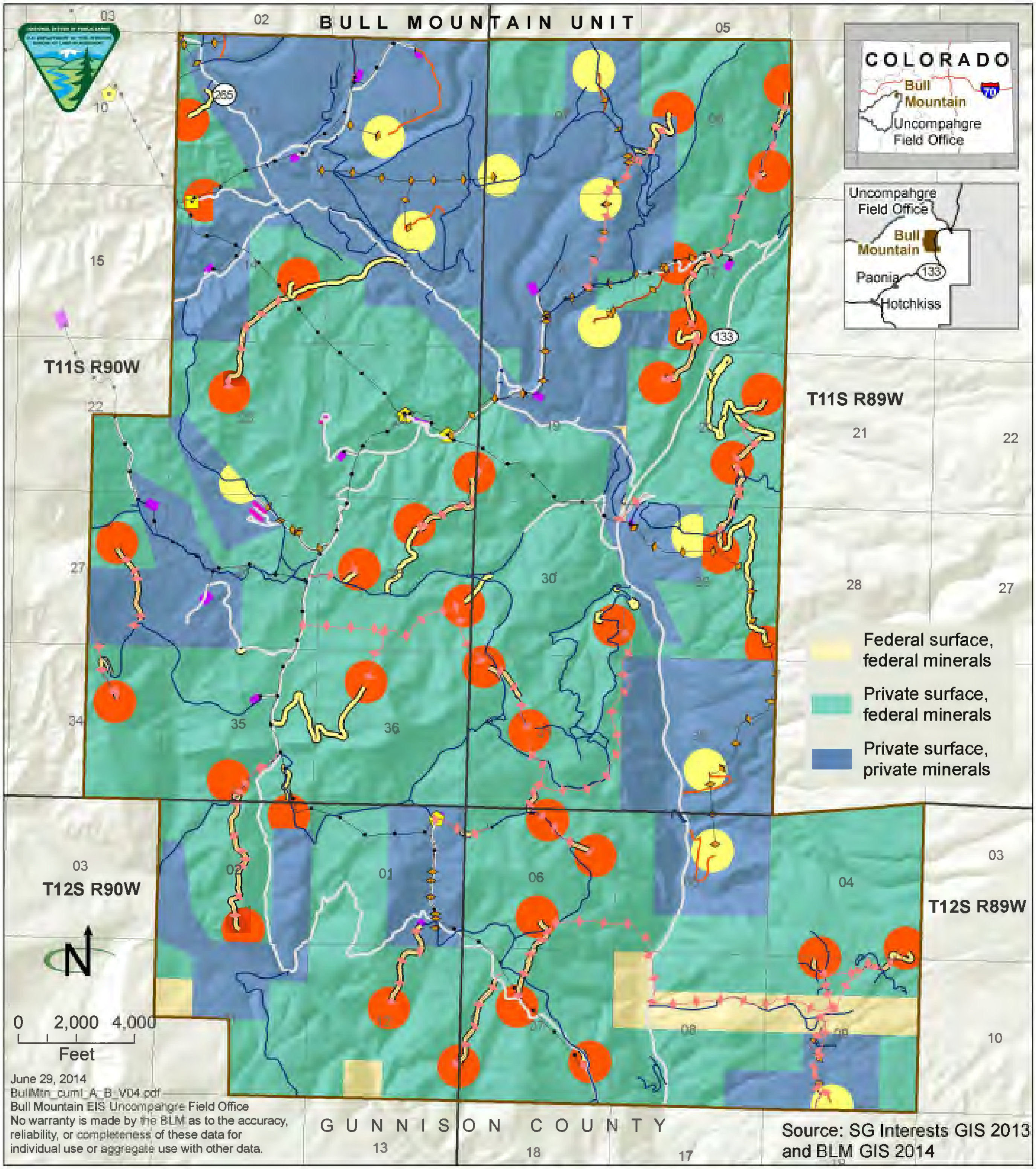
| Phase | Action | Alternative A, No Action | Alternative B Proposed Action | Alternative C Modified Action |
|---|---|---|---|---|
| Completion | Gas Wells | Well completion duration: 8 – 10 days<br>Flow testing duration: 25 – 50 days | | |
| | Water-Disposal Wells | Well completion duration: 8 – 10 days | | |
| Production and Maintenance | Compressor Station | 4 compressor stations | | |
| | Produced Water Management | Production: 500 – 3,000 barrels per day | | |
| | | Coalbed Methane Natural Gas-produced water injected into water disposal wells or trucked to disposal location | | |
| Water Use and Sources | Drilling | 618,000 barrels for all wells | | |
| | Completion | Up to 27,446,200 barrels[1] or 2,662 acre-feet for all new wells<br>(109 coalbed methane)(1,800 bbls) = 196,200<br>(109 shale)(250,000 bbls) = 27,250,000 | | |
| | Dust abatement | 100 – 400 barrels per day | | |
| | Source for all uses | 30% fresh water and 70% recycled and/or produced water | | |
| | Total Water Usage for Drilling and Completion[2] (based on source percentages noted above) | 8,419,260 barrels or 817 acre-feet fresh water<br>19,644,940 barrels or 1,905 acre-feet recycled/produced water | | |

[1] Calculated based on assuming 50 percent CBNG wells and 50 percent shale wells as discussed in the Bull Mountain EA. Water amounts for each type of well were taken from the general SUPO in Appendix D. Calculations used number of new wells per alternative divided in half for each type of well (coalbed methane/shale). To estimate the amount of water use per well type, the number of wells was multiplied by the highest amount of water use for that well type. Water usage totals were added together for a total maximum amount of water usage.

[2] Amounts were calculated based on adding together the Drilling barrels and Completion barrels. The total was multiplied by 30 percent to determine the fresh water amount and 70 percent to determine the amount of recycled/produced water that would be used.

**Table 4-2**
**Summary Cumulative Surface Disturbance Acres within the Unit by Alternative**

| Project Feature | Alternative A Short-term surface disturbance | Alternative A Long-term surface disturbance | Alternative B Short-term surface disturbance | Alternative B Long-term surface disturbance | Alternative C Short-term surface disturbance | Alternative C Long-term surface disturbance |
|---|---|---|---|---|---|---|
| Well Pads | | | | | | |
| Existing Well Pads | NA | 34 acres | NA | 34 acres | NA | 34 acres |
| New Well Pads | 235 acres | 94 acres | 235 acres | 94 acres | 230 acres | 92 acres |
| Roads | | | | | | |
| Existing suitable roads | NA | 41 acres | NA | 41 acres | NA | 41 acres |
| Upgrades to existing | 275 acres | 146 acres | 275 acres | 146 acres | 139 acres | 74 acres |
| New road construction | 77 acres | 41 acres | 77 acres | 41 acres | 60 acres | 32 acres |
| Pipelines | | | | | | |
| Existing, co-located with roads | NA | 11 acres | NA | 11 acres | NA | 11 acres |
| Existing cross-country | NA | NA | NA | NA | NA | NA |
| New, co-located with roads | 213 acres | 33 acres | 213 acres | 33 acres | 285 acres | 45 acres |
| New cross-country | 94 acres | 0 acres | 94 acres | 0 acres | 47 acres | 0 acres |
| Facilities | | | | | | |
| Existing Flowback Pits | NA | 5 acres | NA | 5 acres | NA | 5 acres |
| New Compressor Stations | 20 acres | 8 acres | 20 acres | 8 acres | 20 acres | 8 acres |
| New Storage Yard | 5 acres | 2 acres | 5 acres | 2 acres | 5 acres | 2 acres |




## Alternatives A and B Cumulative

Alternative A proposed well pad analysis area
Alternative B proposed well pad analysis area
Alternative A proposed pipeline
Alternative B proposed pipeline
Alternative A proposed new road construction
Alternative B proposed new road construction
Alternatives A and B existing road requires upgrade for use
Alternatives A and B proposed screw compressor
Alternatives A and B potential storage yard

Existing Infrastructure
Existing road currently suitable for use
Existing pipeline
Existing flowback pit
Existing well pad

Figure 4-1

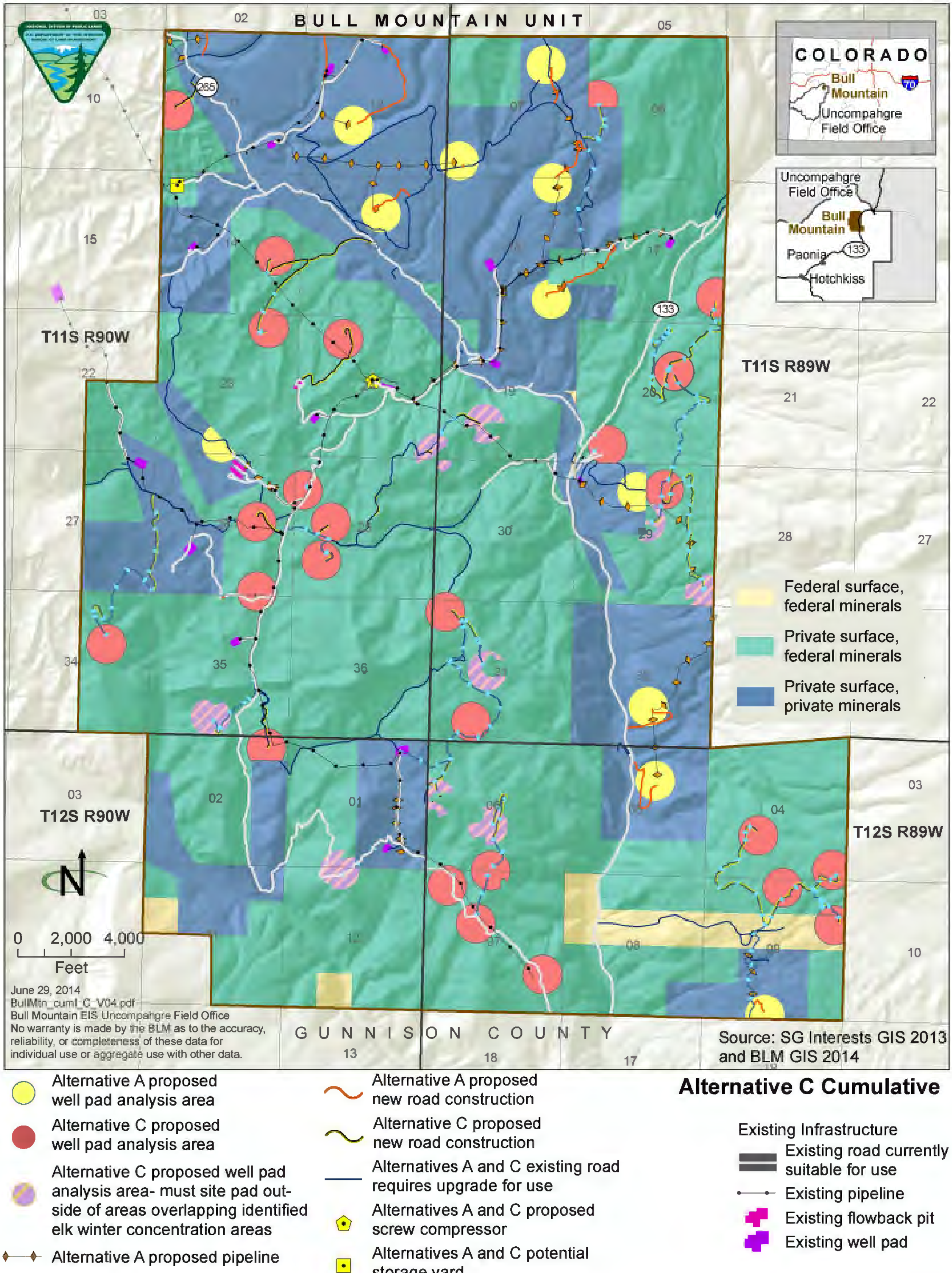

BULL MOUNTAIN UNIT
COLORADO
Bull Mountain
Uncompahgre Field Office
Uncompahgre Field Office
Bull Mountain
Paonia
Hotchkiss
133
265
T11S R90W
T11S R89W
T12S R90W
T12S R89W
Federal surface, federal minerals
Private surface, federal minerals
Private surface, private minerals
0 2,000 4,000
Feet
June 29, 2014
BullMtn_cuml_C_V04.pdf
Bull Mountain EIS Uncompahgre Field Office
No warranty is made by the BLM as to the accuracy, reliability, or completeness of these data for individual use or aggregate use with other data.
GUNNISON COUNTY
Source: SG Interests GIS 2013 and BLM GIS 2014
Alternative C Cumulative
Alternative A proposed well pad analysis area
Alternative C proposed well pad analysis area
Alternative C proposed well pad analysis area- must site pad outside of areas overlapping identified elk winter concentration areas
Alternative A proposed pipeline
Alternative C proposed pipeline
Alternative A proposed new road construction
Alternative C proposed new road construction
Alternatives A and C existing road requires upgrade for use
Alternatives A and C proposed screw compressor
Alternatives A and C potential storage yard
Existing Infrastructure
Existing road currently suitable for use
Existing pipeline
Existing flowback pit
Existing well pad

Figure 4-2

The BLM has considered other potential future actions that have been eliminated from further analysis because of the small likelihood these actions would be pursued and implemented within the life of the plan or because so little is known about the potential action that formulating an analysis of impacts is premature. In addition, potential future actions protective of the environment (such as new potential threatened or endangered species listings or regulations related to fugitive dust emissions) have less likelihood of creating major environmental consequences alone, or in combination with this programmatic effort. Federal actions such as species listing may cause the BLM to reconsider decisions created from this action because the consultations and relative impacts might no longer be appropriate. These potential future actions may have greater capacity to affect resource uses within the Unit; however, until more information is developed, no reasonable estimation of impacts could be developed.

Data on the precise locations and overall extent of resources within the Unit are considerable, although the information varies according to resource type and locale. Furthermore, understanding of the impacts on and the interplay among these resources is evolving. As knowledge improves, management measures (adaptive or otherwise) would be considered to reduce potential cumulative impacts in accordance with law, regulations, and BLM RMPs.

Projects and activities identified as having the greatest likelihood to generate potential cumulative impacts when added to the Bull Mountain Unit MDP alternatives are displayed in **Table 4-3**, Past, Present, and Reasonably Foreseeable Projects, Plans, or Actions that Comprise the Cumulative Impact Scenario.

**Table 4-3**
**Past, Present, and Reasonably Foreseeable Projects, Plans, or Actions that Comprise the Cumulative Impact Scenario**

<table>
<tr><td rowspan="2">Energy and minerals development</td><td>Summary. Most oil and gas development on BLM-administered lands within the cumulative analysis area has been in the North Fork of the Gunnison River area. Numerous mining claims exist. Most coal mining occurs in the North Fork of the Gunnison area.</td></tr>
<tr><td>Coal. There are three active underground coal mines on federal mineral estate in the cumulative impacts analysis area. The following table contains recent production data for the three coal mines in the North Fork Valley.<br>Raw Coal Production in the North Fork Valley<br>Year Averages (Tons)
<table>
<tr><th>Average Based on[1]</th><th>Bowie No. 2 Mine</th><th>Elk Creek Mine</th><th>West Elk Mine</th><th>Total</th></tr>
<tr><td>5 Year</td><td>2,808,556</td><td>4,378,814</td><td>5,721,944</td><td>12,909,314</td></tr>
<tr><td>1 Year</td><td>1,873,357</td><td>3,495,575</td><td>6,499,048</td><td>11,867,980</td></tr>
</table>
[1]Periods end Sept. 30, 2011<br>Note: Each of these mining operations control coal reserves with a mix of federal and fee coal; however, 90 percent or more of local production is federal. As mining progresses, only federal coal will be available in the reserve base.<br>Bowie No. 2 Mine was opened in 1997 as a room-and-pillar mine but converted to a longwall system in late 1999. It is located northeast of Paonia, Colorado, and is operated by Bowie Resources, LLC with a loadout northeast of Paonia. There are 14,540 acres permitted in the combined permits of the Bowie No. 1 and No. 2 Mines accessed by the Bowie No. 2 Mine.<br><br>The Elk Creek Mine is a longwall operation north of Somerset, Colorado, operated by Oxbow Mining, LLC, with a loadout immediately north of Somerset. There are 13,430 acres permitted.<br><br>The West Elk Mine is a longwall operation located south and east of Somerset and is operated by Mountain Coal Company with a loadout about 1 mile east of Somerset. There are 17,160</td></tr>
</table>

**Table 4-3**
**Past, Present, and Reasonably Foreseeable Projects, Plans, or Actions that Comprise the Cumulative Impact Scenario**

acres permitted. The mine is approximately the seventh largest underground longwall coal mine in the US.

The UFO has completed environmental analysis for a Coal Exploration License on Oak Mesa (in Delta County, North of Hotchkiss, Colorado). The planned exploration drilling is to confirm the quality, quantity, and extent of the coal within this area. The approved Oak Mesa project encompasses about 13,873 acres north of Hotchkiss. A Decision Record was approved in September 2012.

Oil and Gas Leasing. The BLM routinely offers land parcels for competitive oil and gas leasing to allow exploration and development of oil and gas resources for public sale. Continued leasing is necessary for oil and gas companies to seek new areas for oil and gas production, or to develop previously inaccessible/uneconomical reserves.

Twenty-five percent (224,950 acres) of the federal fluid mineral estate in the UFO (916,030) is already leased. This includes 160,510 acres (24 percent) of BLM surface and 64,440 acres (27 percent) of split-estate lands (private, state, and local surface with federal fluid mineral subsurface). Total fluid minerals acres leased annually by the BLM over the past 12 years are as follows:

| Year | Average Lease Acreages | Total Leased Acres* | Total Number of Leases |
|---|---|---|---|
| 2000 | 745 | 16,130 | 21 |
| 2001 | 545 | 40,070 | 71 |
| 2002 | 490 | 2,240 | 5 |
| 2003 | 460 | 14,070 | 32 |
| 2004 | 635 | 4,250 | 7 |
| 2005 | 900 | 54,710 | 52 |
| 2006 | 510 | 15,850 | 29 |
| 2007 | 500 | 31,560 | 48 |
| 2008 | 490 | 23,540 | 37 |
| 2009 | 80 | 390 | 5 |
| 2010 | N/A | 0 | 0 |
| 2011 | 40 | 40 | 1 |
| 2012** | 800 | 800 | 1 |

Source: BLM 2012a
*Includes all leased BLM surface acres, plus all federal fluid mineral subsurface under private, local, and State surface. Values are limited to active leases and do not include pending leases.
**As of August 2012.

On private lands within Delta and Gunnison Counties, COGIS records as of November 2011 show a total of 43 natural gas wells; 19 wells are producing, 16 are shut-in and capable of producing; 2 are waiting on completion; and the remaining 6 were drilled, abandoned, and plugged.

**Table 4-3**
**Past, Present, and Reasonably Foreseeable Projects, Plans, or Actions that Comprise the Cumulative Impact Scenario**

| | |
|---|---|
| Vegetation Management | Forestry. Past, current, and foreseeable forestry uses in the cumulative analysis area include personal and commercial harvest of pinyon and juniper fuel wood, poles and posts for fence building, wildings (live trees and shrubs), and Christmas trees. |
| | Vegetation treatments. Prescribed fire and mechanical treatments of vegetation (e.g., chaining, rollerchops, Dixie-harrow, drill seeding, hydro-axing, and brush mowing) were very common in the past on public and private rangelands in the cumulative analysis area. These treatments and maintenance of these vegetation treatments are still fairly common and will likely continue (except chaining). In addition, manual and mechanical treatments of large woody invasive species such as tamarisk have occurred in the riparian areas of rivers and streams; this type of restoration work will likely continue in the foreseeable future. |
| | Hazardous fuels reduction. Fuels treatments, including prescribed fires, chemical and mechanical treatment, and seeding, will likely continue and potentially increase in the future. |
| | Sage-grouse habitat. Implementation of conservation plans for sage-grouse within the cumulative impacts analysis area includes active management techniques to improve habitat quality for sage-grouse, maintain or increase suitable habitat within population areas, and maintain or increase sage-grouse numbers. Plans include the San Miguel Basin Gunnison Sage-grouse Conservation Plan (San Miguel Basin Gunnison Sage-grouse Working Group 2009), Gunnison Sage-grouse Rangewide Conservation Plan (Gunnison Sage-grouse Rangewide Steering Committee 2005), Conservation Assessment of Greater Sage-grouse and Sagebrush Habitats (Connelly et al. 2004), and Colorado Sagebrush: A Conservation Assessment and Strategy (Boyle and Reeder 2005). |
| Livestock grazing | The UFO manages 240 grazing allotments with 165 grazing permittees. Historically, several areas throughout the Unit sustained high levels of both sheep and cattle grazing. Seasonal cattle grazing still occurs, to a lesser degree, from approximately June through September. The Forest Service conducted an Environmental Assessment in 2005 for the Muddy Creek basin (also known as Muddy country). On National Forest System lands surrounding the unit, there are 11 allotments with multiple permittees managing approximately 12,480 ewe/lamb pairs, 1,048 cow/calf pairs, and 30 horses. These allotments are managed intensely with multi-pasture rotations of relatively short duration.<br><br>This resource is primarily affected by surface disturbance of forage habitat for the livestock. With the coal mines and increasing oil and gas development, there continues to be a loss of grass/forb vegetation communities, which have become a limiting factor for grazing. On the Forest, some shut-in wells had not been reclaimed, which continues to affect the amount of forage available to livestock. |
| Recreation and visitor use | Colorado's population has grown significantly in the past 10 years, and an increasing number of people are living near or seeking local BLM-administered lands for a diversity of recreational opportunities characterized by the "mountain resort or outdoor lifestyle." The primary recreational activities in the UFO are motorized vehicle touring, all-terrain vehicle use, motorcycling, mountain biking, big and small game hunting, fishing, hiking, backpacking, horseback riding, sight-seeing, target shooting, dog-walking, and river boating. Recreation-based visitor use in the UFO has increased in most areas in recent years and is expected to continue to increase on BLM and non-BLM lands. |
| | Unauthorized travel. Travel off of designated or existing routes as well as the creation of social trails has occurred and will likely continue to occur within the cumulative analysis area. |

**Table 4-3**
**Past, Present, and Reasonably Foreseeable Projects, Plans, or Actions that Comprise the Cumulative Impact Scenario**

| | |
|---|---|
| Lands and realty | Designation of Energy Corridors on Federal Lands in the 11 Western States Programmatic EIS (DOE and BLM 2009). This multi-federal agency Programmatic EIS analyzes the environmental impacts of designating federal energy corridors on federal lands in 11 western states and incorporating those designations into relevant land use and resource management plans. |
| | Colorado Department of Transportation: 2011 activities on State Highway 133 include snow maintenance and emergency response actions. CDOT is working on highway improvement projects on Highway 92 from Hotchkiss to Delta and Highway 50 in the Blue Mesa Lake area; both of these projects are likely to continue for the next several years |
| | Delta County Master Plan (Delta County 1996). Countywide land use and growth plan for Delta County. With one exception, Gunnison Energy is the sole oil and gas operator in Delta County. Since 2005 they have drilled approximately 10 wells and installed a gathering line in the Oak Mesa area, which is north of Hotchkiss and west of Paonia.<br><br>Several gravel pits have also been approved in the past 5 years; however, most are within just a few miles of the city of Delta itself.<br><br>Residential developments in the area around the communities of Paonia, Hotchkiss, Crawford, and Delta have been growing in population, with many new houses being built. Most of this development has been down-valley from the coal mines in broader portions of the North Fork Valley. This development has increased the traffic load and demand for maintenance on State Highway 133. |
| | Gunnison County: Lands in the Bull Mountain Unit area are designated almost exclusively agricultural and that the current land use is primarily ranching with interspersed residences. The area is nearly surrounded by National Forest System lands. There is a small mixed use area south and southeast of County Road 849; however, there are no commercial or industrial uses occurring in this area. The East Bull Mountain subdivision is in the general area; it consists of 6 35-acre lots of which only one has been developed. As detailed above, Gunnison Energy Corporation permitted 16 wells on 9 pads (Hotchkiss Federal) through Gunnison County; several pads have been constructed, and several wells have been drilled to-date |
| Roadway development | Road construction has occurred in association with timber harvesting, historic vegetation treatments, energy development, and mining on BLM-administered lands, private lands, State of Colorado lands, and National Forest System lands. The bulk of new road building is occurring for community expansion and energy development. Road construction is expected to continue at the current rate on BLM and National Forest System lands; the future rate is unknown on private and State of Colorado lands. |
| Water diversions | The UFO has been and will continue to be affected by irrigation and drinking water diversions. Reservoir operations have affected water supply, aquatic conditions, and timing. Irrigation rights are expected to continue being bought and sold in the future, with some new property owners informally changing how the right was historically used. Due to population growth and land sales, more agricultural water rights may be converted to municipal and industrial uses. Future oil shale development in the region could also result in water diversions. |
| Water | The Natural Resources Conservation Service and US Bureau of Reclamation have been replacing irrigation ditches with buried pipe to conserve water and reduce salinity and selenium within the Colorado River system. |
| | The Town of Paonia plans to replace its current 2-million-gallon water treatment plant, add an additional 2 million gallons of treated water storage, and incorporate hydropower components on the water lines in an effort to reduce plant costs with sustainable energy. Estimated completion 2015. |

**Table 4-3**
**Past, Present, and Reasonably Foreseeable Projects, Plans, or Actions that Comprise the Cumulative Impact Scenario**

| | |
|---|---|
| Spread of noxious/invasive weeds | Noxious weeds, including tamarisk, have invaded and will continue to invade many locations in the cumulative analysis area. Noxious weeds are carried by wind, humans, machinery, and animals. The BLM UFO currently manages weed infestations through integrated weed management, including biological, chemical, mechanical, manual, and educational methods. The 1991 and 2007 Records of Decision for Vegetation Treatment on BLM Lands in Thirteen Western States (BLM 2007a), and the 2007 Programmatic Environmental Report (BLM 2007g), guide the management of noxious weeds in western states. The BLM UFO finalized a noxious weed management strategy in 2013 (BLM 2013) that guides the treatment of weeds in the field office. Noxious and invasive weeds are expected to continue to spread on all lands. Due to their ability to tolerate certain conditions, some species are expected to remain a serious long-term challenge in the cumulative analysis area. |
| | Delta County Noxious Weed Management Plan (Delta County 2010). |
| Wildland fires | Fires within the cumulative analysis area are both naturally occurring and used as a management tool. Naturally occurring fires have been widely distributed in terms of frequency and severity. Increasing recurrence and severity of drought conditions have been predicted for this area as a result of climate change. This could, in turn, increase the occurrence and severity of wildfires on BLM-administered land. |
| Spread of forest insects and diseases | Several years of drought in western states have resulted in severe stress on pine trees. This stress has made the trees less able to fend off attacks by insects such as mountain pine beetles. Mountain pine beetle infestation has been occurring in Colorado since 1996, and some pinyon pine stands in the cumulative analysis area have experienced ips beetle kill. Sudden Aspen Decline is also impacting parts of the cumulative analysis area. |
| Drought | For much of the last decade, most of the western US has experienced drought. Inflows to Lake Powell (indicative of the Upper Colorado Basin) have been below average since 2000, and Colorado regularly goes through periods of drought that may be statewide, region-wide, or within a more localized area. Agriculture, drinking water supplies, and wildland fires are all impacted by drought. |
| Climate change | Increased concern over greenhouse gas emissions and global warming issues may lead to future federal and state regulations limiting the emission of associated pollutants. |
| Air Quality | The area near Telluride is in the Telluride PM10 maintenance area. The area is currently in compliance with all applicable National Ambient Air Quality Standards. For as long as the area remains in maintenance, the BLM will analyze any authorized activities in accordance with the provisions of the General Conformity Rule and document any findings in the applicable authorizing NEPA document. |
| Other | Forest Service Special Areas; Roadless Area Conservation; Applicability to the National Forests in Colorado; Final Rule (77 *Federal Register* 39576-39612, 3 July 2012). The Colorado Roadless Rule provides management direction for conserving and managing approximately 4.2 million acres of Colorado Roadless Areas on National Forest System lands. |

### 4.1.4 Incomplete or Unavailable Information

The CEQ established implementing regulations for NEPA requiring that a federal agency identify relevant information that may be incomplete or unavailable for an evaluation of reasonably foreseeable significant adverse effects in an EIS (40 CFR 1502.22). If the information is essential to a reasoned choice among alternatives, it must be included or addressed in an EIS. Knowledge and information is, and will always be, incomplete, particularly with complex ecosystems considered at various scales.

The best available information pertinent to the decisions to be made has been used in developing this EIS. Considerable effort has been taken to acquire and convert resource data from both the BLM and outside sources into digital format for use in the EIS.

Certain information was unavailable for use in developing this plan because inventories have either not been conducted or are not complete. Some of the major types of data that are incomplete or unavailable include the following:

- Class III cultural resources inventory for the entire Unit
- Field surveys for paleontological resources
- General fish and wildlife focused on migratory bird and raptor surveys for the entire Unit

For these resources, estimates were made concerning the number, type, and significance of these resources based on previous surveys and existing knowledge. In addition, some impacts cannot be quantified given the proposed management actions. Where this gap occurs, impacts are projected in qualitative terms or, in some instances, are described as unknown. Subsequent project-level analysis will provide the opportunity to collect and examine site-specific inventory data required to determine appropriate application of the land use plan-level guidance. In addition, ongoing inventory efforts by the BLM and other agencies in the Unit are updating and refining information for the project area.

## 4.2 Resources

### 4.2.1 Air Quality

***Methods of Analysis***

Air quality modeling analyses were performed to assess the potential impacts on ambient air quality and air quality related values (AQRVs) from potential air emissions resulting from Bull Mountain Unit MDP alternatives. Emissions inventories were developed for Alternative A and Alternative B, and both near-field and far-field air quality analyses were performed to assess the potential impacts from these alternatives. Potential ambient air quality impacts were quantified and compared to applicable state and federal ambient air quality standards (AAQS), Prevention of Significant Deterioration (PSD) increments, and hazardous air pollutant (HAP) thresholds. Potential AQRV impacts (impacts on visibility, atmospheric deposition, and potential increases in acidification to acid-sensitive lakes) were determined and compared with applicable thresholds. The information for this section is pulled directly from the air quality analysis provided in the Bull Mountain Project Air Quality Technical Support Document (AQTSD; Carter Lake 2014).The project-specific air quality impact analyses as described in the AQTSD shows that there are several key air quality related impacts of concern due to predicted air quality impact levels being close to acceptable impact thresholds (AAQS, DAT, etc.). A primary objective of this section is to summarize the overall air quality analysis as described in the AQTSD and provide discussions for the following impacts of concern: near-field particulate matter (PM) impacts from construction and traffic activities, near-field NO2 1-hour and HAPs impacts, far-field nitrogen deposition at nearby Forest Service sensitive areas and regional ozone.

*Emission Inventory Development*
Air pollutant emissions would 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 pollutants emitted during construction would be $PM_{10}$, $PM_{2.5}$, $NO_x$, CO, $SO_2$, volatile organic compounds (VOCs), and HAPs including benzene, toluene, ethyl benzene, xylene, n-hexane, and formaldehyde. These activities would temporarily elevate pollutant levels, but impacts would be localized and would occur only for the short-term duration of the activities. Fugitive dust emissions ($PM_{10}$ and $PM_{2.5}$) would result from work crews commuting to and from the work site and from the transportation and operation of equipment during construction. Wind-blown fugitive dust emissions would also occur from open and disturbed land during construction.

Emissions were quantified using accepted methodologies, including manufacturer's emission factors, EPA emission factors and standards (emissions standards described in Chapter 3), and engineering estimates. Drill rig and completion engines emissions estimated assuming Non-Road Engine Tier-2 Standards emissions compliant.

During field production air pollutant emissions would occur from compressor station operation, well site pumping unit engines, water transfer pump engines, well site heaters, valve/flanges (fugitives), vehicle traffic on roads during routine field operations and maintenance, and work-over activities. The primary pollutants emitted would be $PM_{10}$, $PM_{2.5}$, $NO_x$, CO, $SO_2$, VOCs, and HAPs (benzene, toluene, ethyl benzene, xylene, n-hexane and formaldehyde). These emissions would impact air quality in the project area over the life of the project. Production equipment is subject to current and future CDPHE Best Available Control Technology (BACT) and Reasonably Achievable Control Technology (RACT) guidance and applicable portions of 40 CFR Part 63 Subpart OOOO, Standards of Performance for Crude Oil and Natural Gas Production.

<u>Greenhouse Gases</u>
As part of the development of the project emission inventories, inventories of $CO_2$, $CH_4$, and $N_2O$ emissions from field development and production activities were prepared. Modeling GHG impacts is not within the scope of either the near-field or far-field impact analyses, but the GHG inventories are presented herein for informational purposes and compared to other GHG emission inventories in order to provide context for the project GHG emissions.

In the emission inventory, emissions of the greenhouse gases $CO_2$, $CH_4$, and $N_2O$ from new and existing sources are quantified in terms of $CO_2$ equivalents ($CO_2e$). Measuring emissions in terms of $CO_2e$ allows for the comparison of emissions from different greenhouse gases based on their Global Warming Potential (GWP). GWP is defined as the cumulative radiative forcing of a gas over a specified time horizon relative to a reference gas resulting from the emission of a unit mass of gas. The reference gas is taken to be $CO_2$. The $CO_2e$ emissions for a greenhouse gas are derived by multiplying the emissions of the gas by the associated GWP. The GWPs for the inventoried greenhouse gases are $CO_2$:1, $CH_4$:21, $N_2O$:310 (EPA 2011).

<u>Near-Field Modeling</u>
A near-field ambient air quality impact assessment was performed to evaluate potential maximum pollutant impacts within and near the project area resulting from project alternative

construction and operation activities. EPA's Guideline (EPA 2005) model, AERMOD (version 13350), was used to assess these near-field impacts. The near-field modeling analyses performed provide an estimate of the potential impacts resulting from Alternative A and Alternative B source emissions.

Due to the absence of any available representative monitored meteorology data for the Unit, the 2008 Weather Research and Forecasting (WRF) meteorological model output produced as part of the Western Regional Air Partnership's (WRAP) West-wide Jump Start Air Quality Modeling Study (WestJumpAQMS; ENVIRON et al. 2012) was used to develop meteorological datasets for the AERMOD modeling. To generate appropriate meteorology for input into AERMOD, the Mesoscale Model Interface Program (MMIF) Version 3.0 (ENVIRON 2013) was used in conjunction with 2008 WRF model output. There are 2 WRF model (4-kilometer/2.5-mile) grid cells within the project area, a north site and a south site. MMIF was used to extract the WRF meteorology data for these two sites and both these meteorological data sets were used to assess impacts from emissions for each alternative. Impacts reported herein represent the maximum modeled impacts from either of the two meteorological data sets.

The near-field criteria pollutant impact assessment was performed to estimate maximum potential impacts of CO, $NO_2$, $SO_2$, and $PM_{10}$ and $PM_{2.5}$ from field development and field production emissions sources. Near-field HAP emissions were evaluated for purposes of assessing impacts in the immediate vicinity of the project area for both short-term exposure assessment and for calculation of long-term human health risk. Potential impacts on regional ozone formation from this project are discussed below in the cumulative impacts summary section.

For well pad and access road construction during field development, near-field modeling assessed $PM_{10}$ and $PM_{2.5}$ impacts. The entire Unit layout for the proposed development shows that the minimum distance separating new wells pads is approximately 600 meters and therefore, fugitive dust and vehicle tailpipe particulate emissions from one representative well pad and road segment under construction were analyzed. Wind erosion emissions were included in the modeling. Road and pad vehicle activities were idealized as volume sources and wind erosion emissions were idealized as area sources. Model receptors were placed at 25-meter increments along a boundary 100 meters from the well pad and accessed road, and then defined on 100-meter intervals extending outward approximately 1.5 kilometers. Flat terrain receptors were used. The source and receptor layout for this modeling scenario is shown in **Figure 4-3**, Near-Field Analysis, Well Pad and Access Road Construction Modeling Scenario.

For well production and drilling, modeling scenarios were developed for a concentrated area of development proposed in the Unit, shown in **Figures 4-4**, Near-Field Analysis, Well Production Modeling Scenario, and **4-5**, Near-Field Analysis, Well Development Modeling Scenario. The modeling scenario for well production included 10 new well pads, 4 existing well pads, and 3 proposed compressor stations. New well pads included three pumping units, and associated

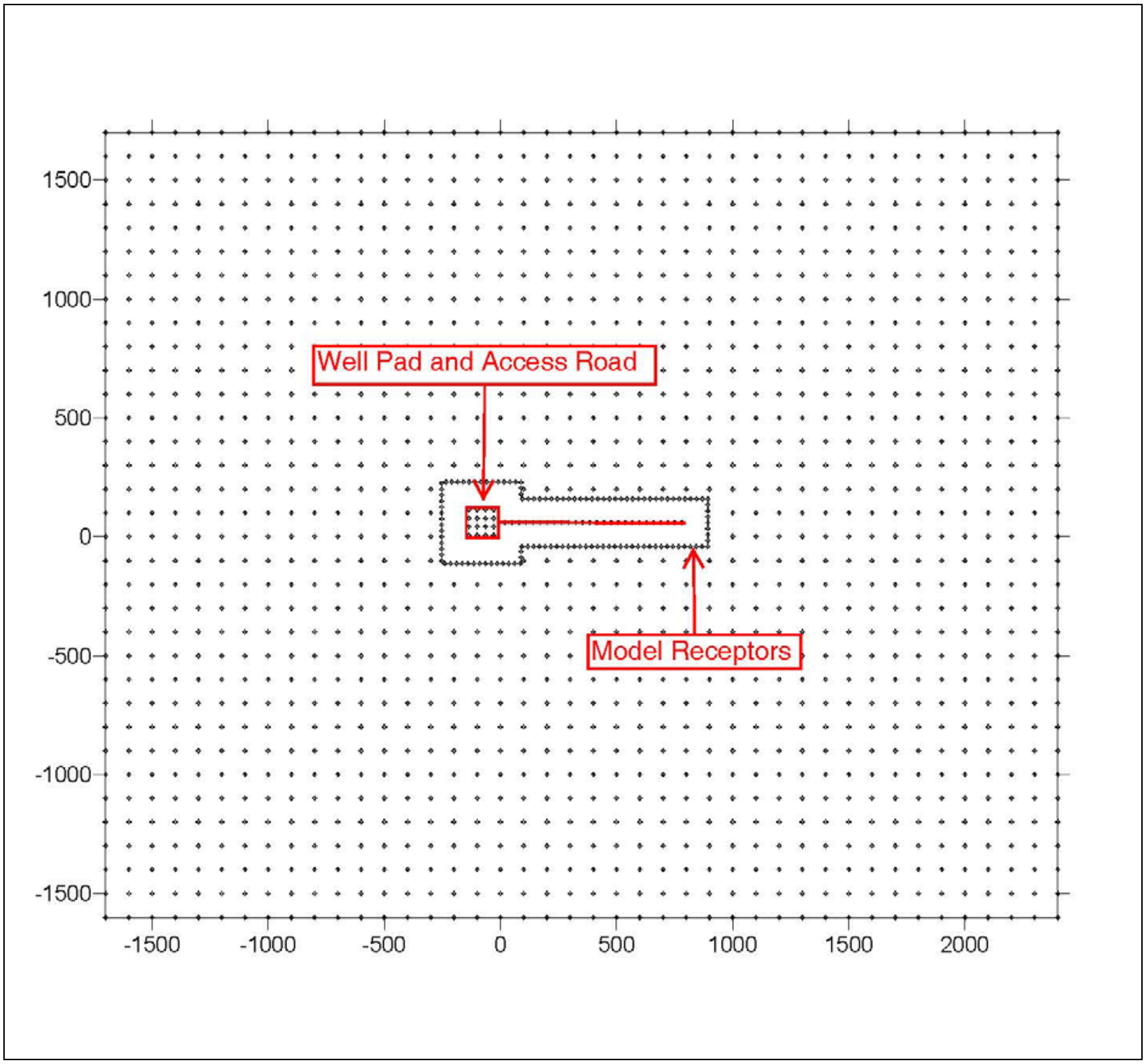



**Figure 4-3: Near-Field Analysis, Well Pad and Access Road Construction Modeling Scenario**

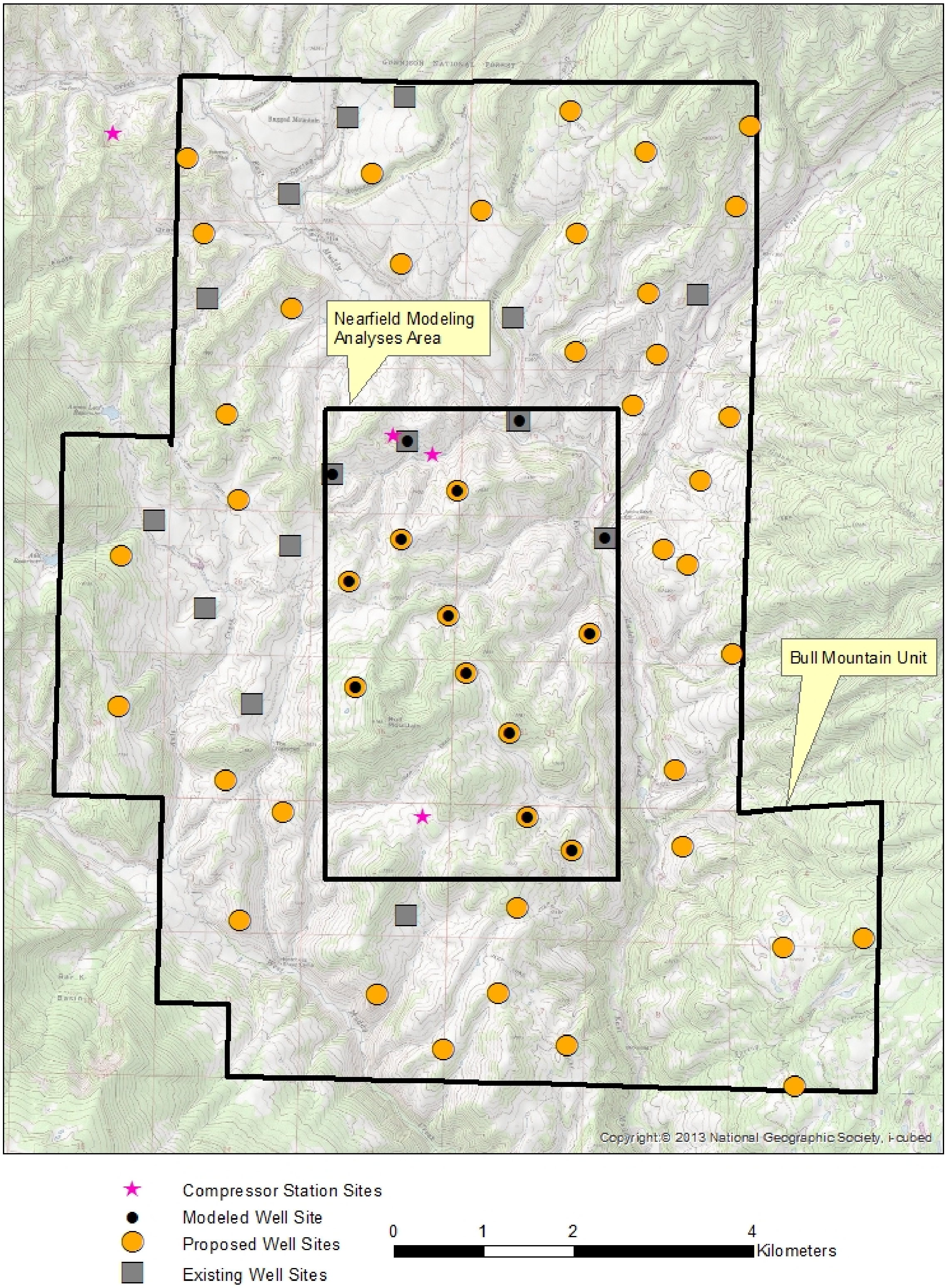



**Figure 4-4: Near-Field Analysis, Well Production Modeling Scenario**

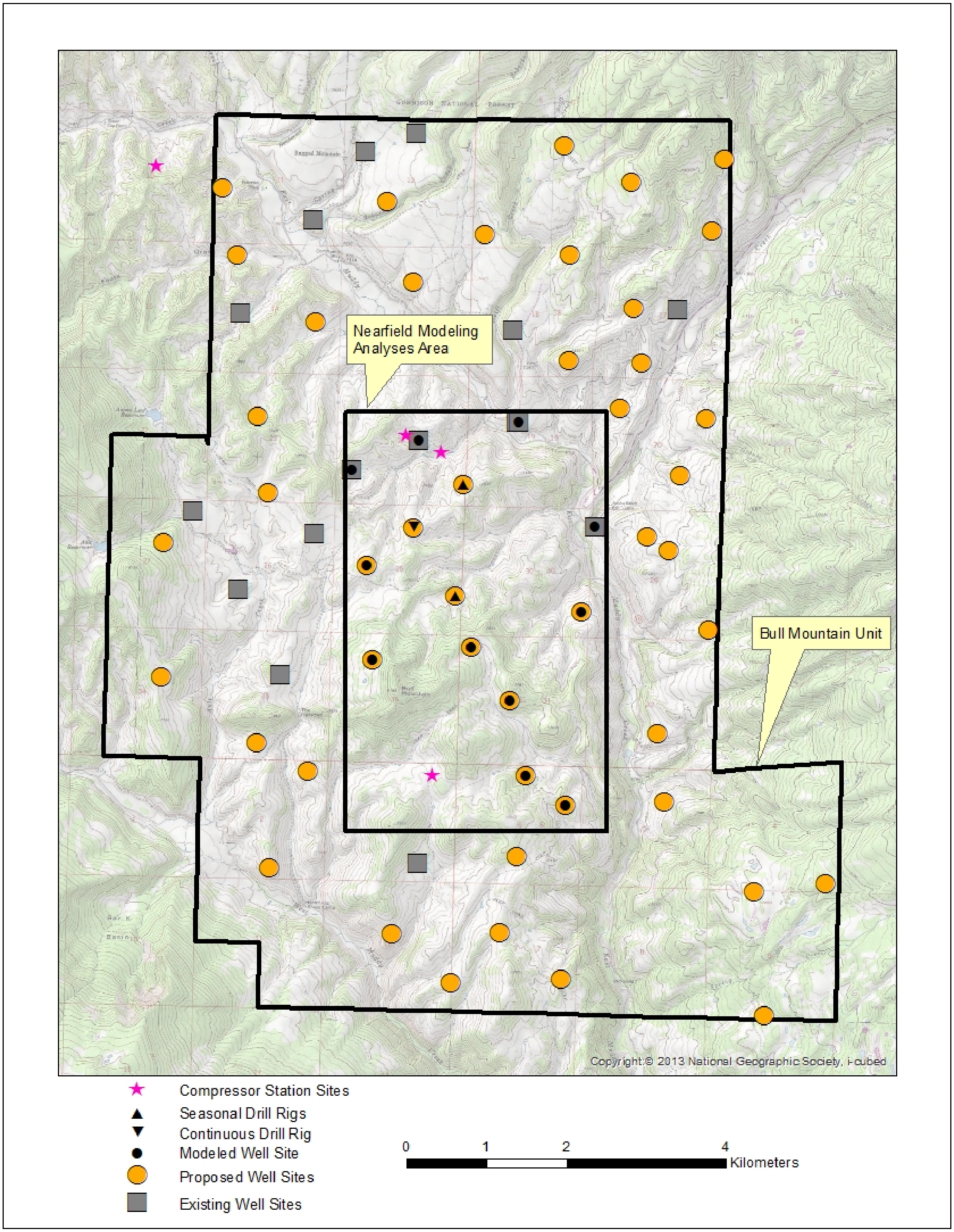



**Figure 4-5: Near-Field Analysis, Well Development Modeling Scenario**

activities (well site heaters, traffic, and fugitive emissions) for 4 wells in production. Existing well pads included two pumping units and related activities for two wells in production. A 100-meter pad size (approximately 2 acres) was used for well production and compressor station pads. The modeling scenario developed for analyzing drilling included seven new well pads and four existing well pads under production, three compressor stations, and three Tier-2 drilling rigs operating (one year-round and two operating from April through November). Drill rig emissions were based on a maximum hourly load conditions. New well pads included three pumping units, and associated activities for four wells in production. Existing well pads included two pumping units and related activities for two wells in production. A 100-meter pad size was used for well and compressor station pads. For the 3 well pads with drilling, a 150-meter (approximately 5 acres) pad size was used.

Both analyses utilized receptor grids that extended outward approximately 1.5 kilometer from the edge of any well pad. Discrete modeling receptors were defined on a 25-meter interval along boundaries, and then defined on 100-meter intervals throughout the modeling domain. **Figures 4-6**, Well Production Receptor Grid, and **4-7**, Near-field Analysis, Well Production Receptor Grid, illustrate the receptor grids used for analyzing well production and well construction, respectively. Where applicable, terrain elevations for each receptor were developed using the AERMAP (Version 11103) processor along with available digital elevation model data.

Point sources were used for modeling emissions from compressors, heaters, pumping units, and drilling rigs. Volume sources were used for modeling well-site fugitive emissions and road travel. Volume source parameters were also used for modeling one pumping unit at each well given that these units could have a horizontal stack release.

The AERMOD near-field modeling utilized default regulatory model switch settings, with the exception of the non-default Ozone Limiting Method (OLM) option, which was used for modeling $NO_2$ concentration estimates. Modeling analyses for $NO_2$ concentration estimates utilized seasonal diurnal ozone concentration profiles developed using the years 2011-2013 data collected at the Clean Air Status and Trends Network (CASTNET) Gothic ozone site located in Gunnison County, Colorado. A value of 20 percent was used for all source in-stack $NO_2$ concentration estimates. This value is a conservative estimate supported by data from EPA's $NO_2/NO_x$ In-Stack Ratio (ISR) Database (EPA 2013) and from data provided from oil and gas operators.

For 1-hour $NO_2$ NAAQS compliance demonstrations, where the 1-hour NAAQS is defined as the 3-year average of the 98th percentile of the yearly distribution of 1-hour daily maximum concentrations, all modeled impacts presented represent the 3-year average of the eighth-highest daily maximum 1-hour concentrations. For scenarios where drilling operations were modeled, drilling operations were assumed to occur for a maximum of 1 year during the 3-year averaging period. Since drill rigs move to different locations during field development, it is unlikely that drilling would occur for 3 consecutive years in the same location.

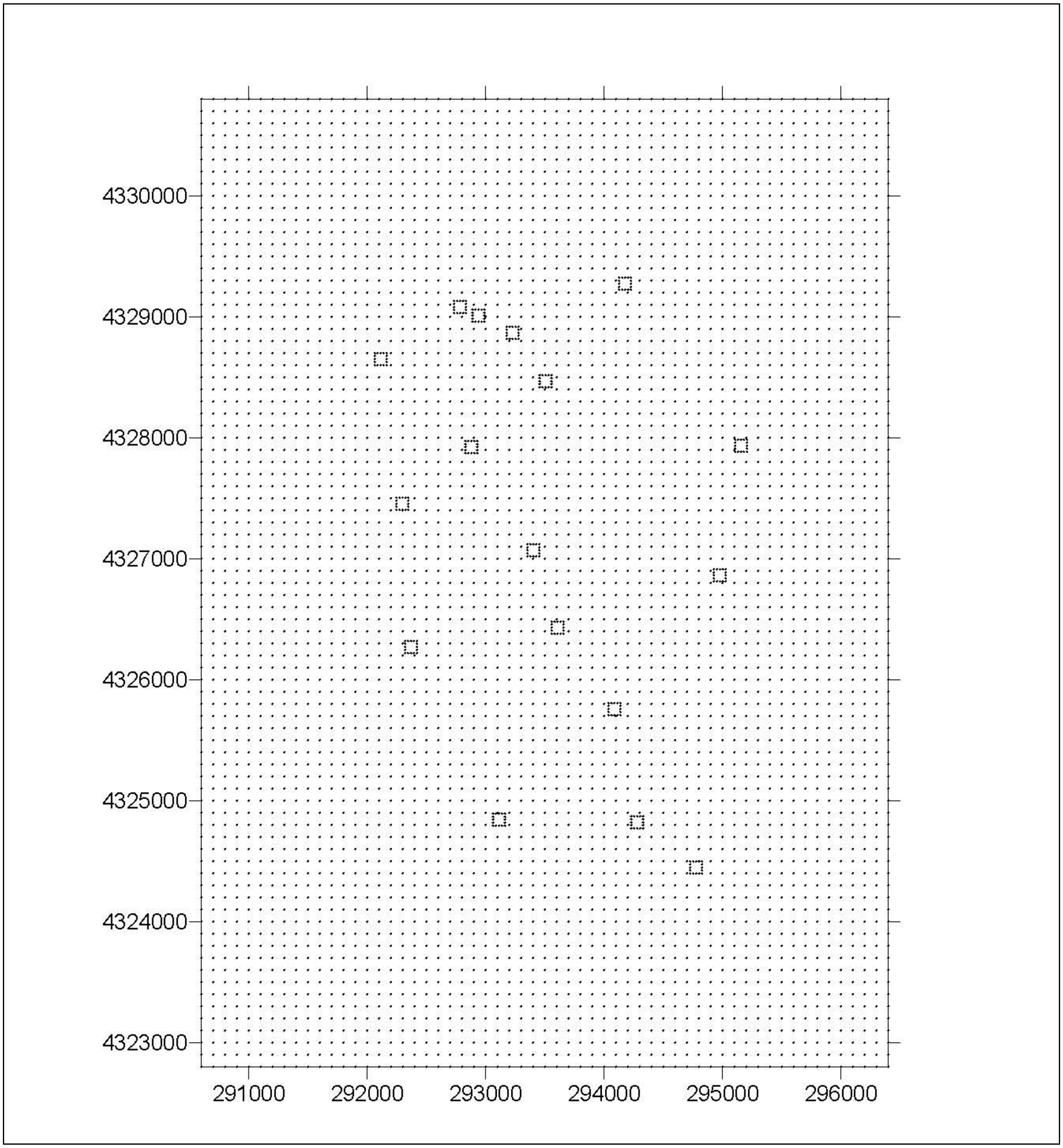



**Figure 4-6: Well Production Receptor Grid**

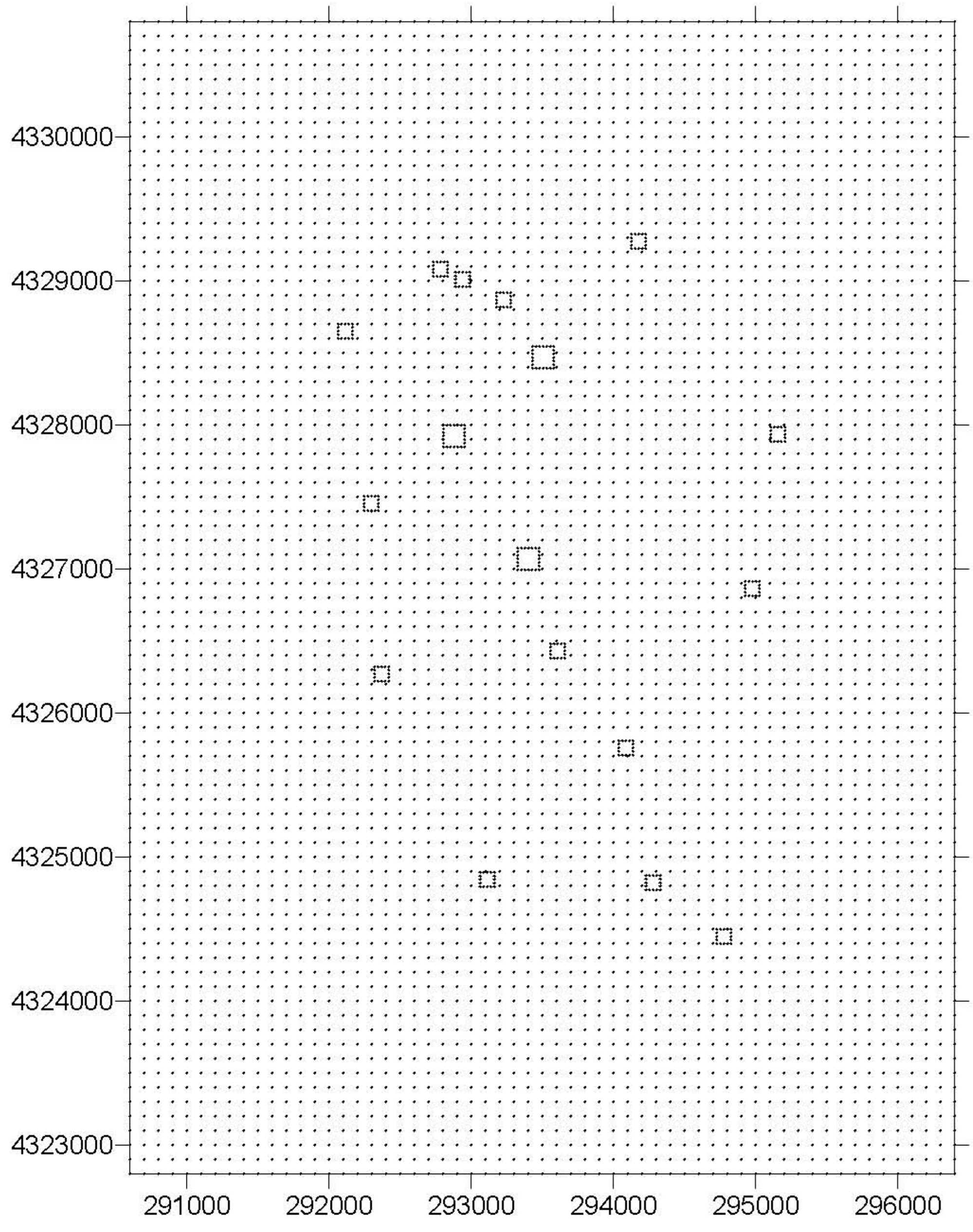



**Figure 4-7: Near-Field Analysis, Well Development Receptor Grid**

Hazardous Air Pollutants

Short-term and long-term near-field modeling analyses were conducted for HAPs. Short-term, 1-hour (acute) HAP concentrations were compared with acute reference exposure level (REL) thresholds. Long-term (annual) HAP concentrations were compared with non-carcinogenic reference concentrations for chronic inhalation thresholds (RfCs).

Modeling analyses estimated the potential cancer risk from emissions of suspected carcinogens benzene, ethyl benzene and formaldehyde. Impacts were evaluated based on estimates of the increased latent cancer risk over a 70-year lifetime. This analysis presents the potential incremental risk from formaldehyde and does not represent a total risk analysis. The cancer risks were calculated using the maximum predicted annual concentrations and EPA's chronic inhalation unit risk factors (URF) for carcinogenic constituents (EPA 2012b). Two estimates of cancer risk are presented: 1) a most likely exposure (MLE) scenario; and 2) a maximum exposed individual (MEI) scenario. The estimated cancer risks are adjusted to account for duration of exposure and time spent at home.

The adjustment for the MLE scenario is assumed to be 9 years, which corresponds to the mean duration that a family remains at a residence (EPA 1993). This duration corresponds to an adjustment factor of 9/70 = 0.13. The duration of exposure for the MEI scenario is assumed to be 50 years (i.e., the life of the project), corresponding to an adjustment factor of 50/70 = 0.71. A second adjustment is made for time spent at home versus time spent elsewhere. For the MLE scenario, the at-home time fraction is 0.64 (EPA 1993), and it is assumed that the individual would remain in an area where annual air toxics concentrations would be one-quarter as large as the maximum annual average concentration during the rest of the day. Therefore, the final MLE adjustment factor is (0.13) x [(0.64 x 1.0) + (0.36 x 0.25)] = 0.094. The MEI scenario assumes that the individual is at home 100 percent of the time, for a final MEI adjustment factor of (0.71 x 1.0) = 0.71.

For the air analysis short-term (1-hour) hazardous air pollutant concentrations are compared to acute reference exposure levels (EPA 2011) shown in **Table 4-4**, Acute Reference Exposure Levels (1-hour exposure). Reference exposure levels are defined as concentrations at or below which no adverse health effects are expected. No reference exposure levels are available for ethyl benzene and n-hexane; instead, the available “Immediately Dangerous to Life or Health values divided by 10 are used. These values were determined by the National Institute for Occupational Safety and Health and were obtained from EPA's Air Toxics Database (EPA 2011). These values are approximately comparable to mild effects levels for 1-hour exposures.

Long-term exposure to hazardous air pollutants are compared to reference concentrations for chronic inhalation. A reference concentration for chronic inhalation is defined by EPA as the daily inhalation concentration at which no long-term adverse health effects are expected. Reference concentrations for chronic inhalation exist for both non-carcinogenic and carcinogenic effects on human health (EPA 2012). Annual modeled hazardous air pollutant concentrations for all hazardous air pollutants emitted were compared directly to the non-carcinogenic reference concentrations for chronic inhalation shown in Table 3-7, Non-Carcinogenic Hazardous Air Pollutant Reference Concentrations for Chronic Inhalation (Annual Average). Long-term

**Table 4-4**
**Acute Reference Exposure Levels (1-hour exposure)**

| Hazardous Air Pollutant | REL ($\mu g/m^3$) |
|---|---|
| Benzene | 1,300 |
| Toluene | 37,000 |
| Ethyl Benzene | 350,000[1] |
| Xylene | 22,000 |
| n-Hexane | 390,000[1] |
| Formaldehyde | 55 |

Source: EPA 2011
[1] No reference exposure levels available for these hazardous air pollutants.

exposures to emissions of suspected carcinogens (benzene, ethyl benzene, and formaldehyde) are also evaluated based on estimates of the increased latent cancer risk over a 70-year lifetime.

Far-Field Modeling
The CALPUFF model was used to assess potential far-field impacts on ambient air pollutant concentrations and AQRVs (visibility and atmospheric deposition) from air pollutant emissions of $NO_x$, $SO_2$, $PM_{10}$, and $PM_{2.5}$ from project alternative sources. Concentration and AQRV impacts were assessed at the following Class I and sensitive Class II areas within 200 kilometers of the project area (exceptions noted):

- Arches National Park, Utah (Class I)
- Black Canyon of the Gunnison National Park, Colorado (Class I)
- Colorado National Monument, Colorado, (Class II)
- Dinosaur National Monument, Colorado-Utah (Federal Class II, Colorado Class I ($SO_2$ only)
- Eagles Nest Wilderness Area, Colorado (Class I)
- Flat Tops Wilderness Area, Colorado (Class I)
- La Garita Wilderness Area, Colorado (Class I)
- Maroon Bells – Snowmass Wilderness Area, Colorado (Class I)
- Mount Zirkel Wilderness Area, Colorado (Class I)
- Ragged Wilderness Area, Colorado (Class II) (deposition analysis only)
- Rocky Mountain National Park, Colorado (Class I)
- Weminuche Wilderness Area , Colorado (Class I)

- West Elk Wilderness Area, Colorado (Class I)

Twenty-eight lakes within the Class I and sensitive Class II areas identified as being sensitive to atmospheric deposition were assessed for potential increases in lake acidification from atmospheric deposition impacts. These lakes are listed below in **Table 4-5**, Sensitive Lakes Analyzed in Far-Field Analysis.

**Table 4-5**
**Sensitive Lakes Analyzed in Far-Field Analysis**

| Wilderness Area | Lake |
|---|---|
| Eagles Nest Wilderness Area | Booth Lake |
| Eagles Nest Wilderness Area | Upper Willow Lake |
| Flat Tops Wilderness Area | Ned Wilson Lake |
| Flat Tops Wilderness Area | Upper Ned Wilson Lake |
| Flat Tops Wilderness Area | Lower Packtrail Pothole |
| Flat Tops Wilderness Area | Upper Packtrail Pothole |
| La Garita Wilderness Area | Small Lake Above U-Shaped Lake |
| La Garita Wilderness Area | U-Shaped Lake |
| Maroon Bells Wilderness Area | Avalanche Lake |
| Maroon Bells Wilderness Area | Capitol Lake |
| Maroon Bells Wilderness Area | Moon Lake |
| Mount Zirkel Wilderness Area | Lake Elbert |
| Mount Zirkel Wilderness Area | Seven Lakes (LG East) |
| Mount Zirkel Wilderness Area | Summit Lake |
| Raggeds Wilderness Area | Deep Creek Lake |
| Weminuche Wilderness Area | Big Eldorado Lake |
| Weminuche Wilderness Area | Four Mile Pothole |
| Weminuche Wilderness Area | Lake Due South of Ute Lake |
| Weminuche Wilderness Area | Little Eldorado Lake |
| Weminuche Wilderness Area | Little Granite Lake |
| Weminuche Wilderness Area | Lower Sunlight Lake |
| Weminuche Wilderness Area | Middle Ute Lake |
| Weminuche Wilderness Area | Small Pond Above Trout Lake |
| Weminuche Wilderness Area | Upper Grizzly Lake |
| Weminuche Wilderness Area | Upper Sunlight Lake |
| Weminuche Wilderness Area | West Snowdon Lake |
| Weminuche Wilderness Area | White Dome Lake |
| West Elk Wilderness Area | South Golden Lake |

The far-field analyses used the EPA-approved version of the CALPUFF modeling system (Version 5.8.4) along with a windfield developed for year 2008 using the MMIF (Version 3.0) program and the 2008 WRF meteorological model output that was produced as part of the WRAP WestJumpAQMS. The modeling domain and the Class I and sensitive Class II areas are shown in **Figure 4-8**, Far-field Analysis Modeling Scenario.

The far-field assessment assumed maximum field-wide emissions scenarios with well development and production activities occurring simultaneously throughout the project area. Three drilling rigs operating continuously (one year-round and two operating from April through November), and one completion rig operating year-round were included in the modeling analysis

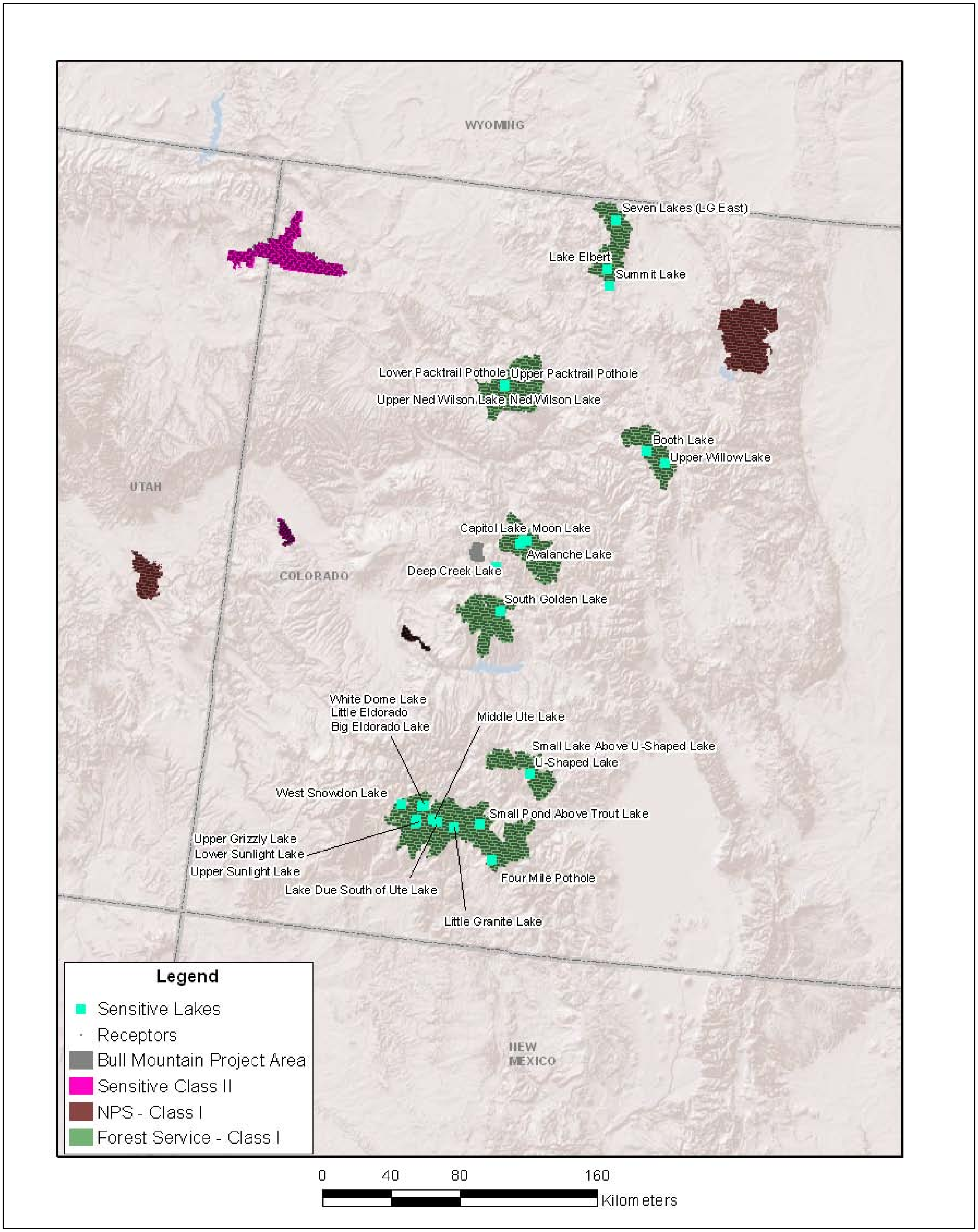



**Figure 4-8: Far-field Analysis Modeling Scenario**

for each project alternative. Compression and well site production emissions (including heaters, pumping units, and traffic emissions) were included in the modeling analysis. Drilling rigs, completion rigs, and four compressor stations were idealized as point sources, and well site activities were idealized as volume sources. The source layout analyzed for the far-field analysis is shown in **Figure 4-9**, Far-field Analysis, Source Layout.

***Nature and Type of Effects***

*Air Quality and Air Quality Related Values*
Air quality impacts from pollutant emissions are limited by regulations, standards and implementation plans established under the Federal Clean Air Act, as administered by the CDPHE-APCD under authorization of the EPA. The operator will conform to all applicable local, state, tribal or federal air quality laws, statutes, regulations, standards or implementation plans. As such, significant impacts on air quality from project-related activities would result if it is demonstrated that:

- NAAQS or CAAQS likely would be exceeded
- AQRVs likely would be impacted beyond acceptable levels

Short-term, 1-hour (acute) HAP concentrations are compared with the acute RELs. RELs are defined as concentrations at or below which no adverse health effects are expected. Long-term (annual) HAP concentrations are compared with non-carcinogenic RfCs. An RfC is defined by EPA as the daily inhalation concentration at which no long-term adverse health effects are expected. Analyses for cancer risk are based on a 1-in-1 million cancer risk factor. An Acceptable Exposure Level (AEL) is generally concentration levels that represent lifetime cancer risk to an individual of between (1 in 10,000) and (1 in 1,000,000) (EPA 2014a).

Climate Change
The current scientific consensus is that the warming of the climate system is "unequivocal" and "continued greenhouse gas emissions at or above current rates would cause further warming and induce many changes in the global climate system during the 21st century that would very likely be larger than those observed during the 20th century" (IPCC 2007). It is not possible to attribute emissions of GHGs from any particular source as having a specific climate impact global or regionally, due to the longevity of GHGs in the atmosphere. GHG emissions from all sources contribute to increased incremental concentrations in the earth's atmosphere and the global climate response. The GHG inventories are presented herein for informational purposes and compared to other GHG emission inventories in order to provide context for the project GHG emissions.

***Effects Common to All Alternatives***

*Near-field Impacts*
Near-field pollutant impacts resulting from well development and well production activities would be below the NAAQS or CAAQS. In addition pollutant impacts would not exceed the PSD Class II increments, with the exception of annual $NO_2$ impacts which could exceed the

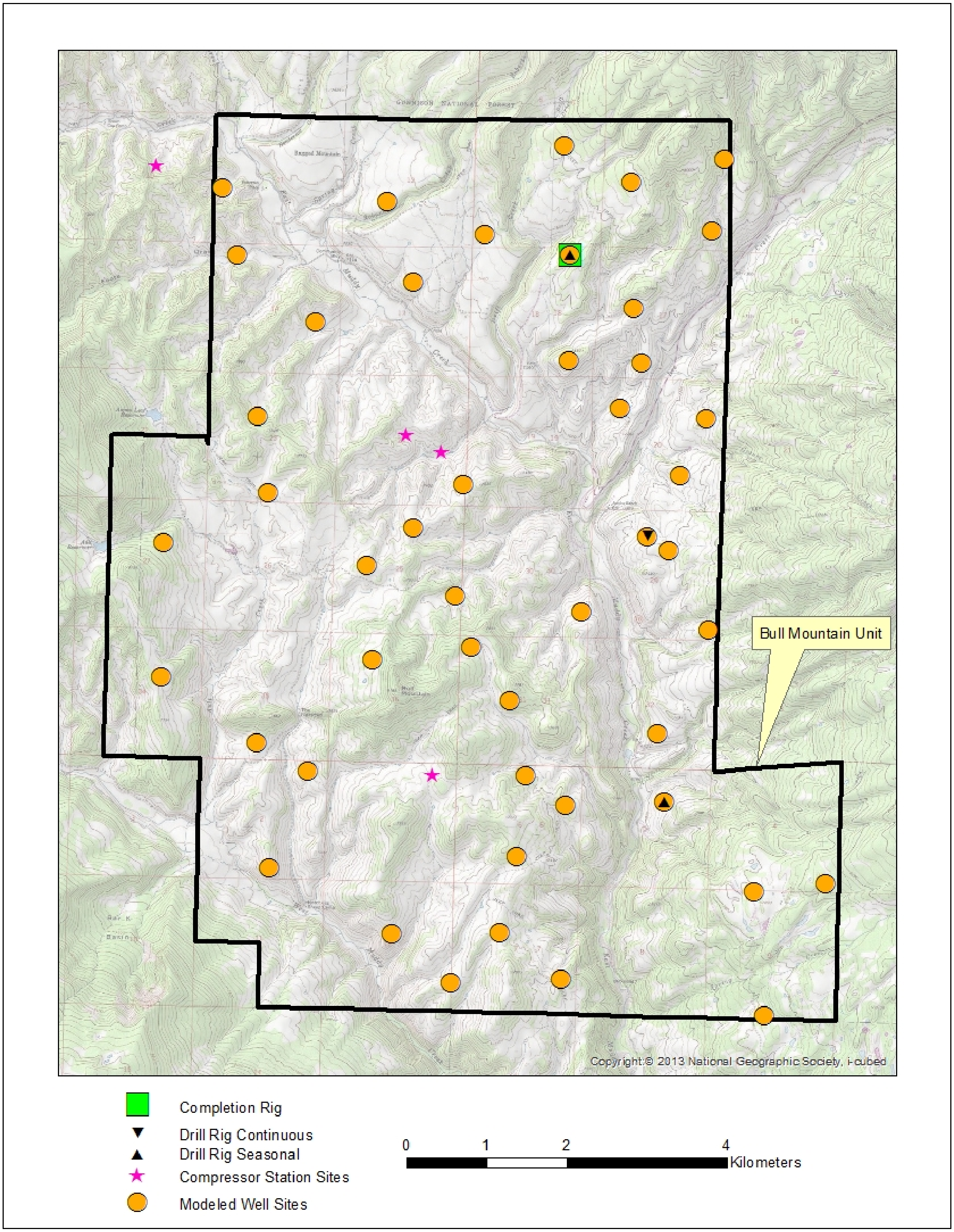



**Figure 4-9: Far-field Analysis, Source Layout**

annual increment value. The maximum predicted acute and chronic (long-term) HAP impacts from well site production would be below all applicable REL and RfC exposure thresholds, with the exception of the modeled formaldehyde concentrations from compression emissions which could exceed the short-term REL threshold.

*Far-Field Impacts*

Pollutant Impacts
Far-field pollutant impacts from project sources would be below PSD increments at all Class I and sensitive Class II areas.

Visibility Impacts
Impacts on visibility from project sources would be below the 0.5 delta-deciview (Δdv) threshold at all Class I and sensitive Class II areas.

Deposition Impacts
Sulfur deposition impacts from project sources would be below the DAT at all Class I and sensitive Class II areas.

Potential nitrogen and sulfur deposition impacts from project sources would not contribute to ANC changes that exceed threshold values at any of the analyzed sensitive lakes.

*Alternative A*
Alternative A includes the construction and operation of 55 natural gas wells, 12 well pads, 1 water disposal well, and associated roads and production facilities, including 1 compression station.

Alternative A Emissions
Maximum annual field-wide criteria pollutant ($PM_{10}$, $PM_{2.5}$, $NO_x$, CO, $SO_2$, and VOC), HAP and GHG emissions were calculated for the first 10 years of the life of the project (LOP). The maximum field-wide emissions are expected to occur during project year 2, the last year with drilling occurring at a rate of 27 wells per year. The criteria pollutant and HAP emissions for well development and production activities in project year 2 are shown in **Table 4-6**, Alternative A Year 2 Emissions. Total HAP emissions for project year 2 are also provided in this table, including benzene, toluene, ethyl benzene, xylene, n-hexane, and formaldehyde emissions of 1.38, 2.06, 0.11, 0.92, 0.75, and 1.84 tons per year (tpy), respectively. Maximum total GHG emissions from construction and production activities are also expected to occur in project year 2 and are shown in **Table 4-7**, Alternative A Year 2 GHG Emissions.

**Table 4-6**
**Alternative A Year 2 Emissions (TPY)**

| Activity | $PM_{10}$ | $PM_{2.5}$ | $NO_x$ | CO | $SO_2$ | VOC | HAPs |
|---|---|---|---|---|---|---|---|
| Construction Emissions | | | | | | | |
| Well Pad and Road Construction | 1.67 | 0.17 | -- | -- | -- | -- | -- |
| Well Pad and Road Construction Traffic | 2.78 | 0.30 | 0.47 | 0.45 | 0.002 | 0.05 | -- |
| Well Pad and Road Construction Heavy Equipment | 0.13 | 0.13 | 2.37 | 2.20 | 0.11 | 0.17 | -- |

**Table 4-6**
**Alternative A Year 2 Emissions (TPY)**

| Activity | $PM_{10}$ | $PM_{2.5}$ | $NO_x$ | CO | $SO_2$ | VOC | HAPs |
|---|---|---|---|---|---|---|---|
| Pipeline Construction | 0.94 | 0.09 | -- | -- | -- | -- | -- |
| Pipeline Construction Traffic | 0.85 | 0.09 | 0.09 | 0.15 | 0.0004 | 0.01 | -- |
| Pipeline Construction Heavy Equipment | 0.06 | 0.06 | 1.79 | 1.03 | 0.05 | 0.16 | -- |
| Drill Rig Engines | 1.16 | 1.16 | 34.71 | 20.06 | 0.11 | 2.31 | 0.03 |
| Drilling Traffic | 15.25 | 15.25 | 2.44 | 2.49 | 0.01 | 0.28 | -- |
| Drilling Heavy Equipment | 0.006 | 0.006 | 0.18 | 0.10 | 0.005 | 0.25 | -- |
| Fracturing Engines | 0.31 | 0.31 | 9.43 | 5.45 | 0.11 | 0.63 | 0.009 |
| Completion Rig Engines | 0.09 | 0.09 | 2.68 | 1.55 | 0.003 | 0.18 | 0.003 |
| Completion Traffic | 0.62 | 0.07 | 0.13 | 0.10 | 0.001 | 0.01 | 0.00 |
| Completion Flaring | 0.10 | 0.10 | 0.91 | 4.97 | 0.00 | 0.37 | 0.09 |
| Production Emissions | | | | | | | |
| Workover Rig Engines | 0.06 | 0.06 | 1.72 | 0.99 | 0.002 | 0.11 | 0.002 |
| Production Traffic | 1.36 | 0.14 | 0.09 | 0.17 | 0.0004 | 0.02 | 0.00 |
| Separator Heaters | 0.11 | 0.11 | 1.45 | 0.72 | -- | 0.46 | 0.06 |
| Tank Heaters | 0.15 | 0.15 | 1.93 | 0.97 | -- | 0.61 | 0.09 |
| Production Fugitives | -- | -- | -- | -- | -- | 20.58 | 4.87 |
| Screw Compressors | 0.26 | 0.26 | 6.15 | 13.16 | -- | 2.52 | 1.44 |
| C.S. Separators | 0.004 | 0.004 | 0.05 | 0.03 | -- | 0.02 | 0.002 |
| Water Transfer Pumps | 0.51 | 0.51 | 18.00 | 3.71 | -- | 1.26 | 0.13 |
| Pumping Units | 1.16 | 1.16 | 41.24 | 8.50 | -- | 2.89 | 0.31 |
| Total Construction Emissions | 23.96 | 17.82 | 55.19 | 38.55 | 0.40 | 4.43 | 0.14 |
| Total Production Emissions | 3.61 | 2.39 | 70.64 | 28.26 | 0.002 | 28.47 | 6.91 |
| Total Emissions | 27.57 | 20.21 | 125.83 | 66.80 | 0.40 | 32.90 | 7.05 |

**Table 4-7**
**Alternative A Year 2 GHG Emissions (metric tons per year)**

| Pollutant | Construction | Production | Total |
|---|---|---|---|
| $CO_2e$ | 7,107 | 13,071 | 20,178 |

<u>Near-field Impacts</u>

Near-field pollutant impacts for Alternative A would be similar to those presented below for Alternative B. Impacts from Alternative A sources would below the NAAQS or CAAQS. In addition impacts would not exceed the PSD Class II increments, with the exception of annual $NO_2$ concentrations which could exceed the annual increment value.

The maximum predicted acute and chronic (long-term) HAP impacts from well site production would be similar to the impacts for the Alternative B. HAP impacts under Alternative A would be below all applicable REL and RfC exposure thresholds, with the exception of the modeled formaldehyde concentrations from compression emissions which could exceed the short-term REL threshold.

For the suspected carcinogens (benzene, ethyl benzene, and formaldehyde), the cancer risk level for production activities for either the MLE or the MEI analysis would be similar to Alternative B levels.

Far-Field Impacts

The far-field assessment assumed a field-wide maximum emissions scenario with well drilling/completion and production activities occurring simultaneously throughout the project area. The field-wide scenario included 41 wells in production, 3 drilling rigs operating continuously (one year-round and two operating from April through November), and one completion rig operating year-round.

Pollutant Impacts

The direct modeled concentrations of $NO_2$, $SO_2$, $PM_{10}$, and $PM_{2.5}$ at Class I and sensitive Class II areas are provided in **Table 4-8**, Alternative A - Maximum Modeled Pollutant Concentrations at Class I and Sensitive Class II Areas, for comparison to applicable PSD Class I and Class II increments. As shown in **Table 4-8**, these values are well below the PSD Class I and Class II increments.

**Table 4-8**
**Alternative A - Maximum Modeled Pollutant Concentrations at Class I and Sensitive Class II Areas ($\mu g/m^3$)**

| Location | Pollutant | Averaging Time | Direct Modeled | PSD Increment |
|---|---|---|---|---|
| Arches National Park | $NO_2$ | Annual | 5.91E-06 | 2.5 |
| | $SO_2$ | 3-hour | 4.54E-04 | 25 |
| | | 24-hour | 1.35E-04 | 5 |
| | | Annual | 1.54E-06 | 2 |
| | $PM_{10}$ | 24-hour | 7.08E-04 | 8 |
| | | Annual | 1.03E-05 | 4 |
| | $PM_{2.5}$ | 24-hour | 7.04E-04 | 2 |
| | | Annual | 8.27E-06 | 1 |
| Black Canyon of the Gunnison National Park | $NO_2$ | Annual | 3.58E-04 | 2.5 |
| | $SO_2$ | 3-hour | 3.24E-03 | 25 |
| | | 24-hour | 1.03E-03 | 5 |
| | | Annual | 3.17E-05 | 2 |
| | $PM_{10}$ | 24-hour | 8.35E-03 | 8 |
| | | Annual | 2.25E-04 | 4 |
| | $PM_{2.5}$ | 24-hour | 7.21E-03 | 2 |
| | | Annual | 1.91E-04 | 1 |
| Colorado National Monument | $NO_2$ | Annual | 4.60E-05 | 2.5 |
| | $SO_2$ | 3-hour | 5.67E-04 | 25 |
| | | 24-hour | 1.36E-04 | 5 |
| | | Annual | 6.73E-06 | 2 |
| | $PM_{10}$ | 24-hour | 1.35E-03 | 8 |
| | | Annual | 4.00E-05 | 4 |

**Table 4-8**
**Alternative A - Maximum Modeled Pollutant Concentrations at Class I and Sensitive Class II Areas ($\mu g/m^3$)**

| Location | Pollutant | Averaging Time | Direct Modeled | PSD Increment |
|---|---|---|---|---|
| | $PM_{2.5}$ | 24-hour | 1.11E-03 | 2 |
| | | Annual | 3.26E-05 | 1 |
| Dinosaur National Monument | $NO_2$ | Annual | 6.42E-06 | 25 |
| | $SO_2$ | 3-hour | 2.72E-04 | 512 |
| | | 24-hour | 4.77E-05 | 91 |
| | | Annual | 1.33E-06 | 20 |
| | $PM_{10}$ | 24-hour | 5.12E-04 | 30 |
| | | Annual | 1.17E-05 | 17 |
| | $PM_{2.5}$ | 24-hour | 4.99E-04 | 9 |
| | | Annual | 9.42E-06 | 4 |
| Eagles Nest Wilderness Area | $NO_2$ | Annual | 3.62E-04 | 2.5 |
| | $SO_2$ | 3-hour | 1.79E-03 | 25 |
| | | 24-hour | 3.42E-04 | 5 |
| | | Annual | 4.16E-05 | 2 |
| | $PM_{10}$ | 24-hour | 7.69E-03 | 8 |
| | | Annual | 3.70E-04 | 4 |
| | $PM_{2.5}$ | 24-hour | 7.20E-03 | 2 |
| | | Annual | 2.88E-04 | 1 |
| Flat Tops Wilderness Area | $NO_2$ | Annual | 2.04E-04 | 2.5 |
| | $SO_2$ | 3-hour | 1.67E-03 | 25 |
| | | 24-hour | 4.03E-04 | 5 |
| | | Annual | 2.15E-05 | 2 |
| | $PM_{10}$ | 24-hour | 8.16E-03 | 8 |
| | | Annual | 2.17E-04 | 4 |
| | $PM_{2.5}$ | 24-hour | 7.97E-03 | 2 |
| | | Annual | 1.80E-04 | 1 |
| La Garita Wilderness Area | $NO_2$ | Annual | 1.05E-04 | 2.5 |
| | $SO_2$ | 3-hour | 2.95E-03 | 25 |
| | | 24-hour | 5.29E-04 | 5 |
| | | Annual | 1.53E-05 | 2 |
| | $PM_{10}$ | 24-hour | 1.05E-02 | 8 |
| | | Annual | 1.47E-04 | 4 |
| | $PM_{2.5}$ | 24-hour | 1.11E-02 | 2 |
| | | Annual | 1.21E-04 | 1 |
| Maroon Bells/Snowmass Wilderness Area | $NO_2$ | Annual | 7.78E-03 | 2.5 |
| | $SO_2$ | 3-hour | 2.83E-02 | 25 |
| | | 24-hour | 6.91E-03 | 5 |
| | | Annual | 6.70E-04 | 2 |
| | $PM_{10}$ | 24-hour | 5.49E-02 | 8 |
| | | Annual | 2.96E-03 | 4 |
| | $PM_{2.5}$ | 24-hour | 3.86E-02 | 2 |

**Table 4-8**
**Alternative A - Maximum Modeled Pollutant Concentrations at Class I and Sensitive Class II Areas ($\mu g/m^3$)**

| Location | Pollutant | Averaging Time | Direct Modeled | PSD Increment |
|---|---|---|---|---|
| | | Annual | 1.94E-03 | 1 |
| Mount Zirkel Wilderness Area | $NO_2$ | Annual | 4.87E-05 | 2.5 |
| | $SO_2$ | 3-hour | 5.41E-04 | 25 |
| | | 24-hour | 2.14E-04 | 5 |
| | | Annual | 7.42E-06 | 2 |
| | $PM_{10}$ | 24-hour | 2.96E-03 | 8 |
| | | Annual | 7.01E-05 | 4 |
| | $PM_{2.5}$ | 24-hour | 2.49E-03 | 2 |
| | | Annual | 5.79E-05 | 1 |
| Rocky Mountain National Park | $NO_2$ | Annual | 1.37E-04 | 25 |
| | $SO_2$ | 3-hour | 1.09E-03 | 25 |
| | | 24-hour | 3.48E-04 | 5 |
| | | Annual | 1.97E-05 | 2 |
| | $PM_{10}$ | 24-hour | 2.96E-03 | 8 |
| | | Annual | 1.98E-04 | 4 |
| | $PM_{2.5}$ | 24-hour | 2.31E-03 | 2 |
| | | Annual | 1.60E-04 | 1 |
| Weminuche Wilderness Area | $NO_2$ | Annual | 6.02E-05 | 2.5 |
| | $SO_2$ | 3-hour | 1.20E-03 | 25 |
| | | 24-hour | 2.61E-04 | 5 |
| | | Annual | 9.78E-06 | 2 |
| | $PM_{10}$ | 24-hour | 6.84E-03 | 8 |
| | | Annual | 9.29E-05 | 4 |
| | $PM_{2.5}$ | 24-hour | 6.85E-03 | 2 |
| | | Annual | 7.94E-05 | 1 |
| West Elk Wilderness Area | $NO_2$ | Annual | 2.73E-03 | 2.5 |
| | $SO_2$ | 3-hour | 7.43E-03 | 25 |
| | | 24-hour | 2.82E-03 | 5 |
| | | Annual | 2.05E-04 | 2 |
| | $PM_{10}$ | 24-hour | 2.34E-02 | 8 |
| | | Annual | 1.21E-03 | 4 |
| | $PM_{2.5}$ | 24-hour | 2.08E-02 | 2 |
| | | Annual | 8.79E-04 | 1 |

Visibility Impacts

Visibility impacts were calculated following FLAG 2010 (FLAG, 2010), at Class I and sensitive Class II areas and the results are shown in **Table 4-9**, Alternative A - Maximum Visibility Impacts at Class I and Sensitive Class II Areas. The visibility analysis indicated that there are zero days predicted above the 0.5 delta-deciview ($\Delta dv$) threshold at any of the Class I and sensitive Class II areas.

**Table 4-9**
**Alternative A - Maximum Visibility Impacts at Class I and Sensitive Class II Areas**

| Location | Maximum Impact (Δdv) |
|---|---|
| Arches National Park | 0.003 |
| Black Canyon of the Gunnison National Park | 0.028 |
| Colorado National Monument | 0.004 |
| Dinosaur National Monument | 0.002 |
| Eagles Nest Wilderness Area | 0.033 |
| Flat Tops Wilderness Area | 0.037 |
| La Garita Wilderness Area | 0.045 |
| Maroon Bells/Snowmass Wilderness Area | 0.170 |
| Mount Zirkel Wilderness Area | 0.011 |
| Rocky Mountain National Park | 0.009 |
| Weminuche Wilderness Area | 0.031 |
| West Elk Wilderness Area | 0.086 |

Deposition Impacts

Potential direct atmospheric deposition impacts within Class I and sensitive Class II areas were calculated for Alternative A sources and are shown in **Table 4-10**, Alternative A - Maximum Nitrogen and Sulfur Deposition Impacts at Class I and Sensitive Class II Areas. The maximum direct total (wet and dry) N and S deposition are predicted to be below the DAT of 0.005 kg/ha-yr at all Class I and sensitive Class II areas.

In addition, potential changes in ANC, resulting from potential N and S deposition from Alternative A source emissions, were calculated for 28 sensitive lakes within the Class I and sensitive Class II Wilderness areas. The baseline ANC values for calculating changes were based on approximately 15-20 years of lake chemistry data ending year 2010 for most lakes included in the analysis. The estimated change in ANC for each lake is shown in **Table 4-11**, Alternative A - Maximum Impacts on Lakes within the Class I and Sensitive Class II Areas. For all lakes the estimated changes in ANC are all predicted to be less than the significance thresholds of less than a 10 percent change in ANC for lakes with ANC values greater than 25 μeq/l, and a 1.0 μeq/l change in ANC for lakes with background ANC values equal to or less than 25 μeq/l.

**Table 4-10**
**Alternative A - Maximum Nitrogen and Sulfur Deposition Impacts at Class I and Sensitive Class II Areas**

| Location | Maximum N Deposition (kg/ha/yr) | Maximum S Deposition (kg/ha/yr) |
|---|---|---|
| Arches National Park | 0.00001 | 0.000001 |
| Black Canyon of the Gunnison National Park | 0.00030 | 0.00004 |
| Colorado National Monument | 0.00003 | 0.00001 |
| Dinosaur National Monument | 0.00001 | 0.00000 |
| Eagles Nest Wilderness Area | 0.00047 | 0.00006 |
| Flat Tops Wilderness Area | 0.00030 | 0.00004 |
| La Garita Wilderness Area | 0.00025 | 0.00004 |
| Maroon Bells/Snowmass Wilderness Area | 0.00427 | 0.00071 |
| Mount Zirkel Wilderness Area | 0.00011 | 0.00001 |
| Ragged Wilderness Area (Deep Creek Lake) | 0.00273 | 0.00042 |
| Rocky Mountain National Park | 0.00026 | 0.00003 |
| Weminuche Wilderness Area | 0.00015 | 0.00002 |
| West Elk Wilderness Area | 0.00134 | 0.00018 |

**Table 4-11**
**Alternative A - Maximum Impacts on Lakes within the Class I and Sensitive Class II Areas**

| Wilderness Area | Sensitive Lake | 10th Percentile Lowest ANC Value (µeq/L) | N Deposition (kg/ha/yr) | S Deposition (kg/ha/yr) | ANC Relative Change (%) | ANC Absolute Change (µeq/L) |
|---|---|---|---|---|---|---|
| Eagles Nest | Booth Lake | 86.8 | 0.00040 | 0.00005 | 0.005 | n/a |
| Eagles Nest | Upper Willow Lake | 134.1 | 0.00042 | 0.00005 | 0.004 | n/a |
| Flat Tops | Ned Wilson Lake | 39.0 | 0.00019 | 0.00002 | 0.005 | n/a |
| Flat Tops | Upper Ned Wilson Lake | 12.9 | 0.00019 | 0.00002 | 0.015 | 0.002 |
| Flat Tops | Lower Packtrail Pothole | 29.7 | 0.00019 | 0.00002 | 0.007 | n/a |
| Flat Tops | Upper Packtrail Pothole | 48.7 | 0.00019 | 0.00002 | 0.004 | n/a |
| La Garita | Small Lake Above U-Shaped Lake | 59.9 | 0.00021 | 0.00003 | 0.005 | n/a |
| La Garita | U-Shaped Lake | 81.4 | 0.00021 | 0.00003 | 0.004 | n/a |
| Maroon Bells | Avalanche Lake | 158.8 | 0.00209 | 0.00031 | 0.010 | n/a |
| Maroon Bells | Capitol Lake | 154.4 | 0.00208 | 0.00031 | 0.011 | n/a |
| Maroon Bells | Moon Lake | 53.0 | 0.00207 | 0.00031 | 0.039 | n/a |
| Mount Zirkel | Lake Elbert | 56.6 | 0.00010 | 0.00001 | 0.001 | n/a |
| Mount Zirkel | Seven Lakes (LG East) | 36.2 | 0.00008 | 0.00001 | 0.002 | n/a |
| Mount Zirkel | Summit Lake | 48.0 | 0.00011 | 0.00001 | 0.002 | n/a |
| Raggeds | Deep Creek Lake | 20.6 | 0.00273 | 0.00042 | 0.156 | 0.032 |
| Weminuche | Big Eldorado Lake | 19.6 | 0.00008 | 0.00001 | 0.004 | 0.001 |
| Weminuche | Four Mile Pothole | 123.4 | 0.00009 | 0.00001 | 0.001 | n/a |
| Weminuche | Lake Due South of Ute Lake | 13.2 | 0.00008 | 0.00001 | 0.006 | 0.001 |
| Weminuche | Little Eldorado | -3.3 | 0.00008 | 0.00001 | 0.027 | 0.001 |
| Weminuche | Little Granite Lake | 80.7 | 0.00008 | 0.00001 | 0.002 | n/a |
| Weminuche | Lower Sunlight Lake | 80.9 | 0.00007 | 0.00001 | 0.001 | n/a |
| Weminuche | Middle Ute Lake | 42.8 | 0.00008 | 0.00001 | 0.002 | n/a |
| Weminuche | Small Pond Above Trout Lake | 25.5 | 0.00009 | 0.00001 | 0.005 | n/a |
| Weminuche | Upper Grizzly Lake | 29.9 | 0.00007 | 0.00001 | 0.002 | n/a |
| Weminuche | Upper Sunlight Lake | 28.0 | 0.00007 | 0.00001 | 0.003 | n/a |
| Weminuche | West Snowdon Lake | 39.4 | 0.00008 | 0.00001 | 0.002 | n/a |
| Weminuche | White Dome Lake | 2.1 | 0.00008 | 0.00001 | 0.042 | 0.09 |
| West Elk | South Golden Lake | 111.4 | 0.00091 | 0.00012 | 0.009 | n/a |

Regional Climate Change and Greenhouse Gas Emissions

The maximum GHG emissions resulting from Alternative A are estimated at 20,178 metric tons per year [0.02 terragrams (tg)/yr] of $CO_2$e. To place the project GHG emissions in context, the GHG emissions from the top 5 emitting coal-fired power plants in Colorado range from 2.6 to 9.0 tg/year (EPA 2014b). In addition, 0.02 tg/yr is approximately equivalent to 0.0003 percent of the total 2012 U.S. $CO_2$e emissions. Predicting the degree of impact any single emitter of GHGs may have on global climate change, or on the changes to biotic and abiotic systems that accompany climate change, is not possible at this time. As such, the controversy is to what extent GHG emissions resulting from continued oil and gas development may contribute to global climate change, as well as the accompanying changes to natural systems cannot be quantified or predicted. The degree to which any observable changes can, or would, be attributable to Alternative A cannot be reasonably predicted at this time. See Climate Change discussion for Alternative B for supplemental information.

*Alternative B*

Alternative B includes the construction and operation of up to 146 natural gas wells, 36 well pads, 4 water disposal wells, and associated roads and production facilities, including 4 compression stations.

Alternative B Emissions

Maximum annual field-wide criteria pollutant ($PM_{10}$, $PM_{2.5}$, $NO_x$, CO, $SO_2$, and VOC), HAP and GHG emissions were calculated for the first 10 years of the life of the project (LOP). The maximum field-wide emissions are expected to occur during project year 5, the last year with drilling occurring at a rate of 27 wells per year. The criteria pollutant and HAP emissions for well development and production activities in project year 5 are shown in **Table 4-12**, Alternative B Year 5 Emissions. Total VOC and HAP emissions for project year 5 are also provided in this table. Project year 6 is expected to have slightly higher VOC emissions (82.95 tpy) and HAP emissions (20.65 tpy); including benzene (3.65 tpy), toluene (5.50 tpy), ethyl benzene (0.30 tpy), xylene (2.44 tpy), n-hexane (1.98 tpy), and formaldehyde emissions (6.78 tpy). Maximum total GHG emissions from construction and production activities are also expected to occur in project year 5 and are shown in **Table 4-13**, Alternative B Year 5 GHG Emissions.

**Table 4-12**
**Alternative B Year 5 Emissions (TPY)**

| Activity | $PM_{10}$ | $PM_{2.5}$ | $NO_x$ | CO | $SO_2$ | VOC | HAPs |
|---|---|---|---|---|---|---|---|
| Construction Emissions | | | | | | | |
| Well Pad and Road Construction | 1.67 | 0.17 | -- | -- | -- | -- | -- |
| Well Pad and Road Construction Traffic | 2.78 | 0.30 | 0.47 | 0.45 | 0.002 | 0.05 | -- |
| Well Pad and Road Construction Heavy Equipment | 0.13 | 0.13 | 2.37 | 2.20 | 0.11 | 0.17 | -- |
| Pipeline Construction | 0.94 | 0.09 | -- | -- | -- | -- | -- |
| Pipeline Construction Traffic | 0.85 | 0.09 | 0.09 | 0.15 | 0.0004 | 0.01 | -- |
| Pipeline Construction Heavy Equipment | 0.06 | 0.06 | 1.79 | 1.03 | 0.05 | 0.16 | -- |
| Drill Rig Engines | 1.16 | 1.16 | 34.71 | 20.06 | 0.11 | 2.31 | 0.03 |
| Drilling Traffic | 15.25 | 15.25 | 2.44 | 2.49 | 0.01 | 0.28 | -- |
| Drilling Heavy Equipment | 0.006 | 0.006 | 0.18 | 0.10 | 0.01 | 0.25 | -- |
| Fracturing Engines | 0.31 | 0.31 | 9.43 | 5.45 | 0.11 | 0.63 | 0.01 |
| Completion Rig Engines | 0.09 | 0.09 | 2.68 | 1.55 | 0.003 | 0.18 | 0.003 |
| Completion Traffic | 0.62 | 0.07 | 0.13 | 0.10 | 0.001 | 0.01 | 0.00 |
| Completion Flaring | 0.10 | 0.10 | 0.91 | 4.97 | 0.00 | 0.37 | 0.09 |
| Production Emissions | | | | | | | |
| Workover Rig Engines | 0.14 | 0.14 | 4.33 | 2.50 | 0.005 | 0.29 | 0.004 |
| Production Traffic | 3.65 | 0.37 | 0.23 | 0.46 | 0.001 | 0.04 | 0.00 |
| Separator Heaters | 0.28 | 0.28 | 3.64 | 1.82 | -- | 1.15 | 0.16 |
| Tank Heaters | 0.37 | 0.37 | 4.86 | 2.43 | -- | 1.54 | 0.22 |
| Production Fugitives | -- | -- | -- | -- | -- | 51.73 | 12.25 |
| Screw Compressors | 0.98 | 0.98 | 24.60 | 52.65 | -- | 10.09 | 5.77 |
| C.S. Separators | 0.02 | 0.02 | 0.21 | 0.11 | -- | 0.07 | 0.01 |
| Water Transfer Pumps | 1.42 | 1.42 | 50.22 | 10.35 | -- | 3.52 | 0.38 |
| Pumping Units | 2.87 | 2.87 | 101.84 | 20.99 | -- | 7.14 | 0.76 |

**Table 4-12**
**Alternative B Year 5 Emissions (TPY)**

| Activity | $PM_{10}$ | $PM_{2.5}$ | $NO_x$ | CO | $SO_2$ | VOC | HAPs |
|---|---|---|---|---|---|---|---|
| Total Construction Emissions | 23.96 | 17.82 | 55.19 | 38.55 | 0.40 | 4.43 | 0.14 |
| Total Production Emissions | 9.72 | 6.44 | 189.94 | 91.32 | 0.01 | 75.57 | 19.65 |
| Total Emissions | 33.68 | 24.26 | 245.13 | 129.87 | 0.40 | 79.99 | 19.69 |

**Table 4-13**
**Alternative B Year 5 GHG Emissions (metric tons per year)**

| Pollutant | Construction | Production | Total |
|---|---|---|---|
| $CO_2e$ | 7,107 | 37,282 | 44,389 |

Near-Field Impacts

Air pollutant dispersion modeling was performed to quantify maximum potential $PM_{10}$, $PM_{2.5}$, $NO_x$, CO, $SO_2$, and HAP impacts from construction and production. AERMOD was used to model the maximum potential emissions of $PM_{10}$, $PM_{2.5}$, $NO_x$, CO and $SO_2$ that could occur from Alternative B well pad/road construction, drilling/completion and production sources. **Table 4-14**, Alternative B - Criteria Pollutant Modeling Results for Field Development Activities, presents the maximum modeled air pollutant concentrations that could occur from well development activities. **Table 4-15**, Alternative B - Criteria Pollutant Modeling Results for Field Production Activities, presents maximum concentrations that could occur from well production activities. When maximum modeled concentrations from the modeled scenarios are added to representative background concentrations, total ambient air concentrations are less than the applicable NAAQS and CAAQS. In addition, direct modeled concentrations are below the applicable PSD Class II increments, with the exception of the modeled annual $NO_2$ concentration which is above the annual increment value.

Note that the emissions from field development activities would be temporary and would not consume PSD increment and, as a result, are excluded from increment comparisons.

**Table 4-14**
**Alternative B - Criteria Pollutant Modeling Results for Field Development Activities**

| | Averaging Time | Maximum Concentration (μg/m$^3$) | Background Concentration (μg/m$^3$) | Total Concentration (μg/m$^3$) | NAAQS/CAAQS (μg/m$^3$) |
|---|---|---|---|---|---|
| CO | 1-Hour | 775.1 | 1150 | 1,925.1 | 40,000 |
| | 8-Hour | 480.9 | 1150 | 1,630.9 | 10,000 |
| $NO_2$ | 1-Hour | 159.4 | 21 | 180.4 | 188 |
| | Annual | 37.3 | 1.9 | 39.2 | 100 |
| $SO_2$ | 1-Hour | 4.0 | 3 | 7.0 | 196 |
| | 3-Hour | 3.0 | 3 | 6.0 | 1,300/700 |
| | 24-Hour | 0.8 | 3 | 3.8 | 365/-- |
| | Annual | 0.09 | 3 | 3.1 | 80/-- |
| $PM_{10}$ | 24-Hour | 84.7 | 36 | 120.7 | 150 |
| | Annual | 8.1 | 15 | 23.1 | 50 |

**Table 4-14**
**Alternative B - Criteria Pollutant Modeling Results for Field Development Activities**

| | Averaging Time | Maximum Concentration (μg/m³) | Background Concentration (μg/m³) | Total Concentration (μg/m³) | NAAQS/CAAQS (μg/m³) |
|---|---|---|---|---|---|
| $PM_{2.5}$ | 24-Hour | 12.6 | 14 | 26.6 | 35 |
| | Annual | 1.2 | 3 | 4.2 | 12 |

Notes:
Maximum modeled CO, $NO_2$ and $SO_2$ impacts occur during drilling operations, and maximum $PM_{10}$ and $PM_{2.5}$ impacts occur during well pad and access road construction.
Modeled highest second-high values shown for all short term averaging times
$NO_2$ 1-hour value calculated as the 3-year average of the 8th highest daily maximum 1-hour concentrations
$SO_2$ 1-hour value is the maximum 1-hour concentration
$PM_{2.5}$ 24-hour value is the eighth-highest value
24-hour and annual $SO_2$ NAAQS remain in effect until 1 year after the area is designated for the 2010 (1-hour) standard.
Designations for the 1-hr $SO_2$ NAAQS in CO have not occurred.

**Table 4-15**
**Alternative B - Criteria Pollutant Modeling Results for Field Production Activities**

| | Averaging Time | Maximum Concentration (μg/m³) | Background Concentration (μg/m³) | Total Concentration (μg/m³) | NAAQS/CAAQS (μg/m³) | PSD Class II Increment (ug/m³) |
|---|---|---|---|---|---|---|
| CO | 1-Hour | 775.4 | 1150 | 1,925.4 | 40,000 | -- |
| | 8-Hour | 481.1 | 1150 | 1,631.1 | 10,000 | -- |
| $NO_2$ | 1-Hour | 159.1 | 21 | 180.1 | 188 | -- |
| | Annual | 38.6 | 1.9 | 40.5 | 100 | 25 |
| $SO_2$ | 1-Hour | 0.002 | 3 | 3.0 | 196 | -- |
| | 3-Hour | 0.001 | 3 | 3.0 | 1,300/700 | 512 |
| | 24-Hour | 0.001 | 3 | 3.0 | 365/-- | 91 |
| | Annual | 0.0003 | 3 | 3.0 | 80/-- | 20 |
| $PM_{10}$ | 24-Hour | 0.007 | 36 | 36.0 | 150 | 30 |
| | Annual | 0.002 | 15 | 15.0 | 50 | 17 |
| $PM_{2.5}$ | 24-Hour | 0.007 | 14 | 14.0 | 35 | 9 |
| | Annual | 0.002 | 3 | 3.0 | 12 | 4 |

Notes:
Modeled highest second-high values shown for all short term averaging times
$NO_2$ 1-hour value calculated as the 3-year average of the 8th highest daily maximum 1-hour concentrations
$SO_2$ 1-hour value is the maximum 1-hour concentration
24-hour and annual $SO_2$ NAAQS remain in effect until 1 year after the area is designated for the 2010 (1-hour) standard.
Designations for the 1-hr $SO_2$ NAAQS in CO have not occurred.

As described in the footnote for Table 4-14, the maximum $PM_{10}$ and $PM_{2.5}$ impacts (primarily dust) occur during access road and well-pad construction activities. For construction phase near-field modeling, impacts are below applicable AAQS at receptors starting 100 meters from the emissions sources (see Figure 4-3 for construction scenario near-field modeling layout). Emissions calculations for the construction phase PM near-field modeling analysis assume dust control applied routinely to disturbed unpaved surfaces. To ensure that dust impacts are acceptable at receptors near well-pad and access road construction / development phase activities (< 100 meters of source), additional dust mitigation will be required (see Mitigation Section for more details).

As previously described in this section as well as the in-depth discussion in the AQTSD, $NO_2$ 1-hour 98th percentile daily maximum 3-year average impacts for the Field Development (Table 4-14) activities modeling scenario are calculated assuming 1 year of drilling and 2 years of production related activities at each well-pad. Three years of production related activities at each well-pad are assumed for calculating $NO_2$ 1-hour 98th percentile daily maximum 3-year average impacts for the production modeling scenario (Table 4-15). The near-field modeling scenarios were based on the best available information from the Project proponent at the time of conducting the analysis. $NO_x$ emissions rates totals for new well-pad development are primarily made up of large engine (drilling / fracturing / completion) emissions. $NO_x$ emissions rates totals for the new well-pad production level equipment configuration are primarily driven by the pumping units and were developed for modeling to support compliance with the applicable AAQS. The number of pumping units designated for new well-pads for the modeling analysis to support compliance is reasonable for the average number of wells per pad. Well-pad level $NO_x$ emissions rate limits (one for development and production phases) will be required for each new well-pad to ensure that near-field $NO_2$ impacts are acceptable. (See Mitigation Section for more information).

Modeling was performed to estimate the maximum impacts that could occur from HAP emissions from field production sources as well as an analysis for long-term (annual) HAP concentrations was performed for benzene, toluene, ethyl benzene, n-hexane, and formaldehyde emission resulting from field production activities. Potential maximum acute (short-term; 1-hour) HAP concentrations compared with the acute RELs and potential annual HAP concentrations compared with non-carcinogenic RfCs are shown in **Table 4-16**, Alternative B - HAP Modeling Results for Field Production Sources. RELs are defined as concentrations at or below which no adverse health effects are expected. As shown in Table 4-14, all HAP impacts are below the applicable short-term RELs and the long-term non-carcinogenic RfCs, with the exception of the maximum modeled formaldehyde concentration from compression emissions which at 81.6 $\mu g/m^3$ is above the short-term REL threshold of 55 $\mu g/m^3$.

**Table 4-16**
**Alternative B - HAP Modeling Results for Field Production Sources**

| | Maximum 1-hour Concentration ($\mu g/m^3$) | REL ($\mu g/m^3$) | Annual Concentration ($\mu g/m^3$) | RFC($\mu g/m^3$) |
|---|---|---|---|---|
| Formaldehyde | 81.6 | 55 | 3.89 | 9.8 |
| n-Hexane | 8.0 | 390000[1] | 1.33 | 700 |
| Benzene | 14.8 | 1,300 | 2.47 | 30 |
| Toluene | 23.6 | 37,000 | 3.92 | 5,000 |
| Ethyl Benzene | 1.3 | 350000[1] | 0.21 | 1,000 |
| Xylene | 10.4 | 22,000 | 1.74 | 100 |

[1] No REL available for these air toxics. Values shown are from Immediately Dangerous to Life or Health (IDLH/10), EPA Air Toxics Database, Table 2 (EPA 2011).

Modeling estimated the potential cancer risk resulting from suspected carcinogens (benzene ethyl benzene and formaldehyde) emissions. Impacts were evaluated based on estimates of the increased latent cancer risk over a 70-year lifetime. This analysis presents the potential incremental risk from formaldehyde and does not represent a total risk analysis. The cancer risks were calculated using the maximum predicted annual concentrations and EPA's chronic inhalation unit risk factors (URF) for carcinogenic constituents. Two estimates of cancer risk are presented: 1) a most likely exposure (MLE) scenario; and 2) a maximum exposed individual (MEI) scenario. The estimated cancer risks are adjusted to account for duration of exposure and time spent at home.

The modeled long-term risk from project emissions is shown in **Table 4-17**, Alternative B - Unit Risk Analyses. Under both the MLE and MEI scenarios, the estimated cancer risk associated with long-term exposure to benzene and formaldehyde is greater than 1-in-1-million risk level, but within AEL concentration levels (EPA 2014a). Consideration should also be given while reviewing these results to recognize that these maximum impacts occur along the edge of the well pad (50 meters) for benzene, and within 150 meters of a compressor station for formaldehyde. Maximum emissions are assumed to occur continuously for a 50-year life of project, and that the MEI risk level assumes a person would have to live within close proximity to a well pad and/or a compressor station for 50 years.

**Table 4-17**
**Alternative B - Unit Risk Analyses**

| | Analysis | HAP | Modeled Concentration (ug/m3) | Unit Risk Factor 1/(ug/m3) | Exposure Adjustment Factor | Cancer Risk |
|---|---|---|---|---|---|---|
| Field Production | MLE | Benzene | 2.47 | 7.8E-06 | 0.0949 | 1.8E-06 |
| | | Ethylbenzene | 0.21 | 2.5E-06 | 0.0949 | 5.0E-08 |
| | | Formaldehyde | 3.89 | 1.3E-05 | 0.0949 | 4.8E-06 |
| Total Combined | | | | | | 6.7E-06 |
| Field Production | MEI | Benzene | 2.47 | 7.8E-06 | 0.71 | 1.4E-05 |
| | | Ethylbenzene | 0.21 | 2.5E-06 | 0.71 | 3.7E-07 |
| | | Formaldehyde | 3.89 | 1.3E-05 | 0.71 | 3.6E-05 |
| Total Combined | | | | | | 5.0E-05 |

Refined air quality analyses for compressor stations will be required for CDPHE permitting at a later stage when detailed information for the compressor station layout and equipment (i.e. emissions sources) configuration will be known. It is anticipated that the CDPHE will analyze and address potential formaldehyde impacts at the compressor station permitting stage.

Far-Field Impacts

The far-field assessment assumed a field-wide maximum emissions scenario with well drilling/completion and production activities occurring simultaneously throughout the project area. The field-wide scenario included 135 wells in production, 3 drilling rigs operating continuously (one year-round and two operating from April-November), and one completion rig operating year-round.

Pollutant Impacts

The direct modeled concentrations of $NO_2$, $SO_2$, $PM_{10}$, and $PM_{2.5}$ at Class I and sensitive Class II areas are provided in **Table 4-18**, Alternative B - Maximum Modeled Pollutant Concentrations at Class I and Sensitive Class II Areas, for comparison to applicable PSD Class I and Class II increments. These values are well below the PSD Class I and Class II increments.

**Table 4-18**
**Alternative B - Maximum Modeled Pollutant Concentrations at Class I and Sensitive Class II Areas ($\mu g/m^3$)**

| Location | Pollutant | Averaging Time | Direct Modeled | PSD Increment |
|---|---|---|---|---|
| Arches National Park | $NO_2$ | Annual | 1.3E-05 | 2.5 |
| | $SO_2$ | 3-hour | 5.2E-04 | 25 |
| | | 24-hour | 1.6E-04 | 5 |
| | | Annual | 1.9E-06 | 2 |
| | $PM_{10}$ | 24-hour | 1.8E-03 | 8 |
| | | Annual | 2.7E-05 | 4 |
| | $PM_{2.5}$ | 24-hour | 1.8E-03 | 2 |
| | | Annual | 2.0E-05 | 1 |
| Black Canyon of the Gunnison National Park | $NO_2$ | Annual | 8.7E-04 | 2.5 |
| | $SO_2$ | 3-hour | 4.3E-03 | 25 |
| | | 24-hour | 1.2E-03 | 5 |
| | | Annual | 4.0E-05 | 2 |
| | $PM_{10}$ | 24-hour | 2.4E-02 | 8 |
| | | Annual | 5.9E-04 | 4 |
| | $PM_{2.5}$ | 24-hour | 2.0E-02 | 2 |
| | | Annual | 4.8E-04 | 1 |
| Colorado National Monument | $NO_2$ | Annual | 1.0E-04 | 2.5 |
| | $SO_2$ | 3-hour | 6.7E-04 | 25 |
| | | 24-hour | 1.5E-04 | 5 |
| | | Annual | 7.9E-06 | 2 |
| | $PM_{10}$ | 24-hour | 3.3E-03 | 8 |
| | | Annual | 1.0E-04 | 4 |
| | $PM_{2.5}$ | 24-hour | 2.5E-03 | 2 |
| | | Annual | 7.6E-05 | 1 |
| Dinosaur National Monument | $NO_2$ | Annual | 1.4E-05 | 25 |
| | $SO_2$ | 3-hour | 3.1E-04 | 512 |
| | | 24-hour | 5.5E-05 | 91 |
| | | Annual | 1.6E-06 | 20 |
| | $PM_{10}$ | 24-hour | 1.4E-03 | 30 |
| | | Annual | 3.0E-05 | 17 |
| | $PM_{2.5}$ | 24-hour | 1.4E-03 | 9 |
| | | Annual | 2.3E-05 | 4 |
| Eagles Nest  Wilderness Area | $NO_2$ | Annual | 8.7E-04 | 2.5 |
| | $SO_2$ | 3-hour | 3.0E-03 | 25 |
| | | 24-hour | 5.2E-04 | 5 |
| | | Annual | 5.3E-05 | 2 |
| | $PM_{10}$ | 24-hour | 2.4E-02 | 8 |
| | | Annual | 9.7E-04 | 4 |
| | $PM_{2.5}$ | 24-hour | 2.2E-02 | 2 |
| | | Annual | 7.0E-04 | 1 |

**Table 4-18**
**Alternative B - Maximum Modeled Pollutant Concentrations at Class I and Sensitive Class II Areas ($\mu g/m^3$)**

| Location | Pollutant | Averaging Time | Direct Modeled | PSD Increment |
|---|---|---|---|---|
| Flat Tops Wilderness Area | $NO_2$ | Annual | 4.9E-04 | 2.5 |
| | $SO_2$ | 3-hour | 3.0E-03 | 25 |
| | | 24-hour | 5.9E-04 | 5 |
| | | Annual | 2.8E-05 | 2 |
| | $PM_{10}$ | 24-hour | 2.5E-02 | 8 |
| | | Annual | 5.7E-04 | 4 |
| | $PM_{2.5}$ | 24-hour | 2.5E-02 | 2 |
| | | Annual | 4.5E-04 | 1 |
| La Garita Wilderness Area | $NO_2$ | Annual | 2.8E-04 | 2.5 |
| | $SO_2$ | 3-hour | 7.0E-03 | 25 |
| | | 24-hour | 1.2E-03 | 5 |
| | | Annual | 2.0E-05 | 2 |
| | $PM_{10}$ | 24-hour | 3.3E-02 | 8 |
| | | Annual | 3.9E-04 | 4 |
| | $PM_{2.5}$ | 24-hour | 3.5E-02 | 2 |
| | | Annual | 3.0E-04 | 1 |
| Maroon Bells/Snowmass Wilderness Area | $NO_2$ | Annual | 1.8E-02 | 2.5 |
| | $SO_2$ | 3-hour | 3.3E-02 | 25 |
| | | 24-hour | 8.3E-03 | 5 |
| | | Annual | 8.4E-04 | 2 |
| | $PM_{10}$ | 24-hour | 1.6E-01 | 8 |
| | | Annual | 8.1E-03 | 4 |
| | $PM_{2.5}$ | 24-hour | 1.0E-01 | 2 |
| | | Annual | 4.7E-03 | 1 |
| Mount Zirkel Wilderness Area | $NO_2$ | Annual | 1.1E-04 | 2.5 |
| | $SO_2$ | 3-hour | 7.7E-04 | 25 |
| | | 24-hour | 2.6E-04 | 5 |
| | | Annual | 9.2E-06 | 2 |
| | $PM_{10}$ | 24-hour | 7.1E-03 | 8 |
| | | Annual | 1.8E-04 | 4 |
| | $PM_{2.5}$ | 24-hour | 5.5E-03 | 2 |
| | | Annual | 1.4E-04 | 1 |
| Rocky Mountain National Park | $NO_2$ | Annual | 3.3E-04 | 25 |
| | $SO_2$ | 3-hour | 1.9E-03 | 25 |
| | | 24-hour | 4.4E-04 | 5 |
| | | Annual | 2.5E-05 | 2 |
| | $PM_{10}$ | 24-hour | 8.5E-03 | 8 |
| | | Annual | 5.1E-04 | 4 |
| | $PM_{2.5}$ | 24-hour | 6.4E-03 | 2 |
| | | Annual | 3.8E-04 | 1 |

**Table 4-18**
**Alternative B - Maximum Modeled Pollutant Concentrations at Class I and Sensitive Class II Areas ($\mu g/m^3$)**

| Location | Pollutant | Averaging Time | Direct Modeled | PSD Increment |
|---|---|---|---|---|
| Weminuche Wilderness Area | $NO_2$ | Annual | 1.5E-04 | 2.5 |
| | $SO_2$ | 3-hour | 3.6E-03 | 25 |
| | | 24-hour | 6.8E-04 | 5 |
| | | Annual | 1.3E-05 | 2 |
| | $PM_{10}$ | 24-hour | 2.2E-02 | 8 |
| | | Annual | 2.4E-04 | 4 |
| | $PM_{2.5}$ | 24-hour | 2.2E-02 | 2 |
| | | Annual | 1.9E-04 | 1 |
| West Elk Wilderness Area | $NO_2$ | Annual | 6.7E-03 | 2.5 |
| | $SO_2$ | 3-hour | 1.2E-02 | 25 |
| | | 24-hour | 3.3E-03 | 5 |
| | | Annual | 2.6E-04 | 2 |
| | $PM_{10}$ | 24-hour | 6.7E-02 | 8 |
| | | Annual | 3.3E-03 | 4 |
| | $PM_{2.5}$ | 24-hour | 6.3E-02 | 2 |
| | | Annual | 2.2E-03 | 1 |

Visibility Impacts

Visibility impacts were calculated following FLAG 2010 (FLAG, 2010), at Class I and sensitive Class II areas. The results are shown in **Table 4-19**, Alternative B - Maximum Visibility Impacts at Class I and Sensitive Class II Areas. The visibility analysis indicated that there are zero days predicted above the 0.5-Δdv threshold at any of the Class I and sensitive Class II areas. The maximum predicted visibility impact was 0.45 Δdv, occurring at the Maroon Bells - Snowmass Wilderness Area.

**Table 4-19**
**Alternative B - Maximum Visibility Impacts at Class I and Sensitive Class II Areas**

| Location | Maximum Impact (Δdv) |
|---|---|
| Arches National Park | 0.01 |
| Black Canyon of the Gunnison National Park | 0.08 |
| Colorado National Monument | 0.01 |
| Dinosaur National Monument | 0.01 |
| Eagles Nest Wilderness Area | 0.10 |
| Flat Tops Wilderness Area | 0.12 |
| La Garita Wilderness Area | 0.14 |
| Maroon Bells/Snowmass Wilderness Area | 0.45 |
| Mount Zirkel Wilderness Area | 0.02 |
| Rocky Mountain National Park | 0.03 |
| Weminuche Wilderness Area | 0.10 |
| West Elk Wilderness Area | 0.26 |

Deposition Impacts

As shown in **Table 4-20**, Alternative B - Maximum Nitrogen and Sulfur Deposition Impacts at Class I and Sensitive Class II Areas, modeled nitrogen deposition for Alternative A are below the DAT for all Class I and sensitive Class II areas. Modeling for Alternative A and B used the same emissions source layout and Alternative B was modeled with more emissions from the sources. Using this information along with modeled Alternative B nitrogen deposition impacts, a Unit-wide emissions control plan will be required so that production level emissions for the Proposed Action (Alternative B) are at or below the levels modeled for Alternative A that resulted in acceptable nitrogen deposition impacts. See Mitigation Section at the end of the air quality section for more information.

**Table 4-20**
**Alternative B - Maximum Nitrogen and Sulfur Deposition Impacts at Class I and Sensitive Class II Areas**

| Location | Maximum N Deposition (kg/ha/yr) | Maximum S Deposition (kg/ha/yr) |
|---|---|---|
| Arches National Park | 0.00002 | 0.000001 |
| Black Canyon of the Gunnison National Park | 0.00070 | 0.000054 |
| Colorado National Monument | 0.00008 | 0.000006 |
| Dinosaur National Monument | 0.00002 | 0.000002 |
| Eagles Nest Wilderness Area | 0.00110 | 0.000075 |
| Flat Tops Wilderness Area | 0.00069 | 0.000045 |
| La Garita Wilderness Area | 0.00057 | 0.000043 |
| Maroon Bells/Snowmass Wilderness Area | 0.00953 | 0.000874 |
| Mount Zirkel Wilderness Area | 0.00025 | 0.000017 |
| Ragged Wilderness Area (Deep Creek Lake) | 0.00623 | 0.000521 |
| Rocky Mountain National Park | 0.00061 | 0.000039 |
| Weminuche Wilderness Area | 0.00034 | 0.000026 |
| West Elk Wilderness Area | 0.00319 | 0.000221 |

In addition, potential changes in ANC, resulting from potential N and S deposition from Alternative B source emissions, were calculated for 28 sensitive lakes within the Class I and sensitive Class II Wilderness areas. The estimated change in ANC for each lake is shown in **Table 4-21**, Alternative B - Maximum Impacts on Lakes within the Class I and Sensitive Class II Areas. For all lakes the estimated changes in ANC are all predicted to be less than the significance thresholds of less than a 10 percent change in ANC for lakes with ANC values greater than 25 μeq/l, and a 1.0 μeq/l change in ANC for lakes with background ANC values equal to or less than 25 μeq/l.

**Table 4-21**
**Alternative B - Maximum Impacts on Lakes within the Class I and Sensitive Class II Areas**

| Wilderness Area | Sensitive Lake | 10th Percentile Lowest ANC Value (μeq/L) | N Deposition (kg/ha/yr) | S Deposition (kg/ha/yr) | ANC Relative Change (%) | ANC Absolute Change (μeq/L) |
|---|---|---|---|---|---|---|
| Eagles Nest | Booth Lake | 86.8 | 0.00093 | 0.00006 | 0.011 | n/a |
| Eagles Nest | Upper Willow Lake | 134.1 | 0.00098 | 0.00007 | 0.009 | n/a |
| Flat Tops | Ned Wilson Lake | 39.0 | 0.00042 | 0.00003 | 0.011 | n/a |

**Table 4-21**
**Alternative B - Maximum Impacts on Lakes within the Class I and Sensitive Class II Areas**

| Wilderness Area | Sensitive Lake | 10th Percentile Lowest ANC Value (µeq/L) | N Deposition (kg/ha/yr) | S Deposition (kg/ha/yr) | ANC Relative Change (%) | ANC Absolute Change (µeq/L) |
|---|---|---|---|---|---|---|
| Flat Tops | Upper Ned Wilson Lake | 12.9 | 0.00042 | 0.00003 | 0.032 | 0.004 |
| Flat Tops | Lower Packtrail Pothole | 29.7 | 0.00042 | 0.00003 | 0.014 | n/a |
| Flat Tops | Upper Packtrail Pothole | 48.7 | 0.00042 | 0.00003 | 0.009 | n/a |
| La Garita | Small Lake Above U-Shaped Lake | 59.9 | 0.00049 | 0.00004 | 0.012 | n/a |
| La Garita | U-Shaped Lake | 81.4 | 0.00049 | 0.00004 | 0.009 | n/a |
| Maroon Bells | Avalanche Lake | 158.8 | 0.00471 | 0.00038 | 0.021 | n/a |
| Maroon Bells | Capitol Lake | 154.4 | 0.00467 | 0.00038 | 0.024 | n/a |
| Maroon Bells | Moon Lake | 53.0 | 0.00465 | 0.00039 | 0.083 | n/a |
| Mount Zirkel | Lake Elbert | 56.6 | 0.00022 | 0.00002 | 0.003 | n/a |
| Mount Zirkel | Seven Lakes (LG East) | 36.2 | 0.00018 | 0.00001 | 0.004 | n/a |
| Mount Zirkel | Summit Lake | 48.0 | 0.00025 | 0.00002 | 0.004 | n/a |
| Raggeds | Deep Creek Lake | 20.6 | 0.00623 | 0.00052 | 0.335 | 0.069 |
| Weminuche | Big Eldorado Lake | 19.6 | 0.00018 | 0.00002 | 0.010 | 0.002 |
| Weminuche | Four Mile Pothole | 123.4 | 0.00021 | 0.00002 | 0.001 | n/a |
| Weminuche | Lake Due South of Ute Lake | 13.2 | 0.00018 | 0.00001 | 0.014 | 0.002 |
| Weminuche | Little Eldorado | -3.3 | 0.00018 | 0.00002 | 0.057 | 0.002 |
| Weminuche | Little Granite Lake | 80.7 | 0.00019 | 0.00002 | 0.004 | n/a |
| Weminuche | Lower Sunlight Lake | 80.9 | 0.00017 | 0.00001 | 0.002 | n/a |
| Weminuche | Middle Ute Lake | 42.8 | 0.00018 | 0.00001 | 0.005 | n/a |
| Weminuche | Small Pond Above Trout Lake | 25.5 | 0.00022 | 0.00002 | 0.011 | n/a |
| Weminuche | Upper Grizzly Lake | 29.9 | 0.00016 | 0.00001 | 0.005 | n/a |
| Weminuche | Upper Sunlight Lake | 28.0 | 0.00017 | 0.00001 | 0.006 | n/a |
| Weminuche | West Snowdon Lake | 39.4 | 0.00017 | 0.00002 | 0.004 | n/a |
| Weminuche | White Dome Lake | 2.1 | 0.00018 | 0.00002 | 0.089 | 0.19 |
| West Elk | South Golden Lake | 111.4 | 0.00215 | 0.00015 | 0.019 | n/a |

<u>Regional Climate Change and Greenhouse Gas Emissions</u>

The maximum GHG emissions resulting from Alternative B are estimated at 39,689 metric tons per year [0.04 terragrams (tg)/yr] of $CO_2$e. To place the project GHG emissions in context, the GHG emissions from the top 5 emitting coal-fired power plants in Colorado range from 2.6 to 9.0 tg/year (EPA 2014b). In addition, 0.04 tg/yr is approximately equivalent to 0.0006 percent of the total 2012 $CO_2$e emissions. To provide additional context, the EPA has recently modeled global climate change impacts from a model source emitting 20 percent more GHGs than a 1,500-MW coal-fired steam electric generating plant (approx. 14,132,586 metric tons per year of CO2, 273.6 metric tons per year of nitrous oxide, and 136.8 metric tons per year of methane). It estimated a hypothetical maximum mean global temperature value increase resulting from such a project. The results ranged from 0.00022 and 0.00035 degrees Celsius occurring approximately 50 years after the facility begins operation. The modeled changes are extremely small, and any downsizing of these results from the global scale would produce greater uncertainty in the predictions. The EPA concluded that even assuming such an increase in temperature could be downscaled to a particular location, it "would be too small to physically measure or detect", see Letter from Robert J. Meyers, Principal Deputy Assistant Administrator, Office of Air and Radiation re: "Endangered Species Act and GHG Emitting Activities (Oct. 3, 2008)".

Predicting the degree of impact any single emitter of GHGs may have on global climate change, or on the changes to biotic and abiotic systems that accompany climate change, is not possible at this time primarily because climate change is a cumulative phenomenon that requires global scale emissions inventory / budget and many resources (computational power, etc.) to determine the sensitivity of climate with respect to changing global conditions. As such, the controversy is to what extent GHG emissions resulting from continued oil and gas development may contribute to global climate change, as well as the accompanying changes to natural systems cannot be quantified or predicted. The degree to which any observable changes can or would be attributable to Alternative B cannot be reasonably predicted at this time.

*Alternative C*

Alternative C includes the construction and operation of up to 146 natural gas wells, 35 well pads, 1 water disposal well, and associated roads and production facilities, including 4 compression stations. This alternative would include use of drilling rig engines with Tier 3 or Tier 4 level emissions.

<u>Near-field Impacts</u>

Near-field pollutant impacts for Alternative C would be similar to those presented below for Alternative B. Impacts from Alternative C sources would below the NAAQS or CAAQS. In addition impacts would not exceed the PSD Class II increments, with the exception of annual $NO_2$ concentrations which could exceed the annual increment value.

The maximum predicted acute and chronic (long-term) HAP impacts from well site production would be similar to the impacts for the Alternative B. HAP impacts under Alternative C would be below all applicable REL and RfC exposure thresholds, with the exception of the modeled formaldehyde concentrations from compression emissions which could exceed the short-term REL threshold. For the suspected carcinogens (benzene, ethyl benzene, and formaldehyde) the cancer risk level for production activities for either the MLE or the MEI analysis would be similar to Alternative B.

<u>Far-Field Impacts</u>

Pollutant Impacts

Pollutant impacts would be similar to those presented in for Alternative B. Pollutant impacts would be below PSD increments at all Class I and sensitive Class II areas.

Visibility Impacts

Visibility impacts estimated resulting from Alternative C emissions would be similar to those presented for Alternative B, which indicated that there would be zero days predicted above the 0.5 $\Delta$dv threshold at any of the Class I and sensitive Class II areas.

Deposition Impacts
Nitrogen deposition impacts under Alternative C would be less than the impacts for Alternative B and greater than the impacts for Alternative A. Sulfur deposition impacts would be below the DAT.

Potential sensitive lake acidification resulted from nitrogen and sulfur deposition impacts under Alternative C would be similar to the impacts for Alternative B, where modeling results indicated that there would be no ANC changes at any of the analyzed lakes that exceeded threshold values.

<u>Regional Climate Change and Greenhouse Gas Emissions</u>
The maximum greenhouse gas emissions resulting from Alternative C sources would be comparable to the emissions estimated for Alternative B. See discussion for Alternative B.

*Regional Ozone and Cumulative Air Quality and AQRV analyses*
As part of the adaptive management strategy for managing air resources within the BLM GJFO and UFO planning areas, the BLM is conducting a regional air modeling study to evaluate potential impacts on air quality from future mineral development in western Colorado. The Colorado Air Resources Management Modeling Study (CARMMS) (BLM 2014a) assesses predicted impacts on air quality and air quality related values (AQRVs) from projected increases in oil and gas development. The CARMMS includes potential impacts using projections of oil and gas development up to a maximum of 10 years in the future to reflect realistic estimations of development projections and technology improvements.

The CARMMS includes cumulative air quality and AQRV impact assessments from future year (year 2021) oil and gas development on federal and non-federal lands within 13 separate Colorado BLM planning areas as well as mining within the 13 Colorado BLM planning areas (BLM 2014a). CARMMS also includes emissions from other regional sources including oil and gas emissions throughout the modeling domain which encompasses all of Colorado, western Arizona, western Utah and north-central New Mexico and extends into southern Wyoming, western Nebraska, western Kansas and northwest Texas.

The CARMMS includes use of the Comprehensive Air-quality Model with extensions (CAMx) photochemical grid model (PGM) model to estimate air quality and AQRV impacts for both a base case year (2008) and future year 2021. Emissions from all sources types (anthropogenic and natural) are included in the CAMx modeling.

As part of CARMMS future year 2021 emissions estimates were developed for 3 development scenarios for the 13 Colorado planning areas. These include year 2021 high, medium and low oil and gas development scenarios. Modeling results for the CARMMS 2021 high oil and gas development scenario have been completed (BLM 2014b), and these results are applicable for use in estimating potential ozone formation from regional emissions and Bull Mountain project emissions, and for determining the maximum contribution of Bull Mountain sources to regional ozone formation. The CARMMS results are also applicable for Bull Mountain project cumulative air quality and AQRV analyses.

The CARMMS 2021 high oil and gas development scenario modeling analysis included BLM UFO planning area oil and gas emissions on BLM-administered of: 612 tpy $NO_x$, 620 tpy VOC, 788 tpy CO, 1 tpy $SO_2$, 144 tpy $PM_{10}$ and 37 tpy $PM_{2.5}$. The maximum future year emissions from Bull Mountain project area emissions, including existing sources, Alternative A sources and Alternative B sources, are: 413.3 tpy $NO_x$, 124.5 tpy VOC, 206.5 tpy CO, 0.8 tpy $SO_2$, 65.6 tpy $PM_{10}$ and 46.0 tpy $PM_{2.5}$.

Regional Ozone Impacts

The CARMMS included estimates of future year regional ozone impacts using two analysis methods. One method uses the change in the PGM modeled concentrations between base case or current year (DVC) (year 2008) and future year (DVF) (year 2021) simulations to scale observed ozone concentrations from monitoring sites to obtain projected future year ozone concentrations. This method utilized EPA's Modeled Attainment Test Software (MATS) (Abt 2012) projection tool with the CAMx 2008 Base Case and 2021 High Development Scenario ozone concentrations to estimate ozone impacts. The second method uses the absolute modeling results from the CAMx model to estimate ozone impacts.

**Figure 4-10** presents the CAMx predicted ozone concentrations using MATS. The current year DVCs indicate areas of ozone exceedances of the NAAQS (75 ppb) in Denver and Salt Lake City with a maximum DVC of 81.5 ppb just northwest of Denver (Figure 4-10, top left). For the 2021 High Development Scenario the area of 2021 ozone DVF exceedances is reduced and still limited to smaller areas in the Denver and Salt Lake City area with a peak DVF of 79.3 ppb still northwest of Denver (Figure 4-10, top right). The 2021 DVF – 2008 DVC difference plot (Figure 4-10, bottom) shows mainly ozone reductions with the largest reduction in the Denver and Salt Lake City areas but ozone increases in the Piceance Basin (Garfield County, Colorado).

The CAMx absolute modeling results are presented in **Figure 4-11**. The ozone NAAQS is defined as the 3-year average of the 4$^{th}$ highest daily maximum 8-hour ozone concentrations. Since CARMMS only has 1 year of modeling results, the 2021 4$^{th}$ highest daily maximum 8-hour ozone concentrations are used for the NAAQS comparison metric. Figure 4-11 displays the 4$^{th}$ highest ozone concentrations for the 2008 Base Case and the 2021 High Development Scenario and their differences. For the 2008 Base Case, there are ozone exceedance areas in the Denver, Salt Lake City and northern New Mexico, and on the border of UT/AZ (Figure 4-11, top left). In the 2021 High Development Scenario, the area of ozone exceedances in Denver is reduced and the ozone exceedances in Salt Lake City and on the UT/AZ border area are gone, the area in northern New Mexico remains the same and there is a new ozone exceedance area in the Uinta Basin (Figure 4-11, top right). The 2021 – 2008 ozone differences (Figure 4-11, bottom) show more decreases than increases and the areas of ozone increases tend to occur in oil and gas development areas, for example, the D-J, Piceance and Uinta Basins.

**Figure 4-12** presents the maximum ozone contributions due to federal oil and gas emissions in the UFO planning area from the CAMx absolute model results. The maximum ozone contribution from the UFO planning area oil and gas sources is 0.8 ppb. Given that the UFO planning area oil and gas emissions include 612 tpy $NO_x$ and 620 tpy VOC and that the maximum future year emissions from Bull Mountain project sources include 413.3 tpy $NO_x$ and 124.5 tpy VOC, the contribution to regional ozone from Bull Mountain project sources would likely be less.

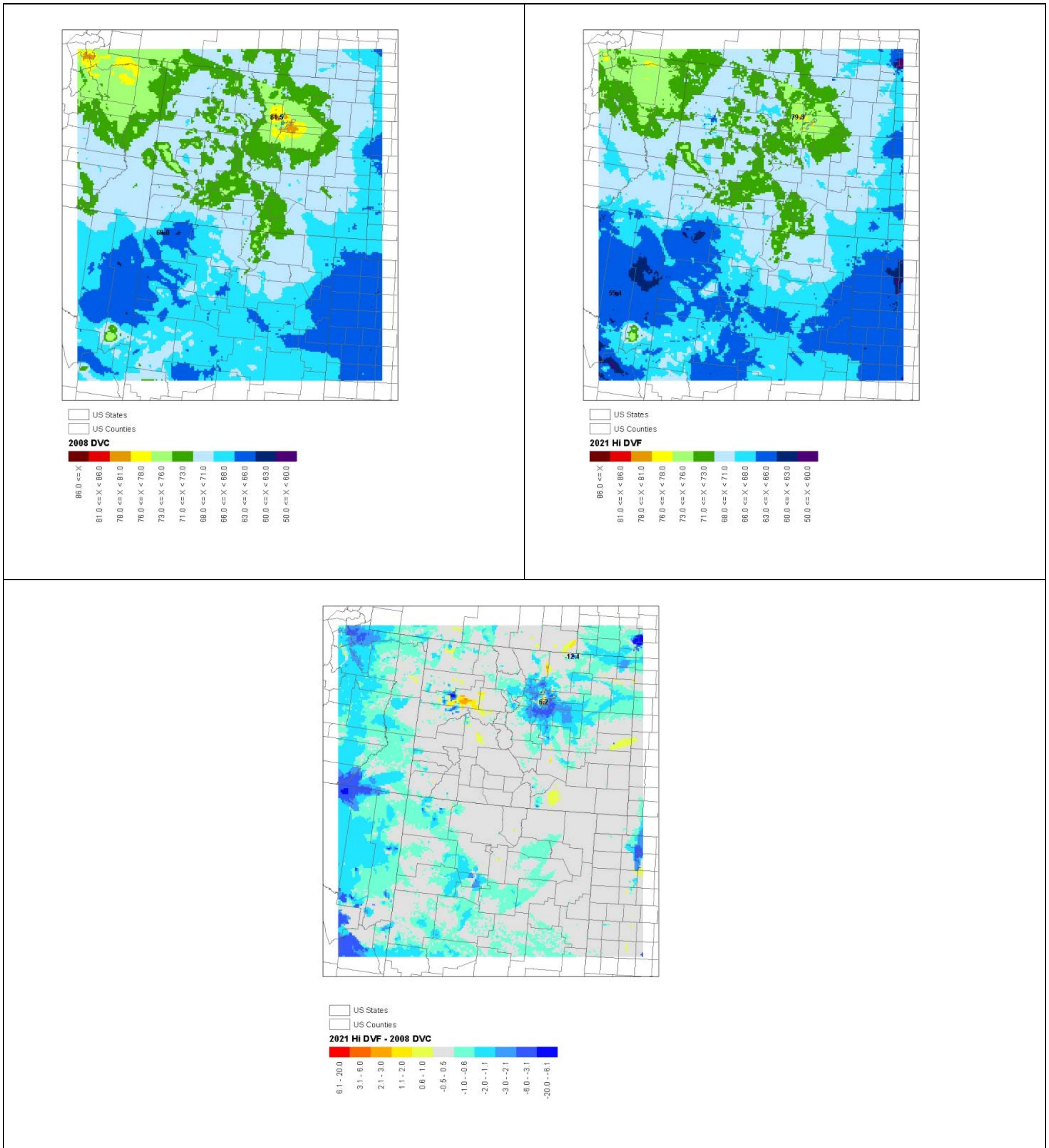



**Figure 4-10. 2008 ozone DVC (top left), 2021 ozone DVF (top right) and 2021 – 2008 ozone DVF differences calculated using MATS for the CARMMS 2021 High Development Scenario.**

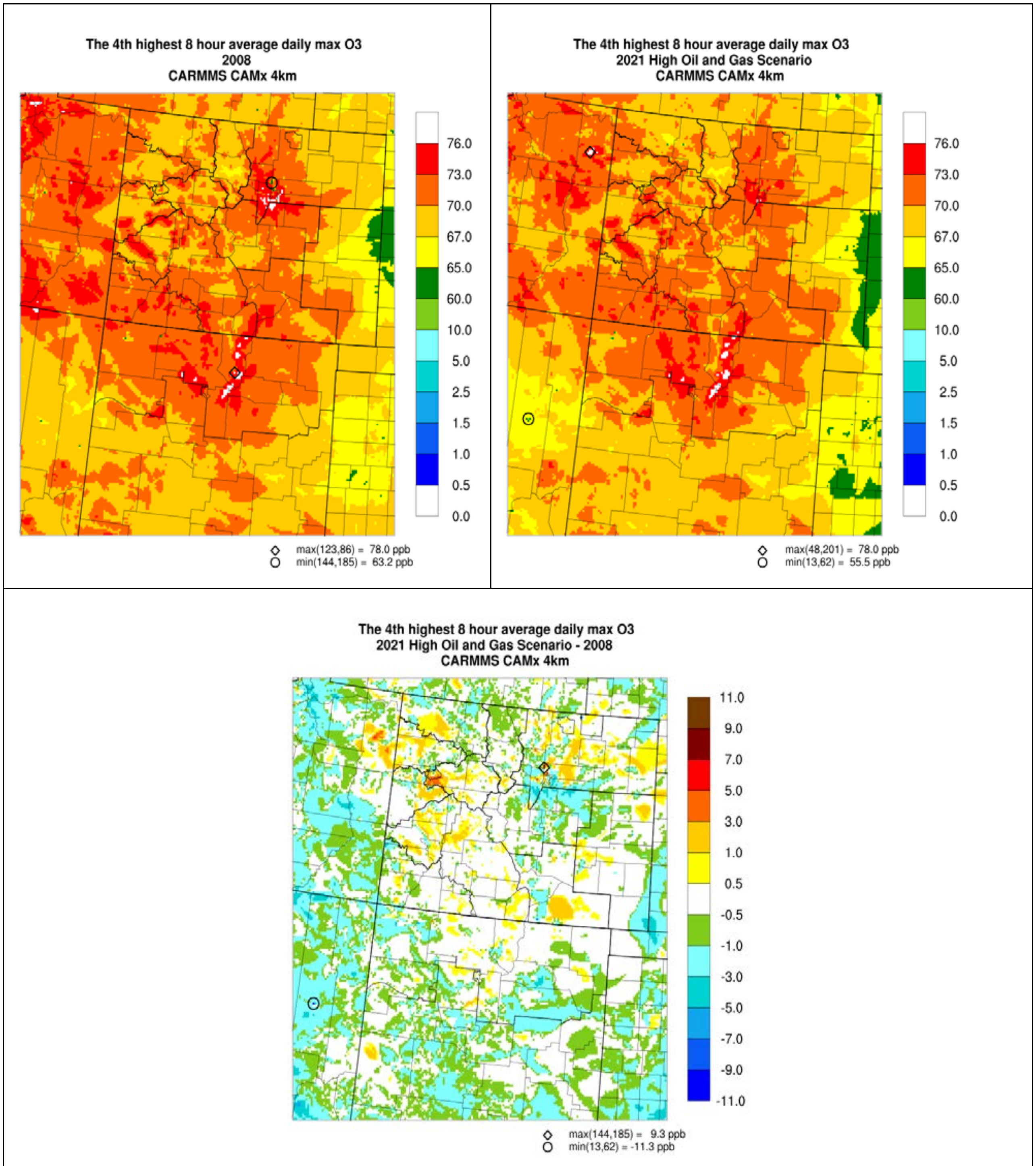



**Figure 4-11. Fourth highest daily maximum 8-hour ozone concentrations for the 2008 Base Case (top left), CARMMS 2021 High Development Scenario (top right), 2021 minus 2008 differences (bottom).**

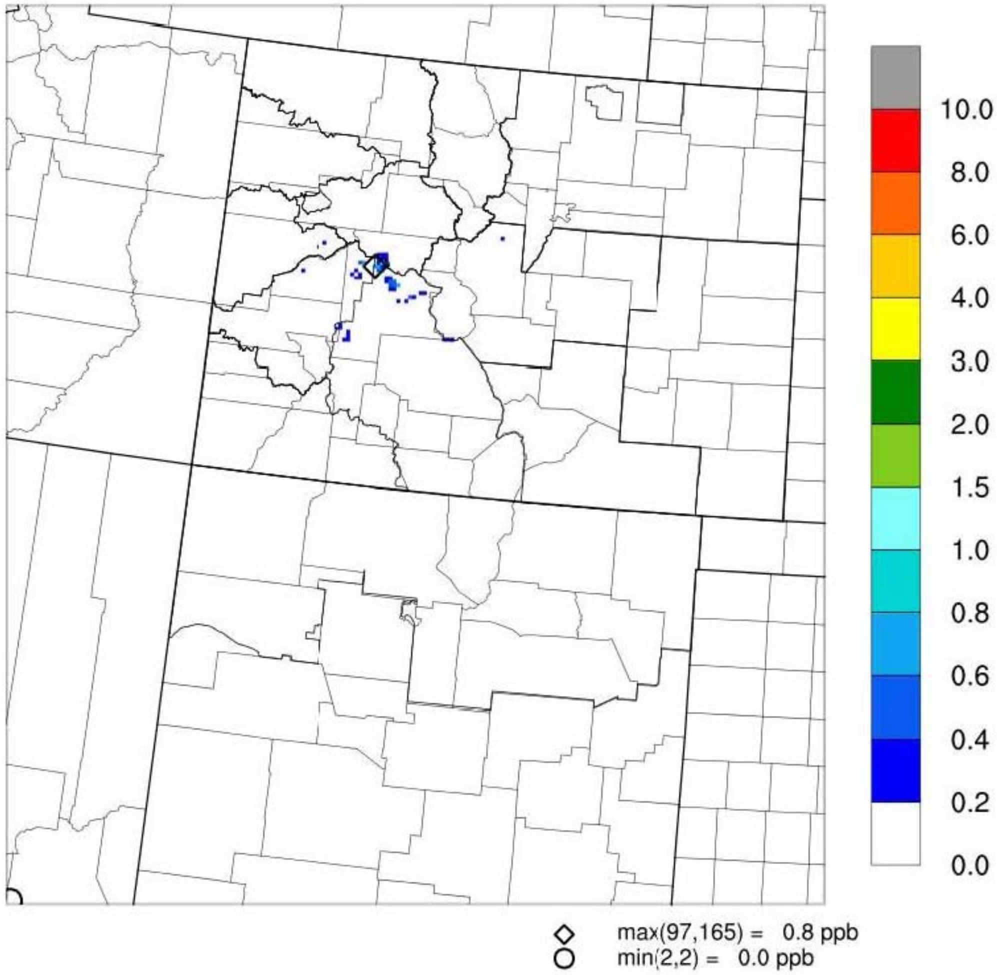



**Figure 4-12. Contribution to Fourth Highest Daily Maximum Ozone Concentrations Due to Emissions from Federal Oil and Gas within the UFO Planning Area for the CARMMS 2021 High Development Scenario.**

Cumulative Air Quality and AQRV Impacts

The CARMMS 2021 high oil and gas development modeling analysis presented a scenario which included future year 2021 projected federal and non- federal oil and gas emissions throughout the 4-kilometer (2.5-mile) CARMMS domain plus mining on BLM-administered in Colorado. This scenario which includes future year oil and gas emissions from the 13 Colorado BLM planning area plus the Mancos Shale area in Northern New Mexico, and emissions from the Piceance Basin (CO) and Uinta Basin (UT), is presented herein to describe cumulative impacts for the Bull Mountain project. For the Bull Mountain project cumulative analysis these cumulative oil and gas emissions and mining emissions are considered reasonably foreseeable development (RFD) emissions.

The CARMMS included impact assessments at 55 PSD Class I and sensitive Class II areas, and at 58 lakes throughout the CARMMS modeling domain, which included each of the Class I and

Class II areas and lakes that have been included in the Bull Mountain project Calpuff impacts analyses. For the Bull Mountain project cumulative assessment, the CARMMS impacts are presented for the PSD Class I and sensitive Class II areas and lakes that were included in the Calpuff analyses.

Air Quality Impacts

The modeled concentrations of $NO_2$, $SO_2$, $PM_{10}$, and $PM_{2.5}$ at Class I and sensitive Class II areas resulting from cumulative RFD source emissions are provided in **Table 4-22**, Cumulative Pollutant Concentrations (CARMMS 2021 High Development Scenario) at Class I and Sensitive Class II Areas (µg/m3), for comparison to applicable PSD Class I and Class II increments. All values are well below the PSD Class I and Class II increments.

**Table 4-22**
**Cumulative Pollutant Concentrations (CARMMS 2021 High Development Scenario) at Class I and Sensitive Class II Areas (µg/m³)**

| Location | Pollutant | Averaging Time | Modeled Concentration | PSD Increment |
|---|---|---|---|---|
| Arches National Park | $NO_2$ | Annual | 0.352 | 2.5 |
| | $SO_2$ | 3-hour | 0.107 | 25 |
| | | 24-hour | 0.046 | 5 |
| | | Annual | 0.006 | 2 |
| | $PM_{10}$ | 24-hour | 0.577 | 8 |
| | | Annual | 0.093 | 4 |
| | $PM_{2.5}$ | 24-hour | 0.430 | 2 |
| | | Annual | 0.077 | 1 |
| Black Canyon of the Gunnison National Park | $NO_2$ | Annual | 0.516 | 2.5 |
| | $SO_2$ | 3-hour | 0.086 | 25 |
| | | 24-hour | 0.052 | 5 |
| | | Annual | 0.006 | 2 |
| | $PM_{10}$ | 24-hour | 0.763 | 8 |
| | | Annual | 0.199 | 4 |
| | $PM_{2.5}$ | 24-hour | 0.555 | 2 |
| | | Annual | 0.104 | 1 |
| Colorado National Monument | $NO_2$ | Annual | 0.661 | 2.5 |
| | $SO_2$ | 3-hour | 0.190 | 25 |
| | | 24-hour | 0.080 | 5 |
| | | Annual | 0.012 | 2 |
| | $PM_{10}$ | 24-hour | 1.233 | 8 |
| | | Annual | 0.194 | 4 |
| | $PM_{2.5}$ | 24-hour | 0.890 | 2 |
| | | Annual | 0.155 | 1 |
| Dinosaur National Monument | $NO_2$ | Annual | 1.686 | 25 |
| | $SO_2$ | 3-hour | 1.856 | 512 |
| | | 24-hour | 0.629 | 91 |
| | | Annual | 0.151 | 20 |

**Table 4-22**
**Cumulative Pollutant Concentrations (CARMMS 2021 High Development Scenario) at Class I and Sensitive Class II Areas (μg/m³)**

| Location | Pollutant | Averaging Time | Modeled Concentration | PSD Increment |
|---|---|---|---|---|
| | $PM_{10}$ | 24-hour | 3.539 | 30 |
| | | Annual | 0.551 | 17 |
| | $PM_{2.5}$ | 24-hour | 3.535 | 9 |
| | | Annual | 0.546 | 4 |
| Eagles Nest Wilderness Area | $NO_2$ | Annual | 0.262 | 2.5 |
| | $SO_2$ | 3-hour | 0.093 | 25 |
| | | 24-hour | 0.029 | 5 |
| | | Annual | 0.005 | 2 |
| | $PM_{10}$ | 24-hour | 0.566 | 8 |
| | | Annual | 0.131 | 4 |
| | $PM_{2.5}$ | 24-hour | 0.485 | 2 |
| | | Annual | 0.099 | 1 |
| Flat Tops Wilderness Area | $NO_2$ | Annual | 0.626 | 2.5 |
| | $SO_2$ | 3-hour | 0.473 | 25 |
| | | 24-hour | 0.161 | 5 |
| | | Annual | 0.016 | 2 |
| | $PM_{10}$ | 24-hour | 0.972 | 8 |
| | | Annual | 0.233 | 4 |
| | $PM_{2.5}$ | 24-hour | 0.758 | 2 |
| | | Annual | 0.175 | 1 |
| La Garita Wilderness Area | $NO_2$ | Annual | 0.138 | 2.5 |
| | $SO_2$ | 3-hour | 0.074 | 25 |
| | | 24-hour | 0.024 | 5 |
| | | Annual | 0.004 | 2 |
| | $PM_{10}$ | 24-hour | 0.297 | 8 |
| | | Annual | 0.057 | 4 |
| | $PM_{2.5}$ | 24-hour | 0.249 | 2 |
| | | Annual | 0.044 | 1 |
| Maroon Bells/Snowmass Wilderness Area | $NO_2$ | Annual | 0.325 | 2.5 |
| | $SO_2$ | 3-hour | 0.114 | 25 |
| | | 24-hour | 0.032 | 5 |
| | | Annual | 0.006 | 2 |
| | $PM_{10}$ | 24-hour | 0.635 | 8 |
| | | Annual | 0.169 | 4 |
| | $PM_{2.5}$ | 24-hour | 0.503 | 2 |
| | | Annual | 0.122 | 1 |
| Mount Zirkel Wilderness Area | $NO_2$ | Annual | 0.216 | 2.5 |
| | $SO_2$ | 3-hour | 0.145 | 25 |
| | | 24-hour | 0.058 | 5 |
| | | Annual | 0.009 | 2 |

**Table 4-22**
**Cumulative Pollutant Concentrations (CARMMS 2021 High Development Scenario) at Class I and Sensitive Class II Areas (μg/m$^3$)**

| Location | Pollutant | Averaging Time | Modeled Concentration | PSD Increment |
|---|---|---|---|---|
| | $PM_{10}$ | 24-hour | 0.707 | 8 |
| | | Annual | 0.174 | 4 |
| | $PM_{2.5}$ | 24-hour | 0.649 | 2 |
| | | Annual | 0.156 | 1 |
| Raggeds Wilderness Area | $NO_2$ | Annual | 1.778 | 25 |
| | $SO_2$ | 3-hour | 0.114 | 25 |
| | | 24-hour | 0.036 | 5 |
| | | Annual | 0.008 | 2 |
| | $PM_{10}$ | 24-hour | 2.031 | 8 |
| | | Annual | 0.739 | 4 |
| | $PM_{2.5}$ | 24-hour | 1.209 | 2 |
| | | Annual | 0.351 | 1 |
| Rocky Mountain National Park | $NO_2$ | Annual | 0.276 | 25 |
| | $SO_2$ | 3-hour | 0.087 | 25 |
| | | 24-hour | 0.021 | 5 |
| | | Annual | 0.005 | 2 |
| | $PM_{10}$ | 24-hour | 1.882 | 8 |
| | | Annual | 0.207 | 4 |
| | $PM_{2.5}$ | 24-hour | 1.164 | 2 |
| | | Annual | 0.116 | 1 |
| Weminuche Wilderness Area | $NO_2$ | Annual | 0.542 | 2.5 |
| | $SO_2$ | 3-hour | 0.163 | 25 |
| | | 24-hour | 0.047 | 5 |
| | | Annual | 0.007 | 2 |
| | $PM_{10}$ | 24-hour | 0.458 | 8 |
| | | Annual | 0.103 | 4 |
| | $PM_{2.5}$ | 24-hour | 0.423 | 2 |
| | | Annual | 0.065 | 1 |
| West Elk Wilderness Area | $NO_2$ | Annual | 0.309 | 2.5 |
| | $SO_2$ | 3-hour | 0.095 | 25 |
| | | 24-hour | 0.030 | 5 |
| | | Annual | 0.005 | 2 |
| | $PM_{10}$ | 24-hour | 0.720 | 8 |
| | | Annual | 0.211 | 4 |
| | $PM_{2.5}$ | 24-hour | 0.584 | 2 |
| | | Annual | 0.167 | 1 |

### Visibility Impacts

The visibility impacts due to RFD oil and gas emissions and mining emissions were examined following the procedures provided by the USFWS and NPS (USFWS and NPS, 2012). These procedures use EPA's Modeled Attainment Test Software (MATS) to project current year observed visibility impairment for the best 20 percent (B20%) and worst 20 percent (W20%) days to the future year using the 2008 Base Case and 2021 High Development Scenario modeling results [which include contributions from all sources categories (anthropogenic and natural)] with and without emissions from RFD sources.

Tables 4-22 and 4-23 display the cumulative visibility results for the 2021 High Development Scenario and RFD sources for W20% and B20% days, respectively. Note that since MATS was used and MATS only includes observed data for Class I areas, cumulative visibility results are presented for just the Class I areas.

As is indicated in **Table 4-23**, Cumulative Visibility Results (Δdv) for B20% Visibility Days at Class I Areas for Current Year (2008) and 2021 High Development Scenario all Emissions and Contributions from RFD Sources, from the 2008 current year to the 2021 High Development Scenario future year, the W20% visibility metric is estimated to improve at each of the Class I areas. The biggest improvement is a reduction of 0.86 dv that occurs at Rocky Mountain National Park that goes from 12.04 dv in 2008 to 11.18 dv in 2021. The lowest current year W20% days visibility at any Class I area is 8.68 dv which occurs at the Eagles Nest, Flat Tops, Maroon Bells-Snowmass, and West Elk Wilderness Areas. Visibility is estimated to improve to 8.07 dv at these areas in 2021, a 0.61 dv visibility improvement. RFD emissions are estimated to contribute a maximum of 0.30 dv to the 2021 W20% days visibility at these wilderness areas.

Cumulative visibility results at Class I areas for the B20% days are provided in Table 4-23. From the 2008 current to 2021 future year, the B20% days visibility is estimated to degrade in 5 and improve in 5 Class I areas. The largest B20% visibility degradation is a 0.14 dv increase from 2.25 to 2.39 dv at Black Canyon of the Gunnison National Park, and at the LaGarita and Weminuche Wilderness Areas. Whereas the largest B20% visibility improvement is a 0.20 dv decrease at the Mount Zirkel Wilderness Area Rawah from 0.95 to 0.75 dv. The maximum contribution from RFD sources to 2021 B20% visibility metrics is 0.21 dv at the Eagles Nest, Flat Tops, Maroon Bells-Snowmass, and West Elk Wilderness Areas.

**Table 4-23**
**Cumulative Visibility Results (Δdv) for Best 20% Visibility Days at Class I Areas for Current Year (2008) and 2021 High Development Scenario all Emissions and Contributions from RFD Sources**

| Class I Area | State | IMPROVE Site | 2008 Base | 2021 High | 2021 High Improvement from 2008 | Contribution from RFD |
|---|---|---|---|---|---|---|
| Arches NP | UT | CANY1 | 11.02 | 10.63 | 0.39 | 0.29 |
| Black Canyon of the Gunnison NP | CO | WEMI1 | 9.95 | 9.52 | 0.43 | 0.06 |
| Eagles Nest Wilderness | CO | WHRI1 | 8.68 | 8.07 | 0.61 | 0.30 |
| Flat Tops Wilderness | CO | WHRI1 | 8.68 | 8.07 | 0.61 | 0.30 |
| La Garita Wilderness | CO | WEMI1 | 9.95 | 9.52 | 0.43 | 0.06 |
| Maroon Bells-Snowmass Wilderness | CO | WHRI1 | 8.68 | 8.07 | 0.61 | 0.30 |
| Mount Zirkel Wilderness | CO | MOZI1 | 9.36 | 8.52 | 0.84 | 0.09 |
| Rocky Mountain NP | CO | ROMO1 | 12.04 | 11.18 | 0.86 | 0.14 |
| Weminuche Wilderness | CO | WEMI1 | 8.68 | 8.07 | 0.43 | 0.06 |
| West Elk Wilderness | CO | WHRI1 | 9.95 | 9.52 | 0.61 | 0.30 |

Deposition Impacts

Potential atmospheric deposition impacts within Class I and sensitive Class II areas were calculated for cumulative RFD sources and are shown in **Table 4-24**, Cumulative RFD Nitrogen and Sulfur Deposition Impacts (CARMMS 2021 High Development Scenario) at Class I and Sensitive Class II Areas. The maximum direct total (wet and dry) N and S deposition are predicted to be well below the cumulative analysis thresholds of 1.5 ky/ha/yr for nitrogen and 3 kg/ha/yr for sulfur at all Class I and sensitive Class II areas. The maximum total nitrogen and sulfur deposition rates are approximately 58 percent and 3 percent of the cumulative analysis thresholds at Dinosaur National Monument, respectively.

**Table 4-24**
**Cumulative RFD Nitrogen and Sulfur Deposition Impacts (CARMMS 2021 High Development Scenario) at Class I and Sensitive Class II Areas**

| Location | Maximum N Deposition (kg/ha/yr) | Maximum S Deposition (kg/ha/yr) |
|---|---|---|
| Arches National Park | 0.254 | 0.003 |
| Black Canyon of the Gunnison National Park | 0.296 | 0.006 |
| Colorado National Monument | 0.400 | 0.006 |
| Dinosaur National Monument | 0.866 | 0.075 |
| Eagles Nest Wilderness Area | 0.414 | 0.015 |
| Flat Tops Wilderness Area | 0.619 | 0.032 |
| La Garita Wilderness Area | 0.248 | 0.007 |
| Maroon Bells/Snowmass Wilderness Area | 0.429 | 0.019 |
| Mount Zirkel Wilderness Area | 0.472 | 0.038 |
| Ragged Wilderness Area | 0.410 | 0.018 |
| Rocky Mountain National Park | 0.456 | 0.019 |
| Weminuche Wilderness Area | 0.505 | 0.013 |
| West Elk Wilderness Area | 0.309 | 0.010 |

Potential changes in ANC from baseline conditions resulting from potential N and S deposition from cumulative RFD source emissions were calculated for 28 sensitive lakes within the Class I and sensitive Class II Wilderness areas. The estimated change in ANC for each lake is shown in **Table 4-25**, Cumulative Impacts on Lakes (CARMMS 2021 High Development Scenario) within the Class I and Sensitive Class II Areas. The estimated changes in ANC are all predicted to be above the applicable significance thresholds (less than a 10 percent change in ANC for lakes with ANC values greater than 25 μeq/l, and a 1.0 μeq/l change in ANC for lakes with background ANC values equal to or less than 25 μeq/l); at Ned Wilson and Upper Ned Wilson Lakes and Lower Packtrail Pothole in the Flat Tops Wilderness Area; at Deep Creek Lake in the Raggeds Wilderness Area; and at Big and Little Eldorado lakes, the Lake Due South of Ute Lake, the Small Pond Above Trout Lake, and Upper Grizzly and Upper Sunlight lakes in the Weminuche Wilderness Area. The greatest percent change for lakes with ANC values greater than 25 μeq/l is 14.4 percent at Lower Packtrail Pothole. The greatest ANC change for lakes with background ANC values equal to or less than 25 μeq/l is 4.3 μeq/l at Upper Ned Wilson Lake.

**Table 4-25**
**Cumulative RFD Impacts on Lakes (CARMMS 2021 High Development Scenario) within the Class I and Sensitive Class II Areas**

| Wilderness Area | Sensitive Lake | 10th Percentile Lowest ANC Value (μeq/L) | N Deposition (kg/ha/yr) | S Deposition (kg/ha/yr) | ANC Relative Change (%) | ANC Absolute Change (μeq/L) |
|---|---|---|---|---|---|---|
| Eagles Nest | Booth Lake | 86.8 | 0.0123 | 0.3417 | 5.1 | n/a |
| Eagles Nest | Upper Willow Lake | 134.1 | 0.0093 | 0.2509 | 2.8 | n/a |
| Flat Tops | Ned Wilson Lake | 39.0 | 0.0271 | 0.4399 | 10.9 | n/a |
| Flat Tops | Upper Ned Wilson Lake | 12.9 | 0.0271 | 0.4399 | n/a | 4.3 |
| Flat Tops | Lower Packtrail Pothole | 29.7 | 0.0271 | 0.4399 | 14.4 | n/a |
| Flat Tops | Upper Packtrail Pothole | 48.7 | 0.0271 | 0.4399 | 8.8 | n/a |
| La Garita | Small Lake Above U-Shaped Lake | 59.9 | 0.0059 | 0.2279 | 4.5 | n/a |
| La Garita | U-Shaped Lake | 81.4 | 0.0059 | 0.2279 | 3.3 | n/a |
| Maroon Bells | Avalanche Lake | 158.8 | 0.0186 | 0.4116 | 2.2 | n/a |
| Maroon Bells | Capitol Lake | 154.4 | 0.0186 | 0.4049 | 2.6 | n/a |
| Maroon Bells | Moon Lake | 53.0 | 0.0186 | 0.4049 | 7.6 | n/a |
| Mount Zirkel | Lake Elbert | 56.6 | 0.0381 | 0.4724 | 5.5 | n/a |
| Mount Zirkel | Seven Lakes (LG East) | 36.2 | 0.0278 | 0.3881 | 7.8 | n/a |
| Mount Zirkel | Summit Lake | 48.0 | 0.0411 | 0.4659 | 7.7 | n/a |
| Raggeds | Deep Creek Lake | 20.6 | 0.0143 | 0.3358 | n/a | 4.2 |
| Weminuche | Big Eldorado Lake | 19.6 | 0.0073 | 0.2460 | n/a | 2.4 |
| Weminuche | Four Mile Pothole | 123.4 | 0.0109 | 0.4706 | 3.5 | n/a |
| Weminuche | Lake Due South of Ute Lake | 13.2 | 0.0080 | 0.2771 | n/a | 2.8 |
| Weminuche | Little Eldorado | -3.3 | 0.0073 | 0.2460 | n/a | 2.4 |
| Weminuche | Little Granite Lake | 80.7 | 0.0077 | 0.3326 | 5.4 | n/a |
| Weminuche | Lower Sunlight Lake | 80.9 | 0.0094 | 0.3075 | 3.5 | n/a |
| Weminuche | Middle Ute Lake | 42.8 | 0.0068 | 0.2530 | 6.1 | n/a |
| Weminuche | Small Pond Above Trout Lake | 25.5 | 0.0077 | 0.3367 | 13.2 | n/a |
| Weminuche | Upper Grizzly Lake | 29.9 | 0.0105 | 0.3282 | 10.2 | n/a |
| Weminuche | Upper Sunlight Lake | 28.0 | 0.0105 | 0.3282 | 10.9 | n/a |
| Weminuche | West Snowdon Lake | 39.4 | 0.0061 | 0.2284 | 6.5 | n/a |
| Weminuche | White Dome Lake | 2.1 | 0.0073 | 0.2460 | n/a | n/a |
| West Elk | South Golden Lake | 111.4 | 0.0080 | 0.2852 | 2.8 | n/a |

<u>Additional Mitigation Measures</u>

As described in the Methods of Analysis description at the beginning of the this Air Quality Section, there are several key air quality related impacts of concern identified in the AQTSD due to predicted air quality impact levels being close to acceptable impact thresholds. Specifically, additional mitigation is needed for the following impacts of concern: near-field particulate matter (PM) impacts from construction and traffic activities, near-field $NO_2$ 1-hour impacts and far-field nitrogen deposition at nearby Forest Service sensitive areas.

As described early in this Air Quality Section and in the AQTSD, maximum modeled PM impacts are associated with the resource road and well pad construction activities modeling scenario. That scenario includes routine water / dust control application achieving approximately 50 percent dust control. Near-field impacts are acceptable for the construction scenario at receptors 100 meters of more from the emissions sources assuming this level of emissions control. It is not technically practicable to exclude PM impacts at all locations within 100 meters of the emissions source (i.e. well-pad and road construction activities) and for that reason, additional emissions control will be needed to reduce dust emissions.

The $NO_2$ 1-hour modeling production scenario was based on a configuration of well-pad production equipment (i.e. pumping units, heaters, etc.) that resulted in acceptable $NO_2$ 1-hour modeled impacts. The well-pad production equipment configuration (i.e. emissions levels) is reasonable for the average number of wells per pad based on operator input. To ensure that $NO_2$ 1-hour concentrations are acceptable near well-pads for any number of new wells (~ 4 - 12) per pad, there will be a $NO_x$ well-pad emissions limit requirement so that well-pad production $NO_x$ emissions are at or below the levels modeled for the near-field analysis as described in the AQTSD. In addition, the $NO_2$ 1-hour modeling development scenario assumed Tier 2 development engines at 2,000 horsepower total operating at any one time for a single year at each well-pad, and there will be an engine operation or NOx emissions limit requirement for well development related engines.

Modeled nitrogen deposition for Alternative A are below the DAT for all Class I and sensitive Class II areas, however, nitrogen deposition for Alternative B (Proposed Action) are above the DAT for a nearby Class I and sensitive Class II area. Modeling for Alternatives A and B used the same emissions source layout (same number of sources and locations) and the main difference for the two scenarios is that Alternative B was modeled with more emissions from the Project-related emissions sources. Using this information, a Unit-wide emissions control plan will be required so that production level emissions for the Proposed Action (Alternative B) will be at or below the levels modeled for Alternative A that resulted in acceptable nitrogen deposition impacts.

The following provides details for the additional emissions control requirements as identified by the modeling analyses performed for this EIS:

- The BLM will place a Condition of Approval (COA) on each permit, requiring the operator to apply continuous (keep surface moist) watering during access road and well-pad construction activities, and during heavy traffic periods including drilling and completion phases of well development. The operator will be required to limit off-site transport by maintaining “no visible dust plume” operations.

- The BLM will place a COA on each permit, requiring the operator to emit 5 tons per year (TPY) or less of $NO_x$ at each well-pad for production operations (post- construction and production phase) as defined by the acceptable emissions level analyzed in the $NO_2$ 1-hour modeling analysis. The operator will be required to submit a detailed well-pad production emissions inventory for each APD or details for the well-pad production equipment and operations (including refined emissions factors) to use to develop project-specific emissions inventories. An annual $NO_x$ emissions rate greater than 5 tons per year may be acceptable if the operator can demonstrate compliance with the NO2 1-hour NAAQS for the APD. Any additional impacts analyses will need to be reviewed and approved by BLM prior to BLM authorizing activities.

- The BLM will place a COA on each permit, requiring the operation of Tier 2 engines or cleaner for drilling / fracturing / completion activities. The operator will be required to submit a detailed well-pad development phase emissions inventory for each APD or details for the well-pad development equipment and operations (including refined emissions factors and hours of operation) to use to develop project-specific emissions inventories. Operation of engines totaling greater than 2,000 hp at any one time during the development phase (this total horsepower was analyzed for the EIS-specific $NO_2$ 1-hour impacts analysis) could trigger the need for additional impacts analysis and potentially warrant a requirement (COA) for Tier 3-4 engines. The goal of the requirement is for development (drill / completion / fracturing) related engines to emit no more than 1 gram per second of $NO_x$ total at any one time (total of all engines operating concurrently), unless another $NO_x$ emissions rate can be demonstrated to achieve compliance with the $NO_2$ 1-hour NAAQS.

- The BLM will require the operator to provide a detailed Unit-wide equipment configuration plan (with specific information for the pumping units) and emissions inventory for BLM review that shows a plan / projection for Unit-wide federal wells production phase NOx emissions at or below 143 tpy of NOx (annual NOx emissions level limit determined using the acceptable project-level nitrogen deposition threshold [0.005 kg/ha-yr] and an equation of a line for the annual NOx emissions levels and corresponding modeled nitrogen deposition for Alternatives A and B). The BLM will place a COA on each permit (APD), requiring the operator to submit a NOx emissions accounting analysis summary that provides information for how the APD emissions fit into the overall Unit-wide production phase (post construction and development) NOx emissions budget (approximately 143 tpy of NOx).

### 4.2.2 Noise

***Methods of Analysis***

Noise from the development and operation of gas wells and construction of associated infrastructure has the potential to impact sensitive land uses and users in the Unit. For this analysis, potential sensitive receptor locations within the Unit were identified, and the distances to potential well pads, compressor stations, pipelines, electrical lines, and access roads were assessed. The nature and types of noise sources associated with construction and operation and approximate noise levels by distance were then described. Actual noise levels at sensitive receptor locations would depend upon the exact locations of wells and related infrastructure, the amount of development activity occurring, and the local topography and would be assessed in tiered analysis as described in **Section 1.6.1**, Requirements for Future NEPA Analysis. This analysis assumes that measures for noise abatement would be applied to meet DOI and USDA Gold Book guidelines (DOI and USDA 2007) and COGCC maximum permissible noise levels described in **Section 3.2.2**, Noise, and in **Appendix C**, Best Management Practices and Conditions of General Approval, Requirement 1.

***Nature and Type of Effects***

Sources of noise include construction activities (earth-moving equipment for road, well pad, compressor station, electrical line, and pipeline construction); vehicle traffic; well drilling, completion, and production; and compressor station operations. Noise levels that typically result from these activities are described under Effects Common to All Alternatives, below.

Noise resulting from each alternative has the potential to affect sensitive receptors in the project area, primarily residents, recreational users, and wildlife. Potential noise impacts on wildlife are addressed separately in **Section 4.2.7**, Fish and Wildlife. The magnitude of the effect would depend upon the distance between the receptor and the noise source, the duration and frequency of the noise, and the time at which the noise occurred (noise is viewed as more disruptive when it occurs at night). In addition, individuals react differently to changes in ambient noise levels and to various types of sound; therefore, the perceived level of impact may vary by receptor. Noise levels that meet maximum permissible noise levels may still be perceived as a noise impact for some sensitive receptors.

***Effects Common to All Alternatives***

Noise under all alternatives would occur from construction activities and from operational activities. Construction would produce short-term, localized, and intermittent increases in ambient noise levels, while operations may produce long-term increases in ambient noise levels over the life of the project.

<u>Construction-related Actions</u>. Construction activities would include well pad development, access road improvement and development, pipeline and electrical line development, and compressor station development. These activities would require the use of earth-moving equipment (e.g., bulldozers, graders, and backhoes), heavy trucks (e.g., dump trucks and water trucks), generators, and air compressors at the construction site. In addition, heavy truck traffic and personal vehicle traffic would increase along area roadways to bring personnel and supplies to the staging and construction site locations. Noise from these activities would be short term and intermittent. For access roads, electrical lines, and pipelines, the construction equipment would not remain in one location for a long period of time given the linear nature of this type of development. Construction of these features would occur during working hours and would not affect nighttime ambient noise levels. In general, well pads would each take 1 to 3 weeks to construct, and access roads would be constructed at a rate of 600 to 800 yards per day.

Well drilling and completion would also be a short-term source of noise but would occur 24 hours per day, 7 days per week for an average of 60 days per natural gas well and 60 to 120 days per water disposal well. Drilling would take an average of 60 days for coalbed methane wells and 85 days for shale and sandstone. Completions would take an additional 8 to 10 days for all types of wells. The primary noise sources associated with drilling include large diesel engines that power the rotary rig and pumps and the large diesel-driven air compressors. In addition, heavy truck traffic and personal vehicle traffic would increase along area roadways to bring personnel and supplies to the well site.

<u>Operation-Related Actions</u>. The primary sources of noise during operation include natural gas or electric well pumps at each well, natural gas-fired internal combustion engines to power the compressors at each compressor station, and intermittent traffic related to operations and maintenance. In addition, periodic workovers would be needed to correct problems with producing wells, and road maintenance would occur to replace surface materials and apply dust abatement.

Noise from oil and gas development has been studied at federal, state, and local levels. Within Colorado, the COGCC conducted surveys of noise generated by various types of equipment used for drilling and production of natural gas (COGCC 2006), while La Plata County published a county impact report that included noise analysis from oil and gas operations (La Plata County

2002). **Table 4-26**, Average Noise Levels Produced during Construction and Operations, shows noise levels contained within those reports. The noise level reported was extrapolated to other distances; noise levels generally decrease by 6 dBA with a doubling of distance.

**Table 4-26**
**Average Noise Levels Produced during Construction and Operations**

| Activity | Duration of Noise | Noise Level at 50 Feet (dBA) | Noise Level at 500 Feet (dBA) | Noise Level at 1,000 Feet (dBA) | Noise Level at 2,500 Feet (dBA) |
|---|---|---|---|---|---|
| Well Pad, Access Road, Pipeline Construction Equipment[1] | Short-term, daytime | 86 | 66 | 60 | 52 |
| Well Drilling[1] | Short-term, 24 hours/day | 86 | 66 | 60 | 52 |
| Three-Axle On-Road Vehicle, 35 mph[1] | Short-term, daytime | 88 | 68 | 62 | 54 |
| Two-Axle On-Road Vehicle, 35 mph[1] | Short-term, daytime | 72 | 52 | 46 | 28 |
| Well Pump Units (Electric) [2] | Long-term, 24 hours/day | 47 | 27 | 21 | 13 |
| Well Pump Units (Natural Gas) [1] | Long-term, 24 hours/day | 67 | 47 | 41 | 33 |
| Compressor Station (muffled and shielded) [1] | Long-term, 24 hours/day | 60 | 48 | 42 | 26 |

Source: [1]La Plata County 2002, [2]COGCC 2006

Actual noise levels at a given location depend upon the topography of the area, atmospheric conditions (e.g., temperature, wind speed and direction, and humidity), vegetative conditions (which can absorb sound), and the presence of structures between a noise source and a noise receptor.

*Alternative A*

Alternative A would include new developments on fee lands and fee minerals. Activities on these lands would be subject to COGCC maximum permissible noise levels described in **Section 3.2.2**, Noise. Under Alternative A, 11 new well pads, up to 55 new natural gas wells, 1 new water disposal well, and 1 new compressor station would be developed over approximately 3 years.

<u>Construction-Related Impacts</u>. Construction related to well pad, road, and pipeline construction would have short-term, localized, and intermittent noise impacts as facilities are constructed. These actions would not occur during nighttime hours. Well drilling would have localized impacts within the vicinity of the well drilling activities that would last approximately 60 days per well. These activities would occur 24 hours per day and would thus have greater impacts, especially during nighttime hours, if drilling occurred in the vicinity of sensitive receptors such as residences. Construction-related traffic would produce intermittent noise impacts during the construction period, with greater impacts occurring on more heavily used routes such as State Route 133.

Under Alternative A, no proposed well pad analysis areas or new pipelines would be within 1,000 feet of existing residences except for the well pad that would be located within T11S

R90W Section 13 (see **Figure 2-1**, Alternative A), as measured from the edge of the well pad analysis area (actual well pad and well placement likely would be greater than 1,000 feet from residences within this area). Well pad construction and drilling are estimated to be within the maximum permissible noise levels allowed under COGCC rules for gas facility installation based on average noise levels presented in Table 4-26. Under COGCC rules, well pad development, pipeline development, well drilling, workover, and completion are subject to the noise standards for light industrial or industrial land uses. For construction-related actions, the standards are 70 dBA (light industrial) or 80 dbA (industrial) from 7 AM to 7 PM and 65 dbA or 70 dBA from 7 PM to 7 AM. At 1,000 feet, the construction activities are within these levels for all phases of construction. Activities may exceed this level for short periods of time if blasting or flaring is required, as allowed for by COGCC rules.

Under Alternative A, there are residences along roads that require upgrade for use and roads that do not require upgrade but that would be utilized over the 3-year construction period for construction-related traffic. These residences would experience intermittent and short-term noise level increases from road improvement as well as noise level increases from construction-related traffic. Construction traffic is not subject to COGCC maximum permissible noise levels, and noise levels at sensitive receptor locations would depend upon setback of the residence from the road as well as volume, speed, and type of traffic. Construction traffic would generally not occur during nighttime hours and would not affect the nighttime ambient noise levels.

Construction would have the potential to affect recreational users of the areas. Because noise related to construction could affect game movements within the Unit, hunters would be particularly impacted.

<u>Operation-Related Noise Impacts</u>. The primary operation-related noise sources would be natural gas-fired production well pumps and the compressor station. As described above, there are generally no well pad analysis areas within 1,000 feet of residences. Well pump operations are projected to be 41 dBA at 1,000 feet, which is below the COGCC standards of 55 dBA from 7 AM to 7 PM and 50 dBA from 7 PM to 7 AM for residential/agricultural/rural uses. The water disposal well would utilize electric pumps and would produce noise levels below those of natural gas-fired production well pumps. Well pads containing multiple wells may result in higher cumulative noise levels than those described for discrete wells but would be subject to the same maximum permissible noise levels.

Under Alternative A, the nearest residence is approximately 3,000 feet east of the proposed compressor station site. While the projected noise level would be below 26 dBA at locations farther than 2,500 feet based on Table 4-26, compressor stations also have the potential to produce low frequency sounds (measured as dBC) that are less likely to attenuate with distance or at downwind locations. COGCC rules address low frequency noise by requiring noise readings at the request of a landowner and mitigation for noise levels over 65 dBC within 25 feet of a residence or occupied structure (COGCC Rule 802d).

Siting to avoid impacts, requiring mufflers, and other sound reducing-measures would be determined during permitting and subsequent environmental review to ensure that construction and operational activities comply with COGCC maximum permissible noise levels.

*Alternative B*

Alternative B would include new developments primarily on split-estate (private surface over federal mineral estate) lands. Per **Appendix C**, Best Management Practices and Conditions of General Approval, General Requirement 1, operators would be required to comply with BLM Gold Book Standards and COGCC regulations related to noise control. Under Alternative B, 36 new well pads, up to 146 new natural gas wells, 4 new water disposal wells, and up to 4 compressor stations would be developed over approximately 6 years, over 3 times the amount of development proposed under Alternative A.

Construction-Related Impacts. Construction related to well pad, road, and pipeline construction would have short-term, localized, and intermittent noise impacts as facilities are constructed. These actions would not occur during nighttime hours. Well drilling would have localized impacts within the vicinity of the well drilling activities that would last approximately 60 days per well. These activities would occur 24 hours per day and would thus have greater impacts, especially during nighttime hours, if drilling occurred in the vicinity of sensitive receptors such as residences. Construction-related traffic would produce intermittent noise impacts during the construction period, with greater impacts occurring on more heavily used routes. Construction would occur over 6 years, resulting in a longer duration of elevated construction noise levels when compared with Alternative A.

Under Alternative B, no proposed well pad analysis areas would be within 1,000 feet of existing residences and many would be more than 1 mile from existing residences, with the exceptions of 1 house within T11S R90W Section 11, 1 house within T11S R89W Section 29, a cluster of 3 houses within T11S R90W Section 27, a cluster of 6 houses within T12S R89W Sections 4 and 9, and a single house within Section 9 (see **Figure 2-2**, Alternative B), as measured from the edge of the well pad analysis area. Actual well pad and well placement could be greater than 1,000 feet from residences within these areas. In addition, the same residences within T12S R89W Sections 4 and 9, as well as residences within T11S R89W Section 31, could be within 1,000 feet of proposed pipeline construction. Residences within T12S R89W Sections 4 and 9 could also be within 1,000 feet of a new proposed access road or road upgrades.

As described under Alternative A, well pad construction, pipeline and access road construction, and well drilling are estimated to be within the maximum permissible noise levels allowed under COGCC rules for gas facility installation. Activities may exceed this level for short periods of time if blasting or flaring is required, as allowed for by COGCC rules.

Under Alternative B, there are residences along roads that require upgrade for use throughout the Unit, as well as roads that do not require upgrade but that would be utilized over the 6-year construction period for construction-related traffic. These residences would experience intermittent and short-term noise level increases from road improvement as well as noise level increases from construction-related traffic. Noise levels at sensitive receptor locations would depend upon setback of the residence from the road as well as volume, speed, and type of traffic. Construction traffic would generally not occur during nighttime hours and would not affect the nighttime ambient noise levels.

Construction would have the potential to affect recreational users of the areas. Because noise related to construction could affect game movements within the Unit, hunters would be particularly impacted.

Operation-Related Noise Impacts. The primary operation-related noise sources would be natural gas-fired production well pumps and the four compressor stations. Well pump operations are projected to be 41 dBA at 1,000 feet, which is below the COGCC standards. The water disposal wells would utilize electric pumps and would produce noise levels below those of natural gas-fired production well pumps. Well pads containing multiple wells would result in higher noise levels than those described for discrete wells depending upon the location and number of wells.

Under Alternative B, the nearest residences are approximately 3,000 feet east of the 2 proposed compressor stations in T11S R90W Section 24 and northeast of the proposed compressor station in T11S R90W Section 10, while the nearest residents are approximately 1 mile away from the proposed compressor station in T12S R90W Section 1. While the projected noise level would be below 26 dBA at locations farther than 2,500 feet based on Table 4-26, compressor stations have the potential to produce low frequency sounds (measured as dBC) that are less likely to attenuate with distance or at downwind locations. COGCC rules address low frequency noise by requiring noise readings at the request of a landowner and mitigation for noise levels over 65 dBC within 25 feet of a residence or occupied structure (COGCC Rule 802d).

*Alternative C*

Alternative C would include new developments primarily on split-estate (private surface over federal mineral estate) lands. Per **Appendix C**, Best Management Practices and Conditions of General Approval, General Requirement 1, operators would be required to comply with BLM Gold Book Standards and COGCC regulations related to noise control.

Compared with Alternative B, Alternative C would have additional facility location constraints designed to reduce impacts that would modify the number and placement of potential well pads, roads, and pipelines. Under Alternative C, up to 35 new well pads, up to 146 new natural gas wells and 4 new water disposal wells, and up to 4 compressor stations would be developed over approximately 6 years. While Alternative C would have fewer well pads, the same number of wells would be concentrated in fewer areas, resulting in the potential for increased localized noise impacts during construction and operation.

Construction-Related Impacts. Construction-related noise impacts associated with well pad, road, and pipeline construction would have short-term, localized, and intermittent noise impacts as facilities are constructed. These actions would not occur during nighttime hours. Well drilling would have localized impacts within the vicinity of the well drilling activities that would last approximately 60 days per well. These activities would occur 24 hours per day and would thus have greater impacts, especially during nighttime hours, if drilling occurred in the vicinity of sensitive receptors such as residences. Construction-related traffic would produce intermittent noise impacts during the construction period, with greater impacts occurring on more heavily used routes. Construction would occur over 6 years, resulting in a longer duration of elevated construction noise levels when compared with Alternative A.

Like Alternative B, no proposed well pad analysis areas would be within 1,000 feet of existing residences and many would be more than 1 mile from existing residences, with the exceptions of one residence within T11S R90W Section 11, a cluster of 6 residences within T12S R89W Sections 4 and 9, and a single residence within Section 9 (see **Figure 2-3**, Alternative C), as measured from the edge of the well pad analysis area. Actual well pad and well placement could be greater than 1,000 feet from residences within these areas. In addition, the same residences within T12S R89W Sections 4 and 9, as well as 1 residence within T11S R89W Section 31, could be within 1,000 feet of proposed pipeline construction. Residences within T12S R89W Sections 4 and 9 could also be within 1,000 feet of a new proposed access road or road upgrades.

As described under Alternative A, well pad construction, pipeline and access road construction, and well drilling are estimated to be within the maximum permissible noise levels allowed under COGCC rules for gas facility installation. Activities may exceed this level for short periods of time if blasting or flaring is required, as allowed for by COGCC rules.

Under Alternative C, there are residences along roads that require upgrade for use throughout the Unit, as well as roads that do not require upgrade but that would be utilized over the 6-year construction period for construction-related traffic. These residences would experience intermittent and short-term noise level increases from road improvement as well as noise level increases from construction-related traffic. Noise levels at sensitive receptor locations would depend upon setback of the residence from the road as well as volume, speed, and type of traffic. Construction traffic would generally not occur during nighttime hours and would not affect the nighttime ambient noise levels.

Construction would have the potential to affect recreational users of the areas, primarily hunters, because noise related to construction could affect game movements within the Unit.

<u>Operation-Related Noise Impacts</u>. The primary operation-related noise sources would be natural gas-fired production well pumps and the four compressor stations. Well pump operations are projected to be 41 dBA at 1,000 feet, which is below the COGCC standards. The water disposal wells would utilize electric pumps and would produce noise levels below those of natural gas-fired production well pumps. Well pads containing multiple wells would result in higher noise levels than those described for discrete wells depending upon the location and number of wells. Noise levels at well pads near residences likely would be higher under Alternative C compared with Alternative B if a greater number of wells were developed on these pads.

Compressor station-related noise impacts would be the same as described under Alternative B.

Specific BMPs would be determined during permitting and subsequent environmental review to ensure that construction and operational activities comply with COGCC maximum permissible noise levels and minimize potential noise impacts on sensitive receptors within the project area.

*Cumulative*

The cumulative impacts assessment area for noise is the Unit. Development of additional natural gas production facilities under all alternatives would result in the addition of noise sources to those that already exist within the Unit. Existing noise sources include existing traffic and equipment noise from natural gas development and well maintenance, agricultural activities, and recreational and tourist traffic on State Highway 133 and County Route 265.

Natural gas development actions under all alternatives, in combination with the 17 existing wells and the 55 wells and 1 compressor station that would be developed under Alternative A, would contribute to increases in ambient noise levels in the short term during construction and over the long term as wells go into production and operate for the life of the field (estimated to be 40 years). The types of noise impacts from implementing Alternatives B or C would be similar to those described under Effects Common to All Alternatives but would occur for a longer duration and over a wider area. Cumulative noise impacts would be similar across alternatives. Cumulative projects under Alternative B would create new long-term sources of noise throughout the Unit, while cumulative projects under Alternative C would concentrate the same amount of development within fewer areas.

In some areas, the density of development under either alternative could be considered by some individuals to be noisy. The continuous noise from production wells and compressor stations may be disruptive or objectionable to some residents as well as recreationists, hunters, and livestock operators and may result in displacement of such activities. Ambient noise levels at buildout would be expected to increase in some areas within the Unit as a result of Alternative B in combination with past and reasonably foreseeable future actions.

### 4.2.3 Soil Resources

This section discusses impacts on soil resources from proposed management actions under each alternative. Existing conditions concerning soil resources are described in **Section 3.2.3**, Soil Resources. Soils, especially in fragile soil areas, are susceptible to impacts from surface disturbance, which can lead to compaction, accelerated erosion, soil loss, and reduced productivity

#### *Methods of Analysis*

Each 5-acre well pad may be placed within a 40-acre area as identified in Figures 2-1, 2-2, and 2-3. Due to the uncertainty of final well pad placement, a total sediment production based on well pad placement is not available. Every soil type within the Unit (see Table 3-14) may be impacted by wellhead placement and other features of the proposed projects. Soils within the Unit have soil erosion hazard ratings from slight to very severe, an erosion potential of roads and trails ranging from slight to severe and slope classification ranging from gently sloping to very steep. Erosion hazard ratings for roads and trails are broken out into three categories. A rating of "slight" indicates that little or no erosion is likely; "moderate" indicates that some erosion is likely, that the roads or trails may require occasional maintenance, and that simple erosion-control measures are needed; and "severe" indicates that significant erosion is expected, that the roads or trails require frequent maintenance, and that costly erosion-control measures are needed. Slope classification has a scale connotation that refers to the ground surface configuration for scales that exceed about 10 meters of range upward to the landscape as a whole, and includes gradient, complexity, length, and aspect (NRCS 1993).

Overall, soils with moderate erosion ratings and gently sloping slopes are less likely to produce sediment, whereas soils with severe or very severe erosion ratings and steep slopes are more likely to produce sediment. Soil erosion and slope steepness are correlated. That is, the steeper the slope that the soil is found on, the more erosion that is likely to happen. Due to the varying nature of slope, soil type, and soil erosion ratings, the absolute amount of erosion based on erosion ratings is not specified (NRCS 1993).

Impacts were determined by assessing number of acres planned for modification under each alternative. This assessment was completed for soils within the Unit and sensitive soils. For the purpose of this analysis, sensitive soils are defined as soils suitable for farmland as classified by the USDA under the Farmland Protection Act, soils on steep slopes, soils susceptible to natural erosion, and soils susceptible to erosion in reference to road and trail maintenance.

*Indicators*

Indicators of impacts on soil resources are based on proposed changes in the level of surface disturbing activities from construction and development of roads, pipelines, well pads, and other facility placements. Management actions involving ground-disturbing activities, reduced vegetation cover, trampling, and vehicle and heavy machinery use contribute to soil impacts through compaction and increased erosion rates.

The following indicators were used to evaluate effects on soils resources from the proposed actions:

- Acres proposed for disturbance
- Acres of farmlands and sensitive soils proposed for disturbance
- Acres proposed for long term and short term disturbance (as shown in Table 2-2)

*Assumptions*

The analysis of soil resources has the following assumptions:

- Soil resources will be managed to meet Standard 1 of the Colorado Standards for Public Land Health.
- Fragile soils will be managed to minimize erosion and maintain soil productivity.
- Applicable BMPs and mitigation measures as outlined under approved ROWs, APDs, and lease stipulations would apply under all alternatives.

***Nature and Type of Effects***

Direct effects include short- and long-term surface disturbance of soils resources. This may result in compaction from overland travel and land grading, vegetation clearing for construction of well pads, roads, pipelines, and ancillary facilities, increased erosion, runoff and sedimentation, and fragmentation of soil features on the landscape scale. Compaction of soils results in decreased vegetation cover and more exposure of the soil surface to erosion (Burton et al. 2008). In addition, soil surface would be removed from facility sites and stockpiled for later reclamation use and purposes, which may result in soil horizon mixing and changes to the initial soil properties of individual sites during reclamation.

Indirect effects may include introduction of invasive weeds to the project area, which can result in decreased soil stability and increased soil erosion. In addition, if chemical spills were to occur, they would result in the removal of soil layers for proper disposal at designated facilities depending on the chemical spilled.

***Effects Common to All Alternatives***

Under all alternatives, interim reclamation of areas not needed for long-term operations would reduce short-term direct effects from construction activities.

In addition, an Integrated Spill Prevention, Control and Countermeasures Plan and Emergency Response Plan would reduce the likelihood for hazardous material spills and subsequent removal and disposal of soil at proper disposal facilities.

Finally, mitigation measures, as required by the BLM, and site selection, as described under **Appendix A** and under Surface Disturbing Activities in **Appendix C**, would be implemented.

*Alternative A*

Under Alternative A, impacts from gas development would continue on private lands with non-federal mineral estate, and on existing lease rights on federal mineral estate. No new development on federal lands or development of federal mineral estate would occur under a Master Development Plan, which would limit future soil impacts. Future soil impacts would be concentrated on non-federal mineral estate. The BLM may receive and consider proposals for individual APDs, access, and/or other production-related activities at any time on federal surface and/or federal mineral estate which may result in more scattered impacts on soil resources. There would be no change to BLM land health under Alternative A.

**Table 2-11** shows the direct, short- and long-term impacts on soil resources under Alternative A. This table is based on the conceptual placement of project components and estimated project footprint, and exact acreages could change during site-specific design and permitting. **Tables 4-27**, **4-28**, and **4-29** show the direct short-and long-term impacts on farmlands and sensitive soil resources. Sensitive soil resources with proposed construction and development may require more frequent application of mitigation measures (e.g., mitigation measure numbers 7, 10, and 15) and more frequent monitoring (e.g., mitigation measure 4) to prevent undue impacts.

**Table 4-27**
**Acres of Soils on Steep Slopes Potentially Impacted (Alternative A)**

| Slope Percent | Pipes: Co-located | Pipes: Cross-country | New Road Construction | Roads: Requires Substantial Upgrades for Use | Well Pads |
|---|---|---|---|---|---|
| Long Term | | | | | |
| 1-10 | 2 | 0 | 4 | 11 | 12 |
| 11-20 | 3 | 0 | 2 | 16 | 8 |
| 21-30 | 0 | 0 | 0 | 4 | 1 |
| 31-40 | 0 | 0 | 0 | 2 | 0 |
| 41+ | 2 | 0 | 3 | 18 | 1 |
| Total | 8 | 0 | 9 | 49 | 22 |

**Table 4-27**
**Acres of Soils on Steep Slopes Potentially Impacted (Alternative A)**

| Slope Percent | Pipes: Co-located | Pipes: Cross-country | New Road Construction | Roads: Requires Substantial Upgrades for Use | Well Pads |
|---|---|---|---|---|---|
| Short Term | | | | | |
| 1-10 | 15 | 13 | 7 | 21 | 28 |
| 11-20 | 21 | 22 | 4 | 29 | 21 |
| 21-30 | 2 | 0 | 1 | 8 | 1 |
| 31-40 | 2 | 0 | 0 | 11 | 0 |
| 41+ | 14 | 11 | 5 | 33 | 5 |
| Total | 54 | 46 | 17 | 92 | 55 |

Source: SGI 2013, BLM GIS 2014, NRCS 2013

**Table 4-28**
**Acres of Soils with Erosion Hazard Ratings Potentially Impacted (Alternative A)**

| Erosion Hazard | Pipes: Co-located | Pipes: Cross-country | New Road Construction | Roads: Requires Substantial Upgrades for Use | Well Pads |
|---|---|---|---|---|---|
| Long Term | | | | | |
| Slight | 2 | 0 | 4 | 11 | 12 |
| Moderate | 4 | 0 | 2 | 21 | 9 |
| Severe | 2 | 0 | 1 | 10 | 0 |
| Very Severe | 0 | 0 | 1 | 7 | 1 |
| Total | 8 | 0 | 9 | 49 | 22 |
| Short term | | | | | |
| Slight | 15 | 13 | 7 | 21 | 28 |
| Moderate | 24 | 23 | 4 | 38 | 22 |
| Severe | 13 | 4 | 3 | 19 | 1 |
| Very Severe | 2 | 7 | 2 | 14 | 4 |
| Total | 54 | 46 | 17 | 92 | 55 |

Source: SGI 2013, BLM GIS 2014, NRCS 2013

**Table 4-29**
**Acres of Soils with Erosion Hazard Ratings for Roads (Alternative A)**

| Erosion Hazard | Pipes: Co-located | Pipes: Cross-country | New Road Construction | Roads: Requires Substantial Upgrades for Use | Well Pads |
|---|---|---|---|---|---|
| Long term | | | | | |
| Slight | 1 | 0 | 0 | 1 | 0 |
| Moderate | 0 | 0 | 2 | 2 | 3 |
| Severe | 7 | 0 | 7 | 47 | 18 |
| Total | 9 | 0 | 9 | 49 | 22 |
| Short term | | | | | |
| Slight | 5 | 2 | 0 | 1 | 0 |
| Moderate | 2 | 4 | 3 | 3 | 8 |
| Severe | 46 | 44 | 14 | 87 | 47 |
| Total | 54 | 46 | 17 | 92 | 55 |

Source: SGI 2013, BLM GIS 2014, NRCS 2013

Reseeding and reclaiming interim reclamation areas with approved seed mixes would reduce the likelihood for noxious weed invasion, erosion, and dust through restoration of plant cover. Monitoring would help to ensure that vegetation is deemed successful and reclamation plans would be submitted for each new well.

*Alternative B*

Impacts from the phases of development would be similar to those described for Alternative A, but under Alternative B, impacts would occur on federal lands and federal mineral estate only. BLM land health in developed areas would likely be reduced under this alternative.

The acreage of impacts would increase under Alternative B compared to Alternative A, as shown in **Table 2-10**, as additional facilities would be constructed. **Table 2-10** also shows the direct, short- and long-term impacts on soil resources under Alternative B. **Tables 4-30**, **4-31**, **4-32**, and **4-33** shows the direct short- and long-term impacts on farmlands and sensitive soil resources. Sensitive soil resources with proposed construction and development may require more frequent application of mitigation measures (e.g., **Appendix C**, Best Management Practices and Conditions of General Approval, COA numbers 7, 10, and 15) and more frequent monitoring (e.g., COA 4) to prevent undue impacts.

**Table 4-30**
**Acres of Soils on Steep Slopes Potentially Impacted (Alternative B)**

| Slope Percent | Pipes: Co-located | Pipes: Cross-country | New Road Construction | Roads: Requires Substantial Upgrades for Use | Well Pads |
|---|---|---|---|---|---|
| Long term | | | | | |
| 1-10 | 1 | 0 | 2 | 17 | 4 |
| 11-20 | 15 | 0 | 18 | 36 | 40 |
| 21-30 | 1 | 0 | 1 | 7 | 2 |
| 31-40 | 0 | 0 | 1 | 2 | 2 |
| 41+ | 8 | 0 | 11 | 35 | 22 |
| Total | 25 | 0 | 32 | 97 | 71 |
| Short term | | | | | |
| 1-10 | 3 | 3 | 4 | 32 | 10 |
| 11-20 | 95 | 24 | 33 | 67 | 102 |
| 21-30 | 6 | 8 | 1 | 13 | 5 |
| 31-40 | 1 | 4 | 1 | 5 | 6 |
| 41+ | 54 | 7 | 21 | 66 | 60 |
| Total | 159 | 47 | 60 | 182 | 182 |

Source: SGI 2013, BLM GIS 2014, NRCS 2013

**Table 4-31**
**Acres of Farmlands Potentially Impacted (Alternative B)**

| Farmland Type | Pipes: Co-Located | Pipes: Cross-country | Roads: New Road Construction | Roads: Requires Substantial Upgrades for Use | Well Pads |
|---|---|---|---|---|---|
| Long term disturbance | | | | | |
| Farmland of statewide importance | 0 | 0 | 1 | 11 | 2 |
| Prime farmland if irrigated | 0 | 0 | 0 | 2 | 0 |

**Table 4-31**
**Acres of Farmlands Potentially Impacted (Alternative B)**

| Farmland Type | Pipes: Co-Located | Pipes: Cross-country | Roads: New Road Construction | Roads: Requires Substantial Upgrades for Use | Well Pads |
|---|---|---|---|---|---|
| Short term disturbance | | | | | |
| Farmland of statewide importance | 2 | 2 | 2 | 21 | 5 |
| Prime farmland if irrigated | 0 | 0 | 1 | 3 | 0 |

Source: SGI 2013, BLM GIS 2014, NRCS 2013

**Table 4-32**
**Acres of Soils with Erosion Hazard Ratings Potentially Impacted (Alternative B)**

| Erosion Hazard | Pipes: Co-located | Pipes: Cross-country | New Road Construction | Roads: Requires Substantial Upgrades for Use | Well Pads |
|---|---|---|---|---|---|
| Long term | | | | | |
| Slight | 1 | 0 | 2 | 17 | 4 |
| Moderate | 16 | 0 | 19 | 46 | 45 |
| Severe | 8 | 0 | 9 | 26 | 21 |
| Very Severe | 0 | 0 | 2 | 9 | 1 |
| Total | 25 | 0 | 32 | 97 | 71 |
| Short term | | | | | |
| Slight | 3 | 3 | 4 | 32 | 10 |
| Moderate | 103 | 36 | 36 | 85 | 112 |
| Severe | 52 | 7 | 16 | 49 | 57 |
| Very Severe | 1 | 0 | 4 | 17 | 3 |
| Total | 159 | 47 | 60 | 182 | 182 |

Source: SGI 2013, BLM GIS 2014, NRCS 2013

**Table 4-33**
**Acres of Soils with Erosion Hazard Ratings for Roads (Alternative B)**

| Erosion Hazard | Pipes: Co-located | Pipes: Cross-country | New Road Construction | Roads: Requires Substantial Upgrades for Use | Well Pads |
|---|---|---|---|---|---|
| Long term | | | | | |
| Slight | 0 | 0 | 0 | 2 | 0 |
| Moderate | 1 | 0 | 1 | 9 | 5 |
| Severe | 23 | 0 | 30 | 87 | 66 |
| Total | 25 | 0 | 31 | 97 | 71 |
| Short term | | | | | |
| Slight | 0 | 0 | 1 | 3 | 0 |
| Moderate | 10 | 6 | 2 | 17 | 12 |
| Severe | 149 | 41 | 57 | 162 | 169 |
| Total | 159 | 47 | 60 | 182 | 182 |

Source: SGI 2013, BLM GIS 2014, NRCS 2013

BMPs such as erosion control and dust abatement measures, minimizing vegetation removal, limiting weed spread from vehicle traffic, and providing guidelines for vegetation reestablishment, would be applied where appropriate and would reduce the likelihood for long-term impacts on soil resources (e.g., **Appendix C**, Best Management Practices and Conditions of General Approval, BMP numbers 92, 93, and 99).

*Alternative C*

Alternative C is a modified action alternative, with fewer overall well pads, access roads and other facilities planned. The overall acreage of impacts under Alternative C would be less than for Alternative B, but more than Alternative A.

**Table 2-10** shows the direct and short- and long-term impacts on soil resources under all alternatives. Although the acres of impacts are estimates, the overall acreage of impacts would be less than those for Alternative B, but more than Alternative A, as additional facilities would be constructed. **Tables 4-34**, **4-35**, **4-36**, and **4-37** show the direct short-and long-term impacts on farmlands and sensitive soil resources. Sensitive soil resources with proposed construction and development may require more frequent application of mitigation measures (e.g., mitigation measure numbers 7, 10, and 15) and more frequent monitoring (e.g., mitigation measure 4) to prevent undue impacts.

Alternative C would also include additional BMPs and mitigation measures to reduce impacts on vegetation, such as requiring an annual reclamation monitoring status reports, which would help identify areas for improvement. Interim reclamation would ultimately increase soil health and stability through replanting an appropriate composition of grasses, forbs, and shrubs for the ecological site.

**Table 4-34**
**Acres of Farmlands Potentially Impacted (Alternative C)**

| Farmland Type | Pipes: Co-Located | Pipes: Cross-country | Roads: New Construction | Roads: Requires Substantial Upgrades for Use | Potential Yard Storage | Proposed Screw Com-pressor | Well Pads |
|---|---|---|---|---|---|---|---|
| Long term disturbance | | | | | | | |
| Farmland of statewide importance | 1 | 0 | 1 | 0 | 0 | 0 | 3 |
| Prime farmland if irrigated | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Short term disturbance | | | | | | | |
| Farmland of statewide importance | 8 | 0 | 2 | 0 | 0 | 0 | 8 |
| Prime farmland if irrigated | 0 | 0 | 1 | 0 | 0 | 0 | 0 |

Source: SGI 2013, BLM GIS 2014, NRCS 2013

**Table 4-35**
**Acres of Soils on Steep Slopes Potentially Impacted (Alternative C)**

| Slope Percent | Pipes: Co-located | Pipes: Cross-country | New Road Construction | Roads: Requires Substantial Upgrades for Use | Potential Yard Storage | Proposed Screw Compressor | Well Pads |
|---|---|---|---|---|---|---|---|
| Long term | | | | | | | |
| 1-10 | 3 | 0 | 3 | 1 | 1 | 0 | 4 |
| 11-20 | 18 | 0 | 12 | 12 | 1 | 6 | 35 |
| 21-30 | 4 | 0 | 2 | 4 | 0 | 0 | 5 |
| 31-40 | 0 | 0 | 0 | 1 | 0 | 0 | 2 |
| 41+ | 12 | 0 | 0 | 7 | 0 | 0 | 23 |
| Total | 37 | 0 | 23 | 25 | 2 | 6 | 69 |
| Short term | | | | | | | |
| 1-10 | 21 | 0 | 6 | 15 | 3 | 0 | 10 |
| 11-20 | 110 | 0 | 23 | 30 | 2 | 13 | 89 |
| 21-30 | 25 | 0 | 4 | 5 | 0 | 0 | 15 |
| 31-40 | 0 | 0 | 0 | 2 | 0 | 0 | 3 |
| 41+ | 74 | 0 | 11 | 27 | 0 | 2 | 61 |
| Total | 230 | 0 | 44 | 78 | 5 | 15 | 177 |

Source: SGI 2013, BLM GIS 2014, NRCS 2013

**Table 4-36**
**Acres of Soils with Erosion Hazard Ratings Potentially Impacted (Alternative C)**

| Erosion Hazard | Pipes: Co-located | Pipes: Cross-country | New Road Construc-tion | Roads: Requires Substantial Upgrades for Use | Potential Yard Storage | Proposed Screw Compressor | Well Pads |
|---|---|---|---|---|---|---|---|
| Long term | | | | | | | |
| Slight | 3 | 0 | 3 | 1 | 1 | 0 | 4 |
| Moderate | 22 | 0 | 14 | 17 | 1 | 6 | 42 |
| Severe | 9 | 0 | 4 | 6 | 0 | 0 | 22 |
| Very Severe | 3 | 0 | 2 | 1 | 0 | 0 | 0 |
| Total | 37 | 0 | 23 | 25 | 2 | 6 | 69 |
| Short term | | | | | | | |
| Slight | 21 | 0 | 6 | 2 | 3 | 0 | 10 |
| Moderate | 135 | 0 | 27 | 32 | 2 | 13 | 106 |
| Severe | 57 | 0 | 7 | 11 | 0 | 2 | 59 |
| Very Severe | 18 | 0 | 4 | 2 | 0 | 0 | 2 |
| Total | 231 | 0 | 44 | 47 | 5 | 15 | 177 |

Source: SGI 2013, BLM GIS 2014, NRCS 2013

**Table 4-37**
**Acres of Soils with Erosion Hazard Ratings for Roads Potentially Impacted (Alternative C)**

| Erosion Hazard | Pipes: Co-located | Pipes: Cross-country | New Road Construction | Roads: Requires Substantial Upgrades for Use | Well pads |
|---|---|---|---|---|---|
| Long term | | | | | |
| Slight | 0 | 0 | 0 | 0 | 0 |
| Moderate | 6 | 0 | 5 | 2 | 8 |
| Severe | 31 | 0 | 18 | 23 | 61 |
| Total | 37 | 0 | 23 | 25 | 69 |
| Short term | | | | | |
| Slight | 0 | 0 | 1 | 0 | 0 |
| Moderate | 36 | 0 | 9 | 3 | 20 |
| Severe | 194 | 0 | 34 | 44 | 157 |
| Very Severe | 0 | 0 | 0 | | |
| Total | 231 | 0 | 44 | 47 | 177 |

Source: SGI 2013, BLM GIS 2014, NRCS 2013

*Cumulative*

Combined with other past, present, and reasonably foreseeable future actions, Alternative B would contribute to short- and long-term soil disturbance and reduction of land health in the region. Past, present, and future grazing, mining, oil and gas, forestry and vegetation management would continue to disturb soils in the region due to trampling, project facilities, transmission lines, access roads, and overland travel. Increasing recreation pressure, including OHVs, would continue to disturb vegetation and spread weeds, which may result in a reduction of soil stability and an increase in erosion rates. If Alternative B was constructed simultaneously with other projects, cumulative construction and operation impacts on soil resources could increase. Alternately, land use planning efforts could help prioritize areas for disturbance and streamline the reclamation and revegetation process. Implementation of BMPs in **Appendix C** would minimize cumulative impacts caused by Alternative B, and no additional mitigation measures are recommended.

### 4.2.4 Water Resources

***Methods of Analysis***

Existing surface and groundwater quality data, including results of baseline sampling, were compiled and evaluated to identify existing and baseline conditions. The water rights database maintained by the Colorado Division of Water Resources (CDWR) was queried to identify existing water rights holders within the Unit, and to evaluate the distribution and general magnitude of existing allocations, and the sources of water within the Unit. The Colorado Oil and Gas Information System (COGIS) was searched for records of oil and gas wells located in the Unit and surrounding area.

Sources of, and mechanisms for, potential impacts of proposed activities on water resources were gleaned from scientific literature, environmental documentation of similar projects, scoping comments, experience from other gas and oil development sites, and from a range of sources, including regulatory agency, industry, research, and advocacy group sources. For example, much public controversy surrounds the use of hydraulic fracturing as a means of extracting oil and gas from tight formations that would not have been considered economically recoverable a few years ago. Although the technique is not new, the amount of data available about applications of the technology in a wide range of environments has grown rapidly in recent years along with the number of oil and gas wells where it has been used. Success in reducing the cost of extraction and expansion of the use of hydraulic fracturing has resulted in many innovations in the technology, and greater regulatory involvement, and it is likely that these changes will continue in coming years.

Estimates of the level of significance of program-specific and location-specific effects in this impact analysis have been made based on evaluation of the hydrologic and geologic context of the project, relying on documented descriptions of effects in similar environments, opinions of experts consulted during preparation, and on engineering judgment of the analyst.

Some potential impacts are expected to be reduced as a result of compliance with existing regulatory requirements and agency policies, BMPs, and required design features (see **Appendix C**, Best Management Practices and Conditions of General Approval, BMP numbers 130-133). In general, compliance with regulatory requirements is assumed as an inherent component of the project, and theoretical impacts would be avoided by this compliance. Specific siting details, and specific project details, such as the particular well drilling methods, waste containment or disposal methods, well completion methods, and number of wells, will be evaluated in project-specific plans, and specific mitigation measures that will be developed as part of the planning process for the specific project sites.

***Nature and Type of Effects***

Effects on water resources can be divided between water quantity effects and water quality effects. Water quantity effects relate to the quantity of water that would be required to accomplish the project objectives of drilling and maximizing the recovery of gas while minimizing the costs of production and the environmental effects associated with production.

Water quality effects include effects on both surface water and groundwater resources. Groundwater resources include both potable and non-potable resources. Most of the beneficial uses of water in the project area are derived from surface water resources. However, surface water and groundwater are connected, in that groundwater is recharged by surface water, and groundwater in turn discharges to streams and springs.

Effects can be either direct and indirect, or cumulative. Direct effects are those in which there is a direct cause and effect relationship between the project action and the effect. Indirect effects tend to be less obvious than direct effects and are less predictable, since they may be contingent on a sequence of triggering actions. Direct *water quantity* effects would include effects such as reduction in streamflow or decline in groundwater levels as a result of water withdrawals from streams or wells, respectively. Indirect *water quantity* effects might include effects such as a depletion of regional groundwater supplies as a result of consumptive use of surface water. Direct *water quality* effects include the effects that would result from a waste spill that discharged to a surface water body, or from migration of saline wastewater into a freshwater aquifer because of a failure of containment. Indirect *water quality* effects might include effects such as impairment of water quality in a fresh water aquifer because of a decline in water levels in the aquifer that induces lower quality water to flow into the aquifer.

Effects can also be divided among short-term and long-term effects. Short-term effects are mainly associated with construction. They tend to occur early in the project and typically have a short duration relative to long-term impacts. Construction activities of the project include earth moving activities such as pad construction and road and pipeline construction, and also well construction. Some of these activities, especially well construction, would be initiated at different individual sites within the project area over a relatively long period, though at any particular location they would be short in duration. Short-term effects could occur at many locations simultaneously with long-term effects. Long-term effects are usually associated with operation and maintenance activities. Not only are they more likely to occur over periods of years rather than months, but their timing is also generally less predictable.

The nature and magnitude of some types of potential effects would depend on options that have not yet been specified at the programmatic level of analysis. As discussed in Chapter 2, more specific and detailed analysis of effects would be evaluated in future project-specific plans required during permitting or to meet other environmental requirements. In this analysis, where more than one option is available (such as use of recovery pits versus closed loop systems during drilling), the range of effects is discussed in an attempt to bracket the potential effects.

***Effects Common to All Alternatives***

Most of the effects of the project would occur under any of the alternatives, and only the magnitude of the effects would vary. Even under Alternative A, most of the same impacts would occur as under the action alternatives. Since these effects are common to all of the alternatives, they are discussed in detail below, and the differences in magnitude of these common effects are discussed for each of the alternatives.

*Short-Term Effects*

Short-term effects are associated with construction activities, such as construction of roads, pipelines, well pads and associated infrastructure, and wells.

**Water Quantity.** As discussed in Chapter 2, SGI anticipates drilling new wells at a rate of up to 27 wells per year under all of the alternatives. Each alternative includes installation of wells over multiple years, but the maximum water requirements in a given year would be the same for each alternative until the maximum number of wells for the alternative is reached. Water is required for drilling and development of each new well, and for dust suppression during construction of roads, pipelines, and well pads.

Fresh water needed for drilling, pad construction, completion, and dust suppression would be obtained from nearby sources (per agreements with landowners), or would be obtained in accordance with SGI's water augmentation plan (see **Appendix L**). Under the augmentation plan, SGI would store water in Bainard Reservoir No. 1 to augment stream diversion amounts of up to 50.64 acre-feet per year, based on the following estimated consumptive uses:

- Construction of up to 8 wells per year (at 1.69 acre-feet per year per well);
- Construction of an estimated 8 well pads per year (0.77 acre-feet per site);

- Dust suppression to maintain approximately 15 miles of roads (500,000 gallons, or about 1.5 acre-feet per mile);
- Transit losses of 7.96  acre-feet per year from the reservoir outlet to the point of replacement at the confluence of Muddy Creek and West Muddy Creek.

In addition, the Augmentation Plan estimates evaporative losses of 33.1 acre-feet per year from Bainard Reservoir No. 1 where the augmentation water would be stored.

These quantities represent a maximum amount estimate, since augmentation is only necessary when senior water rights holders downstream place a call on the water.  In addition to the water needed for drilling and dust suppression, additional water is needed for well completions, involving hydraulic fracturing  of the gas-containing formations.  The quantity of water required for hydraulic fracturing will vary with the geology encountered in the reservoir rock, the type of well (vertical or horizontal/direction and the length(s) of the perforated interval(s), and will also depend on the amount of waste fluid that can be recycled for subsequent fracturing stages.  The water requirements for hydraulic fracturing will not be known until the wells are drilled and logged, but coalbed methane deposits are expected to require the least water per length of well (because of the water that can be produced from these deposits, and the low fracture resistance), sandstone somewhat more, and shale will require the most, because of its low porosity and high fracture resistance.  Nor is it certain that water would be used as the base fluid for hydraulic fracturing.  Use of waterless fracturing techniques could greatly reduce the quantity of water required for construction off wells.  For purposes of this analysis, the conservative maximum estimate of the average water requirements per well used for evaluation purposes in this report is 124,000 barrels of water, about 16 acre-feet per well, although this would significantly overestimate the consumptive use if the water is recycled.

Although fresh water is often a convenient and inexpensive source for most of the water used for hydraulic fracturing, other sources can be used, including the water produced from a well during drilling.  It is expected that about 80 percent of the volume injected for hydraulic fracturing will be returned during completion, and this water can potentially be recycled.  Assuming that the water can be recycled and that about 30 percent is lost to the formation or to evaporation or other losses, a more realistic estimate is that 70 percent of water entered into the system could be recovered and used as recycled water for the next well. The remaining 30 percent of water would need to be replenished with fresh water sources.

According to state regulations, water produced from oil and gas wells is not considered to be beneficial, and operators are not required to have a permit to extract water.  However, the State of Colorado considers water produced from coalbed methane wells to have a beneficial use, and therefore the well is subject to a permit (CDWR 2010).  If a coalbed methane well produces nontributary groundwater (that is, groundwater that does not contribute to flow in a stream) then the well can be operated without an augmentation plan or a substitute water supply plan.  Some of the wells in the project area will produce coalbed methane, and others will produce shale gas. The proportion of each is not known, but for evaluation purposes, it is assumed that there will be an equal number of each.  It is unlikely, given the depths of the coalbeds that are targeted for gas exploration, that any of the coalbed methane wells will require augmentation plans; however, this would be determined at the time a permit is obtained.

Rules establishing the procedures for a determination of whether produced waters are nontributary are codified in 2 CCR 402-17 ("Produced Nontributary Ground Water Rules"). The rules establish certain areas and formations as nontributary waters without requiring further evaluation. According to these rules, ground water in the Mesaverde Formation, Cameo and South Canyon Coal Groups within the boundaries of the Bull Mountain Unit are delineated as nontributary waters. Since this includes the target formations for gas development in the Unit, augmentation is not expected to be required for water produced from these formations in the Unit. However, an augmentation plan will be needed to off-set water usage for drilling the freshwater portion of the wells, as discussed at the top of this section.

**Impacts on Surface Water Quality.** The quality of surface waters in the Unit, including streams and reservoirs, is generally high, and is suitable for most beneficial uses. Water quality could be degraded by accidental spills or releases of substances stored or used at the project sites, such as hydraulic oil and fuel used in heavy equipment, chemical additives used in well stimulation, or waste fluids stored in tanks or pits, transported by truck, or conveyed in pipelines.

Engineering controls (such as spill containment structures) and use of BMPs can provide a high level of protection against spill reaching surface water bodies. In the event than unanticipated uncontrolled spills occur, setbacks from surface water bodies of chemical storage facilities, impoundments, pipelines, and other improvements, or of ground disturbing activities, can provide additional protection by allowing more time and opportunity to detect and remediate spills before they reach surface water resources.

As described in Chapter 2, fresh, production, and recycled water may be transferred overland via portable polyethylene (HDPE) pipe, and via existing buried steel pipelines, to the four McIntyre flowback pits located on private lands on the west-central portion of the Unit. Two of the pits have capacities of about 30,000 barrels. Two larger pits each have about five times the capacities of the smaller pits. The pits must conform to requirements in COGCC 900 Series Rules. Pipelines are also addressed in the 900 Series Rules. However, use of portable pipelines is not specifically addressed. The use of pipelines to convey stimulation fluids to a central water storage facility has a number of advantages over hauling the water in trucks, or even transporting it in permanent steel pipelines, such as reducing land disturbance, dust and wear on roads, and encouraging recycling of the fluids. However, portable pipelines may be vulnerable to breakage or sabotage, and it may be difficult to monitor the integrity of the pipelines during use, or to shut off the pipelines in the event a failure is detected. Under a worst case scenario, a large volume of brine could be discharged near a stream crossing when the stream is flowing, causing a sudden change in salinity capable of impacting riparian habitat and biota downstream of the release. The effects would depend on the concentrations in the fluid and the quantity and rate of the release.

Surface water could also be degraded by sediment eroded from areas of soil disturbance such as pipeline trenches, roads, or well pads. BMPs would be applied during construction and as part of the site design. BMPs include drainage controls at the disturbed site; grading to help maintain internal drainage and low slopes; runoff containment; directing runoff to retention/infiltration areas and away from surface water features; revegetation to establish ground cover; and installing silt fences around the perimeter of erodible areas. See **Appendix C**, Best Management Practices and Conditions of General Approval, COAs 53-55, for a list of protections for water resources. Although not easily implemented, other techniques for reducing erosion during construction activities include minimizing the size of the area that is disturbed at any one time, and avoiding construction during the wet season.

A Storm Water Construction Permit is required by the State of Colorado Department of Public Health and Environment (DPHE) for new construction involving disturbance of more than 1 acre of land, including access roads and feeder pipelines. The state requirement applies to oil and gas facilities until the site is “finally stabilized,” which for oil and gas sites is defined by the COGCC as the stage of interim reclamation. Multiple oil and gas sites within a field can be covered under a single Field permit certification.

The purpose of the Storm Water Construction Permit is to prevent non-storm water discharges from entering Waters of the State. The permit must identify and implement BMPs. The Permit requires a minimum inspection schedule and specifies that the stormwater management system of each individual site under active construction must be inspected at least once every 14 calendar days, and within 24 hours after the end of any precipitation or snowfall event that causes surface erosion (except during periods of winter snow cover), to ensure that the BMPs are effective in preventing non-storm water discharges.

BMPs are required to address materials handling and spill prevention. If Spill Prevention Control and Countermeasures (SPCC) Plans are required for the site (combined above-ground oil storage capacity of more than 1,320 gallons), the SPCC Plans can be incorporated into the Storm Water Construction Plan to comply with the BMP requirements applicable to bulk storage at the site. The Storm Water Construction Plan also describes site stabilization methods at each portion of the site(s) in accordance with COGCC standards.

Compliance with the requirements for the Storm Water Construction Permit is expected to ensure that the potential for impacts on surface water quality from spills or releases during construction are reduced to less than significant levels, but some idea of the risk of a spill occurring can be obtained from past spill records maintained by the COGCC (2014).

According to the US Energy Information Agency (US EIA 2013), the number of producing gas and gas condensate wells in Colorado grew from about 5,125 in 1989, to about 32,000 in 2012. **Table 4-38**, Estimated Risk of a Reportable Spill from a Producing Gas Well in Colorado 2009 to 2013, shows the number of combined oil and gas spills reported to COGCC from 2009 to 2013, and as a percentage of the number of producing gas wells. The table overestimates the risk of a spill related to gas wells only, since the spill data includes spills from oil wells. There were approximately 50,000 active oil and gas wells in Colorado in 2013, so the risk of a spill as a percentage of active oil and gas wells combined was closer to 1 percent (1 in 100) in 2013.

COGCC records indicate that, from 2006 to present, 9 spill incidents were reported at oil and gas wells in Gunnison County (no spills are recorded in Gunnison County prior to 2006), which is a rate of about 1 incident per year in an area with about 44 active wells. The higher rate of incidents per well in this area compared to the state average probably reflects a higher risk of spills during well construction. None of the spills impacted surface water, and most spills are contained within a berm or are cleaned up before they threaten surface water.

**Table 4-38**
**Estimated Risk of a Reportable Spill**
**from a Producing Gas Well in Colorado 2009 to 2013**

| Year | Number of Producing Gas and Gas Condensate Wells[1] | Number of Reported Oil and Gas Spills[2,3] | Percent Spills per Well |
|---|---|---|---|
| 2009 | 27,021 | 384 | 1.4% |
| 2010 | 28,813 | 497 | 1.7% |
| 2011 | 30,101 | 526 | 1.7% |
| 2012 | 32,000 | 402 | 1.3% |
| 2013 | 34,000 (estimated) | 534 | 1.7% |

1 - US EIA 2013; 2 -EnergyWire, May 4, 2013;
Source: COGCC 2014

One such spill occurred in 2012 at well Jacobs 29-1 on the Jacobs Ranch property just east of Highway 133 and about 300 feet east of Muddy Creek. The spill involved a release of 158 barrels (6,636 gallons) of produced water caused by pump failure during transfer of the water to containment vessels, and was contained within the berm surrounding the containment vessels. An estimated 95 barrels (3,990 gallons) of the spilled fluid was recovered.

In its most recent annual report (2014), COGCC reported only three releases of exploration and production waste fluids in Northwestern Colorado (which includes the Piceance Basin) that impacted either surface water or dry drainages leading to surface water (COGCC 2014).

**Impacts on Groundwater Quality from Surface Spills.** Groundwater quality can be impacted by surface spills of the same sort that might impact surface water quality. Instead of running off or being transported by storm water, the spill infiltrates the vadose zone (the unsaturated area between the ground surface and water table) to the water table. The rate of migration is dependent on the nature of the materials; infiltration is slower through clays than through sands. Spills and releases at the ground surface would be prevented or mitigated through compliance with existing regulatory requirements and policies, including regulations under state and federal laws and adherence to BLM lease stipulations (see Section 3.2.4).

The BLM's protection of groundwater resources begins during the resource management planning process with the development of stipulations or lease notices to be applied to oil and gas leases.

BLM standard practice includes performing a site-specific analysis of groundwater occurrence and vulnerability during BLM's review of an APD. A BLM geologist and/or hydrologist would perform an independent review of each APD utilizing Colorado Geological Survey (CGS) and U.S. Geological Survey (USGS) geologic and hydrologic data and maps to identify usable groundwater resources that require protection.

**Groundwater Impacts from Drilling.** For federal lands and mineral estate, a BLM petroleum engineer would review the drilling plan to ensure that the casing and cementing program is protective of freshwater aquifer zones identified in the geologic report. A natural resource specialist would review the surface use plan and determine the adequacy of reserve pit design. COAs would be attached to the APD as necessary.

Fresh water tends to occur at relatively shallow depths below the ground surface, on the order of hundreds of feet deep, rather than thousands of feet. Fresh water is low in dissolved salts. The federal secondary drinking water standard for dissolved salts (called “total dissolved solids,” or TDS) is 1,000 milligram per liter (mg/L), which is approximately equivalent to 1,000 parts per million (ppm) by weight. By contrast, seawater has a TDS concentration of about 30,000 to 40,000 ppm. Water with higher concentrations is called brine. Groundwater at the depths at which the gas-containing formations are found (thousands of feet), is brackish, with TDS concentrations in the range of about 7,000 ppm up to about 15,000 ppm.

Before an oil or gas well is drilled, a plan must be submitted to the COGCC (and to the BLM where the wells target the federal mineral estate) for approval, specifying the groundwater zones and geologic units the well will encounter, and how the well will be constructed to protect groundwater resources. To protect freshwater aquifers, COGCC requires that a *surface casing* be installed to a depth of at least 50 feet below the depth of the deepest water well or below the depth of the bottom of the aquifer, whichever is greater. The surface casing must be terminated in an impermeable formation below the aquifer. If multiple freshwater aquifers are present, each may need to be isolated from the others. (In some instances, the COGCC may require a larger diameter *conductor casing* that extends a short distance below the surface and provides greater protection against migration of contaminants at the surface to the aquifer during drilling, but in most locations, the surface casing alone is sufficient.) BLM requirements are similar.

After the surface casing is installed, the borehole is continued through the surface casing and a smaller diameter casing is installed. In many wells, an *intermediate casing* is installed below the surface casing, to a depth above the formation containing the targeted hydrocarbon deposits. The intermediate casing is sealed and cemented, and then the production casing string is installed to the depth of the target formation. In some wells the production casing is installed with no intermediate casing.

**Groundwater Impacts from Hydraulic Fracturing (Well Stimulation).** Some geologic materials (clays, cemented sandstones, shale) act as barriers to the vertical flow of water and fluids, due to their low porosity and low permeability, while other geologic units (loose sands, gravels) are highly conductive and allow fluids to migrate easily. The presence of accumulations of fluid hydrocarbons in the subsurface is evidence that the hydrocarbons have been isolated and trapped, since otherwise the hydrocarbons would escape to the earth’s surface. In the case of shale gas, the gas is trapped in the fine porosity of the shale and within the matrix of the shale formation.

Hydraulic fracturing creates or widens fractures in the fine, impermeable deposits and creates interconnected pathways that allow the hydrocarbon fluids to escape or be pumped from the formation. The process of hydraulic fracturing involves directing hydraulic fracturing fluids into a small region within a tight formation that has been penetrated by a well. The well may be either a vertical well or a horizontal well created by directional drilling. The pressure is applied through a perforated segment of production casing enclosed above and below by packers inside casing and by cement applied in the annular space between the casing and the borehole. The packers limit the distance within which the pressure is applied to the adjacent formation, and the cement outside the casing prevents the pressure from being directed into the annular space of the well bore. The segments of the well in which the hydraulic fracturing pressure is directed are selected based on the presence of the targeted deposits, and an assessment of the geologic structure, based on information from logs made during drilling.

If not properly cemented and sealed, the annular space around a well casing (the space between the borehole and the steel casing of the well) could act as a conduit for the brackish or saline fluids to move from one depth to another in response to hydraulic fracturing pressures.

As water is recycled in the hydraulic fracturing process, salt concentrations in the fluids increase because more salts are removed from the formation each time water is circulated and recovered. Brines with concentrations of up to 70,000 ppm TDS may be generated in the process of drilling and hydraulic fracturing the wells, and will be stored at the surface for reuse or disposal.

In addition to the natural salts that are present in the formations at depth, the fluids used in hydraulic fracturing can contain a variety of additives designed to accomplish various objectives, including improving the permeability of porous materials, increasing secondary porosity (fracture diameter), maintaining pumps and equipment, preventing biofouling, and adjusting viscosity. Proppants are added to the hydraulic fracturing fluid to hold open the newly created or widened fractures. COGCC regulations (Rule 205) require operators to identify and report the additives used in the hydraulic fracturing fluids and their quantities within 30 days of completion of a well. Since April 2012, this information, with the exception of certain trade secret information, must be made available to the public on a publicly available website, FracFocus (http://www.fracfocusdata.org). Prior to promulgation of Rule 205, some information about the nature and quantities of chemicals used in a well were reported in the Colorado Oil and Gas Information System (COGIS) online database, with varying degrees of completeness.

The constituents of the hydraulic fracturing fluid vary. Hydraulic fracturing involves the use of water as the base injection fluid. According to COGCC, water and proppants (primarily sand, which may be supplemented by synthetic materials), account for more than 99 percent of the mass of hydraulic fluid. A variety of additives comprise the remaining less than 1 percent of the hydraulic fracturing fluid, including gels to increase fluid viscosity to suspend the proppants, biocides to eliminate bacteria, scale inhibitors to maintain piping, surfactants, iron controlling agents, and crosslinking agents that maintain viscosity with temperature increase, friction reducers to promote entry and distribution of the proppants into fractures. Most of the additives used in the industry are non-toxic and highly dilute in the fluid, so that they would present very little threat to water quality even if the cement seals in the wells were to fail, or the fractures themselves were to become conduits (COGCC 2011).

Recently, a technique called waterless fracturing has begun to gain prominence. Waterless fracturing substitutes a non-aqueous fluid for some or all of the water that would ordinarily be used. Waterless fracturing was recently used in one well in the Unit (Federal 11-89-17 #1, located just west of Highway 133 and southwest of Chair Creek, and completed to a depth of 8,510 feet). The well had been drilled in 2009, but did not produce until it was hydraulically fractured in 2012. The base fluid utilized in fracturing this well was a mixture of 50 percent butane and 50 percent propane, which together comprised about 82 percent of the hydraulic fracturing fluid by weight. Proppants constituted about 13 percent, and other additives, including gelling agents, comprised the remaining approximately 3 percent (FracFocus 2012).

Most of the hydraulic fracturing fluid (often up to about 80 percent or more) is recovered in flowback from the well during completion and prior to production, and most of the rest of the residual hydraulic fracturing fluid is recovered during production, along with some water already present in the formation. Maximum recovery of gas requires that the formation be as free of water as possible. This means that the pressure gradients that force fluids into the formation away from the well during hydraulic fracturing are temporary, and reverse toward the well when production begins. COGCC requirements governing the hydraulic fracturing process include Rule 341, which requires monitoring of the pressures applied during well stimulation, and Rules 903 and 904 which include the requirements for containing hydraulic fracturing fluids. In addition, special requirements apply to Coal Bed Methane (coalbed methane) wells (Rule 608).

The water and chemical additives used in hydraulic fracturing must be stored and mixed at the wellhead during well construction, and chemicals must be stored at certain central storage points in the project area. Chemical storage and handling during construction are governed by the spill prevention requirements under the Clean Water Act, and more specifically by Construction Storm Management Plans, and SPCC Plans, where applicable, as described above. If a spill were to occur, COGCC Rule 906 requires notification of the COGCC, the Colorado Department of Public Health and Environment (CDPHE), and the landowner of any spill incident that could impact Waters of the State.

**Impacts Associated with Disposal of Production Wastewater.** It is likely that much of the water injected for hydraulic fracturing will be recycled and used in subsequent hydraulic fracturing operations of other wells, until the fluid becomes too saline for reuse. The quantity of waste water that will need to be disposed is therefore dependent not only on the amount recovered, but on the amount that can be recycled. Additional water (not only some of the water injected during hydraulic fracturing, but also the saline water naturally present in the formation) is produced during production of gas, and must be recycled or disposed.

Currently, SGI operates one deep injection well (Federal 24-2 WDW, which is centrally located in the Unit in Section 24 of Township 11S/Range 90W). No other injection wells are currently active within more than 1 mile of the Unit. Federal 24-2 WDW was drilled to a depth of nearly 10,000 feet, and is designed to inject production water into the Maroon Formation, which lies deep below the Mancos Shale. (See also the discussion of deep injection, seismic effects, and mitigation measures in Section 2.4.5, Geologic Resources).

The deep groundwater is not potable. The water that will initially be produced from the formation is brackish, with TDS concentrations generally less than 15,000 ppm. As the water is recycled, the salt concentration increases, because more salts are removed from the formation. Brines with concentrations of up to 70,000 ppm TDS may be generated in the process of hydraulic fracturing.

Other methods of handling produced water besides deep injection may be considered in individual APDs. A number of innovative options are available, but they tend to be more costly than standard disposal methods, and their feasibility depends on the composition of the produced water, the re-use objectives of the treated water, disposal options and costs of the residual waste, and the scale of treatment required. Although large-scale plants may be more efficient, they must be centrally located and produced water must be transported to the treatment site. Small-scale treatment systems are desirable because they can be placed close to the well site and can avoid the need transport of waste fluids. The two best developed technologies applicable to treatment of produced water are membrane filtration (specifically reverse osmosis, but it also includes microfiltration, ultrafiltration, and nanofiltration) and electrocoagulation. Other technologies that may be considered alone or as part of a treatment chain include: thermal treatment (which uses heat for distillation); hydrocyclones (for particulate separation, possibly as a pretreatment in combination with other technologies), gas floatation (to remove particulates and organic matter, as a pre-treatment technology), filtration, ion exchange, chemical oxidation, electrodialysis/electrodialysis reversal, freeze thaw evaporation, Dewvaporation, and macro-porous polymer extraction (Igunnu and Chen 2013). Each of these technologies has disadvantages, ranging from high cost to limited effectiveness, to lack of data to demonstrate reliability. Each would require further evaluation of cost and feasibility.

*Long-Term Effects*

**Water Quantity.** The long-term effects on water quantity would be similar to the short-term effects, but would be lower in magnitude as construction tapers off and the focus turns to long-term operation and maintenance, which would demand less water.

**Water Quality.** The long-term effects on water quality would be similar to the short-term effects, but would probably be lower in magnitude as construction tapers off and the focus turns to long-term operation and maintenance, which would demand less water.

*Alternative A*

**Water Quantity.** Alternative A involves development primarily on private lands and, therefore, does not require management by the BLM. For comparison purposes, Alternative A assumes that up to 27 new wells per year may be constructed. If augmentation water in Bainard Reservoir No. 1 is estimated to be sufficient for all dust suppression and pad construction as well as the drilling of 8 wells per year, and assuming that construction of each well consumes approximately 1.7 acre-feet, the remaining 19 new wells would require approximately 32 acre-feet of water per year to be purchased from willing sellers. This is approximately the amount of annual evaporative loss from Bainard Reservoir. Hydraulic fracturing would require about 536 acre-feet per year and a total of about 552 acre-feet for all purposes combined. Assuming that the water is obtained between April and July, when average historical daily flows in Muddy Creek have ranged from about 200 cubic feet per second (cfs) to over 500 cfs, this 468 acre-feet could be obtained from diverting approximately 2.6 cfs during this 4-month period, which would represent less than 1 percent of the streamflow during this period.

Water requirements could be greatly reduced by implementing closed loop drilling methods, recycling fracturing water, or by using waterless hydraulic fracturing methods. Assuming that 30 percent of the required water comes from freshwater sources and 70 percent comes from other sources, such as produced and recycled water, the wells would require 140 acre-feet total of freshwater, which would be equivalent to diversion of about 0.8 cfs during a 4-month period. The diversion rate would be less if it was spread over a longer period. For example, if spread over the year, the diversion rate would only be about 0.25 cfs. If this water requirement were obtained by purchase from existing holders of water rights, then no impacts on water resources would be expected.

Overall water quantity under Alternative A was estimated based on known water quantities, anticipated drilling rates, and number of wells. For drilling, it is estimated that up to 3,000 barrels of water would be needed per well and this amount is assumed for both water disposal and gas wells. Based on this and the 56 wells proposed under Alternative A, up to 168,000 bbls of water would be needed to drill all wells. Using a standard conversion factor of 7,758 bbls per acre-foot of water, drilling would require up to 21.3 acre-feet.

For completion, the calculations assumed a 50/50 split of coalbed methane to shale wells. The water amounts for each type of well are provided in **Appendix D**. Assuming the highest water amount for each type of well would be used, this amount was multiplied by the total number of gas wells (23 coalbed methane wells and 22 shale wells), it is estimated that up to 5,541,200 bbls or 714.3 acre-feet of water would be needed for completion of all wells.

Dust abatement water usage estimates required understanding the time frame as well as the stages when water would be applied to suppress dust. Calculations estimated that there would be up to 190 bbls of fresh water used per day for dust suppression. Assuming that water usage would be higher in the drier months than in the wetter months, calculations assumed that this maximum rate of application would occur for six months out of the year, with each month estimated at 30 days. As Alternative A estimates 3 years for drilling and construction, up to 102,600 bbls or 13.2 acre-feet of water would be needed for dust abatement.

When all of these estimates are totaled, up to 748.8 acre-feet of water (220.7 acre-feet fresh water and 514.9 acre-feet of recycled/produced water) would be needed to meet anticipated water demands.

**Impacts on Surface Water Quality.** Impacts on surface water quality are generally expected to be lowest under Alternative A because it involves the least new construction and the least change from existing conditions. Under Alternative A, new construction would primarily be located in the northern and eastern areas of the Unit. The proposed well pads in the northern portion of the Unit are generally closer to perennial streams (Muddy Creek, and others). Most of the slopes at the proposed sites are relatively flat, and there are more and better established roads in the northern area, than in the southern portion of the site, which helps to minimize the potential for erosion.

The area east of Highway 133 is probably more likely to have large landslides and debris flows that could cause severe damage to the surface completions of wells, or could damage storage tanks or pipelines, which could increase the risk of spills and releases compared to existing conditions.

**Impacts on Groundwater Quality from Surface Spills.** The northern and eastern portions of the site, where most of the private lands are located comprise the majority of the cultivated and irrigated lands. These are probably located over or near more abundant fresh groundwater supplies than in the south, which is steeper and contains thinner soils and generally narrower valleys. The new well pad sites on private lands under Alternative A are relatively far from the McIntyre Flowback Pits, and it may not be feasible to run portable above-ground piping to the flowback pits from east of Highway 133, or across East Muddy Creek, which would reduce the cost and logistical advantages of using the flowback pits to recycle hydraulic fracturing fluids, and thereby reducing the potential for spills or releases due to breaches of the HPDE overland water pipes.

**Groundwater Impacts from Drilling**. The potential impacts from drilling would be greater than under current conditions, but would be least among the alternatives, since Alternative A involves construction of the fewest new wells.

**Groundwater Impacts from Hydraulic Fracturing (Well Stimulation)**. As with the impacts from drilling, the impacts on groundwater from hydraulic fracturing would also be lowest under the Alternative A. To the extent that the well sites in Alternative A are generally far from the McIntyre Flowback Pits, more hydraulic fracturing water might need to be stored on the proposed well pads before and after hydraulic fracturing, increasing the risk of a spill at each well pad somewhat.

**Impacts Associated with Disposal of Production Wastewater.** A new injection well is expected under Alternative A. The effects would be as described above, but since Alternative A involves the fewest new wells, it would likely generate the lowest volume of water to be disposed in the injection wells.

*Alternative B*

**Water Quantity.** Alternative B involves development on federal mineral estate lands and therefore would involve active management and oversight by BLM. Alternative B assumes that up to 146 new wells would be constructed over a period of 6 years. Since the rate of construction is the same for Alternatives A, B and C, augmentation requirements would be the same for all three alternatives, except that the augmentation would continue for a longer time under Alternative B than under Alternative A.

Overall water quantity would be higher under Alternative B due to more wells and a longer timeframe for development. For drilling, the BLM estimates that up to 3,000 barrels of water would be needed per well and this amount is assumed for both water disposal and gas wells. Based on this and the 150 wells proposed under Alternative B, up to 450,000 barrels of water would be needed to drill all wells. Using a standard conversion factor of 7,758 barrels per acre-foot of water, drilling would require up to 58 acre-feet.

For completion, the calculations assumed a 50/50 split of coalbed methane to shale wells. The water amounts for each type of well are provided in **Appendix D**. Assuming the highest water amount for each type of well would be used, this amount was multiplied by the total number of gas wells (73 coalbed methane wells and 73 shale wells), the BLM estimates estimated that up to 18,381,400 barrels or 2,369.3 acre-feet of water would be needed for completion of all wells.

Dust abatement water usage estimates required understanding the time frame as well as the stages when water would be applied to suppress dust. Calculations estimated that there would be up to 380 barrels of fresh water used per day for dust suppression. Assuming that water usage would be higher in the drier months than in the wetter months, calculations assumed that this maximum rate of application would occur for 6 months out of the year, with each month estimated at 30 days. As Alternative B estimates 6 years for drilling and construction, up to 410,400 barrels or 52.9 acre-feet of water would be needed for dust abatement.

When all of these estimates are totaled, up to 2,480 acre-feet of water (744 acre-feet fresh water and 1,736 acre-feet of recycled/produced water) would be needed to meet anticipated water demands.

**Impacts on Surface Water Quality.** As discussed above under Effects Common to All Alternatives, effects on surface water quality would result mainly from either spills and releases of chemicals, or from soil erosion caused by ground disturbed by construction activities such as well pad construction, pit construction, and road and pipeline construction. Alternative B would involve construction of more than 3 times as many well pads (36 instead of 11), and about 4 times as many miles of new roads (16 miles instead of 5 miles) compared to Alternative A. However, the rate of development would be about the same as under Alternative A, meaning that construction activities would extend over a longer period than under Alternative A. Not only would there be increased construction activity under Alternative B, but the construction activity would be spread throughout a larger area, and would be located on different sites (belonging to the federal mineral estate) than under Alternative A. Compliance with existing regulatory requirements, including implementation of BMPs for storm water management, and SPCC plans, would greatly reduce the potential for spills and releases.

As discussed earlier in this chapter, the use of portable HDPE piping to convey wastewater from well stimulation activities, and production water to the centrally-located flowback pits for recycling could increase the risk of releases and are less secure than underground pipes, depending on how many of these systems are operating at one time. The risks of a spill associated with a pipe failure could be reduced by development of a contingency plan as part of the existing SPCC plan.

The broader distribution of well pad sites under Alternative B includes areas with different soils, different vegetation cover, and in some cases steeper slopes than Alternative A. Most of the land with privately-held mineral rights is located in areas suitable for agriculture, near surface water sources, and with deeper alluvial deposits, while most of the increase in well pad sites under Alternative B are in the area west of Highway 133 and between East Muddy Creek and West Muddy Creek, on the flanks of Bull Mountain. There are fewer level sites in this area, and road and pipeline routes are more likely to cross difficult terrain.

Alternative B also would allow a higher density of well pads in the area east of Highway 133, and along the east-facing slopes west of Lee Creek, than under Alternative A (13 new pads under Alternative B versus only 3 pads under Alternative A). This area contains extensive landslide deposits derived from rocks on the slopes of Chair Mountain, and these deposits are not only potentially vulnerable to reactivation by infiltration of surface water, but also have relatively low cohesiveness and are susceptible to rapid erosion.

Although ground-disturbing activities are likely to result in increased erosion, the streams draining the project area normally carry a high sediment load. Additional sediment loading rates could be greatly reduced by implementation of BMPs, as required for compliance with Construction Stormwater Planning and permitting requirements.

**Impacts on Groundwater Quality from Surface Spills.** The same types of spills and releases that affect surface water could also affect groundwater. Therefore, there would be an increased risk of spills and releases resulting from the increased number of facilities under Alternative B than Alternative A, but no new types of impacts are expected.

**Groundwater Impacts from Drilling**. Alternative B includes 146 new wells, compared to the 55 new wells expected under Alternative A. The wells would be drilled and completed at the same assumed rate under both alternatives. The main difference between the alternatives, besides location of the wells, would be the duration of the well construction activities (6 years instead of just 3 years under Alternative A). During drilling, either closed loop or pit methods may be used. The BLM encourages the use of the closed loop drilling method, but does not require it. Due to the higher cost of closed loop drilling, it is likely that pits will be used more frequently. Pits would be lined to prevent releases. The constituents of the drilling fluid additives would be non-toxic, with the exception of fluids returned from the formation, which may contain petroleum hydrocarbons and heavy metals. Drilling wastes would be properly disposed. Compliance with COGCC and BLM requirements for management of drilling wastes would reduce the potential for impacts on groundwater to negligible levels.

**Groundwater Impacts from Hydraulic Fracturing (Well Stimulation)**. The impacts on groundwater from drilling and completion are expected to be the same or similar regardless of location, since potable groundwater occurs at relatively shallow depths relative to the thousands of feet depth of the target gas formations. Therefore, the impacts from Alternative B are expected to be similar in nature to those under Alternative A, and are expected to be minor. The fractures created by hydraulic fracturing would extend to limited distances and are expected to be confined to the target formations. Surface and intermediate casings would be cemented throughout their length, and would be subject to inspection and documentation by performing cement bond logs, if necessary. The effects of hydraulic fracturing under Alternative B would be the same as under Alternative A, but would occur over a longer period (6 years instead of 3 years). In some areas coal bed methane deposits may be encountered, involving production of more water than would be expected from shale. However, both types of deposits are well isolated from potable groundwater by depth, and so hydraulic fracturing is not expected to impact potable groundwater resources.

**Impacts Associated with Disposal of Production Wastewater.** The construction and operation of deep disposal wells are governed by state and federal regulations. Direct impacts of disposal of production wastewater are expected to be minor, since injection of the production water will be at depths on the order of 10,000 feet, and because casings will be properly cemented to avoid contamination migration through the well annulus. Compliance with regulatory requirements is expected to reduce the potential direct impacts to non-significant levels.

Potential for indirect impacts from disposal of production wastewater, such as increased potential for spills or releases of production wastewater from the conveyance systems between the wells and the injection well, potential for a release from one of the flowback pits used to store production wastewater, or potential for impacts associated with the construction of four new deep injection wells, represent a subset of the impacts of spills and releases of chemicals and fluids discussed above. Compliance with regulatory requirements would reduce these impacts to less than significant levels.

*Alternative C*

**Water Quantity.** The potential impacts of Alternative C on water quantity would be nearly identical to those under Alternative B, except that Alternative C would consume slightly less water for dust control on fewer miles of new and upgraded roads, and fewer miles of pipelines collocated with the new roads.  These impacts are expected to be less than significant.

**Impacts on Surface Water and Groundwater Quality.** The impacts on surface water and groundwater quality from spills would be less than under Alternative B, due to construction of fewer well pads (35 new pads under Alternative C versus 36 new pads under Alternative A), and slightly few miles of new roads.  Under Alternative C, six of the well pads proposed under Alternative B along the Highway 133 corridor, and eight well pads proposed under Alternative B in the somewhat steeper terrain on the slopes of Bull Mountain between East Muddy Creek and West Muddy Creek, would not be constructed.  Since these locations are likely to have somewhat higher risks of spills associated with landslides and the conveyance of materials, wastes, and equipment over difficult terrain, the potential for water quality impacts is expected to be lower than under Alternative B.  Because the well pads eliminated under Alternative C along the Highway 133 corridor, and at the south end of the Unit would have been relatively close to these perennial streams, and their elimination reduces the overall risk that a surface spill would reach one of these streams, or the shallow groundwater associated with the valley bottoms.  It is assumed that these streams are gaining streams most of the year and that groundwater contributes to their flow.

**Groundwater Impacts from Drilling, Hydraulic Fracturing, and Disposal of Production Wastewater.** The impacts of Alternative C on groundwater quality from drilling and hydraulic fracturing activities would be the same as under Alternative B, because the same number of wells would be installed under both alternatives.

*Cumulative*

Alternative A has been defined with specific numbers of additional well pads and associated roads, pipelines and other ancillary facilities to support a particular level of gas exploration and extraction activity, as a way of fixing the baseline for comparison the alternative in time.  It has further been assumed, for purposes of comparison, that Alternative A would not proceed under either of the project alternatives.  In practice, however, the future actions described under Alternative A are independent of the project alternatives and could be implemented concurrently or at any time, in addition to the project alternatives.   For this reason, the combined Alternative A and Alternative B must be evaluated with regard to the cumulative impacts of both actions.

Other gas extraction projects on both public and privately held lands, and inside and outside of the Unit boundaries, will also continue to be carried forward by various entities, subject to assessment of the economic and mineral resource potential.  Based on COGIS records of oil and gas well permits, a total of 46 wells have been completed since 1960 within the approximately 140 square mile area containing the UNIT and bounded by Townships 11S and 12S, and Ranges 89W and 90W.   Of these, approximately half (27 wells) were completed in the 9 years since 2005, or an average of 3 wells per year.  All of these recent wells were constructed by either SGI, or by Gunnison Energy Corporation.  If the project results in completion of 27 wells per year, it will represent a significant increase in the rate of well construction in the area.  During this period, SGI completed four wells outside the Unit, and GEC completed one well inside the Unit. A total of 16 wells were completed within the Unit during this time, and 11 were completed outside the Unit, mainly south of West Muddy Creek and near the southern boundary of the Unit (about 1 well per year outside the boundary, and 2 wells per year inside). Assuming that drilling outside the Unit boundary continues at the same pace, very little additional drilling activity is expected except for the proposed project and Alternative A. If both of those were completed, it would result in a total of 64 well pads and 218 gas wells inside the Unit in 6 years, and 5 deep injection wells. If the rate of well drilling outside the Unit continues at the same pace, there will be about 17 completed wells outside the Unit in 6 years, including 1 deep injection well. This would represent a significant increase in the amount of surface disturbance, deep injection activity, and gas production, compared to previous years.

**Water Quantity.** Since the rate of well construction is assumed to be steady, and capped at about 27 new wells per year, the demand for water will remain relatively steady for about 10 years. As explained above, the annual demand of drilling for water will not be significant at these levels, so the cumulative impact on water quantity is not expected to be significant but the expanded demand would continue for a longer time than under either of the alternatives alone. Based on calculations, the total cumulative water demands over the course of the development is estimated at 8,419,260 barrels or 817 acre-feet fresh water and 19,644,940 barrels or 1,905 acre-feet recycled/produced water.

**Impacts on Surface and Groundwater Quality.** The cumulative impacts on surface and groundwater quality from spills and releases during construction would be similar to those under Alternative B except that the period of higher risk associated with construction activities would extend further into the future than under the Proposed Alternative. If the rate of well construction increases so that the expected number of wells is completed in 6 years instead of 8 years, the cumulative rate of water consumption per year would be approximately 25 percent higher than assumed under each of the alternatives alone. However, assuming that the source of this additional water use is in exchange for existing water uses, no significant impacts are expected.

**Groundwater Impacts from Drilling, Hydraulic Fracturing, and Disposal of Production Wastewater**. As with the risk of spills, the rate of development of the gas resources would not increase, but the impacts would be extended further into the future. Since the impacts of drilling and hydraulic fracturing are expected to be minimal for any given well, due to the regulatory protections currently in place, and ability to monitor conditions in the well, the cumulative impacts are not expected to be significant either. Direct and indirect impacts of disposal of production wastewater would also be much the same as under Alternative B, since the rate of disposal would not change, and are therefore expected to be less than significant also.

### 4.2.5 Geology

***Methods of Analysis***

Areas of proposed activities, such as construction of well pads, roads, and pipelines, were identified on maps and compared with areas with potential geologic hazards, such as steep slopes, landslides, or active (Quaternary) faults. Engineering judgment was used to identify the types of effects and general magnitude of the effects that could occur. Some potential impacts are expected to be reduced as a result of compliance with existing regulatory requirements and agency policies as well as through the implementation of BMPs and required design features.

***Nature and Type of Effects***

Alternative B would affect geologic resources or be affected by geologic hazards if it exposes people, structures, or the environment to potential substantial adverse effects, including the risk of loss, injury or death from proximity to geologic hazards, such as earthquakes, subsidence, or landslides, or if it results in damage to unique geologic features.

***Effects Common to All Alternatives***

**Construction-related effects.** Each of the alternatives includes construction of new well pads and wells, pipelines, roads, electrical transmission lines, and ancillary structures and facilities. During well drilling and completion, tanks or pits would be constructed on well pads and drilling fluids and various hazardous and non-hazardous materials would be stored on the pads or in associated storage areas. During the production and maintenance phase of operations, highly flammable gas will be produced and conveyed in pipelines and stored under pressure in tanks. Throughout the period of development of gas resources in the Unit both construction-related, and production and maintenance-related activities will be occurring simultaneously, sometimes at the same locations, and sometimes at different locations.

**Slope Failure.** The area east of Highway 133 (western slopes of Ragged Mountain to Muddy Creek) contains unstable slopes with high potential for landslide activity. The underlying geology and mechanisms for downslope movement are different on the eastern side of the Unit from the west side. In general, on the eastern side, there are larger areas containing landslide deposits, the deposits are thicker, and large areas are prone to steady and continuous downslope movement (creep). North of Jacobs Ranch and East Muddy Creek, the area between Lee Creek and Drift Creek on the west side of Highway 133 also contains thick alluvial, colluvial, and landslide deposits (Ellis and Freeman 1984), but this area is probably not as prone to new landslides because the watershed above the area is smaller, and therefore it is less likely for groundwater to accumulate within the deposits. The rate of movement can be enhanced by heavy precipitation as it infiltrates the unconsolidated deposits of previous landslides. In 1986, following major storm events, a swath of saturated soil and debris moved more than 200 feet downslope and engulfed the channel of Muddy Creek in the East Muddy Creek Slide in the southeastern portion of the Unit. Wells that penetrate landslide-prone deposits could be deformed by creep, or ruptured by rapid movement of slide deposits relative to the underlying rock. Surface equipment including tanks and pipelines could be damaged in a landslide, potentially resulting in releases or safety hazards. West of Highway 133 there are many areas with greater than 15 percent slopes and some areas, particularly bordering West Muddy Creek, and along the larger streams, where slopes exceed 30 percent. Steep slopes are susceptible to rock slides and debris flows, and slope stability can be reduced by construction activity if material at the toe of a slope is removed or destabilized, such as for road cuts or leveling of well pads.

Slope failure would be a significant impact.

**Mitigation 1 – Avoidance of Areas with Geologic Hazards**. The most effective mitigation to reduce effects of slope failure is to avoid areas with higher risks. Project-specific conditions would be evaluated during the site permitting process, and avoiding disturbance in areas with higher risks within the proposed sites would minimize hazards.

**Mitigation 2 – Engineering Controls**. If geologic hazards cannot be avoided, mitigation measures such as designing drainage systems to reduce soil saturation and prevent erosion in areas with steep slopes, and to stabilize the toes of slopes, could be implemented, based on recommendations following site-specific geotechnical site evaluations.

**Mitigation 3 – Monitoring of Landslides**. If landslide-prone areas cannot be avoided, such as east of Highway 133, mass movement of the landslide deposits can be monitored, such as by installation of tensiometers to monitor the rate of differential horizontal movement so that corrective action can be taken. Alarm systems can be installed to enable automated shutoff of gas pipelines at critical points in the event of slope failure.

**Existing Seismic Hazards.** Strong earthquakes have the potential to damage containment structures or trigger landslides or slope failure, resulting in damage to containment structures or pipelines, with potential for releases of liquids or gas to the environment. Rupture of gas lines or pressurized storage tanks could have the potential to lead to fire or explosion hazards. There are no known active faults within the Unit and the region of the site has a low potential for strong seismic shaking.

**Potential for Triggering Earthquakes during Deep Well Injection.** Disposal of waste fluids is an indirect result of drilling and well stimulation. The volume of fluids that require disposal is highly dependent on the selection of fluid management techniques; whether pits or closed loop drilling systems are used. Significantly more waste fluids would be generated where pit systems are used, but either method is allowable under each of the alternatives, and the choice of methods will be determined based on a variety of location-specific factors.

It has long been known that injection of fluids at depth can trigger earthquakes. Fluid injection has even been suggested as a way, under controlled circumstances, to gradually release the stored energy within locked segments of an earthquake fault zone to reduce the potential for a large earthquake, but the method has not been proven. However, fluid injection has been implicated as the unintended cause of earthquakes along active faults in several instances in the past (Nicholson and Wesson 1990). Deep injection for disposal of waste fluids was responsible, for example, for earthquakes up to magnitude (M) 3.6 near Ashtabula, Ohio in 1987, and for 3 M5 to M5.5 earthquakes at the Rocky Mountain Arsenal in 1967 (the largest fluid injection-related earthquakes to date). A detailed inventory of earthquakes attributed to fluid injection prior to 1990 is presented in the US Geological Survey report authored by Nicholson and Wesson (1990).

Since 2001, the number of earthquakes in the midcontinent area of the U.S. with magnitude greater than M3.0 has increased sharply, from a relatively steady annual rate of about 21 events per year, to a high of 188 in 2011 (Ellsworth 2013). During 2010 and 2011, more than 90 small earthquakes (up to M4.7) occurred along the Guy-Greenbrier Fault Zone in Arkansas shortly after the start of injection of waste fluids in 2 wells (Ausbrooks and Horton 2011). Deep injection of wastewater induced a sequence of earthquakes up to M3.6 in the Hom River Basin in British Columbia in 2009. In 2010, an M4.1 earthquake occurred in a previously quiet region where injection wells had been operating for 18 years. This was followed by an M5.0 and an M5.7 earthquake in the following year. The epicenter was about 1 mile from the injection wells (Ellsworth 2013). In Paradox Valley, in southwestern Colorado, deep injection was used as a method of disposing of shallow saline groundwater to protect water supplies, and the experience provided an opportunity to study the effects of adjusting injection pressures over time. Hundreds of small earthquakes were induced when the injection tests were conducted between 1991 and 1995. The injection pressures needed to accommodate the volume of waste water was greater than the pressure needed to fracture the rock, so the small earthquakes were expected. Over the following years of operation, several earthquakes greater than M3.0 were induced, and the zone of seismic activity expanded to beyond 7.5 miles. These and many other events suggest that deep injection of waste fluids is capable of producing large earthquakes in areas with requisite tectonic stress conditions, that the affected zone can continue to expand with continued injection, and that it is difficult to control or reverse the process, once seismicity is initiated (Ellsworth 2013).

The primary mechanism by which fluid injection is thought to trigger earthquakes is by overcoming the shear strength and the coefficient of friction along a fault by increasing the pore pressure in the rock. The potential for movement along a fault, and the magnitude of that movement, however, depend on the tectonic stress conditions in the fault zone preceding fluid injection. Thus fluid injection facilitates fault rupture in areas where stress has built up along a fault, but does not cause faulting or create strong earthquakes in the absence of existing stress.

Injection wells for waste disposal typically target permeable formations, where the formation has capacity to accommodate the fluids with least injection pressure. Unlike hydraulic fracturing, deep well injection pressures need not exceed the strength of the rock. The most reliable method for estimating the existing stress conditions in the earth's crust is from measurements taken during hydraulic fracturing, and a large body of data from hydraulic fracturing records across the U.S. has made it possible to predict the general orientation and magnitudes of the principal stresses at many sites. In the Rocky Mountains province where the site is located, the principal stresses are extensional along an east-west axis, and normal faulting predominates (Nicholson and Wesson 1990). The magnitude of an earthquake is largely a function of the dimensions of the fault. Not only is the region of the Unit seismically quiet, but the few faults in the surrounding region are relatively small.

The lack of seismicity and of active faults in the region of the Unit leads to a probable low level of risk that deep injection of waste fluids would trigger an earthquake capable of causing damage at the ground surface in the Unit. However, knowledge of the stress field and of the existence or dimensions of faults at depth is imperfect. Monitoring of seismicity during operation of the deep injection wells is recommended to mitigate the potential for inducing earthquakes by injection of fluids over time.

**Mitigation 1 – Monitoring and Maintenance of Acceptable Injection Pressure**. Monitoring of deep well injection pressures and of changes in the transmissivity (a measure of how much fluid can flow horizontally through an aquifer) during injection, can provide a means of determining whether deep injection pressures are causing fracturing of the reservoir rock and injection rates and pressures can adjusted to reduce the potential for these effects.

**Mitigation 2 – Monitoring of Seismicity**. Monitoring of seismic activity with sensitive seismometers could be implemented as a follow-up measure to Mitigation 1, to determine whether earthquakes are triggered at the depth of injection, since this would provide additional evidence as to whether the reservoir rock was being fractured by injection pressures within the targeted injection zone.

Because the state regulates injection wells, both of these mitigation measures would fall under the State of Colorado's jurisdiction. If adopted by the operator, SGI would follow all state mandates, regulations, and policies.

**Potential for Inducing Earthquakes by Well Stimulation (Hydraulic Fracturing).** Unlike deep injection of waste fluids, the purpose of hydraulic fracturing is to overcome the strength of the rock and to open fractures by increasing the pore pressure in the rock. During well stimulation activities associated with some or all well completions, fluids would be injected at high pressure into the targeted geologic formations. Hydraulic fracturing normally produces many micro-earthquakes, but it is unlikely to trigger earthquakes that can be felt at the surface.

Hydraulic fracturing differs from waste injection because injected fluids are removed after hydraulic fracturing, so that the pore pressure increase from hydraulic fracturing is temporary and the affected zone is relatively localized around the well. According to Ellsworth (2013) more than 100,000 wells have been hydraulically fractured in recent years, and no earthquakes larger than M3.6 have been attributed to hydraulic fracturing.

Extensive data collected from hydraulic fracturing events in shale formations suggest that the magnitudes of the micro-earthquakes associated with hydraulic fracturing are mainly in the range of M4 to M1, which cannot be felt (Warpinski 2013). The possibility exists that fractures created by hydraulic fracturing might intercept an existing active fault and trigger it to move, but the probability is low.

Revqust et al (2013) performed modeling studies to evaluate the effects of hydraulic fracturing and concluded that "the possibility of hydraulically induced fractures at great depth (thousands of meters) causing activation of faults and creation of a new flow path that can reach shallow groundwater resources (or even the surface) is remote." Based on these observations, the direct effects of hydraulic fracturing as a trigger for damaging earthquakes are expected to be less than significant.

**Potential for Breaching Geologic Confining Formations during Hydraulic Fracturing.** Warpinski (2013) compiled data from hydraulic fracturing projects throughout the US, supporting the limited vertical extent of fractures above and below the point of injection. Monitoring of the micro-earthquakes that occur during hydraulic fracturing provides a way of assessing the effectiveness of hydraulic fracturing and determining the length of the fractures. Fractures propagated from hydraulic fracturing tend to be longer in the horizontal direction than the vertical, because of bedding orientation. According to Warpinski, most fractures propagated by hydraulic fracturing of shale are limited to a zone about 1,000 feet above and below the injection point, with almost no fractures extending more than 2,000 feet. Gas-containing formations targeted for hydraulic fracturing are usually much too deep below the depths of freshwater to be intercepted by fractures generated during hydraulic fracturing.

**Potential for Breaching Geologic Confining Formations during Deep Well Injection.** One of the objectives of deep injection of fluids is to isolate the fluids within the targeted geologic formation and prevent vertical migration. Due to the depth of the injection wells, fluids can be injected at pressures that could allow the fluids to rise vertically above the targeted formation. The higher the injection pressure the higher the rate of injection that can be achieved, but too high an injection pressure could enable fluids to migrate vertically if the confining pressure of the overlying formation is overcome. If the injection pressure is high enough, the rock confining the target fluid disposal reservoir may be fractured, allowing pathways for fluids to migrate vertically into overlying geologic units. The depth of the target reservoir formation relative to the fresh groundwater aquifer near the land surface makes it unlikely that injected fluids would be able to rise high enough to impact the relatively shallow fresh water aquifer. The operator is required to monitor injection pressure and to maintain hydrostatic pressures well below the elevation of the fresh water aquifer. Compliance with existing requirements is expected to adequately mitigate against significant intrusion of waste fluids into adjacent formations and would prevent cross-contamination of shallow fresh-water aquifers.

*Alternative A*

**Slope Stability.** As described in Chapter 2, well pads and most new roads and pipelines that would be constructed under Alternative A are on private lands. Three new well pads (Jacobs 11-98-32 #1; Borich 11-89-32 #1; and Medved 12-89-5 #1) are proposed east of Highway 133, on the west slope of Chair Mountain and the Raggeds, which have a recent history of landslides in the southern portion of the Unit. Detailed mapping of landslide deposits has not been performed north of Spring Creek, although available mapping suggests that landslide deposits are not as extensive north of Spring Creek as they are south of Spring Creek. The proposed well pads are on the lower slopes where sudden slope failure is less likely although creep may occur. These areas could be in the path of landslides originating upslope.

The most southeastern of the proposed well pad sites (Volk 12-88-9 #2) is south of Spring Creek, and upslope (east) of Ragged Mountain Ranch Road, in an area that is underlain by older (Pleistocene age) landslide deposits (Stover 1986). Because of their age these deposits are probably more stable than the more recently active deposits further to the west, but the thickness of the deposits is not known. It should also be noted that recent landslides have occurred as a result of failure of the older landslide deposits.

On the west side of Highway 133, the pads proposed under Alternative A would be located in relatively level areas. Most are north of East Muddy Creek, where most of the farmed lands are located. Typically, the proposed pads would be located near the margins of farmed lands, which in some cases allows for the possibility of placing them near the edges of ravines, but there is ample room within the proposed siting areas to avoid steep slopes. One proposed pad (McIntyre 11-90-23 #1) is in an area of gently sloping land near the existing McIntyre Flowback Pits #3 and #4.

The proposed roads under Alternative A tend to follow existing tracks and generally would not require significant cutting or filling of slopes, and therefore it is not likely that the roads would contribute to slope failure. A limited geotechnical study of selected slopes conducted by Trautner Geotech (2010), mostly in the area south of East Muddy Creek, concluded that the threshold for slope instability in the areas evaluated was 35 percent (20 degrees), based on the standard safety factor used for roadway stability. The report recommended avoidance of routes where slopes are greater than 35 percent, and noted that if the soil becomes saturated the safety factor decreases, so proper drainage design is important where slopes approach the recommended threshold.

**Potential for Triggering Earthquakes during Deep Well Injection.** Alternative A includes one existing deep waste injection well and one new waste injection to handle the fluids generated from new gas wells on the 11 proposed pads. The potential for inducing large earthquakes is expected to be low, but no data are available to evaluate the existing stress field, and the existing network of seismographs is not designed to accurately detect micro-earthquakes.

*Alternative B*

**Slope Stability.** Alternative B would include construction of 36 new well pads on split estate lands, instead of the 11 new pads on private lands as described under Alternative A. Six of the proposed pads would be constructed east of Highway 133, where some of the underlying deposits are former landslide deposits. (Not all of the area has been mapped to identify landslide deposits in detail, but the landscape east of Highway 133 is characterized by hummocky ground, lobate fan features, deflected stream channels, sparse vegetation, and other features common to landslide terrain. The hazards of constructing the pads on these lands includes the potential for creep as well as rapid mass failure of the underlying surficial materials, particularly reactivation of existing landslide deposits, and potential for landslides originating from an upslope source to move across the site.

The effects associated with slope instability under Alternative B would be similar to those under Alternative A, except that risk is increased by a larger area of pads and larger number of miles of roads and pipelines. **Appendix C**, Best Management Practices and Conditions of General Approval, BMP 97 requires avoiding unstable slopes, old landslides, and slopes in excess of 40 percent unless otherwise approved by the BLM.

**Potential for Triggering Earthquakes during Deep Well Injection.** The effects of Alternative B would be similar to those described under Alternative A, except that Alternative B includes development of four new deep waste injection wells in the Unit, in addition to the existing deep injection well. The locations of the new wells would be determined later. The need for four additional injection wells under Alternative B reflects the increase in waste fluid that would be generated by the higher number of gas wells to be developed under Alternative B, as well as the need to have disposal wells located closer to the points of generation. The increased volume of waste fluid disposal would likely increase the risk of inducing strong earthquakes relative to Alternative A, but the degree of increased risk cannot be easily predicted since it depends on many factors, including the transmissivity of the reservoir formations, the rate of injection, the tectonic stress conditions that exist within the region, and the presence or absence of any incipient active faults at depth that could be within the radius of influence of the injection wells. In general, based on the lack of earthquake activity and lack of any known active faults in the region, the increased risk of inducing earthquakes under Alternative B is considered low.

*Alternative C*
**Slope Stability.** Alternative C would include construction of 35 new well pads on split estate lands, instead of the 11 new pads on private lands as described under Alternative A. Alternative C includes four well pads east of Highway 133; two located north of Jacobs Ranch, and two located in the southeast area just north of Spring Creek, which contains landslide terrain of the western slope of the Raggeds (Ellis and Freeman 1984). Overall, the potential impacts associated with slope stability would be about the same as Alternative B and higher under Alternative C than under Alternative A. Avoiding disturbance on steep slopes to the extent possible, and implementing BMPs, such as designing site drainage to direct runoff away from the site and to reduce infiltration and water saturation of the underlying deposits, would minimize impacts. **Appendix C**, Best Management Practices and Conditions of General Approval, BMP 97 requires avoiding unstable slopes, old landslides, and slopes in excess of 40 percent unless otherwise approved by the BLM.

**Potential for Triggering Earthquakes during Deep Well Injection.** Alternative C includes development of four deep waste injection wells in the Unit, as described for Alternative B, and proposes the same number of gas wells as under Alternative B, except that the gas wells would be concentrated at one fewer well pads than under Alternative B. The effects of Alternative C would be the same as those described under Alternative B.

*Cumulative*
**Slope Failure.** It is anticipated that drilling and gas development activities would continue on private lands independent of the lease of the federal mineral estate. If gas production is economically favorable, it is likely that additional wells and well pads would be constructed, potentially requiring additional roads and pipelines to be constructed. The cumulative effects would increase in proportion to the amount of increased drilling and construction activity. Most of the increased activity that would occur on private lands would probably be related to increased drilling from the existing and proposed well pads, using the existing and proposed infrastructure (e.g. roads, pipelines, and transmission lines) and is therefore not expected to significantly increase the potential for slope failure.

**Potential for Triggering Earthquakes during Deep Well Injection.** If drilling and gas production continues to increase on private lands, the amount of waste requiring disposal will also increase, requiring more fluid injection and potentially requiring more injection wells. Logically, the potential for inducing earthquakes would increase proportionally with the increase in disposal, but the significance of any increase would depend on a number of factors that are not well known, including the tectonic stress field in the region of the site, and the presence or absence of hidden faults. Overall, increased fluid injection of wastes generated on private lands is expected to result in an incremental cumulative increase in the potential impacts relative to the action alternatives.

### 4.2.6 Vegetation and Invasive, Non-Native Species

***Methods of Analysis***
Impacts were determined by assessing which actions, if any, would change the upland vegetation, riparian and wetland vegetation, and weed indicators described below. Some impacts

are direct, while others are indirect and affect vegetation through a change in another resource. Direct impacts on vegetation include disrupting, damaging, or removing vegetation, thereby reducing area, amount, or condition of native vegetation. Included among these are actions that reduce 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 for wildlife habitat.

Indirect impacts are those that cannot be absolutely linked to one action, such as decreased plant vigor or health from dust or reduced water quality. Other indirect impacts include loss of habitat suitable for vegetation colonization due to surface disturbance; introduction of weeds that compete with desirable, native vegetation; conditions that enhance the spread of weeds; and general loss of habitat due to surface occupancy or soil compaction.

*Indicators*

Indicators for upland vegetation communities are based on the BLM Colorado Public Land Health Standards 2 and 3 (BLM 1997) and include:

- Condition of native vegetation communities and individual native plant species
- Connectivity
- Age class distribution

Indicators for riparian and wetland vegetation include:

- Condition of riparian vegetation community and individual riparian plant species
- Hydrologic functionality

Indicators for invasive and noxious weeds include:

- Level of spread of noxious weeds and other undesirable species in the overall plant community

***Nature and Type of Effects***

Direct effects include vegetation loss, conversion, and fragmentation (both short- and long-term), which would result from land grading and clearing, and the construction of well pads, roads, pipelines, and ancillary facilities. Human presence and activity on-site could trample vegetation, causing damage or death. Vegetation removal or trampling would reduce the condition of native vegetation communities and individual native plant species, alter age class distribution, reduce connectivity, and encourage the spread of invasive species. Fragmentation could cause the loss of genetic interchange among vegetation communities and thus reduce fitness of some plant populations.

Reclamation could also affect individual plant species through introduction of new genetic materials into local populations by way of seedings or plantings. As a result, the local genetic make-up of populations could be degraded, resulting in reduced fitness

Indirect effects include spread of weeds. Invasive weeds alter plant community structure and composition, productivity, nutrient cycling, and hydrology and may cause declines in native plant populations through competitive exclusion, niche displacement and other mechanisms. Invasive plants reduce and may eliminate vegetation that provides cover for wildlife and forage for livestock, and may also increase fire risk. Impacts on wetland or riparian systems could involve damage to vegetation, loss of hydrologic function, increased erosion, reduced water retention, and loss of wildlife habitat. Riparian impacts will be avoided under all alternatives.

In addition, activities that would disturb soils could cause erosion, topsoil and biological soil crust loss, and soil compaction. This could affect vegetation's ability to regenerate and could facilitate weed introduction and spread. Soil compaction results in decreased vegetation cover and more exposure of the soil surface to erosion (Burton et al. 2008). 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, construction and maintenance activities could increase dust, which could cover existing vegetation and impair plant photosynthesis and respiration. Resulting impacts could include lowered plant vigor and growth rate, altered or disrupted pollination, and increased 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 native vegetation condition.

Overall, direct and indirect effects from gas development would likely reduce land health in the Bull Mountain Unit.

***Effects Common to All Alternatives***

Under all alternatives, interim reclamation of areas not needed for long-term operations would reduce short-term direct effects from vegetation removal. Reclamation areas would be reseeded 3 to 6 months after construction. Wetlands and riparian vegetation will be avoided when possible by site selection and when they cannot be avoided through approval from the BLM. Distance from streams and wetlands was included as a siting and weighting factor in well pad site selection, see **Appendix A**. Surface-disturbing activities shall avoid riparian/wetland habitat unless otherwise approved by the BLM, see **Appendix C**, Best Management Practices and Conditions of General Approval, BMP 89.

In addition, an Integrated Spill Prevention, Control and Countermeasures Plan and Emergency Response Plan would reduce the likelihood for hazardous material spills and subsequent toxicity to vegetation.

*Alternative A*

Under Alternative A, impacts from gas development would continue on non-federal mineral estate, and existing lease rights on federal mineral estate would remain in effect. However, the BLM may receive and consider proposals for individual APDs, access, and/or other production-related activities at any time on federal surface and/or federal mineral estate.

There would be no change to BLM land health with respect to vegetation under Alternative A.

**Table 4-39**, Direct Impacts on Vegetation Communities in Bull Mountain Unit (Alternative A), shows the direct, short- and long-term impacts on vegetation communities under Alternative A. This table is based on the conceptual siting of project components and estimated project footprint, and exact acreages could change during site-specific design and permitting. Sagebrush and irrigated meadow communities would have the greatest acreage affected, largely on private surface/private mineral and private surface/federal mineral estates. Given the conceptual nature of project siting, indirect impacts are not quantified. However, indirect effects include the effects from spread of weeds, dust, increased accessibility for grazing, and trampling from nearby humans.

**Table 4-39**
**Direct Impacts on Vegetation Communities in Bull Mountain Unit (Alternative A)**

| Vegetation Type[1] | Federal Surface/ Federal Minerals (acres) | Private Surface/ Federal Minerals (acres) | Private Surface/ Private Minerals (acres) | Total (acres)[2] |
|---|---|---|---|---|
| ***Short-Term Impacts*** | | | | |
| Aspen | 0 | 1 | 3 | **4** |
| Aspen/Oak | 1 | 2 | 3 | **6** |
| Disturbed Area | 0 | 6 | 17 | **23** |
| Irrigated Meadow | 0 | 2 | 56 | **58** |
| Meadow | 0 | 2 | 18 | **20** |
| Mixed Mountain Shrub | 1 | 3 | 10 | **14** |
| Oakbrush | 3 | 3 | 4 | **10** |
| Sagebrush | 2 | 52 | 60 | **114** |
| Wetland/Riparian Area | 0 | 3 | 6 | **9** |
| **TOTAL** | **7** | **74** | **177** | **258** |
| ***Long-Term Impacts*** | | | | |
| Aspen | 0 | 0 | 1 | **1** |
| Aspen/Oak | 0 | 0 | 1 | **1** |
| Disturbed Area | 0 | 3 | 11 | **14** |
| Irrigated Meadow | 0 | 0 | 16 | **16** |
| Meadow | 0 | 1 | 8 | **9** |
| Mixed Mountain Shrub | 0 | 0 | 2 | **2** |
| Oakbrush | 1 | 1 | 1 | **3** |
| Sagebrush | 1 | 17 | 18 | **36** |
| Wetland/Riparian Area[3] | 0 | 1 | 2 | **3** |
| **TOTAL** | **2** | **23** | **60** | **85** |

Source: SGI 2013, BLM GIS 2014, Petterson 2012
[1] No short or long term impacts anticipated on aspen/conifer, mixed conifer, pinyon/juniper, riparian woodland, rocky outcrop, willow, or open water communities
[2] In some cases, discrepancies in totals occur due to rounding of acres
[3] Well pads will avoid riparian areas whenever possible. However, since the well pads have not been fully sited yet, the impact analysis was based upon 5 acre and 2 acre conceptual well pads. Some of the conceptual locations may intersect with the wetlands/riparian habitat in the vegetation dataset.

Interim reclamation areas would be reseeded with mixes that would comply with CPW and Gunnison County goals and objectives; this would reduce the likelihood for noxious weed invasion, erosion, and dust through restoration of plant cover. However, seed mixes would not have any forb or shrub species and would be a mix of grasses. This would limit diversity and restoration of initial conditions. Monitoring would help to ensure that vegetation is deemed successful and reclamation plans would be submitted for each new well.

*Alternative B*

Impacts from the phases of development would be similar to those described for Alternative A, but under Alternative B, impacts would occur on federal lands/federal mineral estate. BLM land health with respect to vegetation would likely be reduced in developed areas under this alternative. However, since most lands were found to be meeting Land Health Standard 3 in the most recent North Fork Land Health Assessment, it is unknown whether they would still meet this standard or would be found to be not meeting as a result of this alternative.

**Table 4-40**, Direct Impacts on Vegetation Communities in Bull Mountain Unit (Alternative B), shows the direct, short and long term impacts on vegetation communities under Alternative B. Although the acres of impacts are estimates, the overall acreage of impacts would increase under Alternative B compared to Alternative A, as additional facilities would be constructed. Sagebrush and oakbrush communities would have the greatest acreage affected, with increased impacts on private surface/federal mineral estates compared with Alternative A.

**Table 4-40**
**Direct Impacts on Vegetation Communities in Bull Mountain Unit (Alternative B)**

| Vegetation Type[1] | Federal Surface/ Federal Minerals (acres) | Private Surface/ Federal Minerals (acres) | Private Surface/ Private Minerals (acres) | Total (acres)[2] |
|---|---|---|---|---|
| ***Short-Term Impacts*** | | | | |
| Aspen | 0 | 19 | 3 | **22** |
| Aspen/Oak | 4 | 4 | 4 | **12** |
| Disturbed Area | 1 | 10 | 18 | **29** |
| Irrigated Meadow | 1 | 24 | 13 | **38** |
| Meadow | 0 | 13 | 8 | **21** |
| Mixed Mountain Shrub | 1 | 11 | 9 | **21** |
| Oakbrush | 6 | 56 | 9 | **71** |
| Sagebrush | 4 | 316 | 42 | **362** |
| Wetland/Riparian Area | 1 | 6 | 3 | **10** |
| **TOTAL** | **18** | **459** | **109** | **586** |
| ***Long-Term Impacts*** | | | | |
| Aspen | 0 | 5 | 1 | **6** |
| Aspen/Oak | 1 | 2 | 1 | **4** |
| Disturbed Area | 0 | 7 | 13 | **20** |
| Irrigated Meadow | 0 | 8 | 5 | **13** |
| Meadow | 0 | 6 | 4 | **10** |
| Mixed Mountain Shrub | 0 | 3 | 3 | **6** |
| Oakbrush | 1 | 17 | 3 | **21** |
| Sagebrush | 1 | 113 | 15 | **129** |
| Wetland/Riparian Area | 0 | 2 | 1 | **3** |
| **TOTAL** | **3** | **163** | **46** | **212** |

Source: SGI 2013, BLM GIS 2014, Petterson 2012

[1] No short or long term impacts anticipated on aspen/conifer, mixed conifer, pinyon/juniper, riparian woodland, rocky outcrop, willow, or open water communities

[2] In some cases, discrepancies in totals occur due to rounding of acres

Design features and best management practices from **Appendix C** (COAs 4, 6-9, 14, 17, 18, 20, 22-24, 29-31, 72-88; BMPs 89, 92, 93, 95, 120, 123, 135, and 136) include measures for erosion control and dust abatement, minimize vegetation removal, and provide guidelines for vegetation reestablishment. These would be applied where appropriate to reduce the likelihood for impacts on vegetation. Mandatory noxious and invasive weed design features would be applied, as discussed in **Appendix I** (Sections I.2.2, I.2.3, I.3.1, I.3.2, and I.3.3) and **Appendix C** (COAs 66-71). Together, these design features would reduce impacts on upland, riparian, and wetland vegetation and reduce the likelihood of weed spread. However, the short- and long-term impacts on vegetation communities displayed in Table 4-40 would remain as residual impacts. Further, while design features would reduce impacts, impacts could still occur from erosion, dust, trampling, or ineffective re-establishment.

*Alternative C*

**Table 4-41**, Direct Impacts on Vegetation Communities in Bull Mountain Unit (Alternative C), shows the direct and short- and long-term impacts on vegetation communities under all alternatives. Although the acres of impacts are estimates, the overall acreage of impacts would be less than those for Alternative B, but more than Alternative A, as additional facilities would be constructed. Impacts on land health would likely be similar to Alternative B, though would likely be less under Alternative C. As under Alternative B, sagebrush and oakbrush would be the most impacted vegetation communities under Alternative C.

**Table 4-41**
**Direct Impacts on Vegetation Communities in Bull Mountain Unit (Alternative C)**

| Vegetation Type[1] | Federal Surface/ Federal Minerals (acres) | Private Surface/ Federal Minerals (acres) | Private Surface/ Private Minerals (acres) | Total (acres)[2] |
|---|---|---|---|---|
| ***Short-Term Impacts*** | | | | |
| Aspen | 0 | 15 | 0 | **15** |
| Aspen/Oak | 8 | 10 | 2 | **20** |
| Disturbed Area | 0 | 9 | 5 | **14** |
| Irrigated Meadow | 1 | 26 | 5 | **32** |
| Meadow | 0 | 7 | 3 | **10** |
| Mixed Mountain Shrub | 1 | 7 | 3 | **11** |
| Oakbrush | 3 | 34 | 5 | **41** |
| Sagebrush | 4 | 253 | 31 | **288** |
| Wetland/Riparian Area | 0 | 5 | 2 | **7** |
| **TOTAL** | **17** | **366** | **56** | **439** |
| ***Long-Term Impacts*** | | | | |
| Aspen | 0 | 4 | 0 | **4** |
| Aspen/Oak | 2 | 2 | 0 | **4** |
| Disturbed Area | 0 | 3 | 4 | **7** |
| Irrigated Meadow | 0 | 8 | 1 | **9** |
| Meadow | 0 | 3 | 1 | **4** |
| Mixed Mountain Shrub | 0 | 1 | 0 | **1** |
| Oakbrush | 1 | 9 | 0 | **10** |
| Sagebrush | 1 | 78 | 5 | **84** |
| Wetland/Riparian Area | 0 | 1 | 0 | **1** |
| **TOTAL** | **4** | **109** | **11** | **124** |

Source: BLM GIS 2014

[1] No short or long term impacts anticipated on aspen/conifer, mixed conifer, pinyon/juniper, riparian woodland, rocky outcrop, willow, or open water communities

[2] In some cases, discrepancies in totals occur due to rounding of acres

Similar to Alternative B, design features and best management practices from **Appendix C** (COAs 4, 6-9, 14, 17, 18, 20, 22-24, 29-31, 72-88; BMPs 89, 92, 93, 95, 120, 123, 135, and 136) would be applied where appropriate to reduce the likelihood for impacts on vegetation. Alternative C will also include design features (shown in Table 2-10) to reduce impacts on vegetation, such as increased dust abatement measures and requiring an annual reclamation monitoring status report, which would help identify areas for improvement. Interim reclamation would include the appropriate composition of grasses, forbs, and shrubs for the ecological site, which would go further in restoring a native plant community compared to Alternatives A and B. Mandatory noxious and invasive weed design features would be applied, as described for Alternative B. Together, these design features would reduce impacts on upland, riparian, and wetland vegetation and reduce the likelihood of weed spread more than Alternatives A and B. However, the short- and long-term impacts on vegetation communities displayed in Table 4-41 would remain as residual impacts. Further, impacts could still occur from erosion, dust, trampling, or ineffective re-establishment, despite the implementation of design features.

*Cumulative*

Cumulative impacts would represent the combination of Alternatives A and B or Alternatives A and C. Combined with other past, present, and reasonably foreseeable future actions, either combination of Alternatives A, B, and C would contribute to vegetation disturbance and removal and a reduction of land health in the region both temporarily and permanently (**Tables 4-42**, Cumulative Impacts on Vegetation Communities in Bull Mountain Unit [Alternatives A and B combined], and **4-43**, Cumulative Impacts on Vegetation Communities in Bull Mountain Unit [Alternatives A and C combined]). Past, present, and future grazing, mining, oil and gas, forestry, and forage consumption would continue to disturb and remove vegetation in the region due to trampling, project facilities, transmission lines, and access roads. Increasing recreation pressure, including OHVs, would continue to disturb native vegetation and spread weeds. Forest insects and diseases would continue to spread. If Alternatives A and B, or Alternatives A and C were constructed simultaneously with other projects, cumulative construction and operation impacts on native vegetation could increase. If projects in the region were not successfully revegetated, native vegetation communities would be lost, or native vegetation communities would be permanently converted to communities dominated by invasive, nonnative species, leading to an incremental reduction in land health. Revegetation efforts with non-local genotypes could marginally reduce the fitness of native populations of the reclamation species within vegetation communities. Alternately, current efforts to protect vegetation in the region, including land use planning efforts could help prioritize areas for protection, particularly native plant communities, and would improve adaptive management for forest diseases. Implementation of design features in **Appendix C** (COAs 4, 6-9, 14, 17, 18, 20, 22-24, 29-31, 66-88; BMPs 89, 92, 93, 95, 120, 123, 135, and 136) would minimize cumulative impacts caused by Alternatives A, B, or C, and no additional mitigation measures are recommended.

**Table 4-42**
**Cumulative Impacts on Vegetation Communities in Bull Mountain Unit (Alternatives A and B combined)**

| Vegetation Type[1] | Federal Surface/ Federal Minerals (acres) | Private Surface/ Federal Minerals (acres) | Private Surface/ Private Minerals (acres) | Total (acres)[2] |
|---|---|---|---|---|
| ***Short-Term Impacts*** | | | | |
| Aspen | 0 | 20 | 6 | **26** |
| Aspen/Oak | 5 | 6 | 7 | **18** |
| Disturbed Area | 1 | 16 | 35 | **52** |
| Irrigated Meadow | 1 | 26 | 69 | **96** |
| Meadow | 0 | 15 | 26 | **41** |
| Mixed Mountain Shrub | 2 | 14 | 19 | **35** |
| Oakbrush | 9 | 59 | 13 | **81** |
| Sagebrush | 6 | 368 | 102 | **476** |
| Wetland/Riparian Area | 1 | 9 | 9 | **19** |
| **TOTAL** | **25** | **533** | **286** | **844** |
| ***Long-Term Impacts*** | | | | |
| Aspen | 0 | 5 | 2 | **7** |
| Aspen/Oak | 1 | 2 | 2 | **5** |
| Disturbed Area | 0 | 10 | 24 | **34** |
| Irrigated Meadow | 0 | 8 | 21 | **29** |
| Meadow | 0 | 7 | 12 | **19** |
| Mixed Mountain Shrub | 0 | 3 | 5 | **8** |
| Oakbrush | 2 | 18 | 4 | **24** |
| Sagebrush | 2 | 130 | 33 | **165** |
| Wetland/Riparian Area[3] | 0 | 3 | 3 | **6** |
| **TOTAL** | **5** | **186** | **106** | **297** |

Source: SGI 2013, BLM GIS 2014, Petterson 2012
[1] No short- or long-term impacts anticipated on aspen/conifer, mixed conifer, pinyon/juniper, riparian woodland, rocky outcrop, willow, or open water communities
[2] In some cases, discrepancies in totals occur due to rounding of acres
[3] Well pads will avoid riparian areas whenever possible. However, since the well pads have not been fully sited yet, the impact analysis was based upon 5 acre and 2 acre conceptual well pads. Some of the conceptual locations may intersect with the wetlands/riparian habitat in the vegetation dataset.

**Table 4-43**
**Cumulative Impacts on Vegetation Communities in Bull Mountain Unit (Alternatives A and C combined)**

| Vegetation Type[1] | Federal Surface/ Federal Minerals (acres) | Private Surface/ Federal Minerals (acres) | Private Surface/ Private Minerals (acres) | Total (acres)[2] |
|---|---|---|---|---|
| ***Short-Term Impacts*** | | | | |
| Aspen | 0 | 16 | 3 | **19** |
| Aspen/Oak | 9 | 12 | 5 | **26** |
| Disturbed Area | 0 | 15 | 22 | **37** |
| Irrigated Meadow | 1 | 28 | 61 | **90** |
| Meadow | 0 | 9 | 21 | **30** |
| Mixed Mountain Shrub | 2 | 10 | 13 | **25** |
| Oakbrush | 6 | 37 | 9 | **52** |
| Sagebrush | 6 | 305 | 91 | **402** |
| Wetland/Riparian Area | 0 | 8 | 8 | **16** |
| **TOTAL** | **24** | **440** | **233** | **697** |

**Table 4-43**
**Cumulative Impacts on Vegetation Communities in Bull Mountain Unit**
**(Alternatives A and C combined)**

| Vegetation Type[1] | Federal Surface/ Federal Minerals (acres) | Private Surface/ Federal Minerals (acres) | Private Surface/ Private Minerals (acres) | Total (acres)[2] |
|---|---|---|---|---|
| ***Long-Term Impacts*** | | | | |
| Aspen | 0 | 4 | 1 | **5** |
| Aspen/Oak | 2 | 2 | 1 | **5** |
| Disturbed Area | 0 | 6 | 15 | **21** |
| Irrigated Meadow | 0 | 8 | 17 | **25** |
| Meadow | 0 | 4 | 9 | **13** |
| Mixed Mountain Shrub | 0 | 1 | 2 | **3** |
| Oakbrush | 2 | 10 | 1 | **13** |
| Sagebrush | 2 | 95 | 23 | **120** |
| Wetland/Riparian Area[3] | 0 | 2 | 2 | **4** |
| **TOTAL** | **6** | **132** | **71** | **209** |

Source: SGI 2013, BLM GIS 2014, Petterson 2012
[1] No short- or long-term impacts anticipated on aspen/conifer, mixed conifer, pinyon/juniper, riparian woodland, rocky outcrop, willow, or open water communities
[2] In some cases, discrepancies in totals occur due to rounding of acres
[3] Well pads will avoid riparian areas whenever possible. However, since the well pads have not been fully sited yet, the impact analysis was based upon 5 acre and 2 acre conceptual well pads. Some of the conceptual locations may intersect with the wetlands/riparian habitat in the vegetation dataset.

### 4.2.7 Fish and Wildlife

This section discusses impacts on fish and wildlife habitat from proposed management actions of other resources and resource uses. Habitat types are described in **Section 3.2.6**, Vegetation. Existing conditions concerning fish and wildlife and descriptions of habitat requirements for various species are described in **Section 3.2.8**, Fish and Wildlife.

***Methods of Analysis***

*Terrestrial Wildlife*

Impacts on wildlife and their habitats include the following:

- Disturbance and/or loss of plant communities, food supplies, cover, breeding sites, and other habitat components necessary for population maintenance used by any species to a degree that would lead to substantial population declines

- Disturbance and/or loss of seasonally important habitat (e.g., critical for overwintering or successful breeding) to a degree that would lead to substantial population declines

- Interference with a species' movement pattern that decreases the ability of a species to breed or overwinter successfully to a degree that would lead to substantial population declines

*Aquatic Wildlife*

Impacts on aquatic species and their habitats include the following:

- Sediment and Turbidity – Increased sediment loading in waters containing sediment-intolerant fish species, loss of recruitment, stress, habitat alteration, and habitat loss
- Habitat Alteration – Changes that render habitat nonfunctional for select species or more conducive to competitive species
- Loss or Reduction of Streamside Vegetation/Cover – Increased temperatures, stress, reduced productivity, and impacts on food webs
- Water Quality Alteration – Actions that alter important water quality parameters, including pH, dissolved oxygen, temperature, hardness, alkalinity/salinity, and turbidity
- Water Depletions – Loss of physical habitat, changes in water quality, sediment accumulation, habitat alteration, loss of habitat complexity, or food source reduction
- Potential direct mortalities to aquatic wildlife from motorized travel

*Indicators*
Indicators of impacts on fish and wildlife are as follows:

- Amount and condition of available habitat
- Likelihood of mortality, injury, or direct disturbance
- Likelihood of habitat disturbance

*Assumptions*
The analysis includes the following assumptions:

- Activities associated with the construction, operation, and development of oil and gas resources in the Unit are expected to have the greatest impacts on big game species. Small mammals and reptiles may be less influenced by oil and gas development as habitat use may occur over a smaller spatial extent.
- The actual locations of oil and gas well pads and associated infrastructure including pipelines and access roads is subject to change as a result of the APDs.
- Short-term effects are defined as those that would occur over a timeframe of 5 years or less, and long-term effects would occur over longer than 5 years.

***Nature and Type of Effects***
Mineral exploration and development, and associated ROW use would result in both short-term and long-term impacts on fish and status wildlife species on BLM-administered lands and federal mineral estate in the Unit under all alternatives. Effects are directly linked to vegetation conditions and water quality and quantity (**Section 4.2.6**, Vegetation, and **Section 4.2.4**, Water Resources). Displacement of species could increase competition for resources in adjacent habitats. Over the long term, these activities would remove and fragment habitats due to road development and use, facility construction and placement, creation of well pads, natural gas

wells, water disposal wells, and pipelines, and construction within ROWs. Species could avoid developed areas over the long-term, or they could adapt and recolonize sites after construction. Seasonal closures of ROWs, if implemented in critical limiting habitats, could reduce impacts on targeted wildlife species and limit the effects of habitat fragmentation.

Indirect impacts may include introduction of invasive vegetation that compete with desirable native vegetation and could result in changed habitat and alteration of fire cycles; an increase in predators or predation pressure; decreased survival or reproduction of the species; and decreased habitat effectiveness.

***Effects Common to All Alternatives***

Under all alternatives, oil and gas development actions would continue to use existing infrastructure including well pads, access roads, pipelines, one overhead electrical line (4 power poles), and others. See **Table 2-9**, Summary of Actions by Alternative, for a summary of existing actions in the Unit. Some existing roads would be upgraded and new roads would be built. Therefore, impacts on fish and wildlife populations from oil and gas development activities would continue, irrespective of the proposed alternatives. These activities along with those associated with casual use, permitted activities, and habitat changes, as described in the Nature and Types of Effects section above, would continue to impact fish and wildlife throughout the Unit. Threats specific to aquatic wildlife as a result of oil and gas development within the Unit would be attributed to water depletions as well as road and pipeline crossings of streams, wetlands, and other water bodies.

Areas affected by short-term construction disturbance may have a longer duration of impacts on wildlife than expected. This is because these areas would not be reclaimed to pre-disturbance conditions for many years, given the slow rate of shrub re-establishment and time required to return to functional habitat conditions for many shrub-dependent species, such as mule deer and elk.

Under all alternatives, pipeline crossings of wetlands as well as roads, would be bored (not trenched) outside of road ROWs and wetland boundaries. Impacts from boring activities during construction phases could include a "frac-out", which is caused when excessive pressure builds up forcing drilling mud to the surface (DFO 2007) A frac-out would result in short-term displacement of terrestrial and aquatic wildlife or habitat avoidance as a result of excessive mud (terrestrial) or increased sediment and turbidity as well as reduced water quality (aquatic). Activities associated with stream borings could also result in bank destabilization in the short-term. In the long-term, fish and wildlife species and their habitat would be at risk of hazardous materials contamination in the event of a pipeline rupture under all alternatives. Aquatic wildlife, particularly habitat for Colorado River fish species would continue to be reduced as a result of continued water depletions for ongoing drilling, completion, and dust abatement activities.

*Habitat Quality*

There is a large body of evidence documenting the effects of roads and travel routes on habitat quality for a wide variety of big game species (Foreman et al. 2003; Hebblewhite 2008; Nietvelt 2002; Sawyer et al. 2006, 2009). While many studies quantify the effects of roads and road densities on wildlife and habitat quality, few distinguish between road classifications, traffic volumes, or specific road types and their corresponding effects on wildlife. Road density appears to be the most studied parameter related to roads and their effects on wildlife (Foreman et al. 2003; Hebblewhite 2008; Nietvelt 2002). For this reason, the BLM has chosen to use route density as a means to characterize habitat quality and describe and assess impacts within the Unit, which is mapped as crucial winter range for big game. Doherty et al. (2008), Hebblewhite (2008), Sawyer et al. (2009), Wilbert et al. (2008), and others have used spatial models to characterize the effects of route density on overall habitat quality within a given geographic area.

The response to routes for individual big game species varies. In many cases responses have been documented as displacement distances or avoidance buffers for individual species. When the average documented displacement distance or avoidance buffer for a given species exceeds the distance to the nearest road across available habitats, the habitat quality for that species has decreased substantially and may result in population-level adverse effects (Hebblewhite 2008; Doherty et al. 2008; Ingelfinger and Anderson 2004; Sawyer et al. 2006, 2009).

According to a recent literature review of ungulate response to route development, substantial impacts on ungulate populations begin to manifest themselves when route densities reach 0.5 to 1 mile of road per square mile. Similar route density threshold has been implicated for maintaining sustainable populations of sage-grouse, large carnivores, and bears (Doherty et al. 2008; Van Dyke et al. 1986; Clevenger et al. 1997).

Big game habitat quality within the geographic boundary of the Bull Mountain Unit (Unit) can be characterized as described in **Table 4-44**, Habitat Quality Categories as a Function of Road Density, based on route densities analyzed across the alternatives. Route densities were calculated based on the "Kernel Density" tool provided in ArcGIS with a search radius of 1000 meters based on the average route avoidance distance for ungulates described in Rost and Bailey 1979 and Freddy et al. 1986.

**Table 4-44**
**Habitat Quality Categories as a Function of Road Density**

| Habitat Quality | Existing Route Density and Fragmentation |
|---|---|
| Category 1 | 0.0 - 0.5 road miles/sq. mile |
| Category 2 | 0.6 - 2.0 road miles/sq. mile |
| Category 3 | 2.1 - 4.0 road miles/sq. mile |
| Category 4 | > 4.0 road miles/sq. mile |

Source: CPW 2011

*Alternative A*

Effects on fish and wildlife from access road use and pipeline development would be as described under the Nature and Types of Effects for casual use and permitted use. Surface disturbance from current oil and gas development would continue. New access roads would not be purposefully sited to reduce impacts on key big game habitat such as winter habitats. Within the Unit, crucial winter range is of greatest importance for deer and elk. Seasonal restrictions to human activities may reduce impacts on crucial winter range. Under Alternative A, impacts from road development and use would have the least direct effect on wildlife and their habitat as Alternative A would result in the fewest number of well pads, miles of roads, and pipelines. However, under Alternative A, no voluntary seasonal winter timing limitations would be included to protect critical winter habitat for big game. Additionally, reducing the number of pipeline and road crossings of streams and other water bodies as well as decreasing the amount of surface water used within the Unit would reduce impacts on aquatic species and their habitat. Actions proposed under Alternative A would result in the least amount of water depletions since Alternative A proposes to develop the fewest number of well pads which would require the least amount of project water for oil and gas development (see **Table 2-8**, Summary of Actions by Alternative, for water quantities). Therefore, aquatic habitat would be least affected by surface water use under Alternative A.

Terrestrial Wildlife

Under Alternative A, proposed well pads, roads, pipelines and other supporting infrastructure would result in the short-term disturbance of over 260 acres in the Unit; in the long-term over 88 acres would be disturbed Estimates of impacts on wildlife resources were determined quantitatively in GIS to analyze potential indirect impacts and potential habitat loss during construction, resource development, and completion phases. See Table 4-39 for a description of indirect impacts on habitat vegetation types under Alternative A.

The road density analysis indicates that Alternative A would result in 4,440 acres of Category 1 habitat and 15,230 acres (sum of habitat Categories 2, 3, and 4) with road densities greater than 0.5 road miles per square mile (**Table 4-45**, Habitat Categories by Alternative). Scattered throughout the Unit are islands of Category 1 habitat, some of which overlap severe winter range for elk and deer. Road densities are greatest (Category 4) along Highway 133 in the eastern portion of the Unit where human disturbance is greatest. Travel activities associated with other road uses in the Unit would also contribute to human disturbances that could cause wildlife displacement or avoidance. Under Alternative A, federal minerals within the Unit would continue to be subject to a winter seasonal timing limitation from December 1 through April 30 to protect deer and elk winter ranges from development activities.

**Table 4-45**
**Habitat Categories by Alternative**

| | Alternative A (No Action) | | Alternative B (Proposed Action) | | Alternative C (Modified Action) | | Alternative C (Reduced Winter Activity) | |
|---|---|---|---|---|---|---|---|---|
| **Habitat Category** | **Acres** | **%Δ** | **Acres** | **%Δ** | **Acres** | **%Δ** | **Acres** | **%Δ** |
| Category 1 | 4,440 | -- | 1,180 | -73 | 4,310 | -3 | 5,750 | 30 |
| Category 2 | 6,160 | -- | 4,100 | -33 | 7,300 | 19 | 7,100 | 15 |
| Category 3 | 7,430 | -- | 9,230 | 24 | 7,010 | -6 | 5,960 | -20 |
| Category 4 | 1,640 | -- | 5,170 | 215 | 1,060 | -35 | 870 | -47 |

Source: BLM GIS 2014, CPW 2011

Mule Deer – Mule deer have shown considerable ability to acclimate to human activities within the area, and rarely flee very far from vehicular use of roads. However, it is well-documented that deer stress levels, and thus overall fitness, are compromised when mule deer use habitats near and within areas of major natural gas development. Wilbert et al (2008) provided observations of wildlife responses to indicators including distance to nearest roads and well pads. Mule deer in shrub habitat avoid roads within 328 feet and the minimum distance from active oil and gas development that mule deer are likely to occur in range between 1.6 and 2.3 miles from well pads. Restricting surface-disturbing activities from mineral development through management actions would therefore reduce impacts on wildlife species and their habitat, generally for species within the Unit. At this time, the level of natural gas development in the Unit is not considered to be major, and while there is likely some change in mule deer behavior in the area around producing wells and some of the more heavily used roads, detectable impacts on deer population levels in the area are unlikely.

Direct impacts (i.e., mortality) to mule deer are unlikely in the project area given that all roads within the Unit are dirt roads (with the exception of Highway 133), and road speeds are generally below 30 mph. Within the Unit, the slow road speeds and mobility of deer would limit traffic-related deer mortality. The level of traffic on Highway 133 from development of Alternative A would increase by less than 1 percent over the next 6 years (**Section 4.3.5**, Transportation and Access), which would likely have additive but nominal direct mortality impacts on mule deer wintering in lower elevations along Highway 133. This would likely impact individual deer, but no population level impacts would be expected.

Without fencing around cutting pits (which is not uniformly utilized in the Unit at this time), there is a remote chance that deer could become stuck in a pit, or ingest waters on pit surfaces.

See the Vegetation section for a detailed description of the acres of impact on specific vegetation communities. **Table 4-46**, Impacts on Mule Deer and Elk Habitat in Bull Mountain Unit under Alternative A, shows the quantitative impacts on mule deer and elk habitats that would result from Alternative A. These direct impacts on habitats would be relatively small in scale.

**Table 4-46**
**Impacts on Mule Deer and Elk Habitat in Bull Mountain Unit under Alternative A**

| Impacts | Total (acres) |
|---|---|
| ***Short-Term Impacts*** | |
| Mule deer winter range | 41 |
| Mule deer winter concentration area | 0 |
| Elk highway crossing | 1 |
| Elk severe winter range | 72 |
| Elk winter concentration area | 196 |
| ***Long-Term Impacts*** | |
| Mule deer winter range | 12 |
| Mule deer winter concentration area | 0 |
| Elk highway crossing | 1 |
| Elk severe winter range | 21 |
| Elk winter concentration area | 65 |

Source: SGI 2013, BLM GIS 2014, Petterson 2012

In summary, long-term impacts on habitat would decrease after major activities associated with development are complete, and thus traffic levels and heavy construction activities would also decrease. However, compared to current conditions, the area would see a long-term increase in human activity, which would diminish the utility of the area for mule deer. Mule deer densities within the Unit may decrease over time with full development of the Unit due to increased human activities, but the relatively small footprint of the project would allow for adequate forage for mule deer throughout the area.

The long-term indirect impacts on deer would be largely dependent on the amount of traffic and human activities in the Unit. With automation of facilities and reduced traffic, it is conceivable that deer may continue to utilize much of the Unit. However, if wells are checked daily or roads see regular traffic, deer densities and use of the Unit would likely remain lower than current levels. Overall deer populations would not be expected to decrease from Alternative A, but deer densities in the Unit would be lower.

It would be difficult to anticipate if wintering deer would shift their use patterns more than deer summering in the Unit. During the summer and fall months, deer often seem to be more sensitive to human disturbances (which would also coincide with the construction season and fall hunting seasons), and wintering mule deer seem more accepting of human activities (which coincides with less human activity in the Unit). Mule deer may indeed change winter range utilization patterns and move to less impacted areas, but given the low levels of human activity anticipated in the winter, deer may tend to maintain traditional use patterns. Indirect impacts on deer would be realized through lower fawn weights as they enter the winter season and possibly higher over-winter fawn mortality due to does and fawns needing to travel more or avoid otherwise available habitats near roads, pads, pits, and other areas of human activity, which could therefore limit their use of preferred habitats and refugia and increase their metabolic outputs.

Elk – Direct impacts (e.g., mortality) to elk are unlikely in the project area given that all roads within the Unit are dirt (with the exception of Highway 133), and road speeds are generally below 30 mph. It is possible that some elk may be struck while attempting to cross a road, but this is relatively unlikely given the road speeds (which are even slower during the winter months) and agility of elk. Mortality to elk along Highway 133 is currently occurring due to existing traffic patterns, and development of the Unit would contribute to additional traffic on Highway 133. The level of traffic on Highway 133 from Alternative A would increase by less than 1 percent, depending on the time of year and level of development (see **Section 4.3.5**, Transportation and Access, for more information regarding traffic impacts). Traffic increases would likely have additive but nominal direct mortality impacts on elk wintering in lower elevations along Highway 133. This would likely impact individual elk, but no population-level impacts would be expected, especially when considering that elk would be wintering near Highway 133 when development-related traffic volumes are lower.

Without fencing around cutting pits (which is not uniformly utilized in the Unit at this time), there is a remote chance that elk could become stuck in a pit, or ingest waters on pit surfaces. However, this is relatively unlikely given the odor of cuttings pits, tarps covering pits, and the presence of livestock fencing around pads. While elk mortality from unfenced pits is very unlikely, without wildlife fencing around pits it cannot be ruled out.

Table 4-46 shows the quantitative impacts on mule deer and elk habitats that would result from Alternative A. See the Vegetation section for a detailed description of the acres of impacts on specific vegetation communities. These direct impacts on habitats are very small in scale. Areas affected by short-term construction disturbance may have a longer duration of impacts on elk than expected. This is because these areas would not be reclaimed to pre-disturbance conditions for many years given the slow rate of shrub re-establishment and time required to return to functional habitat conditions for elk.

There may be a 2- to 3-year period when pipeline corridors provide lower elk grazing opportunities throughout the Unit. It is assumed that over 3 years or so, most of the cleared pipeline corridors and other temporary use areas would be revegetated and would once again provide elk with more suitable foraging. However, in some circumstances where landowners or other agencies require the planting of more aggressive non-native grasses and forbs, the recovery of native forbs and shrubs into these short-term disturbance acres may take much longer due to the competitive exclusion of desirable native plants.

Elk would avoid otherwise suitable habitats near access roads, construction areas, and active drilling sites during the construction process due to human activities, traffic, loud noises, and other perceived threats by elk as described under the Nature and Types of Effects. For instance, Wilbert et al. (2008) found that elk habitat effectiveness is eliminated in non-forested habitats when road densities exceed 1 mile/square mile. It is reasonable to assume that decreased utilization would occur near areas of higher human activity, noise, and traffic. Indirect impacts which may occur during the summer construction, drilling, and completion seasons are tempered by the fact that during the summer months most elk have migrated to higher terrain outside of the Unit. Construction, road use, and drilling activities occurring during the calving period (late May through late June) which occur near aspen stands and oakbrush stands may displace some individual calving elk, or disturb some calving activities. As most cows will have left the Unit by this time of year, widespread impacts are not anticipated.

In summary, the development of the Unit under Alternative A would create a direct loss of less than 1 percent of the potentially available habitats under any of the proposed activities. This loss of habitat would have an insignificant impact on elk. However, traffic and human activities in the Unit would have a larger indirect impact footprint, especially during the construction and drilling phases, possibly resulting in a larger range of areas with reduced habitat effectiveness for elk. Since drilling would occur year-round on fee lands/fee mineral estate which are relatively evenly distributed across the unit, impacts on elk would likely occur, causing widespread impacts. It is expected, however, that most construction, drilling, and development would likely occur during the summer months, reducing the likelihood for impacts on elk when they are most common in the Unit (winter).

Elk would continue to use, migrate through, and may even be seen very close to the facilities and roads within the Unit, but scientific literature indicates that elk utilization of habitats near roads decreases with increasing traffic levels (Wilbert et al 2008), and new roads reduce habitat effectiveness for elk (see Petterson 2012). Given the size of the project, its location, and surrounding habitats, this project could have moderate impacts on elk densities and distribution within the Unit. However, it is unlikely that elk populations within the greater Muddy Creek basin would decrease, but elk densities across the Unit would likely be lower, or at least elk would be significantly redistributed in some areas, with elk seeking habitats away from facilities and high-use roads. This may place elk in suboptimal habitats. Some areas would likely support similar elk densities as currently occurring due to low levels of development, but some areas proposed for development are located very close to or within critical winter habitats and impacts on elk in these areas would have disproportionately large impacts.

Black bear – Alternative A would have negligible impacts on bear populations or bear habitat. Bear-proof trash containers should be used on-site at all times to minimize visitation by bears but would not be required.

Moose – The development of the Unit would likely preclude moose lingering or utilizing habitats within the modeled indirect impact areas (see previous discussions). After construction, the low human activity levels around individual well pads would likely cause moose to leave if humans entered the area. Depending on the distance from the pad site, however, some moose may linger, or would not "flee" from human activities on pads and roads. This is not to say that moose stress levels would not rise or changes in behavior would not be noticed.

Increased traffic on local roads would also reduce moose use of habitats near roads. Increased mortality from vehicle strikes is not likely within the project area, as road speeds are fairly low, but moose vehicle strikes have been documented on Highway 133 on the east side of McClure pass near Placita. In summary, while this project may have minor localized impacts on the ability for moose to continue to fully utilize habitats in the Unit, the Unit is not optimal moose habitat, and moose use of this area would already likely be relatively infrequent. Therefore, Alternative A would have negligible impacts on moose or moose habitat.

Aquatic Wildlife

Under Alternative A, 4 miles of new pipeline co-located with roads and 8 miles of new cross country would be used to transport gas from producing wells and to transport water to proposed water disposal wells. Impacts on aquatic wildlife would occur where pipeline construction phases require a pipeline bore at fish-bearing stream crossings. See **Section 3.2.8**, Fish and Wildlife, for a description of fish-bearing streams in the Unit.

Surface water withdrawals would be required for nearly all phases of oil and gas development especially during construction, drilling, and dust abatement activities; 30 percent of project water would be gathered from fresh water sources and the remaining 70 percent would come from a variety of recycled and/or produced sources. Specific water withdrawal points have not yet been identified by SGI; however, it is assumed for the purposes of this analysis that the entire fresh water depletion associated with this project would be a new depletion from the Colorado River. In the short- and long-term, water depletions would threaten the quantity of aquatic habitat for fish and other aquatic species known to inhabit the Unit. See **Section 3.2.8**, Fish and Wildlife and **Section 3.2.10**, Special Status Species, for a list of aquatic wildlife in the Unit. Water volumes required for the activities under Alternative A would be minimal compared with the expected discharge in Muddy Creek (see **Section 4.2.4**, Water Resources) and would not substantially reduce water for aquatic wildlife. Based on the water estimates in **Section 4.2.4**, Water Resources, approximately 74 acre-feet of fresh water annually would be required to meet water demands which is less than the annual depletion amount of 379 acre-feet per year for all oil and gas activities on the western slope per the BLM/USFWS programmatic agreement.

*Alternative B*
Impacts on fish and wildlife from access road use, pipeline development, and water use would be as described under the Nature and Types of Effects for casual use and permitted use. Surface disturbance from current and proposed oil and gas development would be greatest under Alternative B. New access roads would not be purposefully sited to reduce impacts on key big game habitat such as winter habitats. Under Alternative B, impacts from road development and use would have the greatest direct effect on wildlife and their habitat as the Alternative B would result in the greatest number of well pads, miles of roads, and pipelines. No voluntary seasonal winter timing limitations or a progressive development approach would be included to protect big game under Alternative B. Therefore, impacts on wildlife are expected to be greatest under Alternative B as a result of surface disturbance activities and the lack of effective timing limitations on a landscape scale to reduce impacts on big game within crucial winter activity areas.

Actions proposed under Alternative B would result in greater water depletions as a result of developing the greatest number of well pads which would require the greatest amount of water during construction, drilling, and dust abatement phases of the proposed project (see **Table 2-9**, Summary of Actions by Alternative, for water quantities). Therefore, aquatic habitat would be more affected by surface water depletions under Alternative B.

Terrestrial Wildlife
Management actions proposed under Alternative B would result in the greatest amount of surface disturbance relative to Alternative A. Over 592 acres would be disturbed in the short-term and over 214 acres in the long-term within the unit. The road density analysis within the Unit identified 1,180 acres of Category 1 habitat, an approximate decrease of 72 percent compared to Alternative A. Direct impacts on terrestrial wildlife species where road densities are greater than 0.5 road miles per square mile would be most pronounced on 18,500 acres (sum of Categories 2, 3, and 4), a 21 percent increase compared to Alternative A (Table 4-45). Besides the direct loss of habitat and resulting habitat fragmentation, this increase in roads could result in habitat avoidance and an increased likelihood for injury or mortality due to collisions of wildlife with vehicles (See *Habitat Quality*, above).

Under Alternative B, federal minerals within the Unit would continue to be subject to a winter seasonal timing limitation from December 1 through April 30 to protect deer and elk winter ranges from development activities. However, the effectiveness of such timing limitations may be limited, since they would only be applied on federal mineral estate in the Unit. As a result, while disruptive activities would be seasonally limited on these lands, disturbance would continue to occur on fee lands/fee mineral estate spread throughout the Unit. Further, maintenance activities would not be subject to the TL on any lands and wildlife could be disturbed throughout the Unit as a result.

Quantitative estimates of impacts on wildlife resources were determined for potential indirect impacts and potential habitat loss during construction, resource development, and completion phases. See Table 4-40 for a description of indirect impacts on habitat vegetation types under Alternative B.

In addition, under Alternative B, SGI proposes to construct up to 4 new water disposal wells powered by overhead electrical lines requiring 20 new power poles. The addition of power lines and poles pose a threat of disturbance as described under permitted activities in the Nature and Types of Effects section. Power lines and poles may also serve as a perch for birds of prey, which may indirectly increase predation on small mammals and other prey items. Further discussion regarding impacts on birds is provided in **Sections 4.2.8**, Migratory Birds and **4.2.9**, Special Status Species.

Mule Deer and Elk – Under Alternative B, surface disturbance activities from oil and gas development would result in greater impacts on mule deer habitat throughout the Unit compared to Alternative A (Table 4-46). The type of impacts would be as described in the Nature and Types of Effects section above.

The reduction in habitats, as shown in **Table 4-47**, Impacts on Mule Deer and Elk Habitat in Bull Mountain Unit under Alternative B, and habitat quality, described in the road density analysis above, would likely result in increased impacts on mule deer and elk fitness in individuals and would lower mule deer and elk densities in the Unit during the winter months compared to Alternative A.

**Table 4-47**
**Impacts on Mule Deer and Elk Habitat in Bull Mountain Unit under Alternative B**

| **Impacts** | **Total (acres)** |
|---|---|
| ***Short-Term Impacts*** | |
| Mule deer winter range | 151 |
| Mule deer winter concentration area | 3 |
| Elk highway crossing | 1 |
| Elk severe winter range | 146 |
| Elk winter concentration area | 389 |
| ***Long-Term Impacts*** | |
| Mule deer winter range | 51 |
| Mule deer winter concentration area | 1 |
| Elk highway crossing | 1 |
| Elk severe winter range | 49 |
| Elk winter concentration area | 145 |

Source: SGI 2013, BLM GIS 2014, Petterson 2012

Black bear – Under Alternative B, the increase in surface disturbance activities within the Unit from proposed oil and gas development would result in slightly reduced black bear habitat and more frequent encounters with humans as a result of increased activities. However, bear-resistant dumpsters and trash receptacles would be installed at all facilities as required under the design features in **Appendix C** (COAs 57 and 58). Thus, impacts on black bears and their habitat under Alternative B would be negligible.

Moose – Moose habitat would be slightly reduced and human encounters would increase as a result of actions proposed under Alternative B. Impacts on moose and their habitat would be negligible under Alternative B.

Adherence to design features, required plans and BMPs from **Appendix C** (COAs 43, 56- 65 for protection of wildlife; additional design features protecting habitat are included in the Vegetation section; BMPs 112, 113, 116, 117, 118, and 134, with additional BMPs protecting habitat described in the Vegetation section) would minimize the potential for impacts on wildlife. Because of the amount of surface disturbance associated with Alternative B, residual disturbance and harm to wildlife habitat will still occur after implementation of design features and BMPs. In addition, the BLM may include site-specific COAs to the APDs for increased protection of wildlife and their habitat.

Aquatic Wildlife

Given the increased miles of pipeline infrastructure, Alternative B would require more pipeline bores at stream crossings and would, therefore, result in greater impacts on aquatic wildlife compared to Alternative A. The annual rate of oil and gas construction in the Unit would be the same under Alternative B compared to Alternative A, but it would continue for a longer time period. Therefore, under Alternative B, construction and drilling phases would require more water use from local sources over the life of the project but annual withdrawals would be minimal as described in Alternative A. Based on the water estimates in **Section 4.2.4**, Water Resources, approximately 124 acre-feet of fresh water would be required to meet water demands, which is less than the annual depletion amount of 379 acre-feet per year for all oil and gas activities on the western slope per the BLM/USFWS programmatic agreement.

*Alternative C*

Impacts on fish and wildlife under Alternative C would be as described under the Nature and Types of Effects for casual use and permitted use. Surface disturbance from current oil and gas development would continue; however, new access roads would be located in a manner that reduces impacts on big game species and their habitat. Additionally, wildlife design features would implement timing limitations to restrict oil and gas activities in critical elk and deer winter habitat. Aquatic wildlife and their habitat would be impacted more under Alternative C than Alternative A as a result of increased water depletions; however, water use under Alternative C would be less than the water withdrawals proposed under Alternative B.

Terrestrial Wildlife

In general, actions proposed under Alternative C contain elements that are similar to Alternatives A and B in terms of the phases of development and associated actions from construction through reclamation. Alternative C however, will adhere to the COAs and BMPs listed above, and also provides design features to address the impacts of oil and gas development on wildlife and their habitat. For example, centralized production facilities would be established outside of the Reduced Winter Activity Areas shown in **Figure 2-3** to reduce year round truck traffic to the individual wells located within these areas to enhance their utility as winter refugia for wildlife. Remote telemetry would be used to reduce well monitoring trips once a well is put into production. This could result in a substantial reduction in the number of annual truck miles driven within the Unit and a corresponding reduction in disturbance to wildlife.

Under Alternative C, proposed well pads, roads, pipelines and other supporting infrastructure would result in the short-term disturbance of over 441 acres in the Unit; in the long-term, 126 acres would be disturbed. The co-location of all pipelines with roads would maintain habitat patch size and late seral communities as well as reduce the likelihood for weed introduction and spread. However, the short-term impacts from co-location would be greater due to the larger work area required. The road density analysis within the Unit indicates that road development under Alternative C would result in 4,310 acres of Category 1 habitat and big game impacts would be most pronounced on 15,370 acres where road densities are greater than 0.5 road mile per square mile (Table 4-45, Habitat Categories by Alternative). In Alternative A, Category 1 habitat would be about the same as Alternative A. As a result, the potential habitat avoidance and conflict with vehicles would be greater than Alternative A, but less than Alternative B.

Quantitative estimates of impacts on wildlife resources were determined for potential indirect impacts and potential habitat loss during construction, resource development, and completion phases. See Table 4-41, Direct Impacts on Vegetation Communities in Bull Mountain Unit (Alternative C), for a description of indirect impacts on habitat vegetation types under Alternative C.

Under Alternative C, federal minerals within the Unit would continue to be subject to a winter seasonal timing limitation from December 1 through April 30 (COA 134) to protect deer and elk winter ranges from development activities. Exceptions or modifications would not be considered within these areas except for emergency work. In addition to the general TLs already imposed on federal mineral development, Alternative C proposes to use voluntary seasonal winter timing limitations or a progressive development approach to further reduce the potential for impacting critical winter habitat for deer and elk within the Unit (see Additional Mitigation Measures, below).

The voluntary winter timing limitations or a progressive development approach could mitigate for impacts on big game during construction or resource development activities in sensitive winter habitats on federal and private lands. Under this alternative, the BLM would waive winter TLs within agreed-upon areas to allow winter development activities. See **Section 2.2.6**, Alternative C, Modified Action, for information regarding the voluntary seasonal winter timing limitations within the Unit. The voluntary seasonal winter timing limitations would result in an additional 5,750 acres of Category 1 habitat quality during the season of highest occupation by big game populations in the unit, a 30 percent increase from Alternative A, and would reduce Category 2, 3, and 4 habitats by 1,300 acres compared to Alternative A. The TL would also focus activities in a smaller area, providing a refuge for animals elsewhere in the Unit. This TL as well as the centralized gathering facilities and remote telemetry would result in a landscape reduction of human presence and disturbance during the winter and likely maintenance of big game herd size at or near Alternative A levels given the increase in habitat quality and reduced activity areas. Other wildlife species that may inhabit the seasonal winter TL areas would also receive added protection.

Additional wildlife mitigation elements under Alternative C would include pre-construction nesting surveys for migratory birds and raptors would be conducted in advance of proposed surface disturbing activities between April 1 and June 30. Also, the proposed construction of four new water disposal wells would bury electrical lines adjacent to roadways to reduce potential impacts on birds and other wildlife. For more discussion regarding impacts on birds see **Sections 4.2.8**, Migratory Birds and **4.2.9**, Special Status Species.

Mule Deer and Elk – Under Alternative C, surface disturbance activities from oil and gas development would result in overall lesser impacts on mule deer and elk habitat throughout the Unit compared to Alternatives A and B (Table 4-45), though roads would cross through elk winter range. The type of impacts would be as described in the Nature and Types of Effects section above. Additional voluntary winter TLs, described above, would further protect critical winter range for mule deer in the Unit. The reduction in habitats, as shown in **Table 4-48**, Impacts on Mule Deer and Elk Habitat in Bull Mountain Unit under Alternative C, and habitat quality, as described in the road density analysis above, would likely result in increased impacts on mule deer and elk fitness in individuals and would lower mule deer and elk densities in the Unit during the winter months compared to Alternative A, but less than Alternative B.

**Table 4-48**
**Impacts on Mule Deer and Elk Habitat in Bull Mountain Unit under Alternative C**

| Impacts | Total (acres) |
|---|---|
| ***Short-Term Impacts*** | |
| Mule deer winter range | 114 |
| Mule deer winter concentration area | 0 |
| Elk highway crossing | 0 |
| Elk severe winter range | 105 |
| Elk winter concentration area | 277 |
| ***Long-Term Impacts*** | |
| Mule deer winter range | 33 |
| Mule deer winter concentration area | 0 |
| Elk highway crossing | 0 |
| Elk severe winter range | 29 |
| Elk winter concentration area | 74 |

Source: SGI 2013, BLM GIS 2014, Petterson 2012

Black bear – Under Alternative C, the increase in surface disturbance activities within the Unit from proposed oil and gas development would result in slightly reduced black bear habitat and more frequent encounters with humans as a result of increased activities. However, impacts on black bears and their habitat under Alternative C would be less than impacts expected as a result of Alternatives A and B. Bear-resistant dumpsters and trash receptacles would be installed at all facilities as required under the design features described in **Appendix C** (COAs 57 and 58). Impacts on bear habitat under Alternative C would be negligible.

Moose – Moose habitat would be slightly reduced and human encounters would increase as a result of actions proposed under Alternative C. However, impacts on moose and their habitat under Alternative C would be less than impacts expected as a result of Alternatives A and B. Impacts on moose and their habitat would be negligible under Alternative C.

Adherence to design features, required plans and BMPs described in **Appendix C** (COAs 43, 56-65 for protection of wildlife; additional design features protecting habitat are included in the Vegetation section; BMPs 112, 113, 116, 117, 118 and 134, with additional BMPs protecting habitat described in the Vegetation section) would minimize the potential for impacts on wildlife.

Because of the surface disturbance associated with development, residual disturbance and harm to wildlife habitat would still occur after implementation of design features and BMPs, but less than under Alternative B, which incorporates fewer protective measures. In addition, the BLM may include site-specific COAs to the APDs for increased protection of wildlife and their habitat. Further, the acceptance and participation in the voluntary winter TLs would directly increase habitat protection for deer and elk winter habitat and indirectly increase habitat protection for other wildlife species that may inhabit those areas.

Aquatic Wildlife

Given the increased miles of pipeline infrastructure, it is anticipated that Alternative C would require more pipeline bores at stream crossings and would, therefore, result in greater impacts on aquatic wildlife than Alternative A, but less than Alternative B. The annual rate of oil and gas construction in the Unit would be the same under Alternative C compared Alternative B but would require less water use for dust abatement. Based on the water estimates in **Section 4.2.4**, Water Resources, approximately 124 acre-feet of fresh water would be required to meet water demands which is less than the annual depletion amount of 379 acre-feet per year for all oil and gas activities on the western slope per the BLM/USFWS programmatic agreement. Therefore, under Alternative C, annual water withdrawals from local sources in the Unit would be minimal as described in Alternative A above. Under Alternative C, aquatic wildlife within the Unit would have slightly less available water compared to Alternative A and slightly more than Alternative B.

Additional Mitigation Measures

Under Alternative C, centralized production facilities would be established outside of the Reduced Winter Activity Areas (**Figure 2-3**) to reduce year-round truck traffic to the individual wells located within these areas to enhance their utility as winter refugia for wildlife.

Remote telemetry would be used to reduce well monitoring trips once a well is put into production, resulting in a substantial reduction in the number of annual truck miles driven within the Unit and a corresponding reduction in disturbance to wildlife.

Under Alternative C, co-location of all pipelines with roads would maintain habitat patch size and late seral communities as well as reduce the likelihood for weed introduction and spread over the long-term.

Alternative C proposes to use voluntary seasonal winter timing limitations or a progressive development approach to further reduce the potential for impacting critical winter habitat for deer and elk within the Unit.

Voluntary winter timing limitations under Alternative C could mitigate for impacts on big game during construction or resource development activities in sensitive winter habitats. Under this alternative, the BLM would waive winter TLs within agreed-upon areas to allow winter development activities. The voluntary seasonal winter timing limitations would increase Category 1 wildlife habitat while decreasing lower quality habitat. The TL would also focus activities in a smaller area, resulting in reduced human presence on winter range.

Under Alternative C, pre-construction nesting surveys for migratory birds and raptors would occur between April 1 and June 30 (an increase from May 15 through July 15, as described in **Appendix C** (COA 62). Also, four new water disposal wells would bury electrical lines adjacent to roadways to reduce potential impacts on birds and other wildlife.

*Cumulative*

Many past and present actions and current conditions within the cumulative impact analysis area have affected and would likely continue to affect fish and wildlife species. In addition, reasonably foreseeable future actions that may affect fish and wildlife in the future are described in Table 4-3. Recent and planned habitat restoration projects within the region include vegetation treatments to improve habitat and reduce fire threats. These improvement efforts would expand the extent and increase the quality of habitat for many fish and wildlife species that inhabit the surrounding region. However, impacts resulting from energy development, especially from oil and gas resources in the North Fork of the Gunnison River areas, would continue, as less than 25 percent of the Uncompahgre Field Office mineral estate has been leased. As such, access roads would continue to be developed on federal, state, and private lands in the region in support of energy development. These actions would reduce the availability of habitat and forage as well as increase habitat fragmentation. Additionally, continued and future actions resulting in water depletions or impacts on water quality within the region would reduce the quantity and quality of habitat for fish and other aquatic species.

Under all of the alternatives, impacts on fish and wildlife as a result of increased oil and gas development within the Unit would contribute to the impacts from past, present, and reasonably foreseeable actions described in Table 4-3 (**Tables 4-49**, Cumulative Impacts on Mule Deer and Elk Habitat in Bull Mountain Unit [Alternatives A and B combined], and **4-50**, Impacts on Mule Deer and Elk Habitat in Bull Mountain Unit [Alternatives A and C combined]**)**. Alternative A would result in the fewest number of well pads and would therefore result in the least amount of impacts on terrestrial and aquatic wildlife. However, mitigation measures including BMPs, RDFs, and voluntary seasonal winter timing limitations would not be imposed under Alternative A. Actions proposed under Alternative B would result in the greatest direct impacts on fish and wildlife habitat while applying additional design features and BMPs described in **Appendix C** (COAs 43, and 56- 65 for protection of wildlife; BMPs 112, 113, 116, 117, 118 and 134); no voluntary seasonal timing limitations have been proposed under Alternative B. Under Alternative C, oil and gas development activities would result in more disturbance of fish and wildlife habitat compared to Alternative A but less than Alternative B. In addition, Alternative C would implement BMPs, RDFs (as listed above) as well as voluntary seasonal timing limitations and other measures described above under Additional Mitigation Measures, in order to reduce impacts on sensitive winter big game habitat.

**Table 4-49**
**Cumulative Impacts on Mule Deer and Elk Habitat in Bull Mountain Unit (Alternatives A and B combined)**

| Impacts | Total (acres) |
|---|---|
| ***Short-Term Impacts*** | |
| Mule deer winter range | 192 |
| Mule deer winter concentration area | 3 |
| Elk highway crossing | 2 |
| Elk severe winter range | 218 |
| Elk winter concentration area | 585 |
| ***Long-Term Impacts*** | |
| Mule deer winter range | 63 |
| Mule deer winter concentration area | 1 |
| Elk highway crossing | 2 |
| Elk severe winter range | 70 |
| Elk winter concentration area | 210 |

Source: SGI 2013, BLM GIS 2014, Petterson 2012

**Table 4-50**
**Impacts on Mule Deer and Elk Habitat in Bull Mountain Unit (Alternatives A and C combined)**

| Impacts | Total (acres) |
|---|---|
| ***Short-Term Impacts*** | |
| Mule deer winter range | 165 |
| Mule deer winter concentration area | 0 |
| Elk highway crossing | 1 |
| Elk severe winter range | 177 |
| Elk winter concentration area | 473 |
| ***Long-Term Impacts*** | |
| Mule deer winter range | 45 |
| Mule deer winter concentration area | 0 |
| Elk highway crossing | 1 |
| Elk severe winter range | 50 |
| Elk winter concentration area | 139 |

Source: SGI 2013, BLM GIS 2014, Petterson 2012

### 4.2.8 Migratory Birds

Impacts on bird species protected under the Migratory Bird Treaty Act (MBTA) of 1918 as a result of proposed management actions within the Bull Mountain Unit are discussed in this section. Detailed descriptions of habitat types within the Unit are provided in **Section 3.2.6**, Vegetation. See **Section 3.2.9**, Migratory Birds for a list of bird species that are known or have the potential to inhabit the Unit.

***Methods of Analysis***
Impacts on migratory birds and their habitat are similar to those described for terrestrial wildlife in **Section 4.2.7**, Fish and Wildlife.

*Indicators*
Indicators of impacts on migratory birds are as follows:

- Amount and condition of available habitat
- Likelihood of mortality, injury, or direct disturbance
- Likelihood of habitat disturbance

*Assumptions*
The analysis includes the following assumptions:

- Impacts on migratory birds analyzed in this section focus on those species identified in Chapter 3, Migratory Birds, which are known to inhabit the Unit.
- The actual locations of oil and gas well pads and associated infrastructure including pipelines and access roads is subject to change as a result of the APDs.
- Short-term effects are defined as those that would occur over a timeframe of 5 years or less, and long-term effects would occur over longer than 5 years.

***Nature and Type of Effects***
Migratory bird habitats on BLM-administered lands in the Unit would be affected under all alternatives. Changes to bird habitats would be caused by the following three types of disturbances: 1) disturbance and disruption from casual use; 2) disturbance and disruption from permitted activities; and 3) changes to habitat conditions. These potential causes of disturbance are directly linked to vegetation conditions and water quality and quantity (**Section 4.2.6**, Vegetation, and **Section 4.2.4**, Water Resources). See **Section 4.2.7**, Fish and Wildlife, for a complete description of the three types of disturbances that could affect migratory birds.

***Effects Common to All Alternatives***
Within the Unit, oil and gas development activities would continue under all alternatives. Direct and indirect impacts on migratory birds would be as described under Nature and Type of Effects for permitted activities. In addition, activities associate with casual use and habitat changes described in the Nature and Type of Effects section would continue to impact migratory birds and their habitat.

*Alternative A*
For a complete description of activities and disturbances associated with Alternative A, see **Section 4.2.7**, Fish and Wildlife. Increased human activity as a result of ongoing oil and gas development activities and recreation in the Unit could result in impacts on raptor species (as described in the Nature and Type of Effects section) from disturbance from casual use and permitted activities. Direct impacts on migratory bird species would primarily be a result of

injury or mortality from vehicle collisions or from striking oil and gas infrastructure. Indirect impacts on migratory birds would be from the loss of habitat or habitat fragmentation as a result of resource development activities. See **Section 4.2.6**, Vegetation, for a list of impacts on vegetation types under Alternative A. No mitigation measures for migratory bird species would be included under Alternative A.

<u>Neotropical Species</u>
Under Alternative A, sagebrush and irrigated meadows vegetation are expected to be most impacted as a result of continued oil and gas development (e.g., well pads, pipelines, and roads). These activities would therefore result in reduced habitat availability in the short- and long-term for sagebrush obligate species including Brewer's sparrow, western meadowlark, vesper sparrow, and lark sparrow. Reduced irrigated meadow habitat could possibly impact American bittern, although marsh and meadow habitat for the bittern is limited within the Unit. Purple martin habitat, which includes old growth aspen stands, is not expected to be impacted by activities associated with Alternative A.

<u>Raptors</u>
Several raptor species occur or have the potential to occur in the Unit including bald and golden eagles, ferruginous hawks, falcons (peregrine and prairie), as well as flammulated owls. Under Alternative A, surface disturbance within irrigated meadow and sagebrush vegetation would reduce habitat and hunting grounds for golden eagles and prairie falcons in the short- and long-term.

*Alternative B*
Impacts on vegetation within the Unit from well pads, pipelines, and roads would reduce habitat availability for migratory birds compared to Alternative A. For a complete description of activities and disturbances associated with Alternative B, see **Section 4.2.7**, Fish and Wildlife. Increased human activity as a result of ongoing and proposed oil and gas development activities in the Unit could result in impacts on raptor species as described in the Nature and Type of Effects under disturbance from casual use and permitted activities. See **Section 4.2.6**, Vegetation, for a list of impacts on vegetation types under Alternative B. Migratory bird impacts would be mitigated by applying additional design features and BMPs described in **Appendix C** (COAs 43, 56, 58, 59, 60, 61, 62, and 63; additional design features protecting habitat are included in the Vegetation section; BMPs 113, 116, 118, and 134 with additional BMPs protecting habitat described in the Vegetation section), and would include nesting surveys as described in **Table 2-10**, Stipulations and Best Management Practices. Restrictions on surface-disturbing activities during the breeding season (COA 62, and BOA 134 for early-nesting species, such as raptors) would protect breeding migratory birds. Such restrictions could have long-term implications, such as ensuring successful nesting and reproduction for some individuals would maintain the size and diversity of local populations, though they may be reduced in size from pre-development levels. Alternative B may adversely impact individuals, but is not likely to result in a loss of viability on the Unit, nor cause a trend to federal listing or a loss of species viability range-wide.

Neotropical Species

Under Alternative B, sagebrush vegetation is expected to be most impacted by the actions proposed under this alternative in both the short- and long-term. Sagebrush obligate species described above under Alternative A would have decreased habitat as a result of Alternative B. Additionally, oakbrush and some aspen habitat will be disturbed in the short- and long-term. This would reduce the available habitat for purple martin, woodpeckers, flickers, house wren, warbling vireo, cordilleran flycatcher, western wood-pewee, tree swallow, and violet-green swallow. Irrigated meadow habitat is expected to be disturbed in the short-term resulting in less available habitat for American bittern (see **Section 4.2.6**, Vegetation for quantitative impacts on habitat).

Raptors

Surface disturbance within irrigated meadow (short-term) and sagebrush (short- and long-term) vegetation would reduce habitat and hunting grounds for golden eagles and prairie falcons. Flammulated owl oakbrush and aspen habitat would be decreased in the short- and long-term under Alternative B (see **Section 4.2.6**, Vegetation for quantitative impacts on habitat). .

*Alternative C*

Under Alternative C, impacts on vegetation within the Unit from well pads, pipelines, and roads would reduce habitat availability for migratory birds. Refer to **Section 4.2.7**, Fish and Wildlife, for activities and disturbances associated with Alternative C. Impacts as described in Section 4.2.7, such as burial of electrical lines, road development, and habitat loss, would also apply to migratory birds. Increased human activity as a result of ongoing and proposed oil and gas development activities in the Unit could result in impacts on raptor species as described in the Nature and Type of Effects under disturbance from casual use and permitted activities. See **Section 4.2.6**, Vegetation, for a list of impacts on vegetation types under Alternative C. Migratory bird impacts would be mitigated by applying BMPs provided in **Appendix C** (COAs 43, 56- 63; additional design features protecting habitat are included in the Vegetation section; BMPs 113, 116, 118, and 134 with additional BMPs protecting habitat described in the Vegetation section). In addition, under Alternative C, pre-construction nesting surveys for migratory birds and raptors would be conducted before surface disturbance activities occur between April 1 and June 30, as described in **Section 2.2.6**, Alternative C, Modified Action. Additionally, new electrical lines to power the four proposed water disposal wells would be buried adjacent to roads to minimize potential overhead disturbance on birds and other wildlife. **Table 2-10**, Stipulations and Best Management Practices. In general, impacts on migratory birds from actions proposed by Alternative C would be similar to those described under Alternative B; however, less habitat within the Unit would be impacted in the short- and long-term, and more nests would be protected from disturbance. Alternative C “may adversely impact individuals, but is not likely to result in a loss of viability on the Unit, nor cause a trend to federal listing or a loss of species viability range-wide.”

Neotropical Species

In both the short- and long-term, sagebrush vegetation is expected to be most impacted by the actions proposed under this Alternative C. Sagebrush obligate species described above under Alternative A would have decreased habitat as a result of Alternative C; sagebrush habitat would not be reduced as much as described in Alternative B. Oakbrush and some aspen habitat will be disturbed in the short- and long-term. This would reduce the available habitat for purple martin, woodpeckers, flickers, house wren, warbling vireo, cordilleran flycatcher, western wood-pewee, tree swallow, and violet-green swallow. Irrigated meadow habitat is expected to be disturbed in the short-term resulting in less available habitat for American bittern (see **Section 4.2.6**, Vegetation for quantitative impacts on habitat).

Raptors

Surface disturbance within irrigated meadow (short-term) and sagebrush (short- and long-term) vegetation would reduce habitat and hunting grounds for golden eagles and prairie falcons. Flammulated owl oakbrush and aspen habitat would be decreased in the short- and long-term under Alternative C (see **Section 4.2.6**, Vegetation for quantitative impacts on habitat).

Additional Mitigation Measures

Under Alternative C, co-location of all pipelines with roads would maintain habitat patch size and late seral communities as well as reduce the likelihood for weed introduction and spread over the long term.

Under Alternative C, pre-construction nesting surveys for migratory birds and raptors would occur between April 1 and June 30 (an increase from May 15 to July 15, as described in **Appendix C**, Best Management Practices and Conditions of General Approval, COA 62). Also, four new water disposal wells would bury electrical lines adjacent to roadways to reduce potential impacts on birds and other wildlife.

*Cumulative*

Migratory bird habitat would continue to be affected through several past and present actions as well as current conditions within the cumulative impact analysis area. In addition, reasonably foreseeable future actions that may affect migratory birds in the future are described in Table 4-3. Recent and planned vegetation improvement efforts would expand the extent and increase the quality of habitat for many migratory bird species that inhabit the surrounding region. Specifically, sagebrush restoration efforts aimed at improving habitat for sage-grouse would result in an increase in habitat for other sagebrush obligate bird species including Brewer’s sparrow and meadowlark. Also, projects within the region to treat aspen affected by Sudden Aspen Decline as well as aspen stands impacted by insects and disease would reduce habitat for cavity nesters like the purple martin in the short-term but improve aspen health in the long-term. Impacts resulting from energy development, especially of oil and gas resources in the North Fork of the Gunnison River areas, would continue as less than 25 percent of the Uncompahgre Field Office mineral estate has been leased. As such, access roads would continue to be developed on federal, state, and private lands in the region in support of energy development. These actions would reduce the availability of migratory bird habitat as well as increase the risk of direct mortality, habitat fragmentation, and habitat avoidance.

Oil and gas development within the Unit proposed under all alternatives would contribute to the impacts from past, present, and reasonably foreseeable actions described in Table 4-3. Alternative A would result in the fewest number of well pads and would therefore result in the least amount of impacts on migratory bird habitat but no wildlife mitigation measures would be implemented under Alternative A. Actions proposed under Alternative B would result in the greatest direct impacts on available migratory bird habitat while implementing additional design features (COAs 43, 56, 58, 59, 60, 61, 62, and 63) and BMPs (113, 116, 118, and 134), including the requirement to conduct nesting surveys prior to surface disturbing activities in the Unit; no human encroachment would be allowed near active nests from May 15 – July 15.

Under Alternative C, oil and gas development activities would result in more surface disturbance of migratory bird habitat compared to Alternative A, but slightly less than Alternative B. In addition, Alternative C would implement BMPs and RDFs as under Alternative B, as well as voluntary seasonal timing limitations to reduce impacts on sensitive winter big game habitat (see Alternative C in Fish and Wildlife section above). The additional design features proposed under Alternative C (see Additional Mitigation Measures, above) would reduce cumulative impacts on migratory birds and their habitat within the region.

### 4.2.9 Special Status Species

This section discussed impacts on special status species, including federally listed species and BLM sensitive species from proposed management actions of other resources and resource uses. Exiting conditions are described in **Section 3.2.10**, Special Status Species.

#### *Methods of Analysis*

Impacts on special status species would primarily result from unmitigated surface disturbance such as wildfires, wildfire-suppression activities, erosion, and trampling. Direct and indirect impacts on special status species result from any surface-disturbing activity or alteration to occupied habitats. All federal actions would comply with ESA consultation requirements, and all implementation actions would be subject to further special status species review before site-specific projects are authorized or implemented. Federal regulations and BLM policy protecting threatened, endangered, and sensitive species were considered methods for reducing the potential impacts from permitted activities as described in **Section 3.2.8**, Special Status Species. If adverse impacts are identified, mitigation measures, including avoidance, would be implemented to minimize or eliminate the impacts.

*Indicators*

Indicators of impacts on special status species are as follows:

- Amount and condition of available habitat
- Likelihood of mortality, injury, or direct disturbance
- Likelihood of habitat disturbance

*Assumptions*

The analysis includes the following assumptions:

- In general, special status species will be more sensitive to habitat fragmentation, development, or changes in habitat conditions, as populations are often already highly fragmented, require specific microhabitats, and are especially sensitive to disturbance and human presence.

- The actual locations of oil and gas well pads and associated infrastructure including pipelines and access roads is subject to change as a result of the APDs.
- Impacts on special status species will be more significant than impacts on common species because population viability is already uncertain for special status species and certain species, such as special status plants, tend to be poor competitors.
- Short-term effects are defined as those that would occur over a timeframe of 5 years or less, and long-term effects would occur over longer than 5 years.
- USFWS would be consulted on any action that could potentially affect any listed plant or animal species or their habitat.
- No special status plant species inhabit the Unit.

***Nature and Type of Effects***

Special status fish and wildlife habitats on BLM-administered lands in the Unit would be affected under all alternatives. Changes to habitats would be caused by the following three types of disturbances: 1) disturbance and disruption from casual use; 2) disturbance and disruption from permitted activities; and 3) changes to habitat conditions. These potential causes of disturbance are directly linked to vegetation conditions and water quality and quantity (**Section 4.2.6**, Vegetation, and **Section 4.2.4**, Water Resources). See **Section 4.2.7**, Fish and Wildlife for a complete description of the three types of disturbances that could affect special status species.

***Effects Common to All Alternatives***

Under all alternatives, oil and gas development actions would continue to use existing infrastructure including well pads, access roads, pipelines, one overhead electrical line (4 power poles), and others. See **Table 2-9**, Summary of Actions by Alternative, for a summary of existing actions in the Unit. Some existing roads would be upgraded and new roads would be built. Therefore, impacts on special status fish and wildlife populations from oil and gas development activities would continue irrespective of the proposed alternatives. These activities along with those associated with casual use, permitted activities, and habitat changes, as described in the Nature and Types of Effects section above, would continue to impact special status species throughout the Unit. Threats specific to special status aquatic wildlife as a result of oil and gas development within the Unit would be attributed to water depletions as well as road and pipeline crossings of streams, wetlands, and other water bodies.

Under all alternatives, pipeline crossings of wetlands as well as roads, would be bored (not trenched) outside of road rights-of-way and wetland boundaries. Impacts from boring activities during construction phases could include a “frac-out”, which is caused when excessive pressure builds up forcing drilling mud to the surface (DFO 2007). A frac-out would result in short-term displacement of special status wildlife or habitat avoidance as a result of excessive mud (terrestrial) or increased sediment and turbidity (aquatic). Activities associated with stream borings could also result in bank destabilization in the short-term. In the long-term, special status species and their habitat would be at risk of hazardous materials contamination in the event of a pipeline rupture under all alternatives. Aquatic wildlife, particularly habitat for Colorado River fish species would continue to be reduced as a result of continued water depletions for ongoing drilling, completion, and dust abatement activities.

*Alternative A*

*Federally Listed, Proposed, or Candidate Species*

Canada Lynx

Under Alternative A, direct impacts on suitable Canada lynx habitat are not expected. Lynx primary prey source, snowshoe hare, has very limited habitat in the Unit and it is unlikely that impacts from Alternative A would affect lynx. Some habitat for secondary prey sources does occur in the Unit but impacts from Alternative A would not affect the availability of these prey items for lynx (Petterson 2012). Highway 133 passes through the Ragged Mountain Lynx Analysis Unit and McClure Pass Lynx Linkage Area. Traffic would increase along State Highway 133 as it is the primary access road to the Unit. Under Alternative A, well pads and access road construction phases would result in an estimated 6,032 round trips on Highway 133 and an estimated 2,407 round trips during the pipeline development phase although not all traffic associated with accessing the Unit would go over McClure Pass. Alternative A would result in an estimated increase in the overall average annual daily traffic on Highway 133 near the Unit by less than 1 percent over a 6-year timeframe; average annual daily trips by trucks could increase by up to 11 percent compared to existing truck-related traffic levels. See **Section 4.3.5**, Transportation and Access, for additional traffic impacts in the Unit. While an increase in vehicle traffic traveling State Highway 133 does increase the potential for vehicle collision with lynx potentially crossing the highway, the project is not anticipated to cause an increase above the 2,000-vehicle-per-day threshold at which it is believed that lynx are impeded from moving across the highway. Lynx should therefore still be able to cross State Highway 133 unimpeded (Petterson 2012). Further, indirect impacts from habitat fragmentation are not likely to be substantial since the lynx habitat in the area is considered to be poor. The activities under Alternative A “may affect but is not likely to adversely affect” lynx populations.

Endangered Colorado and Gunnison River Fish

Construction and maintenance activities under Alternative A are unlikely to result in water quality impacts on the four endangered Colorado River fish species by continuing to implement Colorado Department of Public Health and Environment and Clean Water Act requirements as well as SGI’s Well Pad Site Suitability Models and Methodologies (**Appendix A**). Water quality impacts from sediment releases or hazardous chemical spills in the Unit would likely be reduced because the Paonia Reservoir would capture these potential contaminants before reaching the North Fork of the Gunnison River.

Surface water use under Alternative A, as described in **Section 4.2.7**, Fish and Wildlife, would result in water depletions that have the potential to impact fish populations. As the Unit would be developed over 6 years, the total fresh water acre-feet depletions would be roughly spread out during this time period, resulting in fresh water annual consumptive depletions of 32 acre-feet for Alternative A. If development of the Unit were to take longer than 6 years, then the annual water depletion amount would decrease accordingly. Based on data from the US Geological Survey gauging station (#09130500), the mean annual discharge rate of East Muddy Creek near Bardine (1935-1953) varied from a low of 53.7 cfs (39,066 acre-feet per year) in 1940 to a high of 135.0 cfs (97,504 acre-feet per year) in 1938 (see the hydrology assessment for the MDP [Berry 2011]). Therefore, under Alternative A, if this water were removed directly from East Muddy Creek, the maximum water depletion for East Muddy Creek would be about 0.1 percent of the average annual discharge during a dry year to 0.03 percent of the discharge during a wet year. SGI has secured previously appropriated water for this project; as such, no “new” water would be depleted from the Muddy Creek system as a result of the construction and drilling phase of this project. For more information regarding water use in the Unit proposed under the alternatives refer to **Section 4.2.4**, Water Resources.

Net water depletions are expected to be lower given SGI’s water augmentation plan (see **Appendix L**). However, the USFWS considers any net water depletion that could decrease instream flows to have direct and/or indirect impact on the four Colorado River endangered fish species. Therefore Alternative A “may affect, and is likely to adversely affect” the Colorado pikeminnow, razorback sucker, humpback chub, and bonytail chub. In May 2008, the BLM prepared a Programmatic Biological Assessment (PBA) that addresses water-depleting activities associated with the BLM’s fluid minerals program in the Colorado River Basin in Colorado. In response to the BLM’s PBA, the USFWS issued a Programmatic Biological Opinion (PBO) (ES/GJ-6-CO-08-F-0006) on December 19, 2008, which determined that BLM water depletions from the Colorado River Basin are “not likely to jeopardize the continued existence” of the Colorado pikeminnow, humpback chub, bonytail, or razorback sucker, and that BLM water depletions are “not likely to destroy or adversely modify designated critical habitat” for any of these fish.

A Recovery Implementation Program for Endangered Fish Species in the Upper Colorado River Basin was initiated in January 1988. The Recovery Program serves as the reasonable and prudent alternative to avoid jeopardy and provide recovery to the endangered fishes by depletions from the Colorado River Basin. The PBO addresses water depletions associated with fluid minerals development on BLM-administered lands, including water used for well drilling, hydrostatic testing of pipelines, and dust abatement on roads. The PBO includes reasonable and prudent alternatives developed by the USFWS that allow BLM to authorize oil and gas wells that result in water depletion while avoiding the likelihood of jeopardy to the endangered fishes and avoiding destruction or adverse modification of their critical habitat. As a reasonable and prudent alternative in the PBO, USFWS authorized the BLM to solicit a one-time contribution to the Recovery Implementation Program for Endangered Fish Species in the Upper Colorado River Basin (Recovery Program) in the amount equal to the average annual acre-feet depleted by fluid minerals activities on BLM-administered lands.

Upon final approval of individual APDs, this project would be entered into the Uncompahgre Field Office fluid minerals water depletion log, which will be submitted, to the Colorado State Office at the end of each fiscal year. SGI is already a signatory to the Endangered Fish Recovery Agreement (USFWS 1999), which is considered to be appropriate compensatory mitigation for likely foreseeable impacts, and because of this as well as possible USFWS-coordinated timed releases from augmenting water sources for the maintenance of instream flows (e.g., additional waters released from the Aspinall Unit), the impacts of additional water depletions could be mitigated by SGI and the BLM, which would therefore make their activities compliant with the PBO and Recovery Agreement and ensure continued recovery of these listed fish species.

Greenback Cutthroat Trout

Greenback cutthroat trout lineage fish occur nearby in Roberts, Henderson, and other tributaries to East Muddy Creek. The construction and operation activities under Alternative A "may affect, and are not likely to adversely affect" greenback cutthroat trout lineage fish due to a pipeline crossing of the GB lineage occupied Roberts Creek. These impacts would be very short in duration, and would require implementation of construction-related proactive impact minimization measures. Under Alternative A, SGI would continue to implement its Well Pad Site Suitability Models and Methodologies (**Appendix A**) which accounts for proximity to stream networks and stream buffer zones into the site suitability assessment, thereby minimizing the likelihood for impacts on greenback cutthroat trout habitat.

*BLM Sensitive Species*

Northern Goshawk

Proposed development activities would have periods that involve loud noises with high levels of activity, but generally lasting for a few months in any given area. Alternative A would have short-term development impacts directly impacting 12 acres, and permanently impact 4 acres of aspen and aspen/oak habitats, but would not impact mixed conifer habitats. Short-term indirect impacts through noise, human activities, and pipeline construction in suitable goshawk habitats would extend beyond the direct habitat impacts described above. Long-term lower-intensity indirect impacts would decrease over time but would likely keep goshawk from nesting within this area, and may also diminish habitat effectiveness for foraging, but would not entirely preclude use in these areas. While some components of Alternative A would occur near isolated and smaller aspen stands, these stands are not large enough to support goshawk nesting activities and would not likely support foraging either, given the dominance of shrublands and agricultural fields within the Unit (Petterson 2012).

The habitats directly and indirectly impacted are relatively poor quality for goshawk nesting, and moderate quality for foraging. With suitable prey-bases and widespread forested habitat types beyond the Unit area, goshawk could still likely forage within the Unit. Outside of the summer reproduction and nesting season, northern goshawk could still encounter low levels of human activity during the winter months, which would have negligible impacts on goshawk given the small footprint of activities proposed and widespread foraging habitats available during the winter.

Alternative A "may impact individuals, but is not likely to result in a loss of viability on the Unit, or cause a trend towards federal listing or a loss of species viability range-wide," but nesting raptor surveys should occur to identify potential nesting activities.

Bald Eagle

Under Alternative A, the short-term construction phase would cause approximately 12 acres of surface impacts (0.1 percent of available habitat) on CPW-mapped bald eagle winter range and winter forage areas within the Unit. Long-term, there would be approximately 4 acres of surface impacts (less than 0.1 percent of available habitat). One pipeline would cross East Muddy Creek within winter ranges. Since drilling would occur year-round on fee lands/fee mineral estate which are relatively evenly distributed across the unit, impacts on wintering bald eagles would likely occur, causing widespread impacts. Aside from one pipeline crossing, these activities would occur well away from large cottonwoods and suitable roost trees near East Muddy Creek. The pipeline crossing would be bored in any season. If a pipeline bore occurs during the low-flow period of early winter it is possible that roosting bald eagles in the area would be disturbed and vacate the area during construction (short-term). Boring operations during higher flow periods in the summer months would occur outside of winter nesting months. The main impact of development on bald eagles under Alternative A could result from a re-distribution of wintering elk and deer in the area and therefore potential scavenging opportunities for eagles. While this may indeed occur near pads and roads, deer and elk would still likely be in the general area, perhaps even closer to East Muddy Creek. The high mobility of bald eagles would still allow them to easily find and feed on any carrion in the general area, and no reduction in winter foraging habitat would be expected.

Because of the potential disturbance to roosting bald eagles during the pipeline bore of East Muddy Creek (for about 5 days if the creek is crossed during the winter months), and the potential for disturbance to wintering bald eagles, Alternative A "may adversely impact individuals, but is not likely to result in a loss of viability on the Unit, nor cause a trend towards federal listing or a loss of species viability range-wide."

<u>Brewer's Sparrow</u>
Alternative A would create short-term construction related impacts on 114 acres and direct long-term production impact on 36 acres of sagebrush habitats. It is assumed that in the long-term, most of the cleared pipeline corridors and other temporary-use areas in sagebrush-dominated habitats would begin to support smaller sagebrush plants. However, in some circumstances where landowners choose to plant non-native grasses and forbs, the recovery of sagebrush plants in these short-term disturbance acres may take much longer due to competitive exclusion of sagebrush. Most areas cleared of sagebrush will recover with the use of native graminoid and forb seed mixes, though selection of seed mixes is at the discretion of the land owner (Petterson 2012).

Some construction activities would occur when sparrows are in various stages of reproduction. Adult sparrows would easily be able to avoid any clearing of sagebrush plants, and therefore there would be no anticipated direct impacts on adult birds (i.e., mortality). However, sagebrush clearing activities occurring during the nesting period (late May through early July) may result in the take of nests (i.e., eggs or nestlings). Indirect impacts on Brewer's sparrow would result from avoidance of nesting in sagebrush habitats near the access roads, construction areas, and active drilling sites during the construction process; however, they may still forage near roads and other active areas. While habitat fragmentation is cited as a cause for population declines, this is mostly tied to widespread community change types; since Alternative A is relatively small in scale and complexity, no detectable impacts on Brewer's sparrow population numbers are expected (Petterson 2012). As a result, Alternative A "may adversely impact individuals, but is not likely to result in a loss of viability on the Unit, nor cause a trend towards federal listing or a loss of species viability range-wide." As Brewer's sparrows are not in the area during the winter months, wintertime operations would have no impact on this species.

Bat Species

The Unit provides suitable foraging habitat for listed sensitive bat species, and while there would be some loss of foraging habitat, the project's impact on potential foraging areas would be very minor given the range of these species and their preference for lower elevation habitats. The project would have negligible impacts on shrubby habitats on the landscape scale, thus those habitats would continue to support the bats' primary prey species (flying and crawling insects). Therefore, there should be no impact to the bats' abilities to procure prey within the Unit (Petterson 2012). As bats require free water on a daily basis, bats would likely use any un-netted cuttings pits, flowback pits, or other available fluid storage areas for drinking. If these pits contain substances toxic to bats and are not netted during the summer months (when bats are active), it is highly likely that bats would drink from these fluid storage areas, resulting in likely adverse effects. With the application of mitigation features 111 and 113 that require netting of pits within 24 hours after drilling activities have begun, the likelihood of such impacts is low. As a result, Alternative A would likely result in "no impacts on these species, and would not result in a loss of viability on the Unit, nor cause a trend towards federal listing or a loss of species viability range-wide."

Leopard Frog

Alternative A would have multiple well pad sites and associated facilities located within irrigated pastures, and would also result in direct construction related short term impacts on 67 acres of wetlands and irrigated meadow habitats. Loss of wetlands would require mitigation per USACE permitting.  Long-term production impacts would occur on 19 acres of potential frog habitats. The potential take of individual frogs could result from trampling or direct mortality during summer construction and development periods, as well as from substances hazardous to aquatic resources and frogs washing off of pad sites or roads and into suitable aquatic habitats. Some temporary diminished habitat effectiveness would occur in wetlands crossed by pipeline corridors. Stormwater sedimentation from roads would result in indirect impacts on wetlands and frog habitat. Water depletions from area ponds and reservoirs would also occur during construction and well development/completion periods, possibly impacting eggs, larvae, and foraging habitats for adults. As northern leopard frogs are hibernating during the winter months, wintertime activities on roads and pads would have no impact. Alternative A "may impact individuals, but is not likely to result in a loss of viability on the Unit, nor cause a trend towards federal listing or a loss of species viability range-wide."

*Alternative B*

*Federally Listed, Proposed, or Candidate Species*

Canada Lynx

Under Alternative B, traffic volume into the Unit would increase during all well development phases, which would last for approximately 3 years. New traffic would result in a 1.35 percent average increase during the 3-year development timeframe. The average annual daily trips associated with trucks could increase by up to 21 percent compared to existing truck-related traffic levels, and 10 percent more than Alternative A (see **Section 4.3.5**, Transportation and Access for more details). Subsequently, it is reasonable to assume an increase in traffic on Highway 133 through the Ragged Mountain Lynx Analysis Unit and McClure Pass Lynx

Linkage Unit compared to Alternative A, thereby increasing the likelihood for a vehicle collision with lynx. However, as discussed under Alternative A above, increased traffic over McClure Pass is not expected to impact lynx populations or their habitat due to a general lack of suitable habitat. Therefore, actions proposed under Alternative B “may affect but is not likely to adversely affect” lynx populations.

<u>Endangered Colorado and Gunnison River Fish</u>
Capturing potential contaminants at Paonia Reservoir would minimize impacts on Colorado River fish as a result of hazardous spills or sediment releases as described under Alternative A above. Actions proposed under Alternative B would result in similar annual water depletions of approximately 32 acre-feet as expected under Alternative A (see **Section 4.2.4**, Water Resources). Therefore, actions under Alternative B are “not likely to jeopardize the continued existence” of Colorado pikeminnow, razorback sucker, humpback chub, or bonytail chub and are “not likely to destroy or adversely modify designated critical habitat” for any of these fish.

<u>Greenback Cutthroat Trout</u>
Under Alternative B, there would be no activities within the Henderson or Roberts Creek drainages. Water depletions from the Ault Creek drainage and from Bainard Reservoir would have no impact on known GB lineage fish or known occupied habitats (Petterson 2012). As a result, oil and gas development in the Unit would have “no effect” to greenback cutthroat trout lineage fish. Any impacts would be very short in duration, and would require implementation of construction-related proactive impact minimization measures.

*BLM Sensitive Species*

<u>Northern Goshawk</u>
Under Alternative B, 34 acres of aspen and aspen/oak habitat would be impacted in the short-term, and 10 acres would be impacted in the long-term. Effects from oil and gas development in the Unit under this alternative would result in impacts on northern goshawk habitat as described under Alternative A but with a two-fold increase in short- and long-term impacts compared to Alternative A. Given the low quality habitat for northern goshawk and moderate foraging quality in the Unit, impacts on this raptor under Alternative B **“**may adversely impact individuals, but is not likely to result in a loss of viability on the Unit, nor cause a trend towards federal listing or a loss of species viability range-wide,” but nesting raptor surveys should occur to identify potential nesting activities.

<u>Bald Eagle</u>
Actions proposed under Alternative B would result in 134 acres of short term surface impacts (4 percent of available habitat) on mapped bald eagle winter range and winter forage areas from oil and gas activities in the Unit. In the long-term, Alternative B would impact 47 acres of these habitats (2 percent of available habitat) in the Unit. Impacts on bald eagle winter range in the long-term would be three times greater than Alternative A and nearly two times greater in the short-term. Under Alternative B, a proposed pipeline would be bored under Spring Creek in the southeastern corner of the Unit near mapped bald eagle winter range. Together, these activities “may affect, but are not likely to adversely affect” bald eagles.

Alternative B could cause re-distribution of wintering elk and deer in the area near pads and roads. Deer and elk would likely remain in the general area, however. Given the high mobility of bald eagles, they are expected to easily continue to find and feed on any winter-kill in the general area and no reduction in available carrion would be expected (Petterson 2012). As stated in Table 2-10, Stipulations and Best Management Practices, nesting surveys would be conducted between April 15 to July 15 and surface-disturbing activities would be avoided near occupied nests.

Brewer's Sparrow

Under Alternative B, 362 acres of sagebrush would be impacted in the short term, and 129 acres in the long-term. Impacts on Brewer's sparrow would be similar to those described under Alternative A but with increased impacts on sagebrush in the short- and long-term. Therefore, Alternative B "may adversely impact individuals, but is not likely to result in a loss of viability on the Unit, nor cause a trend towards federal listing or a loss of species viability range-wide."

Bat Species

Impacts on sensitive bat habitat under Alternative B would be similar to those described under Alternative A. Alternative B would likely result in "no adverse impacts on these species, and would not result in a loss of viability on the Unit, nor cause a trend towards federal listing or a loss of species viability range-wide."

Northern Leopard Frog

Actions proposed under Alternative B would impact 48 acres of wetlands and irrigated meadows combined in the short-term and 16 acres in the long-term. These impacts would affect northern leopard frogs as described under Alternative A and "may impact individuals, but is not likely to result in a loss of viability on the Unit, nor cause a trend towards federal listing or a loss of species viability range-wide."

Adherence to applicable COAs and BMPs listed in **Appendix C** (COAs 32, 53-65, BMPs 110-113, 118, 122, 130-134) would minimize the potential for impacts on Threatened, Endangered, and Candidate species. In addition, BLM may attach site-specific COAs to the APDs.

*Alternative C*

*Federally Listed, Proposed, or Candidate Species*

Canada Lynx

Under Alternative C, traffic volume into the Unit would increase during all well development phases, which would last for approximately 3 years. New traffic would result in a 1 percent average increase during the 3-year development timeframe. The average annual daily trips associated with trucks could increase by up to 16 percent compared to existing truck-related traffic levels, and 7 percent more than Alternative A (see **Section 4.3.5**, Transportation and Access for more details). As discussed under Alternative A, not all of the increased traffic on Highway 133 would go over McClure Pass so the potential impacts estimated under Alternative C would likely be much less than calculated in this analysis. Considering the poor quality of suitable lynx habitat in the Unit actions proposed under Alternative C "may affect but is not likely to adversely affect" lynx populations.

Endangered Colorado and Gunnison River Fish

Capturing potential contaminants at Paonia Reservoir would minimize impacts on Colorado River fish as a result of hazardous spills or sediment releases, as described under Alternative A above. Actions proposed under Alternative C would result in water depletions similar to those expected for Alternative A (see **Section 4.2.4**, Water Resources). Although water use within the Unit under Alternative C would be slightly greater than the volumes predicted under Alternative A, the impacts would be less than those as a result of Alternative B. Therefore, actions under Alternative C "not likely to jeopardize the continued existence" of endangered Colorado and Gunnison River fishes and are "not likely to destroy or adversely modify designated critical habitat" for any of these fish.

Greenback Cutthroat Trout

Under Alternative C, a proposed co-located cross country pipeline would be bored under Grouse Creek in the eastern side of the Unit which is not a recognized GB lineage occupied stream as described under Alternative A. Therefore, actions proposed under Alternative C would likely result in "no effect" on greenback cutthroat trout lineage fish. Any impacts would be very short in duration, and would require implementation of construction-related proactive impact minimization measures.

*BLM Sensitive Species*

Northern Goshawk

Under Alternative C, 35 acres of aspen and aspen/oak habitat would be impacted in the short-term and 8 acres would be impacted in the long-term. Effects from oil and gas development in the Unit under this alternative would result in short- and long-term impacts on northern goshawk habitat as described under Alternative A and would impacts nearly the same amount of aspen and aspen/oak habitat as Alternative B. Given the low quality habitat for northern goshawk and moderate foraging quality in the Unit, impacts on this raptor under Alternative C "may impact individuals, but is not likely to result in a loss of viability on the Unit, nor cause a trend towards federal listing or a loss of species viability range-wide," but nesting raptor surveys should occur to identify potential nesting activities.

Bald Eagle

Actions proposed under Alternative C would result in 98 acres of short-term surface impacts (3 percent of available habitat) on mapped bald eagle winter range and winter forage areas from oil and gas activities in the Unit. In the long-term, Alternative C would impact 28 acres of these habitats (1 percent of available habitat) in the Unit. Impacts on bald eagle winter range in the long-term would be two times greater than Alternative A and eight acres more in the short-term. Under Alternative C, a proposed pipeline would be co-located at Grouse Creek outside of mapped bald eagle winter range. As stated in Table 2-10, Stipulations and Best Management Practices, nesting surveys would be conducted between April 15 to July 15 and surface-disturbing activities would be avoided near occupied nests. Impacts on bald eagles as a result of surface disturbing activities proposed under Alternative C "may affect, but is not likely to adversely affect" bald eagles.

Brewer's Sparrow
Under Alternative C, 287 acres of sagebrush would be impacted in the short-term and 84 acres in the long-term. Impacts on Brewer's sparrow would be similar to those described under Alternative A but with less acres of impacted sagebrush in the short- and long-term compared to Alternative B. Therefore, the management actions proposed under Alternative C "may impact individuals, but is not likely to result in a loss of viability on the Unit, nor cause a trend towards federal listing or a loss of species viability range-wide."

Bat Species
Impacts on sensitive bat habitat under Alternative C would be similar to those described under Alternative A. Alternative C would likely result in "no impacts on these species, and would not result in a loss of viability on the Unit, nor cause a trend towards federal listing or a loss of species viability range-wide."

Northern Leopard Frog
Actions proposed under Alternative C would impact 39 acres of wetlands and irrigated meadows combined in the short-term and 10 acres in the long-term. These impacts would affect northern leopard frogs as described under Alternative A and "may impact individuals, but is not likely to result in a loss of viability on the Unit, nor cause a trend towards federal listing or a loss of species viability range-wide." Reduction to irrigated meadow/wetlands habitat would be similar in acres as Alternative B and would likely result in the same impacts on northern leopard frogs.

Adherence to applicable COAs and BMPs described in **Appendix C** (COAs 32, 53-65; BMPs 110-113, 118, 122, 130-134) would minimize the potential for impacts on Threatened, Endangered, and Candidate species. In addition, the BLM may attach site-specific COAs to the APDs.

*Cumulative*
Past and present actions as well as current conditions within the cumulative impact analysis area have affected and would likely continue to affect special status species. In addition, reasonably foreseeable future actions that may affect special status species in the future are described in Table 4-3. Habitat restoration projects within the region include vegetation treatments to improve habitat and reduce fire threats. These improvement efforts would expand the extent and increase the quality of habitat for many special status fish and wildlife species that inhabit the surrounding region. However, oil and gas development in the North Fork of the Gunnison River area, would continue to affect special status species within the region as less than 25 percent of the Uncompahgre Field Office mineral estate has been leased. Access roads would continue to be developed on federal, state, and private lands in the region in support of energy development. These actions would reduce the availability of habitat and forage as well as increase habitat fragmentation for special status species. Additionally, continued and future actions resulting in water depletions or impacts on water quality within the region would reduce the quantity and quality of habitat for special status fish and other aquatic species. Any proposed project with the potential to impact ESA-listed species would require consultation with the USFWS to determine the potential impacts on federally protected species and to develop mitigation actions.

Under all of the alternatives, impacts on special status species as a result of increased oil and gas development within the Unit would contribute to the impacts from past, present, and reasonably foreseeable actions described in Table 4-3. Alternative A would result in the fewest number of well pads and would therefore result in the least amount of impacts on special status fish and wildlife species. However, mitigation measures including BMPs, RDFs, and voluntary seasonal winter timing limitations would not be imposed under Alternative A. Actions proposed under Alternative B would result in the greatest direct impacts on special status species habitat while imposing BMPs and COAs described in **Appendix C**; no voluntary seasonal timing limitations have been proposed under Alternative B. Under Alternative C, oil and gas development activities would result in more surface disturbance of special status species habitat compared to Alternative A but less than Alternative B. In addition, Alternative C would implement COAs (32, 53-65) and BMPs (110-113, 118, 122, 130-134), as well as voluntary seasonal timing limitations to reduce impacts on sensitive winter big game habitat. The timing restrictions proposed under Alternative C would reduce human activity in designated areas within the Unit, which could potentially increase the habitat quality and the availability of prey species for bald eagles in the region. Current and future water depletions will continue to threaten Colorado River endangered fish species. The implementation of a water augmentation program as proposed by SGI (**Appendix L**) would minimize water depletions; other such water augmentation plans are recommended in the region to reduce the amount of water used for oil and gas development. Increased road and pipeline crossings within the area would contribute to potential habitat impacts for GB lineage occupied streams.

### 4.2.10 Wildland Fire Management

***Methods of Analysis***

Impacts on fire and fuels management generally result from activities that affect firefighter and public safety or fire intensity, frequency, and suppression efforts. Indicators of impacts on wildland fire management resources are the following:

- A change in the likelihood of human caused wildfire in the Unit
- A change in the size, extent, or occurrence of wildfire in the Unit
- A change in the ability to conduct wildfire suppression efforts

***Nature and Type of Effects***

The development of natural gas wells may increase the risk of wildfires by introducing new ignition sources and increasing human activity in the Units. Potential sources of ignition during the construction period include but are not limited to construction equipment, vehicles on access roads, and construction personnel. Operation and maintenance of wells would represent a reduced level of risk of ignition s compared to the construction phase due to decreased vehicle traffic and equipment use. Risks of ignition still exist during production, including those from well workover operations. While the potential for ignition of wildfire from natural gas emitted from wells during drilling and production does exist, best management practices and standard operating procedures generally lower these risks to a minimal level. Operators also reduce risk by shutting down during wildfire events near active wells.

Indirect sources of wildfire risk from natural gas development include the potential for an increase in invasive weeds in disturbed areas. Spread of cheatgrass (*Bromus tectorum*) is widely recognized as modifying fire behavior, resulting in reduced fire intervals and increased intensity of burning (Menakis et al. 2003). Proper reclamation techniques and use of native seed mixes can reduce incidence of cheat grass and associated fire risk.

Energy development may also pose a hazard to firefighters, including unknown toxins, facility protection, industry personnel evacuation, and overhead power line danger. Fire programs could incur additional costs to train firefighting personnel for emergency situations associated with energy development.

New and improved access roads may improve access for wildland fire suppression activities. Proposed development may also create fuel breaks (e.g., areas where there is no vegetation) that could be effective in preventing the spread of wildland fires.

***Effects Common to All Alternatives***

Under all Alternatives fires would be managed with intensive suppression as a priority based on the management prescriptions for the Fire Management Unit laid out in the UFO RMP.

Human-caused wildfires resulting from unsafe well control practices would be averted by compliance with regulatory requirements and standard voluntary applicant-committed mitigation measures which are discussed in **Appendix C**. In general, well pads would be kept free of vegetation and trash in order to minimize the potential of wildfires.

Storage of sensitive or hazardous materials would be handled in compliance with all applicable federal and state regulations, minimizing risk of firefighter exposures to chemicals during suppression efforts.

*Alternative A*

Under Alternative A, the risk of wild fire ignition, as described under *Nature and Type of Impacts*, would continue from operation of existing federal authorizations and the development of up to 56 new wells on 12 new well pads. Under Alternative A, COGCC requirements would be applied which could reduce wildland fire risk.

*Alternative B*

Alternative B would construct up to 36 new well pads on federal mineral estate (24 more than Alternative A) up to 146 new natural gas wells, and up to 4 new water disposal wells. Impacts would be similar to those described in Alternative A and in Nature and Type of Impacts. Due to the increased level of potential development under Alternative B, however, the risk of human caused ignition from construction related vehicles and equipment would be increased.

*Alternative C*

Impacts under Alternative C would be similar to those described under Alternative B. However, under this Alternative, fewer new well pads would be constructed on federal mineral estate (35 new well pads, 10 more than under Alternative A); therefore the likelihood of ignition would be decreased.

In addition, design features imposed to protect wildlife, water, air and other resources, may also provide indirect reduction of wildfire risk. Four new electrical lines would be buried in this alternative, reducing risk of ignition from as compared to overhead lines. Preparation of an annual reclamation monitoring status report may decrease incidence and spread of invasive species and associated risk of wildfire.

*Cumulative*

Past and present management actions and natural events in the cumulative impact analysis area have altered the condition of vegetation and natural fire regimes across the landscape. Examples include fire suppression, energy development, grazing, noxious and invasive weed spread, and drought. Continued development in the wildland-urban interface zone may increase fire risk and result in the need for additional resources including federal, state, and local agency resources for fire suppression. Proposed ROW developments, road and trail construction, as well as oil and gas leasing and development on federal and private lands are activities would represent additional wildfire risks in the region. As discussed in **Section 3.2.11**, Wildland Fire Management, large fires in the Unit have been uncommon, and the focus on intense suppression efforts is likely to continue this trend. The proposed action and alternatives would, however, add to the cumulative wildfire risk in the area, potentially resulting in increased suppression costs for the UFO as well as a strain on resources in the fire protection district. The degree of added ignition risk would vary based on the alternative selected, with cumulative fire risk related to the level of development as discussed under impacts by Alternative, above.

### 4.2.11 Cultural Resources

***Methods of Analysis***

Cultural resources are past and present expressions of human culture and history in the physical environment. The term “cultural resource” can refer to archaeological, historical, and architectural sites, structures, or places with important public and scientific uses and can include locations (sites, natural features, resource gathering areas, or places) of traditional cultural or religious importance to specific social or cultural groups.

This section discusses impacts on cultural resources from the proposed goals, objectives, management actions, and allocation actions noted in **Chapter 2**, Alternatives. Existing conditions concerning cultural resources are described in **Section 3.2.12**, Cultural Resources.

Cultural resource baseline information in **Section 3.2.12**, Cultural Resources, was reviewed for current understanding of known resources and to determine the condition of the resources. All laws pertinent to determining effects on cultural resources (i.e., NHPA) were considered and included in criteria for determining impacts. This known information was overlain with the actions found under each alternative in **Chapter 2**, Alternatives, and conclusions were drawn based on an understanding of how these types of actions could affect known and potentially discoverable resources.

*Indicators*

Cultural resources are impacted when a property is damaged, its physical integrity is lost, or the setting of a resource is damaged. Under NEPA, impacts on cultural resources are assessed by applying the criteria of adverse effect, as defined in the implementing regulations for Section 106 of the NHPA (36 CFR Part 800). For this analysis, indicators for determining effects on cultural resources include asking if the action would result in any of the following:

- Destroy, damage, or alter all or part of the physical nature of a cultural resource
- Change the character of the property's use or physical features within its setting that contribute to its historic significance (e.g., isolating the property from its setting)
- Introduce visual, atmospheric, or audible elements that diminish the integrity of the property's significant historic features
- Disturb any human remains, including those interred outside of formal cemeteries
- Contribute to an adverse effect (under the NHPA) to a cultural resource if it is listed in or eligible for listing in the National Register or if it is an area of importance to a Native American or other traditional community. If a site is determined to be eligible for listing in or is listed in the National Register, any physical disturbance would also constitute a significant impact under NEPA. If a site is determined to be ineligible for listing, then any disturbance could be considered substantial, but it would not be significant under NEPA or adverse under NHPA.

*Assumptions*

This analysis assumes the following:

- Impacts on cultural resources are assessed by applying the criteria of adverse effect, as defined in 36 CFR Part 800.5a: "An adverse effect is found when an undertaking may alter, directly or indirectly, any of the characteristics of a historic property that qualify the property for inclusion in the National Register in a manner that would diminish the integrity of the property's location, design, setting, materials, workmanship, feeling, or association.…Adverse effects may include reasonably foreseeable effects caused by the undertaking that may occur later in time, be farther removed in distance, or be cumulative."
- Human occupation of North America over the last 10,000 years has left its mark on all landforms, and sites could be manifest on the surface or deeply buried. There could be areas of importance to contemporary Native Americans that are not readily identifiable outside of those communities.
- The information on cultural resources in the Unit is based on the results of industry and BLM inventory projects for cultural resource sites in the Unit (Greubel et al. 2010, Millward 2013). However, because these data are biased toward past, project-oriented undertakings, they cannot accurately predict where or how many resources may exist in unsurveyed areas.
- This analysis does not attempt to quantify affected resources. Rather, the relative number of sites that could be affected by actions correlates with the degree, nature, depth, and quantity of surface-disturbing activities in the Unit where the more surface that is disturbed, the more cultural resources may be affected.

- Each of the 40-acre analysis areas used herein represent an area of possible placement for a single 5-acre well pad.
- This analysis does not include resource-specific, protection measures. Cultural resource protection and mitigation measures will be applied at the project design and implementation phases after appropriate Section 106 consultation requirements are met. Mitigation can include project cancellation, redesign, avoidance, or data recovery.

***Nature and Type of Effects***

There would be no immediate impacts from the actions noted in the alternatives of the Bull Mountain Unit MDP, though there could be direct impacts associated with some future management actions. Indirect impacts are those that would result from implementing the actions at a later time and those that are cumulative.

Any activities that would involve surface-disturbing activities could have direct and indirect impacts on cultural resources, including damaging, destroying, or displacing artifacts and features and constructing modern features out of character with a historic setting. Damaging, displacing, or destroying cultural resources could include removing artifacts from their situational context, breaking artifacts, or shifting, obliterating, or excavating features without appropriate scientific recording.

Indirect impacts on cultural resources include changing the character of a property’s use or physical features within a property’s setting that contribute to its historic significance (e.g., isolating the property from its setting) and introducing visual, atmospheric, or audible elements that diminish the integrity of the property’s historic features. Construction activities could result in placing modern features onto a landscape that did not have them previously. Additionally, any action that would result in increased human and worker presence (e.g., more people visiting a recreation area or workers brought in for construction operations) would risk illicit collecting of surface artifacts, resulting in a loss of scientific information.

The potential for undiscovered buried cultural resources and human remains exists despite previous archaeological surveys and investigations. Surface-disturbing activities could directly impact undiscovered cultural resources and human remains by exposing buried material, resulting in inadvertent artifact destruction or loss of scientific context. Indirect impacts could result from the increased human presence, leading to possible illicit collecting of newly exposed materials.

Any actions that would result in reclaiming landscapes to predisturbance conditions would eliminate the indirect viewshed or setting impacts for cultural resources. Reclamation would likely restore the natural landscape setting but may not result in restoring the historic setting. However, direct impacts on cultural resources or any unanticipated discoveries made would remain as they were, permanently destroyed or damaged by surface-disturbing actions. Reclamation impacts on undiscovered buried cultural materials or human remains would be similar to those noted above, namely that activities could expose buried materials, resulting in inadvertent artifact destruction or loss of scientific context.

***Effects Common to All Alternatives***

Actions considered under Alternative A are based on the continuation of existing lease rights. Actions under Alternatives B and C are specific to new actions for BLM-administered surface and/or mineral estates under the Bull Mountain Unit MDP. Cultural resource compliance actions would continue under all alternatives. Laws, regulations, and BLM policies that supersede Bull Mountain Unit MDP decisions would apply. All actions would continue maintaining the integrity or characteristics of historic properties under legal guidelines for protection, preservation, investigation, and public use (i.e., development and interpretation) on a case-by-case or APD-specific basis. Impacts can typically be mitigated by implementing design features identified in **Appendix C**, such as archeological and cultural resources protection (see COAs 37-40), construction monitoring (see COAs 19-24), excavating materials (see BMPs 100 and 103).

Any action that disturbs or diminishes the integrity of a historic property's location, design, setting, materials, workmanship, feeling, or association, as defined in 36 CFR Part 800, is an adverse effect. Potential effects from subsequent undertakings for all resources, resource uses, and special designations would be addressed at the project design and implementation phase. Required separate compliance with Section 106 would result in the continued identification, evaluation, mitigation, and nominations to the National Register. Effects on cultural resources eligible for listing on the National Register would be avoided or mitigated. If previously undiscovered resources were identified during an undertaking, work would be suspended while the resource is evaluated and mitigated to avoid any further effects. Through this process, effects would be minimized or eliminated, although residual effects and adverse effects, as defined by 36 CFR Part 800, would be possible.

All alternatives include surface-disturbing actions that will directly and indirectly impact cultural resources. Surface-disturbing activities include the construction of well pads, access roads, pipelines, electrical lines, and storage areas or the recontouring and reseeding that occurs during reclamation. Drilling or other activities that do not alter the extent of surface disturbances are not likely to directly impact cultural resources. Direct effects on cultural resources would be evaluated for individual undertakings, and protections and mitigations would be applied at project design and implementation phases.

Erosion of soils that are a result of surface disturbance is an indirect impact from construction activities. Many cultural resources are susceptible to erosion damage, including modifying spatial relationships of artifacts and destroying features and stratified deposits; all of which are important to understanding past culture. Nondestructive measures to protect soils are included in the **Appendix C** (COAs 7, 8, 10, 14, and 92) and would be included on a case-by-case basis at project design and implementation phases.

All alternatives include indirect impacts on cultural resources. Any action that increases access can lead to inadvertent damage, unauthorized collection, or vandalism of cultural resources. Additionally, infrastructure construction modifies the visual or audible character of the setting of a cultural resource. Indirect effects on cultural resources would be evaluated on a case-by-case or APD-specific basis.

*Alternative A*

Goals and objectives for BLM-administered lands are to identify, preserve, protect, and manage significant cultural resources under legal guidelines (e.g., Section 106 of the National Historic Preservation Act) for protection, preservation, investigation, and public use (e.g., development and interpretation) to ensure that they are available for appropriate uses by present and future generations through research, education, and cultural heritage preservation.

Current actions under Alternative A in the Bull Mountain Unit MDP include the construction of new well pads on private mineral estate. Additionally, Alternative A will require the modification and construction of roads, pipelines, and one new overhead electrical line, as well as eventual reclamation. All of the actions in Alternative A have the potential to directly and indirectly impact cultural resources. While the general nature of those potential impacts is described above, the exact nature of the direct and indirect impacts is not known because the location of all cultural resources within the Bull Mountain Unit is not known. Specific numbers of impacted cultural resources for the different nature and types of effects under Alternative A are unavailable, though previous work in the Bull Mountain Unit indicates that the resources are sparsely distributed (Millward 2013). Under Alternative A, impacts on cultural resources would be assessed on a case-by-case or APD-specific basis.

*Alternative B*

The BLM would continue to meet its compliance obligations under the NHPA. Goals and objectives for BLM-administered lands are to identify, preserve, protect, and manage significant cultural resources under legal guidelines (i.e., Section 106 of the National Historic Preservation Act) for protection, preservation, investigation, and public use (i.e., development and interpretation) to ensure that they are available for appropriate uses by present and future generations through research, education, and cultural heritage preservation.

All of the actions in Alternative B have the potential to directly and indirectly impact cultural resources. While the general nature of those potential impacts is described above, because the location of all cultural resources within the Bull Mountain Unit is not known, the exact nature of the direct and indirect impacts is not known. Alternative B is likely to impact more cultural resources than Alternative A, and though the specific numbers of impacted resources under Alternative B are unavailable, the total number of impacted resources is expected to be low (Greubel 2010; Millward 2013). Under Alternative B, impacts on cultural resources would be assessed on a case-by-case or APD-specific basis. Alternative B includes design features in **Appendix C**, including COAs 37 - 40.

*Alternative C*

The BLM would continue to meet its compliance obligations under the NHPA. Goals and objectives for BLM-administered lands are to identify, preserve, protect, and manage significant cultural resources under legal guidelines (i.e., Section 106 of the National Historic Preservation Act) for protection, preservation, investigation, and public use (i.e., development and interpretation) to ensure that they are available for appropriate uses by present and future generations through research, education, and cultural heritage preservation.

All of the actions in Alternative C have the potential to directly and indirectly impact cultural resources. While the general nature of those potential impacts is described above, because the location of all cultural resources within the Unit is not known, the exact nature of the direct and indirect impacts is not known. Alternative C is likely to impact more cultural resources than Alternative A, though fewer than Alternative B. In either case, the specific numbers of impacted resources under Alternative C are unavailable. As with the previous alternatives, under Alternative C, impacts on cultural resources would be assessed on a case-by-case or APD-specific basis. Alternative B includes design features in **Appendix C**, including COAs 37 - 40.

*Cumulative*

Decisions within the Unit could have impacts that, when combined with past, present, and reasonably foreseeable future actions, could produce cumulative effects on cultural resources. Cumulative effects would result from the destruction and loss of known and unrecorded resources and unanticipated discoveries. Such activities include changes to federal land use plans; increases in mining, fluid mineral leasing, and renewable energy development; vegetation and habitat management; livestock grazing; increases in recreation and visitor use; road construction; urban encroachment, shifts in water management; invasive plant and animal species; and wildland fire (Table 4-3). These impacts would continue to affect cultural resources, through loss or disturbance to the integrity and setting of cultural resources.

Actions related to recreation, grazing, vegetation treatment, wildland fire, mineral development, and energy development have had past effects and are expected to continue to affect cultural resources. Increased frequency of wildland fire due to shifting environmental parameters, such as drought, climate change, and forest health, could lead to additional direct loss of cultural resources.

Cultural resources next to areas of growth and development would be most susceptible to future effects. The construction of buildings, roads, and associated structures increases ground disturbance, causing effects on cultural resources and their settings. Development near public lands also increases pressure from recreation. Designating travel corridors can protect cultural resources located off the routes, but restrictions are difficult to enforce, especially as population and recreational use grows and other areas are closed. Increased use of the Internet and GPS devices to disseminate the location of cultural resources and encourage visitation to sites can facilitate vandalism and unauthorized collecting.

All undertakings that could affect cultural resources on federal land or actions that are funded, licensed, or permitted by the federal government are subject to the Section 106 process of the NHPA and other applicable laws and regulations. Consideration of the future cumulative effects of undertakings on protected cultural resources would be required, and adverse effects would be resolved on a site-by-site or project-by-project basis. Adherence to appropriate predevelopment, development, and post-development protective measures would reduce most cumulative effects to an insignificant level. Implementation of the proposed MDP is not anticipated to contribute to cumulative effects.

### 4.2.12 Paleontological Resources

This section discusses impacts on paleontological resources from proposed management actions of other resources and resource uses. Existing conditions are described in **Section 3.2.13**, Paleontological Resources.

***Methods of Analysis***

Based on a reasonable prediction of possible future types of development, but not their timing or location, the following impact analysis provides a general description of common impacts on paleontological resources.

*Indicators*

The primary overall indicator for paleontological resources is whether the characteristics that make a fossil locality or feature important for scientific use have been lost or diminished. Natural weathering, decay, erosion, improper collection, and vandalism can remove or damage those characteristics that make a paleontological resource scientifically important. Specific indicators used to assess the condition of in situ paleontological resources are the extent of erosion, rock fall and other natural processes, and human-caused disturbances. Resource condition is assessed through field observations, paleontological reports associated with paleontological use permits and construction activities, commercial site reports, and project reviews.

*Assumptions*

In addition to the assumptions in **Section 4.1.2**, the analysis assumes the following:

- 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 at or near the surface.
- Geologic mapping can be used for assessing the potential for paleontological resources using the BLM’s Potential Fossil Yield Classification (PFYC) system.
- For assessing impacts, only those objectives and actions potentially affecting vertebrate and scientifically important paleontological resources are considered.
- Scientifically important fossils may continue to be discovered throughout the Unit. Discoveries are most likely in geologic units classified as high-potential PFYC Class 4 or 5.
- Inventories conducted before surface disturbance or construction monitoring in high-probability areas could result in the identification and evaluation of previously undiscovered resources, which the BLM would mitigate for accordingly.
- Potential for impacts on both surface and subsurface paleontological resources is directly proportional to the amount of surface disturbance associated with a proposed action.
- At the programmatic level of analysis, it is not possible to identify and evaluate areas of higher paleontological sensitivity with respect to locations of proposed surface disturbance. Therefore, potential impacts on paleontological resources under each alternative can only be generally estimated, and they correlate directly to the amount of anticipated surface disturbance proposed under each alternative.

***Nature and Type of Effects***

Exposed fossils can be damaged by natural weathering and erosion from wind and water, and this damage can be exacerbated by concentration of human use and activity. Other sources of human-caused damage are ground-disturbing activity, vandalism, unauthorized collection, and over-collection of localities. Surface disturbance and excavations could impact fossils that could occur on or underneath the surface in areas containing paleontologically sensitive geologic units. If formations with high potential for yielding fossil vertebrates, such as the Upper Jurassic Morrison Formation noted in **Section 3.2.14,** crop out in the Unit, there is a high probability for impacting fossils during surface-disturbing activities in these areas.

Types of impacts include permanent loss of the paleontological resource and the scientific data it could provide through damage or destruction caused by surface-disturbing activities. Without removing some rock surrounding fossils, they would remain largely undetected; therefore, management actions that result in erosion do not necessarily result in damage to paleontological resources. Excessive erosion, especially from other surface disturbance on exposed localities, could damage fossils at the surface.

Impacts can typically be mitigated to below a level of significance by implementing paleontological design features identified in **Appendix C**, such as archeological and cultural resources protection (see COAs 37-40), construction monitoring (see COAs 19-24), and surface exposure (see COA 79). Pedestrian surveys would typically be necessary before any surface-disturbing activities were authorized in areas with a high potential for yielding fossil vertebrates (e.g., the Morrison formation); on-site monitoring could be required during construction. If data recovery were the prescribed mitigation, this could also result in fossils being salvaged that may never have been unearthed as the result of natural processes. These newly exposed fossils would become available for scientific research, education, display, and preservation into perpetuity at a public museum. Unmitigated surface-disturbing activities could dislodge or damage paleontological resources and features that were not visible before surface disturbance.

An increase in visitors to, workers in, or access to paleontological localities or sensitive areas could result in an increased potential for loss of paleontological resources by vandalism and poaching (Eagles et al. 2002). These impacts are difficult to mitigate to below the level of significance, but they can be greatly reduced by increasing public awareness about the scientific importance of paleontological resources through education, community partnerships, and interpretive displays, and by informing the public about penalties for unlawfully destroying or poaching these resources from BLM-administered lands.

***Effects Common to All Alternatives***

Actions considered under Alternative A are based on the continuation of existing lease rights. Actions under Alternatives B and C are specific to new actions for BLM-administered surface and/or mineral estates under the Bull Mountain Unit MDP. Laws, regulations, and BLM policies that supersede Bull Mountain Unit MDP decisions would apply.

Any action that disturbs or diminishes the scientific integrity of a scientifically important locality would be considered an adverse effect. Potential effects from subsequent exploration and development actions would be addressed at the APD and/or POD stage. Effects on scientifically important paleontological resources would be avoided or mitigated. If previously undiscovered resources were identified during project development, work would be suspended while the resource is evaluated and mitigated to avoid any further effects. Through this process, effects would be minimized or eliminated, although residual effects and adverse effects would be possible.

All alternatives include surface-disturbing actions that will directly and indirectly impact paleontological resources and could result in the nature and types of effects described above.

Erosion of soils that are a result of surface disturbance is an indirect impact from construction activities. Paleontological resources are susceptible to erosion damage, including destroying individual fossils and stratified deposits; all of which are important to understanding past environments. Nondestructive measures to protect soils are included in **Appendix C** and could be included on a case-by-case basis at project design (see COAs 4 through 9).

All alternatives could result in indirect impacts on paleontological resources. Any action that increases access can lead to inadvertent damage, unauthorized collection, or vandalism of fossil resources. Indirect effects on fossil resources would be evaluated on a case-by-case or APD-specific basis.

*Alternative A*

As Alternative A would be continuation of state managed actions, there would be few protections provided to paleontological resources that may occur within the Unit, and effects could be of the type and nature described above. However, if individual APDs are submitted to BLM for consideration (not under a Master Development Plan), then paleontological resources could be directly protected via the paleontological resources lease notification, which requires an inventory be performed by an accredited paleontologist approved by the BLM Authorized Officer before surface-disturbing activities are authorized in Class 4 and 5 Paleontological Areas. Paleontological resources are also indirectly protected via stipulations or actions that would protect other resources, such as those for wildlife or cultural resources.

Due to the BLM's mandate to protect scientifically important paleontological resources, there are few instances when a locality or fossil would be deliberately destroyed. However, as noted above in Nature and Type of Effects, there are instances when human actions can inadvertently lead to damage or destruction of these resources.

*Alternative B*

As Alternative B includes actions under a Master Development Plan, paleontological resources could be directly protected via the paleontological resources lease notification or by COAs on individual APDs or PODs submitted under the Master Development Plan.

Like Alternative A, due to the BLM's mandate to protect scientifically important paleontological resources, there are few instances when a locality or fossil would be deliberately destroyed. However, as noted above in Nature and Type of Effects, there are instances when human actions can inadvertently lead to damage or destruction of these resources.

*Alternative C*
Alternative C would have the same nature and types of effects as described above in Nature and Type of Effects, Effects Common to All Alternatives, and Alternative B sections.

*Cumulative*
The cumulative impact analysis area used to analyze cumulative impacts on paleontological resources is a 50-mile radius around the Bull Mountain Unit. Past, present, and reasonably foreseeable future actions and conditions within the cumulative impact analysis area that have affected and will likely continue to affect paleontological resources are mineral exploration and development, unauthorized travel, forestry, livestock grazing, recreation, road construction, ROWs, water diversions, weed invasion and spread, weed control, prescribed and wildland fires, land planning efforts, vegetation treatments, habitat improvement projects, insects and disease, and drought. Types of impacts from past, present, and reasonably foreseeable future actions that affect paleontological resources are the same as those discussed under Nature and Type of Effects. They include destruction or damage of resources without the benefit of scientific study or interpretation due to construction, recreation, theft, vandalism, and the effects of natural processes without the benefit of recovery, scientific study, or interpretation.

Current and future trends are energy and minerals development, including fluid mineral leasing and development and mineral materials sales; population growth; urbanization; increase in recreational demand; and ROW projects, including pipeline and transmission line construction, road construction, and erosion. For actions on BLM-administered land and mineral estate, impacts would be minimized through existing laws, regulations, and stipulations addressing surface-disturbing activities in PFYC Class 4 and 5 areas and other sensitive areas. Other ground-disturbing activities, such as road construction and utility infrastructure, could be reviewed by other federal, state, or local agencies for the presence and scientific value of paleontological resources, and steps could be taken to recover or avoid significant finds. Actions on private land could result in the inadvertent destruction of paleontological resources or the removal of fossils without any scientific study. Increasing recreation demand could result from unauthorized removal, vandalism, incremental damage of surface resources, and subsequent erosion.

Beyond authorized ground disturbance, cumulative impacts could occur from intensive travel, dispersed recreation, wildfire suppression, erosion, unauthorized collection, and vandalism. These could result in the unmitigated loss of scientific information and could reduce the educational and interpretative potential of the resource. Protections provided by other resource measures (such as those for cultural resources) would reduce the intensity of these effects. Adherence to appropriate protective measures before, during, and after development would reduce most impacts to a minimal level.

### 4.2.13 Visual Resources
This section discusses impacts on visual resources from the alternatives. The area of analysis for visual resources is the proposed project area.

***Methods of Analysis***
The visual resource inventory (VRI) classes form the basis for analysis in this section. Although VRI classes use the same numerical scale (i.e., Class I through IV) as VRM classes, they are

defined differently. Visual resource inventory classes are the categories the BLM uses to classify the current visual character of the landscape and are a way to communicate the degree of visual quality in the area. Generally, VRI Class I indicates high visual quality, and VRI Class IV indicates lower visual quality. The project area is VRI Class II. The VRI is on file at the UFO.

This section identifies impacts on visual resources on BLM-administered and non-BLM-administered lands. Impacts on visual resources are assessed by comparing the proposed actions for each alternative to the VRI class of the project area. Because the sensitivity level is expected to remain high and medium for most of the Unit, the analysis does not consider changes to sensitivity levels. Furthermore, the landscape is entirely within the foreground/middleground distance zone (zero to 5 miles). This is not expected to change from actions under any of the alternatives, so the analysis does not further consider changes to distance zones. As such, the following impact analysis by alternative focuses on the potential for change in VRI classification due to a change in scenic quality. Under no alternative would the scenic quality be anticipated to improve.

When assessing scenic quality, seven factors are considered: landform, vegetation, water, color, adjacent scenery, scarcity, and cultural modifications. Of these factors, actions under the alternatives have the highest potential to change vegetation, color, or 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) changed drastically, the variety, contrast, and harmony of color could change as well. The VRI scenic quality evaluation ratings for vegetation, color, and cultural modifications are provided in **Table 4-51**, Visual Resources Inventory Scenic Quality Evaluation Ratings.

**Table 4-51**
**Visual Resources Inventory Scenic Quality Evaluation Ratings**

| | Scenic Quality Evaluation Rating Criteria | | | | |
|---|---|---|---|---|---|
| **Scenic Quality Rating Unit** | **Vegetation (1 to 5 points)** | **Color (1 to 5 points)** | **Cultural Modification (-4 to 2 points)** | **Total Score* (points)** | **Scenic Quality Rating (A to C)** |
| Bull Mountain | 3.5 | 4 | 0 | 19.5 | A |
| Paonia Reservoir | 5 | 4 | -0.5 | 19 | A |
| Deep Creek | 5 | 4 | 0 | 20.5 | A |

Source: Otak 2009
Notes: Total scenic quality rating score: A = 19 point or more; B = 12-18 points; C = 11 points or less.
*Table does not include ratings for the rating criteria landform, water, adjacent scenery, and scarcity.

*Indicators*

The indicator of impacts on visual resources is the following: Proposed actions would allow changes to the landscape that could alter its character enough that future visual resource inventories would result in a VRI class reclassification due to changes in vegetation, color, and cultural modifications (such as structures and artificial elements not found in nature). For example, the area is currently assigned to VRM Class III and VRI Class II. The level of change allowed by VRM Class III could alter the landscape to the point that future visual resource inventories could result in reclassifying the area to VRI Class III or IV.

Impacts on visual resources are assessed by comparing the actions for each alternative to the VRI class of the project area. Generally, VRI Class II areas are more susceptible to impacts from changes to the landscape because of the high-value visual resources in these areas.

*Assumptions*

The analysis of visual resources has the following assumptions:

- The scenic vistas within the project area will become more sensitive to visual change; in other words, they would increase in value over time.
- Scenic resources will become increasingly important to residents of and visitors to the area.
- Visitors to BLM-administered lands or residents living near BLM-administered lands are sensitive to changes in visual quality.
- Activities that cause the most contrast and are the most noticeable to the viewer and the public are considered to have the greatest effect on scenic quality.
- The severity of a visual effect depends on a variety of factors, including the size of a project (i.e., area disturbed and physical size of structures), the location and design of access roads, and the overall visibility of disturbed areas.
- VRM class objectives would be adhered to through project design, avoidance, or mitigation.
- Visual resource design features for Alternatives B and C would be implemented to reduce harmful impacts. These are found in **Appendix C** (COAs 41, 72-88, 125, 127, 128, 135, and 136).
- Visual contrast ratings would be required for all future site-specific activities. The visual contrast rating system would be used as a guide to analyze site-specific impacts from activities as well as design and placement. Activities will be designed to minimize their visual impacts in order to conform to the area's VRM class objective. This will allow the BLM to reduce impacts on a site-specific basis to ensure compliance with the assigned VRM class.
- Private lands are assigned to the same VRI classes as BLM-administered lands in order to provide a consistent approach for analyzing impacts on visual resources across all lands.
- Highway 133 and County Road 265 serve as the two primary travel routes in the project area. The West Elk Loop Scenic Byway passes through the project area on State Highway 133. These travel routes will become more sensitive to visual change; in other words, they will increase in value over time.

Views of the project area would be afforded to individuals conducting livestock grazing, operating and maintaining access roads and energy developments (primarily oil and gas), driving vehicles along local travel routes (primarily State Highway 133 and County Road 265), and recreating (such as hunting, hiking, mountain biking, dispersed camping, viewing of seasonal colors, cross-country skiing, and snowmobiling).

***Nature and Type of Effects***

In order to accurately and comprehensively analyze and quantify impacts, future site-specific plans need to be provided detailing the location of project features and the amount of cut-and-fill. This information will be used to conduct a future analysis of impacts on visual resources according to the BLM VRM system analysis stage. The process of conducting a visual resource contrast rating, which involves comparing the project features with the existing landscape features using basic elements of form, line, color, and texture, is described in detail in BLM Handbook H-8431-1, Visual Resource Contrast Rating (BLM 1986b). The goal of VRM is to minimize the visual impacts of all surface-disturbing activities, regardless of the class to which an area is assigned. The project area is VRM Class III. The objective of this class is to partially retain the existing character of the landscape. The level of change to the characteristic landscape should be moderate. Management activities may attract attention but should not dominate the view of the casual observer. Changes should repeat the basic elements found in the predominant natural features of the characteristic landscape. Completing the BLM VRM system analysis stage will identify if a proposed site-specific development would meet the VRM class objective for an area.

*Temporary Effects*

Temporary direct effects on visual resources would occur from construction and ground-disturbing activities at well pads, access roads, pipelines, electrical lines, and facilities, such as storage areas, flowback pits, and compressor stations. To the extent practicable and feasible, activities would be located within the right-of-way. During the construction period, crews may be working concurrently at various locations. Therefore, the temporary effects on visual resources described below may occur at the same time in multiple locations. The effects would occur for a short period of time (weeks or months). After construction is completed, all equipment would be removed, and staging, storage, and construction areas would be reclaimed to a pre-disturbance condition. Impacts from construction would not change the VRI classification.

<u>Ground Disturbance and Dust</u>

Construction activities would disturb the ground surface and require removing vegetation, which would affect visual resources by creating land barren of vegetation when compared to adjacent land. Also, ground disturbances would affect visual resources by creating exposed soil with a different texture and color than undisturbed soil. Depending on growing conditions, trees and shrubs may not regenerate quickly, which would affect the timeline for reclaiming disturbed areas.

Ground-disturbing activities would also generate dust from vehicle movement, excavation, and wind blowing across exposed soil. Fugitive dust would affect visual resources by diminishing atmospheric clarity. This effect would persist until the dust settles or is blown elsewhere.

<u>Construction Lighting</u>

Lights would be used during construction only when necessary for safety, and lighting would be kept to a minimum. This would reduce nighttime darkness by adding light to areas lacking sources of artificial light. Nighttime effects on surrounding areas would be limited, because nighttime construction work is not proposed.

Glare

Reflective surfaces on construction equipment and vehicles create glare. The intensity and amount of glare would vary depending on the intensity of sunlight and the time of day. This would affect visual resources by adding artificial points of illumination not found naturally in the landscape where construction equipment and vehicles are present.

Cluttered Views

During construction, views of the project area would be cluttered with construction equipment, construction materials, and temporary support infrastructure, such as pipes, pits, fences, flagging, and stream crossings. The color and geometric, boxy forms of construction materials and equipment would contrast with the rolling form of the terrain and the vegetation. The rigid vertical elements would create various focal points on a mostly open landscape and would not mimic other landscape elements, which are mostly vegetation. The color of construction equipment and vehicles would not resemble the muted tans and greens of the terrain and vegetation.

*Permanent Effects*

Permanent direct effects on visual resources would occur from operating and maintaining sites and facilities. The effects on visual resources would be permanent, unless a site was abandoned and reclaimed. The life of the project is estimated at 50 years.

Roads

New roads would add artificial elements to undeveloped areas. 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, altering the natural topography, and altering 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.

Pipelines and Electrical Lines

New pipelines and electrical lines would add artificial elements to undeveloped areas. The form, line, and texture of these structures would not resemble nearby structures, unless they are co-located with similar existing structures. In particular, pipelines would divide the landscape with strips of land lacking vegetation and electrical lines would introduce prominent vertical elements. The visibility of the new pipelines and electrical lines would vary, depending on viewer distance and location, topography, color and composition of pipelines and electrical line poles, and screening vegetation.

Well Pads and Facilities

Well pads and facilities, such as flowback pits and compressor stations, would add artificial elements to undeveloped areas. These areas would be cleared of vegetation, thereby leaving a clearing that contrasts with the surrounding landscape. The form, line, color, and texture of these facilities would not resemble nearby structures, unless they are co-located with similar existing industrial facilities. Also, the well pads and facilities would be sources of activity and commotion that are not typically found in undeveloped areas. The visibility of the facilities would vary, depending on viewer distance and location, topography, color and composition of facilities, and screening vegetation.

Lights would be installed for safety and to illuminate work areas, such as drilling rigs, at night. This would reduce nighttime darkness by adding light to areas lacking sources of artificial light. As a result, this would diminish opportunities for viewing visual resources between dusk and dawn. In particular, this would affect stargazing opportunities.

***Effects Common to All Alternatives***

The Nature and Types of Effects described above would occur under all alternatives. The intensity of the effects would vary by alternative and is described below for each alternative. The temporary direct effects on visual resources would only last during construction and all equipment would be removed, and staging, storage, and construction areas would be reclaimed to a pre-disturbance condition. Therefore, the impact on visual resources described below focuses on the permanent direct effects. **Table 2-9**, Summary of Actions by Alternative and Table, and **Table 2-11**, Summary Surface Disturbance Acres by Alternative identify the total number of permanent structures and total acres of long-term surface disturbance.

*Alternative A*

A total scenic quality rating of 19 or more results in a Class A scenic quality rating. The Scenic Quality Rating Units barely received enough points (19, 19.5, and 20.5) to receive a Class A scenic quality rating. Given the amount of increase in total acres of long-term surface disturbance (and associated permanent structures) by previously authorized activities, Alternative A has the potential for diminishing the scenic quality evaluation ratings for vegetation, color, and cultural modifications enough to lower the scenic quality ratings of the Scenic Quality Rating Units to a Class B or Class C, thereby potentially changing the VRI Class to Class III or IV. The majority of the impacts would not be near the West Elk Loop Scenic Byway. The actual amount of change to the scenic quality rating depends on a number of factors, including viewer distance and location, topography, color and composition of project structures, and screening vegetation. Additional mitigation measures are described below.

*Alternative B*

Alternative B would involve more total acres of long-term surface disturbance (and associated structures) than Alternative A. Visual resource design features described above under Assumptions would be implemented to reduce harmful impacts. Because Alternative A has the potential for changing the VRI Class to Class III or IV, Alternative B would be even more likely to involve residual impacts that have the potential for changing the VRI Class to Class III or IV. Alternative B would have the most potential for changing the VRI and the most impacts near the West Elk Loop Scenic Byway. The actual amount of change to the scenic quality rating depends on a number of factors, including viewer distance and location, topography, color and composition of project structures, and screening vegetation.

*Alternative C*

Alternative C would involve more total acres of long-term surface disturbance (and associated structures) than Alternative A. Visual resource design features described above under

Assumptions would be implemented to reduce harmful impacts. Because Alternative A has the potential for changing the VRI Class to Class III or IV, Alternative C would be even more likely to involve residual impacts that have the potential for changing the VRI Class to Class III or IV. Alternative C would have more impacts near the West Elk Loop Scenic Byway than Alternative A. The actual amount of change to the scenic quality rating depends on a number of factors, including viewer distance and location, topography, color and composition of project structures, and screening vegetation.

*Cumulative*

This section discusses cumulative impacts on visual resources from the alternatives and the cumulative projects. The cumulative analysis area for visual resources is the proposed project area and adjacent areas. The analysis involves the same process as described above under Methods of Analysis. However, in addition to focusing on vegetation, color, or cultural modifications, adjacent scenery is also addressed in order to capture impacts on scenic quality from nearby cumulative projects.

Construction for one or more of the cumulative projects would be in the same region as construction activities for the alternatives. Cumulative projects, such as energy and minerals development, water diversions, and roadway development, would cumulative involve impacts on scenic quality that are similar to the temporary effects described above. Similar to construction for the alternatives, construction for the cumulative projects should be limited to a short period of time, involve reclaiming construction areas to a pre-disturbance condition, and employ visual resource design techniques and best management practices. Not all construction activities, however, would occur simultaneously. Cumulative impacts from construction would not change the VRI classification.

Operation and maintenance for one or more of the cumulative projects would be in the same region as operation and maintenance activities for the alternatives. Cumulative projects, such as energy and minerals development, water diversions, roadway development, vegetation management, and recreation and visitor use, would involve cumulative impacts on scenic quality that are similar to the permanent effects described above. Additionally, events, such as spread of forest insects and diseases and wildland fires, would also have similar long-term effects on scenic quality. The actual amount of change to the scenic quality rating depends on a number of factors, including viewer distance and location, topography, color and composition of project structures, and screening vegetation. However, the natural landscape has a finite number of changes that it can accommodate before cumulative impacts on scenic quality become readily apparent. Therefore, as the quantity and density of development and change increases, so does the potential for scenic quality degradation. Alternative A would involve the least cumulative development and change affecting visual resources. Alternative B would involve the most cumulative development and change affecting visual resources.

Implementing visual resource mitigation measures for Alternative A would reduce harmful impacts. The visual resource mitigation measures for Alternative A are the same as the design features for Alternatives B and C (see **Appendix C**, Best Management Practices and Conditions of General Approval, COAs 41, 72-88, and BMPs 125, 127, 128, 135, and 136). Given the amount of increase in total acres of long-term surface disturbance (and associated permanent structures) by previously authorized activities, residual impacts would still have the potential for changing the VRI Class to Class III or IV. However, the potential would be lower than Alternative A without visual resource mitigation measures, as described above under Alternative A. The majority of the impacts would not be near the West Elk Loop Scenic Byway. The actual amount of change to the scenic quality rating depends on a number of factors, including viewer distance and location, topography, color and composition of project structures, and screening vegetation.

## 4.3 RESOURCE USES

### 4.3.1 Livestock Grazing

***Methods of Analysis***

Impacts were determined by assessing which actions, if any, would change the livestock grazing indicators described below. Some impacts are direct, including loss of grazing acreage or reduction in AUMs. Indirect impacts affect grazing through a change in another resource, such as decreased forage from dust or reduced water quality for vegetation. Other indirect impacts include increased costs for ranchers due to fencing and difficulties in moving livestock, or loss of forage quality from introduction of unpalatable weeds.

The indicator used for impacts on livestock grazing was acres of grazing habitat lost.

***Nature and Type of Effects***

Direct effects include loss and fragmentation of grazing land resulting from land grading and clearing and construction of well pads, roads, pipelines, and facilities. Human presence and vehicle traffic on-site could disturb livestock and trample vegetation providing forage. Vegetation removal or trampling would reduce the amount and quality of available forage.

Indirect effects on livestock and rangeland include the possibility of injury to livestock from vehicle and equipment traffic onsite. Traffic facilitates spread of weeds, resulting in reduced forage palatability. Vehicles and equipment could also cause erosion and soil compaction, affecting the growth of forage and potentially facilitating weed spread. Furthermore, construction and maintenance activities could increase dust, which could cover vegetation, reduce palatability of forage, and increase tooth wear.

In addition, increased fencing would be required to isolate drilling facilities from livestock grazing areas. Pad sites would be fenced to keep livestock away from reclaimed areas to allow for soil and vegetation recovery, adding to lost grazing potential. Cattle guards and gates would be placed in roadways, which may impede the movement of livestock across the range and require additional time and effort for livestock management, increasing costs for ranchers. Livestock may also be lost if gates are not properly closed on access roads. However, given that approximately 5 percent of acres on BLM-administered land would be impacted, the impacts on ranchers from decreased forage production would be less than significant.

***Effects Common to All Alternatives***

Livestock grazing would continue during development and operation of the Unit. Construction-related disturbance would reduce available grazing acreage and forage for sheep and cattle, and the installation of access roads, well pads and utility lines to access private mineral reserves would reduce forage and acreage in the long term.

On BLM allotments, 14 acres or more would be lost to grazing under all alternatives (**Table 4-52**, Grazing Disturbance on BLM Allotments from Roads and Well Pads), with additional acreage lost from private ranchlands. The acreage would be converted to roads, pipelines and other long-term surface uses. This calculation assumes that all vegetation in these areas provides potential livestock grazing, though vegetation types such as sagebrush are not palatable for cattle, so the actual amount may be less.

Potential impacts include additional sources of income to ranches through lease fees or surface use agreements. Replacement of old fence lines could help with long-term costs of maintaining infrastructure.

**Table 4-52**
**Grazing Disturbance on BLM Allotments from Roads and Well Pads**

| | Alt A | Alt B | Alt C |
|---|---|---|---|
| **Federal surface, federal minerals** | **4** | **13** | **8** |
| Downing (280 acres) | 4 | 8 | 6 |
| Stock Driveway (340 acres) | 0 | 5 | 2 |
| **Private surface, private minerals** | **10** | **9** | **0** |
| Downing | 10 | 9 | 0 |
| **TOTAL** | **14** | **23** | **8** |

Source: BLM GIS 2014
Grazing allotments are in the SE part of Unit. As pipelines are co-located with a north-south running road in Alternative C, they do not go through the BLM land in that allotment.

*Alternative A*

Under Alternative A, existing lease rights granted by the BLM on federal lands and/or federal mineral estate would remain in effect. New wells would continue to be developed on private lands in the Unit. The types of short-term and long-term direct and indirect impacts would be the same as for the Alternative B and Alternative C, but at a reduced level, because only private mineral reserves would be developed. Access roads and other infrastructure would still be constructed on BLM-administered land.

Under Alternative A, no new development on federal lands or of federal mineral estate would occur, which would limit impacts on grazing lands. However, existing lease rights on federal mineral estate would remain in effect and direct and indirect impacts from energy development would continue on non-federal mineral estate, requiring construction of access roads and pipelines on federal lands.

BLM grazing allotments under Alternative A are shown in Table 4-52. The table is based on the conceptual siting of project components and estimated project footprint; the exact acreages could change during design and site permitting. The table includes only BLM-administered surface, because the locations of ranches on private lands are not available. Additional impacts on ranchlands on private lands overlaying federal mineral estate would occur under each alternative.

*Alternative B*

Under Alternative B, impacts described under Alternative A would occur, and impacts would also occur from mineral development on federal lands. The acreage of impacts would increase under Alternative B compared to Alternative A, as shown in Table 4-52, as additional facilities would be constructed. In addition to the acreage shown in the table, impacts would occur to private grazing allotments overlaying federal mineral estate. These acres of impacts were not calculated because the locations of private ranches were not available.

Grazing acreage would be lost and forage quality would be reduced under this alternative in areas being developed. BMPs, including erosion control and dust abatement measures, limiting removal of vegetation and requiring replanting vegetation would be applied, and would reduce the likelihood for impacts on forage quality. Because only approximately 5 percent of acres on BLM-administered land would be impacted, and BMPs (**Appendix C**) would be applied to minimize indirect impacts, the alternative's effects would be less than significant.

*Alternative C*

Alternative C is a modified action alternative, with fewer overall well pads, access roads and other facilities planned. The overall acreage of impacts under Alternative C would be less than for Alternative B, but more than Alternative A. However, the acreage of impacts on BLM surface grazing allotments is would be the same as under Alternative B, and direct impacts would be the same.

Impacts on grazing lands, forage and livestock would be similar to Alternative B, though would likely be less under Alternative C, due to the smaller scale of the projected development. Alternative C would also include additional BMPs and design features to reduce impacts on vegetation, such as dust abatement measures. Reclamation of pipeline corridors would ultimately increase forage through replanting of grasses and forbs. With this mitigation in place, impacts on livestock grazing would be less than significant.

*Cumulative*

Cumulative impacts would include the combined implementation of Alternatives A and B in combination with other reasonably foreseeable future actions in the vicinity. A total of 23 acres, or 4 percent of BLM grazing acreage, would be lost to development under Alternative B. Additional acreage would be lost from private ranches overlaying federal mineral estate that would be developed under Alternative B; the acreage of private grazing land lost is not included in Table 4-52 because the locations of private ranches are not available.

The Unit and larger UFO historically sustained high levels of grazing. Sheep and cattle grazing still occurs at reduced levels, primarily in the spring and summer. BLM-administered lands in the Unit, 60 AUMs are active, while private lands sustain over 1,000 AUMs. On National Forest System lands surrounding the unit, approximately 2,500 sheep AUMs, 1,000 cattle AUMs, and 30 horses.

With increasing oil and gas development, as well as coal mining, grass/forb vegetation communities continue to be lost, reducing grazing potential. Combined with other past, present, and reasonably foreseeable future actions, Alternative B would contribute to the gradual decline of grazing in the vicinity of the proposed project. Implementation of BMPs in **Appendix C** would minimize the cumulative impacts caused by Alternative B, and no additional mitigation measures are recommended.

### 4.3.2 Minerals (Leasable, Locatable, Salable)

***Methods of Analysis***

Impacts on leasable minerals, locatable minerals, and salable minerals could result from requirements to protect other resources in the project area. Because natural gas development is the only mineral activity occurring in the project area, only gas development will be discussed in terms of impacts from this federal action.

Indicators for impacts on federal natural gas resources in the project area from this federal action are as follows:

- Approval or denial of the Bull Mountain Unit master development plan (MDP)
- Application of factors and constraints for pad, road and facility siting to protect other resources
- Application of BMPs and conditions of approval to be applied to protect other resources

***Nature and Type of Effects***

Approval of the Bull Mountain Unit MDP would result in more orderly development of federal resources in the project area. SGI would develop its existing federal gas leases in the project area with vertical, directional, and horizontal wells. Federal gas resources would be extracted through conventional methods as well.

Denial of the Bull Mountain Unit MDP would result in a shift of near-term development focus from federal minerals in the project area to private minerals in the project area. Therefore, the amount of near-term development of federal minerals in the project area would be reduced.

Application of timing limitation stipulations may be required if impacts of fluid mineral development on other resources cannot be mitigated within the standard 60-day suspension of operation period afforded by regulation. Portions of the project area where timing limitation stipulations are applied would be temporarily closed to drilling operations and all subsequent well operations except routine nonsurface disturbing activities. Excepted activities that would be allowed at all times include routine fracturing or acidizing jobs, recompletion in the same interval, well cleanout work, routine well maintenance, and bottom hole pressure surveys (43 CFR Part 3162.3-2). Most activities that would be subject to timing limitation stipulations (drilling operations) can be initiated and completed outside of the restricted dates specified in the stipulation. Application of timing limitation stipulations may also limit the types of wells that can be used to extract federal mineral resources in the project area. Because horizontal wells take up to 30 days longer to drill than vertical wells, drilling horizontal wells in areas subject to timing limitations may not be practicable. However, variances may be granted on a case-by-case basis subject to the terms of the timing limitation.

Application of factors and constraints to determine site suitability for fluid mineral activities limits the location of fluid mineral development. Examples of factors and constraints considered in siting include steep slopes and proximity to known streams containing Colorado River Cutthroat Trout. If either of these factors were present in a given area, roads or other facilities may not be sited in that area, and gas development in that area would be less likely. As a result, application of these factors and constraints could reduce the total amount of development of federal gas resources in the project area.

Application of design features and best management practices listed in **Appendix C** would impact fluid mineral development by restricting the extraction of gas resources in the project area. Examples of design features that may be applied include standards such as slope stability study requirements (COA 5), minimizing construction of new staging areas (COA 20), avoidance of NRHP-eligible sites (COA 27), and interim reclamation requirements (COA 72). Design features would be applied to gas development activities on a site-specific basis as appropriate.

***Effects Common to All Alternatives***

Under all alternatives, gas development activities on SGI federal leases in the project area would continue to be subject to lease stipulations including the standard stipulations applicable to all oil and gas leases in Colorado and a timing limitation stipulation to protect crucial deer and elk winter ranges.  Application of the timing limitation stipulation could reduce development of federal gas resources in the project area and limit the type of wells used as described under Nature and Type of Effects.

Factors and constraints for site suitability, including slope, sensitivity to visual impacts, proximity to roads and pipelines, and proximity to sensitive natural resources, would be applied to fluid mineral siting under all alternatives. Application of these factors and constraints could reduce the total amount of development of federal gas resources in the project area as described under Nature and Type of Effects.

Under all alternatives, various management plans would be applied to gas development activities in the project area. Example plans include a noxious weed management plan and surface use plan of operations.. Application of these plans would restrict development of federal gas resources in the project area as described under Nature and Type of Effects.

*Alternative A*

Under Alternative A, the MDP would not be approved, and SGI's immediate development focus would shift to private minerals. SGI expects to develop 11 new well pads on private mineral estate and drill 55 new gas wells. Because SGI would not pursue much near-term development of federal gas resources in the project area under this alternative, development of federal gas resources would be reduced as described under Nature and Type of Effects.

One proposed well pad would be developed and 10 significant road upgrades would occur in verified elk concentration areas under this alternative. Total new road construction would cover 5 miles. Intensive activities associated with these facilities would be impacted by timing limitation stipulations as described under Nature and Type of Effects.

Near-term development under Alternative A would occur on private minerals, and no design features are applicable to development on private minerals. Some near-term development such as upgrades to existing roads needed to access well pads on private minerals under Alternative A would occur on federal minerals. All federal actions undertaken as a result of the Alternative A are subject to approval by the BLM and BLM BMPs prior to implementation. BMPs would not impact fluid minerals on private minerals under this alternative.

*Alternative B*

Under Alternative B, the MDP would be approved, and SGI's development of federal gas leases in the project area would be guided by this MDP going forward. SGI would develop 36 new well pads over federal mineral estate and drill 146 federal new gas wells in the project area. Because no new wells would be constructed on federal mineral estate in the near-term under Alternative A, Alternative B would result in a large increase in near-term development of federal gas resources in the project area (see ***Nature and Type of Effects***).

SGI would construct 19 new well pads and 3 new roads as well as completing 10 significant road upgrades in verified elk concentration areas under Alternative B. Total new road construction would cover 16 miles. Intensive activities associated with these facilities would be impacted by timing limitation stipulations as described under ***Nature and Type of Effects***. Because more well pads and roads would be constructed under Alternative B, the impacts of timing limitation stipulations on federal mineral development would increase.

Under Alternative B, development of SGI's federal gas leases in the project area would be subject to the design features described in **Appendix C**, as well as a requirement for avoidance of identified occupied raptor nests. Example design features and their impacts on federal fluid minerals are described under ***Nature and Type of Effects***. Because little near-term development of federal gas resources in the project area would have occurred under Alternative A, overall development of federal gas resources in the project area would increase under Alternative B despite the added restrictions of design features.

*Alternative C*

Like Alternative B, under Alternative C, the MDP would be approved, and SGI's development of federal gas leases in the project area would be guided by this MDP going forward. However, additional restrictions to protect big game would limit development in the project area under Alternative C compared with Alternative B. Under Alternative C, SGI would develop 35 new well pads over federal mineral estate and drill 146 new gas wells in the project area. Because no new wells would be constructed over federal mineral estate in the near-term under Alternative A, Alternative C would result in a large increase in near-term development of federal gas resources in the project area (see ***Nature and Type of Effects***). Construction of new wells under Alternative C would be the same as that under Alternative B.

Under Alternative C, additional siting and operational constraints would be applied beyond those described under Effects Common to All Alternatives. Voluntary timing limitations and the progressive development plan in Alternative C would limit where other operations such as workovers and recompletions could be done within the unit (emergency situations excepted) during the winter and not just drilling and construction as in Alternative B. All operations would be allowed throughout the year (including winter) in a smaller portion of the unit. Conversely, much less activity would occur in the remainder of the unit during the winter, providing elk a place to go with relatively less disturbance. However, total miles of new road construction would actually increase by 7 miles compared to Alternative A, to 12 miles total, as would development of new well pads and wells on federal mineral estate in the near-term. Construction of these roads and well pads would facilitate development of federal gas resources in the project area. Additional operational constraints would include requirements such as closed loop drilling, continuous watering for dust suppression, green completions, and the use of remote telemetry to minimize well monitoring trips (see Section 2.2.6, Alternative C, Modified Action). As illustrated by the projected drilling of 146 new federal gas wells under both Alternatives B and C, the siting and operational constraints applied under Alternative C are not likely to reduce the total amount of development of federal gas resources in the project area compared to Alternative B, even though they would reduce total surface disturbance from gas development facilities.

*Cumulative*
The cumulative impact analysis area for the proposed MDP is the federal and private mineral estate in the project area. The UFO has already leased 25 percent of the federal fluid mineral estate for fluid mineral development, including all of the parcels that would be developed by SGI under this MDP.

Under Alternative A, the MDP would not be approved, and development of federal gas resources in the project area would continue to occur on an APD-by-APD basis. As such, near-term development of federal gas resources in the project area would be difficult to determine as it would be dependent on the operator’s drilling schedule; however, as noted in Table 4-1 and 4-2, all 201 gas wells and five water disposal wells would be built, eventually resulting in full developed of federal gas resources. Therefore, in the long term, the amount of development of federal gas resources in the project area is expected to be similar under all alternatives. Conversely, extraction of gas resources from private mineral estate would occur sooner under Alternative A than under Alternatives B and C due to the shift in near-term focus to private minerals under Alternative A. The primary difference under Alternative A, aside from the timing of the development of private vs. federal resources, is that the federal gas development in the project area would occur on a piecemeal basis under Alternative A instead of according to a plan under Alternatives B and C. As a result, cumulative development of federal gas resources in the project area could be less efficient under Alternative A.

Because gas development in the project area would occur according to the MDP under Alternatives B and C, federal gas resources in the project area would be extracted more quickly and potentially more efficiently than under Alternative A. Development of private gas resources in the project area would likely be delayed under these alternatives because SGI would be focusing on federal mineral estate in the near term.

### 4.3.3 Recreation
This section discusses impacts on recreation from proposed management actions in each alternative. Existing conditions concerning recreation are described in **Section 3.3.3**, Recreation. Existing conditions concerning travel and access are discussed in **Section 3.3.5**, Comprehensive Transportation and Access; however, because the two resource uses are closely related and often interdependent, some references to transportation and access have been made in this section.

***Methods of Analysis***

Indicators of impacts on recreation include changes to recreational opportunities within the project area and along primary transportation routes used during construction and operation.

The analysis includes the following assumptions:

- The primary recreational activity occurring in the project area is big game hunting (e.g., mule deer and elk).
- Big game hunting participation in the project area is dependent upon the number of hunters allowed by private landowners.
- Recreational use in the surrounding region will continue to increase as the population increases.
- There are no developed recreation facilities in the project area.
- Development would occur under every alternative, including development on private and state lands with non-federal minerals under Alternative A.

***Nature and Type of Effects***

Recreation is vulnerable to any action that would alter the activities and opportunities in a particular area. These actions could result in changes to recreational access or the amount and quality of a recreational activity.

As described in **Section 3.3.3**, Recreation, primary recreational activities in the project area and major access routes include big game hunting and scenic viewing. In addition, nearby routes provide access for year-round recreational activities.

The quality of hunting opportunities is primarily influenced by access and habitat conditions. Alternatives where access and habitat are enhanced will provide improved hunting opportunities. Likewise, a reduction in access and habitat conditions will diminish hunting opportunities. The timing of project activities will also impact hunting opportunities. Mule deer and elk hunting seasons are in the fall, overlapping portions of September, October, November, and December. A decrease in project activities during this time would lessen adverse impacts on hunting activities.

Scenic viewing is primarily influenced by road conditions (including traffic) and the condition of the viewshed. Impacts on visual quality, described in **Section 4.2.11**, Visual Resources, would also result in impacts on recreation. Alternatives that introduce additional traffic or degrade visual resources will have an adverse impact on scenic viewing. A reduction in traffic or an improvement in visual resources would be beneficial to recreation.

Other recreational opportunities near the project area are dependent upon access provided by the West Elk Loop Scenic Byway and County Road (CR) 265. Impacts on travel and access are discussed in **Section 4.3.5**, Comprehensive Transportation and Access. Alternatives that reduce access will have an adverse impact on the ability to engage in recreational activities along these routes. Likewise, improvements in access would have a beneficial impact on recreation.

***Effects Common to All Alternatives***

Assuming some development occurs under Alternative A, the resulting traffic, habitat fragmentation, and visual degradation would result in adverse impacts on hunting and other recreational opportunities under all alternatives.

*Alternative A*

Under Alternative A, the Bull Mountain Unit MDP would not be approved, but some new development could occur on private and state lands with non-federal minerals. Development occurring on these lands would result in the same types of impacts described under Alternatives B and C, but they would occur over a smaller area. Thus, adverse impacts on hunting opportunities may be less pronounced because there would be less big game habitat fragmentation. Likewise, if fewer construction and operation vehicles use the West Elk Loop Scenic Byway and County Road 265, fewer adverse impacts on driving for pleasure and other recreational activities that occur along those routes would occur.

*Alternative B*

Actions under Alternative B would have the most pronounced disturbances on big game over the short- and long-term (see **Section 4.2.7**, Fish and Wildlife, for analysis of impacts on big game). A decrease in the presence of big game in the project area would mean that hunters could expect less success under this alternative than any other alternative. This may cause hunters to choose to hunt elsewhere, resulting in a loss of this recreational opportunity. (The economic impacts of a loss in hunting opportunities are described in **Section 4.4.2**, Socioeconomics. Impacts would be most pronounced over the short-term, when construction activities are anticipated to result in the greatest disturbance of big game. Long-term impacts would be less noticeable, but given the many high-quality choices for hunting in the region, the impact of project operations on habitat conditions could cause hunters to go elsewhere.

Project-related road construction would create additional access points directly adjacent to West Elk Loop Scenic Byway and County Road 265. However, these access points are not expected to provide recreational value because of project-related truck traffic and the developed setting of the project area.

Noise, congestion, and safety concerns resulting from increased traffic on the West Elk Loop Scenic Byway and County Road 265 would adversely impact scenic viewing. Recreational opportunities near these roads may also be diminished if the activities are sensitive to the intrusion of increased truck noise. An approximately 21 percent increase in truck traffic (compared to existing conditions) would also adversely affect recreational access to nearby designations as a result of lengthened travel times and safety concerns; impacts on access are described in **Section 4.3.5**, Transportation and Access.

*Alternative C*

Actions under Alternative C would disturb big game habitat over the short- and long-term (see **Section 4.2.7**, Fish and Wildlife), but a more comprehensive approach to wildlife management would likely limit these disturbances. However, given the many high-quality choices for hunting in the region, the impact of project operations on habitat conditions could cause hunters to go elsewhere.

As under Alternative B, project-related road construction would create additional access points directly adjacent to West Elk Loop Scenic Byway and County Road 265. However, these access points are not expected to provide recreational value because of project-related truck traffic and the developed setting of the project area.

Alternative C would have less project-related truck traffic on the West Elk Loop Scenic Byway and County Road 265. However, recreationists would experience an approximately 16 percent increase truck traffic on those routes compared to existing conditions impacting their experience.

*Cumulative*

The spatial boundary for cumulative impacts on recreation includes the project area boundary and the West Elk Loop Scenic Byway and County Road 265 corridors.

The cumulative impact analysis area for recreation is relatively undeveloped and is a popular area for big-game hunting. Although there are few existing or proposed oil and gas developments, residential development and the resulting loss of habitat and access pose a threat to hunting. However, the scale of residential development (and the amount of public lands where such development is prohibited) is such that hunting opportunities would remain plentiful throughout the life of the project. As a result, cumulative impacts on hunting would be minor; it is expected that hunters could find success on nearby land away from the disturbances caused by Alternative B.

Past, present, and reasonably foreseeable future actions are expected to have minor cumulative impacts on scenic viewing. The relative lack of existing and proposed development in the cumulative impact analysis area means that scenic viewing opportunities would remain intact in many places. Adverse impacts would be localized and most noticeable along the West Elk Loop Scenic Byway and County Road 265 for the life of the project.

Impacts on recreational access in the cumulative impact analysis area would be similar to those for scenic driving. An increase in traffic would lengthen travel times and may present safety concerns. Traffic is expected to increase in conjunction with the region’s population and popularity as a tourism destination. In the context of these two larger trends, Alternative B would have a relatively minor impact on recreational access. However, adverse impacts would be especially noticeable along the West Elk Loop Scenic Byway and County Road 265 and may contribute to less recreational use of these roads and nearby lands.

### 4.3.4 Lands and Realty

***Methods of Analysis***

Land status baseline information in **Section 3.3.4**, Lands and Realty, was reviewed for an understanding of current lands and realty program goals, management practices, and ownership breakdown in the Unit. This known information was overlain with the actions found under each alternative in Chapter 2, and conclusions were drawn based on an understanding of how these types of actions may affect the lands and realty program, and adjacent landowners.

Potential impacts on lands and realty could occur if reasonably foreseeable future actions were to:

- Conflict with existing or adjacent land uses
- Conflict with existing federal and local land uses, plans, and policies
- Conflict with existing BLM land use authorizations

This analysis assumes the following:

- Existing ROWs would be managed to protect valid existing rights

***Nature and Type of Effects***

*Public Lands*

An increase in natural gas development would lead to adjustments in the existing land uses in the Unit. Existing land uses would be displaced by surface-disturbing activity during both the construction and operation phases of the project. Land users would be affected by intrusive impacts. Examples of intrusive impacts include increases in traffic, noise, dust, and human activity, as well as changes in the visual landscape. These impacts could be a source of potential conflict with recreational users, such as seasonal hunters, and ranchers that would be impacted by temporary forage losses on BLM-administered grazing allotments. Impacts on individual land uses are analyzed in other resource sections of this chapter. Impacts would occur for the life of the project, as well as after the project, since it is possible that some areas would not be fully reclaimed to original condition.

*Private Lands*

Intrusive impacts on private lands would occur from the sights and sounds of resource development on all land jurisdictions in the Unit. These impacts could include increased traffic, fugitive dust, noise, the loss of privacy that results from increased human activity (e.g., crews and equipment), and visual or aesthetic impacts that could devalue private property. In general, implementation of the project and the construction of gas facilities would change the character of the landscape from a rural to a more industrialized setting. Impacts would occur for the life of the project as well as after the project, since some areas would not be fully reclaimed to original condition.

As discussed in **Section 3.3.4**, most private lands within and adjacent to the Unit include oil and gas development, livestock grazing, and seasonal hunting. Development on private land in the Unit would lead to adjustments in existing land uses including loss of private rangeland and irrigated hay meadows. The severity of the impacts would vary depending on surface and mineral ownership at specific locations. Landowners who own mineral rights for the property are able to decide whether to allow development on their land. Land use conflicts are most likely to occur where wells are located on split-estate properties that have private surface ownership without mineral-estate ownership. The specific locations of facilities would be negotiated with landowners on split-estate lands. As discussed in **Section 3.3.4**, approximately 6,300 acres of the leased lands within the Unit are held in split estate. Section 1835 of the 2005 Energy Policy Act requires the BLM to review current policies and practices with respect to management of split-estate lands.

*Land Use Authorizations*

As discussed in **Section 3.3.4**, there are several authorized ROWs within the Unit, including State Highway 133, power and telephone lines, and private accesses. During the development phase, the integrity of existing ROWs would potentially be impacted by construction activities. However, ROWs would be avoided to the extent possible. If they cannot be avoided, caution would be taken to ensure no impacts on facilities or disruption of use occurs.

SGI would not be required to obtain a BLM ROW, provided that the facility (e.g., road, pipeline) is contained within the Unit and its use is specific to the Unit. If the facility also serves off-unit use, then a ROW would be required. For example, a pipeline ROW would be required to transport off-unit gas from development south of unit, across the Unit on the BLM surface in Sections 8 & 9, T12S, R89W. (See proposed pipeline in Figures 2-2 & 2-3 that enters the Unit southern boundary in Section 9.) Potential impacts on current land uses resulting from the authorization of additional ROWs across BLM-administered land include losses of livestock forage due to surface disturbance; losses of wildlife habitat and displacement of wildlife due to surface disturbance and habitat fragmentation; and visual impacts on recreational users.

***Effects Common to All Alternatives***

There are no effects common to all alternatives.

*Alternative A*

Additional individual APDs or ROWs, such as roads or pipelines crossing federal land for non-unit purposes, would be analyzed separately under individual environmental analysis at the time they were received. Impacts under Alternative A are only related to development on fee lands/fee minerals.

Approximately four percent of the long-term and three percent of the short-term surface disturbance under Alternative A would occur on BLM-administered lands, including from the construction of new roads and improvements to existing roads for access, new pipeline construction, and up to one new compressor station. The remaining surface disturbance, approximately 96 and 97 percent, would occur on private surface. The disturbance on private surface would be caused by new and upgraded roads, well pads, and pipelines. **Table 4-53**, Alternative A - Surface Disturbance[1] by Land Ownership, summarizes surface disturbance by land ownership. The factors and constraints for site suitability design features (see Table 2-10) would limit the total amount of surface disturbance.

**Table 4-53**
**Alternative A - Surface Disturbance[1] by Land Ownership**

| Surface Ownership | Short-Term Disturbance | Long-Term Disturbance |
|---|---|---|
| Federal | 7 | 4 |
| Private | | |
| Federal minerals | 74 | 25 |
| Private minerals | 178 | 60 |
| Total | 259 | 88 |

Source: BLM GIS 2014
[1]Disturbance includes well pads, roads, and pipelines.

Following completion activities, portions of the well pads, and access road and pipeline ROWs that are not needed for production activity, would be reclaimed (**Appendix C**, Best Management Practices and Conditions of General Approval, COAs 72-88 and BMPs 135 and 136). The long-term or residual disturbance resulting from Alternative A would be approximately 88 acres, approximately 66 percent less than the short-term disturbance. Reclamation requirements would be determined by the appropriate surface management agency.

As required by FLPMA, Mineral Leasing Act, and the Master Lease Agreement, the BLM would be required to grant SGI and other operators' reasonable access to valid leases on private land in the Unit. Potential impacts on current land uses resulting from the authorization of additional ROWs across public land include losses of livestock forage due to surface disturbance; losses of wildlife habitat and displacement of wildlife due to surface disturbance and habitat fragmentation; and visual impacts on recreation users.

If Alternative A were selected, impacts would be similar to those described under Nature and Type of Effects. However, the extent of land uses displaced by oil and gas facilities would be mostly on private lands. In particular, there could be intrusive impacts on the residential areas along State Highway 133. However, all development of fee lands/fee mineral estate would comply with the COGCC and Gunnison County, Colorado Regulations for Oil and Gas Operations rules and regulations (**Appendix C**, Best Management Practices and Conditions of General Approval, COA 1). Compliance with these rules and regulations would mitigate potential impacts on landowners and users by providing reasonable limitations and safeguards for gas development on fee lands/fee mineral estate. There may also be intrusive effects on hunters on private and BLM-administered lands if gas development occurred in areas they hunt.

*Alternative B*

Approximately 2 percent of the long-term and 3 percent of the short-term surface disturbance under Alternative B would occur on BLM-administered lands. Disturbance on federal surface would be caused by upgrades to existing roads and constructing water and/or gas pipelines or power lines to water disposal wells. The remaining surface disturbance, approximately 98 and 97 percent would occur on private lands. Disturbance on private surface would be caused by new and upgraded roads, well pads, and pipelines. **Table 4-54**, Alternative B - Surface Disturbance[1] by Land Ownership, summarizes surface disturbance by land ownership. The factors and constraints for site suitability design features (see Table 2-10) would limit the total amount of surface disturbance.

**Table 4-54**
**Alternative B - Surface Disturbance[1] by Land Ownership**

| Surface Ownership | Short-Term Disturbance | Long-Term Disturbance |
|---|---|---|
| Federal | 17 | 4 |
| Private | | |
| Federal minerals | 462 | 163 |
| Private minerals | 112 | 47 |
| Total | 591 | 214 |

Source: BLM GIS 2014
[1]Disturbance includes well pads, roads, and pipelines.

Following completion activities, portions of the well pads, and access road and pipeline ROWs that are not needed for production activity, would be reclaimed (**Appendix C**, Best Management Practices and Conditions of General Approval, COAs 72-88 and BMPs 135 and 136). The long-term or residual disturbance resulting from Alternative B would be approximately 214 acres, approximately 64 percent less than the short-term disturbance. Reclamation requirements would be determined by the appropriate surface management agency.

In general, if Alternative B were implemented, land use impacts would be similar in nature those described in under Nature and Type of Effects; however, the extent of land uses displaced by gas facilities would be related to BLM-administered surface and/or mineral estate, the BLM's authority, and the actions approved under a Master Development Plan. Based on the small amount of disturbance to federal surface lands, impacts on these lands would be similar to Alternative A, except for the gas pipeline ROW that would be needed to transport off-unit gas from the south across the Unit. However, the increased development on private surface lands would be greater than under Alternative A. This could result in greater increases in intrusive impacts and loss of forage, irrigated hay meadows, and hunting opportunities than under Alternative A. Similar to Alternative A, all development of fee lands/fee mineral estate would comply with the COGCC and Gunnison County, Colorado Regulations for Oil and Gas Operations rules and regulations (**Appendix C**, Best Management Practices and Conditions of General Approval, COA 1). Compliance with these rules and regulations would mitigate potential impacts on landowners and users by providing reasonable limitations and safeguards for gas development on fee lands/fee mineral estate.

*Alternative C*

Approximately five percent of the long-term and 4 percent of the short-term surface disturbance under Alternative C would occur on BLM-administered lands. Surface disturbance on would be caused by upgrades to existing roads and constructing pipelines. The remaining surface disturbance, approximately 95 and 96 percent would occur on private lands. New and upgraded roads, well pads, and pipelines would result in disturbance on private surface.
**Table 4-55**, Alternative C - Surface Disturbance[1] by Land Ownership, summarizes surface disturbance by land ownership. The factors and constraints for site suitability design features (see Table 2-10) would limit the total amount of surface disturbance.

**Table 4-55**
**Alternative C - Surface Disturbance[1] by Land Ownership**

| Surface Ownership | Short-Term Disturbance | Long-Term Disturbance |
|---|---|---|
| Federal | 16 | 6 |
| Private | | |
| Federal minerals | 369 | 109 |
| Private minerals | 56 | 12 |
| Total | 441 | 126 |

Source: BLM GIS 2014
[1]Disturbance includes well pads, roads, and pipelines.

Following completion activities, portions of the well pads, and access road and pipeline ROWs that are not needed for production activity, would be reclaimed (**Appendix C**, Best Management

Practices and Conditions of General Approval, COAs 72-88 and BMPs 135 and 136). The long-term or residual disturbance resulting from Alternative C would be approximately 126 acres, approximately 71 percent less than the short-term disturbance. Reclamation requirements would be determined by the appropriate surface management agency.

In general, if Alternative C were implemented, land use impacts would be similar in nature to those described in Alternative B with the following exceptions.

Under Alternative C, an additional design feature (e.g., verified elk winter concentration areas factor and constraint for site suitability) and changes to actions would be provided in order to consider options for addressing resources issues of the impacts of gas development on wildlife populations. This additional design feature would limit the total amount of surface disturbance. Long-term surface disturbance would be less than Alternative A and less than Alternative B. Private surface disturbance would be approximately 131 acres less than Alternative A and approximately 41 acres less than Alternative B. As such, the extent of land uses displaced would be less than under Alternatives A and B. Voluntary construction restrictions could also reduce the intensity of traffic, fugitive dust, noise, and human activity in the Unit project area during the winter months. Consequently, private landowners and public land users would not be as severely affected by these intrusive impacts during that time period.

*Cumulative*

The cumulative impact analysis area for lands and realty includes the Unit project area. Lands in the Unit are designated almost exclusively agricultural by Gunnison County and the current land use is primarily ranching with interspersed residences. The Unit is nearly surrounded by National Forest System lands. With the exception of existing oil and gas development, there are no commercial or industrial uses occurring in the area.

Oil and gas leasing in the Unit is guided by the Uncompahgre RMP (1989), which is currently being revised (ROD expected in 2015). According to the RFD prepared in support of the ongoing RMP revision, the Unit is located in an area identified as having High occurrence potential (BLM 2012b). Mineral production within the Unit is limited to natural gas wells developed by SGI and one natural gas well developed by Gunnison Energy Corporation. Additional surface disturbance on BLM-administered and private lands caused by future oil and gas development would lead to adjustments in the existing land uses in the Unit. Land users would be impacted by intrusive effects throughout the Unit. Examples of intrusive effects include increases in traffic, noise, dust, and human activity, as well as changes in the visual landscape. As lands in the Unit become more industrialized, individuals that currently own private lands that are surrounded by BLM-administered or National Forest System lands could be adversely impacted by the shifting character of the landscape.

The cumulative impact of identified actions on the BLM‘s lands and realty program would result from activities that affect the BLM‘s ability to authorize land use authorizations (including ROWs) in the Unit. Alternative B proposed the greatest possible increase, compared to Alternatives A and C, in land use authorizations from oil and gas development.

The collective effects on lands and realty for Alternatives A, B, and C are interrelated with various energy-related economic growth activities. The need for minor ROWs (such as distribution lines and roads) and new or expanded facilities to accommodate energy growth, such as coal mining and natural gas production, are also affected by the increased demand for energy and minerals, as well as potential increased population growth and development on private lands. Most development of utility and transportation corridors has occurred in the eastern portion of the Unit, along State Highway 133. In the future, energy and minerals-related economic development activities and population growth in Gunnison County would likely drive the location and types of ROWs authorized by the BLM.

### 4.3.5 Transportation and Access

***Methods of Analysis***

Impacts on transportation and access would occur as a result of an increase in traffic volume or change in the availability or quality of transportation routes. The following indicators are used to evaluate effects on transportation and access from the proposed actions:

- Change in the number, acreage, and total miles of access roads;
- Change in the average annual daily traffic volume for Highway 133;
- Change in the quality of existing arterial roadways and access roads that would affect the roadway's ability to safely and efficiently accommodate vehicle movement.

***Nature and Type of Effects***

For the purposes of this analysis, transportation describes the movement of vehicles on routes within the project area. Any new oil and gas development activity within the unit would generate additional traffic entering and exiting the unit via Highway 133, County Road (CR) 265 and the network of access roads. The nature and type of vehicle trips would vary depending on the phase of well development. During the well pad and pipeline construction phases, vehicles entering and leaving the Unit would include gravel trucks, semi-trucks, water trucks, pick-up trucks, and a series of flatbed trucks hauling construction equipment. Subsequent well drilling and well production phases would also result in an increase in vehicles entering and leaving the unit. Vehicle traffic associated with the drilling and production phases would include drilling/completion rigs, water trucks, pick-up trucks, workover rigs, and haul trucks. Trip origins for vehicles during all phases would be from areas outside the Unit. Accordingly, traffic volumes would increase on Highway 133, County Road 265 and well site access roads. Effects of increased vehicle traffic volumes on Highway 133 would include congestion and associated longer travel times for other transportation route users and increased probability of traffic-related incidents, including fatalities.

Heavy vehicles (i.e. those 55,000 pounds or heavier) accelerate the rate of road wear. The longevity of road surface conditions depends on several factors, such as surface type, weather conditions, subbase characteristics, and the nature and type of vehicle traffic. Interaction of pavement condition and vehicles takes into account vehicle weight, frequency, axle spacing, vehicle speed, number of tires per axle, suspension, and tire pressure. In general, a twofold increase in vehicle weight can increase road surface deterioration by 800 to 1,600 percent (FHWA 2000). More frequent maintenance would be required to offset the effects of heavy vehicle use.

Indirect effects of higher traffic volumes would include more frequent road construction, the need for additional patrolling by public safety personnel, and deterioration of the highway's scenic attributes. On County Road 265, increased heavy vehicle traffic would deteriorate the gravel road surface requiring more frequent road maintenance. However, improvements to County Road 265 as part of any agreement between the county and a developer would improve the quality and safety of the road surface in the near-term. On-going maintenance would be necessary for long-term transportation quality.

Whereas transportation describes the movement of vehicle traffic, access considers the physical availability of transportation routes. In general, the construction of new roads would improve access within the transportation network. Similarly, improvements to routes that increase the ability of route users to safely reach certain locations would promote greater access. Within the Unit, well pad development requiring new access roads would result in an overall increase in access. However, new access roads typically provide specific localized ingress and egress to and from a single or cluster of well pads and would therefore provide limited accessibility benefits throughout the broader Unit. Access to locations within the Unit would temporarily decrease during construction activities that require the partial or full closure of existing route segments. In the long-term, improvements to existing routes such as more stable surface materials, increased road widths or added lanes, additional slow vehicle turnouts, and longer sight distances would promote greater access to destinations within the Unit.

Route designation as part of a future travel management planning process would also impact transportation and access. Any seasonal or permanent closure of routes within the Unit (e.g., to motorized travel) would decrease or eliminate vehicle trips on those routes and concurrently reduce the level of accessibility to certain locations.

#### ***Effects Common to All Alternatives***

Under all the alternatives, existing drilling operations will continue with associated effects on transportation and access. There will continue to be approximately 96 miles of paved and unpaved routes in the Unit, including a 6.4 mile segment of Highway 133, a 4.8 mile segment of County Road 265, 20 miles of gravel access roads, and 49 miles of 2-track routes. Highway 133 will continue to provide the primary access to the Unit from surrounding areas, while County Road 265 will provide localized access in the northern half of the Unit. Truck traffic and associated transportation impacts as described in the Nature and Type of Effects would be greatest during well pad and pipeline construction activities. During drilling and production phases, transportation impacts would be comparatively less.

##### *Alternative A*

Under Alternative A, oil and gas development would continue within the Unit on private lands with non-federal minerals and previously approved federal actions. Development of federal mineral interests would also occur, but without the benefit of an MDP. The BLM would consider APDs on a case-by-case basis.

Alternative A proposes an estimated 11 new well pads, which would require the construction of 5 miles of new 16-foot wide access roads and the improvement of 26 miles of existing roadways. During road construction, measures would be taken to ensure continued access to existing property owners and leaseholders within the unit. Impacts on access would mostly occur during well pad construction or during construction of individual pipelines or transmission lines directly adjacent to roadways.

Alternative A would increase the average annual daily traffic volume on the existing transportation network within the Unit, including the number of heavy trucks. Most vehicles would enter and exit the unit via Highway 133 from points south of the Unit. Delta, Hotchkiss, Paonia, Crested Butte, and Gunnison are the region's primary population centers, the local distribution centers for construction materials such as gravel, and the regional disposal locations for drilling fluids and other waste from the well development process. A lesser number of vehicles would enter and exit via Highway 133 to the north.

Traffic volume would increase most during the well pad, access road, and pipeline construction phases. During construction phases, Alternative A would add an estimated total of 8,439 round trips to the Unit, 55 percent of which would be from gravel trucks. Another 28 percent of the trips would be associated with crew cab pick-up trucks. Over a 6-year period, the number of average annual daily trips for all phases of development would be 22,751, equivalent to an average annual daily traffic amount of 10 trips. Alternative A would increase the overall average annual daily traffic on the segment of Highway 133 in Gunnison County by less than 1 percent over a 6-year timeframe. The average annual daily trips associated with trucks could increase by up to 11 percent compared to existing truck-related traffic levels.

Daily traffic increases would be greatest during the well pad construction and drilling due to more frequent trips by gravel trucks (4,640 total trips), water trucks (2,320 total trips), and rig-up trucks (2,610 total). The number of new trips for large trucks would be the least during well production (218 total); however, there would be an ongoing average of 71 round trips per well per day of employee pick-up trucks. Construction of individual well pads would take from 1 to 3 weeks. Other routes would experience substantially fewer average annual daily trips compared to Highway 133, but would experience localized, short-term spikes in traffic volumes during construction of nearby wells.

Increased vehicle trips, especially associated with slower moving vehicles such as loaded gravel and water trucks, drill rigs, and lowboy trucks with construction equipment would affect the movement of traffic on Highway 133, and to a lesser extent on County Road 265 and local access roads. Because well pad construction and drilling activities would occur 24 hours per day, 7 days per week, daily vehicle trips would be spaced across a longer time period. However, an overall increase in truck traffic would increase travel times for motorists on Highway 133, especially during already congested periods such as weekends. An increase in vehicle volume would also increase the potential for collisions, disabled vehicles, and other incidents thereby reducing vehicle mobility and driver safety on Highway 133 and other routes in the Unit.

Alternative A would also result in road surface deterioration over time. Gravel trucks, water trucks, and other heavy vehicles used during the well construction and drilling processes would steadily degrade road surfaces requiring more frequent road repairs. At an average loaded weight of 110,000 pounds, gravel trucks would result in the most road surface impacts during the well pad and access road construction phase. The total number of loaded gravel trucks entering the Unit under Alternative A would be 2,320. The same number would leave the Unit, but with a substantially lighter (less than 50,000 pounds) payload.

During pipeline construction and drilling/completing, drilling completion rigs, pipe trucks, and lowboy flatbed trucks carrying bulldozers, tractors, motor graders and other machinery would enter and leave the Unit approximately 5,742 times. On half of these trips (2,871) the trucks would be loaded with an average weight of 120,000 pounds. For the other half, most trucks would be empty with an average weight of 36,000 pounds or less. Because Highway 133 is a key access route into the Unit and to proposed development under Alternative A, there would be the potential for surface conditions on that roadway to degrade overtime. Impacts would include pavement cracking, rutting, and the formation of potholes. Impacts on unpaved routes, such as County Road 265, would primarily be rutting and erosion of the road surface.

For Highway 133, increased traffic volume, reduced mobility, and poorer road surfaces could incrementally decrease motorists' enjoyment of the route as a scenic byway, particularly during the well pad construction phase. Exhaust from additional truck traffic could detract from the roadway's scenic qualities. See **Section 4.2.13**, Visual Resources and **Section 4.3.3**, Recreation, for further analysis related to the Highway 133/West Elk Scenic and Historic Byway.

*Alternative B*

Alternative B proposes an additional 36 well pads than Alternative A. To provide access to the additional well pads, developers would construct an estimated 16 new miles of access roads, 4 times more than Alternative A. The effects of the new access roads would be similar to those described in the Nature and Types of Effects and under Alternative A, above, but would apply to a larger and more widespread area within the Unit.

Under Alternative B, traffic volume would increase during all well development phases, which would last for approximately 6 years. For all development phases, Alternative B would add an estimated total of 41,658 round trips to the Unit, equivalent to an average annual daily traffic amount of 19 trips. As the primary ingress point to the Unit, Highway 133 would experience the greatest increase in average annual daily traffic, particularly with traffic entering the Unit from the south. Based on an existing average annual daily number of trips of 1,400 on Highway 133 through Gunnison County, new traffic proposed under Alternative B would result in a 1.35 percent average increase during the 6-year development timeframe. The average annual daily trips associated with trucks could increase by up to 21 percent compared to existing truck-related traffic levels, and 10 percent more than Alternative A.

Like Alternative A, daily traffic would increase the most during well construction and drilling, access road construction, and pipeline placement. These activities would require frequent trips by gravel trucks (8,480 total trips), water trucks (4,240 total trips), and rig-up trucks (4,770 total). The number of new trips associated with large trucks would be the least during well production (477 total); however, there would be an ongoing average of 162 round trips per well per day of employee pick-up trucks. Construction of individual well pads would take from 1 to 3 weeks. Since trip destinations would be disbursed throughout the Unit, other routes would experience substantially fewer average annual daily trips compared to Highway 133, with localized, short-term spikes in traffic volumes during construction of nearby wells.

Under Alternative B, 20 percent of all new trips would be from gravel trucks. Increased vehicle trips associated with these slower moving vehicles would affect the movement of traffic on Highway 133 and County Road 265. Because well pad construction and drilling activities would occur 24 hours per day, 7 days per week, daily vehicle trips would be spaced across a longer time period. However, an overall increase in truck traffic would increase travel times for motorists on Highway 133, especially during already congested periods such as weekends. An increase in vehicle volume would also increase the potential for collisions, disabled vehicles, and other incidents thereby reducing vehicle mobility and driver safety on Highway 133 and other routes in the Unit.

Similar to Alternative A, Alternative B would also result in road surface deterioration over time. Gravel trucks would result in the most road surface impacts during the well pad and access road construction phase. Other vehicles with average weights of 120,000 pounds, such as drilling completion rigs, rig up trucks, low boys with bulldozers and other construction equipment, work over rigs, and haul trucks, would impact road surfaces throughout well development due to their heavy weights. Because Highway 133 is a key access route into the Unit and to proposed development sites under Alternative B, surface conditions on that roadway would degrade overtime. Compared to Alternative A, Alternative B would result in a greater likelihood for pavement cracking, rutting, and the formation of potholes. Impacts on unpaved routes, such as County Road 265, would include rutting and erosion of the road surface. Because County Road 265 would provide access to more well locations under Alternative B compared to Alternative A, the potential for surface deterioration on County Road 265 would be greater than Alternative A.

For Highway 133, increased traffic volume, reduced mobility, and poorer road surfaces could incrementally decrease motorists' enjoyment of the route as a scenic byway, particularly when heavy vehicle traffic entering and leaving well sites would be greatest. Vehicle exhaust could also detract from the roadway's scenic qualities. See **Section 4.2.13**, Visual Resources and **Section 4.3.3**, Recreation, for further analysis related to the Highway 133/West Elk Scenic and Historic Byway.

*Alternative C*

Under Alternative C, the BLM would approve 35 well pads in addition to Alternative A. Compared to the other alternatives, Alternative C includes added measures to protect wildlife and reduce surface disturbance. New access roads would only be constructed on an as-needed basis. In total, an estimated 12 new miles of access roads are proposed, 3 times more than Alternative A, but 25 percent less than Alternative B. The effects of the new access roads would be similar to those described in the Nature and Types of Effects and under Alternative A, above.

Alternative C would require all new pipelines be buried beneath or directly adjacent to existing or proposed roadways. Placement of new piping within existing roadways would disrupt the movement of traffic on those roadways during construction activities resulting in road closures, detours, and localized travel delays.

Traffic volume would increase during all well development phases under Alternative C. For all development phases, which would last approximately 6 years, Alternative C would add an estimated total of 30,654 round trips to the Unit, equivalent to an average annual daily traffic amount of 14 trips. Highway 133 would experience the greatest increase in average annual daily traffic, particularly with traffic entering the Unit from the south. The increase for all vehicle types would be equivalent to 1 percent of the existing average annual daily traffic for the segment of Highway 133 through Gunnison County. Truck-related traffic under Alternative C could increase by up to 16 percent compared to existing conditions, which is 7 percent more than Alternative A.

Like Alternatives A and B, daily traffic increases would be greatest during the well pad construction phase due to more frequent trips by gravel trucks (6,240 total) and the least during well production (351 total). During production, the use of remote telemetry technology will reduce the need for site visits, thereby minimizing new vehicle trips during production. There would however, be an ongoing average of 162 total round trips per day of employee pick-up trucks during well production. Construction of individual well pads would take from 1 to 3 weeks. Other routes would experience substantially fewer average annual daily trips compared to Highway 133 due to the distributed nature of well sites in the Unit. Similar to Alternatives A and B, there would be localized, short-term spikes in traffic volumes on County Road 265 and access roads during construction of nearby wells.

The proportion of vehicle trips associated with heavy construction equipment such as gravel trucks would be the same as Alternative B. Accordingly, impacts on Highway 133 from heavy trucks would be similar to Alternative B. Impacts on County Road 265 and other access roads in the Unit would vary depending on individual well location.

Similar to Alternatives A and B, Alternative C would result in road surface deterioration over time. Because of vehicle weight and frequency of trips, gravel trucks would result in the most road surface impacts during the well pad and access road construction phase. Drilling completion rigs, rig up trucks, low boys with bulldozers and other construction equipment, work over rigs, and haul trucks would impact road surfaces during other well development phases due to their heavy weights (120,000 pounds). Alternative C would result in a greater likelihood for pavement cracking, rutting, and the formation of potholes compared to Alternative A, but less than Alternative B. Impacts on unpaved routes, such as County Road 265, would include more rutting and erosion of the road surface compared to Alternative A, but less than Alternative B. Because Alternative C proposes new well sites to be accessed via County Road 265, the potential for surface deterioration on County Road 265 would be greater than Alternative A and similar to Alternative B.

Increased traffic volume, reduced mobility, and poorer road surfaces would affect motorists' enjoyment of Highway 133 as a scenic byway more than Alternative A, but less than Alternative B. See **Section 4.2.13**, Visual Resources and **Section 4.3.3**, Recreation, for further analysis related to the Highway 133/West Elk Scenic and Historic Byway.

*Design Features and Additional Mitigation Measures*

For all alternatives, road improvements carried out prior to or in conjunction with well pad construction that strengthen road surfaces, would extend the longevity of roadways. On-going maintenance, such as described in **Appendix C** (see COA Road Construction and Maintenance 21) as a mitigation measure for Alternative A and required design feature for Alternatives B and C, would also ensure road surfaces are safe and passable. However, the need for more frequent road maintenance activity would result in periodic delays, particularly during the summer months, on the routes where maintenance activities are occurring.

Low speed limits on access roads (e.g., 20 miles per hour, as noted in **Appendix C**, Best Management Practices and Conditions of General Approval, COA 19, mitigation measure for alternative A and design feature for alternatives B and C), would result in longer travel times on those roads but would reduce the potential for serious collisions and fatalities.

*Cumulative*
West-central Colorado will continue to be a popular destination for outdoor recreation activities, including motorcycling and pleasure driving on the region's many scenic mountain roadways. Accordingly, the use of Highway 133/West Elk Scenic and Historic Byway for pleasure driving and motorcycling is expected to steadily increase over time. Highway 133 serves as the primary arterial route between population centers in Delta and major destinations along the western front of the Rocky Mountains (e.g. Snowmass and Aspen). As urban populations in nearby municipalities such as Delta, Paonia, Hotchkiss, and Crawford grow, traffic volume on Highway 133 is expected to increase.

Each of the proposed alternatives would increase the average annual daily traffic volume on Highway 133 through the Unit. Alternative A would add an average of 10 trips per day to the unit, while Alternatives B and C would add an average of 19 and 14, respectively. Because many of these trips would be by large trucks carrying heavy loads, drivers on Highway 133 could experience longer travel times for the segment within the Unit, and when travelling between eastern Delta County and the Unit.

An increase in truck volume coupled with more frequent passenger car trips would steadily degrade the Highway 133 road surface. Lane closures to repair cracked pavement and potholes would occur at more frequent intervals resulting in delays to motorists, well operators, and others travelling on Highway 133 within or adjacent to the Unit.

## 4.4 Social and Economic Conditions

### 4.4.1 Hazardous and Solid Wastes

This section describes how implementation of the proposed management actions could impact humans, animals, and resource uses through exposure to hazardous and solid wastes. Existing conditions concerning hazardous and solid wastes are described in **Section 3.4.1**, Hazardous and Solid Wastes. All activities associated with construction and operation of the proposed project would be required to be in compliance with applicable local, state, and federal regulations to protect the health and safety of proposed project employees and the general public. Hydraulic fracturing is exempt from several federal laws and regulations, such as the Clean Water Act, Clean Air Act, the Emergency Planning and Community Right-to-Know Act, the Resource Conservation and Recovery Act, the Comprehensive Environmental Response, Compensation, and Liability Act, and the Safe Drinking Water Act. However, as described in **Section 4.2.4**, Water Resources, and **Section 4.2.5**, Geology, the potential risk of contamination would be reduced as a result of compliance with existing regulatory requirements and agency policies, best management practices, and required design features.

***Methods of Analysis***
Indicators of impacts on health and safety due to exposure to hazardous and solid wastes include the following:

- Faults in the manner in which hazardous materials are used, stored, or transported
- The nature and volume of hazardous materials brought into the Bull Mountain Unit as part of the alternatives
- The proximity of groundwater to the drilling sites, and the ability of the drilling materials to reach groundwater
- The quality of produced water wells and the amount of produced water and drilling fluids that remain underground after completion
- The quality of pipelines, well casing, and plugs and the subsequent likelihood of leaks
- Amount of diesel fuel used on site in transportation and operations
- Proximity of workers to hazardous materials and proximity of residences to the Unit

The analysis includes the following assumptions:

- Occupational Safety and Health Administration health and safety guidelines would be followed by all workers during all construction, operation, and decommissioning phases of the projects.
- Construction areas will be fenced to exclude public entry.
- The design features and best management practices identified in **Appendix C** will be implemented during all stages of the project as appropriate.

***Nature and Type of Effects***

Many chemicals used in hydraulic fracturing are considered hazardous substances under 40 CFR Part 302, Section 302.4, as discussed under **Section 2.2.4**, Alternative A, No Action, sub-section Hazardous Materials and Solid Waste. Health and safety could be impacted should humans or animals come in contact with any of these substances. Risk of direct contact with these substances would be highest for those who are working on project sites.

Based on the actions described in the alternatives, the following are possible impacts that could affect human health and safety:

- Vehicular accidents resulting in spills or leaks of drilling lubricant or processed water
- Tanker or refueling spills that result in surface contaminations, exposure of workers to inhalation and potential skin contact. Depending on the substances spilled, the substance could percolate into shallow aquifers and contaminate groundwater, affecting residents who depend on the Colorado Plateaus aquifers.
- Spills while removing fluids from wellbore

- Well casing breach that could introduce methane and drilling fluid into local shallow aquifers and could result in health and safety risks for residents
- Ignition, explosions, or burns from cigarette smoke or other unexpected heat sources
- Contamination of water or soil during the drilling and hydraulic fracturing processes
- Accidents resulting in improper disposal of wastewater
- Leaks from abandoned wells, water disposal wells, or pipes
- Natural gas upwelling

Impacts could also result if the hazardous substances present in drilling lubricant were to contaminate nearby bodies of water and/or aquifers. Should contamination occur, any individual exposed to the contaminant could be impacted by those hazardous substances.

The injection of produced waters (wastewater) into disposal wells means that contaminated waters are being pumped at high pressure into deep zones underground, usually into the areas from where the oil or gas was extracted, and left there permanently. Produced waters contain potentially harmful pollutants, including salts, oil, grease, inorganic and organic additives, and naturally occurring radioactive material. These pollutants can be dangerous if they are released into the environment and/or if people come into contact them. They can be toxic to humans and aquatic life, radioactive, or corrosive.

Though produced water is injected into deep zones underground, the process of hydraulic fracturing creates new fractures in the deep geologic structures that can change the ability of fluids and gasses to move from one geologic zone to another, potentially creating connectivity between injection zones and shallow drinking water aquifers.

Hydraulic fracturing creates fractures in geologic formations targeted for oil and gas production, which may make it possible for fluids and gasses to move between geologic zones. Additionally, this route of fluid and/or gas exchange may be exacerbated by follow-on injection of produced water (wastewater) into those deep zones via disposal wells. Such injection under pressure is suspected to be the cause of seismic activity around various hydraulic fracturing operations across the United States. Any seismic activity from the disposal phase may be causing new fractures in geological structures and further increasing connectivity between aquifers and other zones, such as those zones containing fossil fuels and injected wastes (BLM 2013a).

A report by the National Research Council reported energy development-induced seismic activity in at least 13 U.S. states, including Colorado, and 20 additional countries (Weinhold 2012). Some of these seismic events have been as severe as magnitude 5.0-7.3 events. Most of these seismic events are linked not directly to the process of hydraulic fracturing, but rather to the associated wastewater disposal process (Weinhold 2012). An analysis conducted by the U.S. Geological Survey and Oklahoma Geological Survey found that seismic activity in Oklahoma has increased by 50 percent since 2013. As of May 2, 2014, 145 earthquakes of magnitude 3.0 or greater had occurred in Oklahoma, compared to a record-breaking 109 earthquakes in 2013

(USGS 2014). The USGS analysis also points to wastewater injection as a likely cause of the increase in seismic activity (USGS 2014).

While research on this phenomenon is limited, regulators across the country have begun taking steps to protect the public from the increase seismic activity that is potentially being caused by hydraulic fracturing and wastewater injection. As more studies are done on the impacts of hydraulic fracturing, uncertainty around the impacts and which part of the process produces these impacts will likely decrease.

Fracture growth and the potential for upward fluid migration, through geologic formations depend on site-specific factors such as the following:

1. Physical properties, types, thicknesses, and depths of the targeted formation as well as those of the surrounding geologic formations

2. Presence of existing natural fracture systems and their orientation in the target formation and surrounding formations

3. Amount and distribution of stress (i.e., in-situ stress), and the stress contrasts between the targeted formation and the surrounding formations (BLM 2013)

Toxins may also leak into shallow drinking waters through failed well casings. For the Bull Mountain Unit, there have been no reported incidents for well casing failures and related contamination of drinking water aquifers to date.

Studies have been published that examine the impacts of hydraulic fracturing and the risk to human health as a result of exposure to chemicals used in and produced by oil and gas development (Kassotis et al. 2013; Bamberger and Oswald 2012; Schmidt 2011). Kassotis et al (2013) found that drilling fluids left underground after extraction have the potential to migrate into shallow groundwater over time and continue to pose a risk of surface water and groundwater contamination. Additionally, the EPA estimates that after hydraulic fracturing is completed, only about 60 to 80 percent of the drilling fluids are recovered (EPA 2004), meaning 20 to 40 percent of the fluids remain underground and have the potential to migrate into shallow groundwater over time. Seismic events that result from injection of produced waters into deep zones via disposal wells could increase the likelihood of the migration of such fluids.

Environment and Energy Publishing conducted an analysis of state records and found that the 15 states with the most onshore oil and gas activity reported 7,662 spills, blowouts, and leaks in 2013 (E&E 2014). Though many of these incidents were small spills, the combined volume of the spills was more than 26 million gallons of oil, fracturing fluid, produced water, and other substances (E&E 2014). In Colorado, reported spills increased by 33 percent, with 402 spills reported in 2012 and 534 reported in 2013 (E&E 2014). This increase doesn’t necessarily imply increased negligence; this increase could be a result of increased spill reporting or could be due to an increase in the amount of development occurring. The data just show that spills do occur with some frequency and it is therefore necessary to assume that despite state and federal regulations and other safety measures, spills, leaks, and blowouts still occur and it is necessary to consider the risk of this occurring.

Agency policies, best management practices, required design features, and existing regulatory requirements would aim to minimize the risk of exposure and impacts on human and animal health from these potential contaminant pathways.

Natural gas drilling would also result in impacts on air quality, which could have consequences for human health. See **Section 4.2.1**, Air Quality, for additional details on the impacts from the alternatives on air resources, including Air Quality Related Values. A recent study has linked inhalation of petroleum hydrocarbons (including benzene, a known carcinogen, and xylene) to many negative human health effects, including eye, nose, and throat irritation, headaches, asthma and difficulty breathing, impaired lung function, nervous system impairment, cancer, acute childhood leukemia, chronic nonlymphocytic leukemia, immunological effects, anemia, other blood disorders, acute myelogenous leukemia, and multiple myeloma (McKenzie et al 2012).

**Section 4.2.1**, Air Quality, used an air quality impact assessment to examine the relationship between hazardous air pollutants (HAPs), such as benzene, toluene, ethyl benzene, xylene, and formaldehyde, and the risk of cancer. The assessment analyzed the potential incremental risk from HAPs, and focused particularly on formaldehyde, which has the largest potential to impact health. The air quality assessment concluded that the presence of formaldehyde and other HAPs in the Unit would not present health risks that were over the acceptable thresholds.

The types of impacts that could occur would partially depend on the chemical make-up of the drilling and hydraulic fracturing fluids used. SGI has chosen to disclose information about the composition of the hydraulic fracturing fluid they use at a site in Gunnison County on fracfocus.org. The list of chemicals used in their drilling lubricant can be found in **Appendix G**.

State and federal regulatory requirements as well as measures included by the operator to prevent drilling and production failures, and contamination by and exposure to hazardous materials, aim to reduce the risk of impacts on human health from natural gas drilling. Additionally, these measures aim to reduce the risk that soil or surface water contamination, groundwater contamination, and direct exposure of workers to hydraulic fracturing chemicals pose to human health.

***Effects Common to All Alternatives***

Under all alternatives, existing drilling operations will continue with effects on health and safety that would be similar to those described under Nature and Types of Effects. Impacts from additional future development would be the same as those described under Nature and Types of Effects and would result under all alternatives.

The types of impacts from hazardous materials would be the same under all alternatives because the chemicals used in the drilling lubricants do not differ by alternative and machinery and vehicles that emit hydrocarbons and other air pollutants would be present under all alternatives. The nature of the impacts would be the same under all alternatives, but impacts may vary in degree based on the number of wells drilled, the amount of wastewater produced, and other design details.

Under all alternatives oil and gas development could continue on private lands with non-federal minerals. This would result in the same kinds of public health and safety impacts as those discussed under Nature and Types of Effects. If the Bull Mountain Unit MDP is denied oil and gas development could shift to private lands.

*Alternative A*

Under Alternative A, the Bull Mountain Unit MDP would not be approved. Fifty-five new natural gas wells and 1 new water disposal well on private land with non-federal mineral estate would be developed under this alternative.

Under this alternative either a closed loop or reserve pit system would be used. A closed loop system would reduce the risk of impacts on health and safety compared to a reserve pit system. A closed loop system would result in less drilling waste and drilling cuttings that would require disposal. Additionally, a closed loop system would maximize the amount of drilling fluid that is recycled and reused in the drilling process. SGI would specify the type of drilling system to be used when submitting the drilling application to the COGCC.

Because less development would occur in the decision area, fewer barrels of produced water would be injected into water disposal wells in the decision area under Alternative A. This would result in a decreased risk of contamination of groundwater, or at least a decreased volume of produced water with which groundwater could be contaminated. However, as development continues on private land, the surrounding community will still experience impacts from hazardous materials to air and water resources, regardless of who administers the land on which the development occurs.

The types of impacts that would occur under Alternative A are described under Nature and Types of Effects.

*Alternative B*

Under Alternative B, as many as 146 new natural gas wells and 4 new water disposal wells would be developed on federal mineral estate only. This is a larger number of new natural gas and water disposal wells than would be developed in the decision area under Alternative A, which could result in greater volumes of hazardous materials and a potentially marginally higher risk of impacts on health and safety than under Alternative A. Under Alternative B, SGI could propose either a closed loop or reserve pit system, similar to Alternative A. Design features from **Appendix C** would reduce the risk of hazardous materials spills and health hazards. Design features 43 – 52 address the transport, storage, and identification of hazardous materials. Design feature 52 requires an Integrated Spill Prevention Plan and Countermeasure Plan per EPA regulations, approved and stamped by a Professional Engineer.

*Alternative C*

Under Alternative C, more development would occur in the decision area than under Alternative A. Under this alternative the same number of new natural gas and water disposal wells would be created as under Alternative B, and impacts would be the same. However, under Alternative C, a closed loop system would be used, resulting in a lower volume of drilling waste and drilling cuttings that would require disposal than would result under Alternative A and Alternative B, if reserve pit systems were used under those alternatives. It would also enable more drilling fluid to be recycled than under the other alternatives, which would decrease the amount of drilling fluid being disposed of and the subsequent risk of spills and contamination of water and soil that could occur during drilling fluid transportation. Design features from **Appendix C** including 43-52 would reduce the risk of hazardous material spills.

*Cumulative*
Additional oil and gas development is expected in the future, and when compounded with the impacts from development of the Unit, this could result in greater impacts on human health and safety. Air pollution from the development of the Unit compounded with air pollution from other nearby energy development could result in more severe impacts on human health. Increased development over time would also increase the risk of water and soil contamination through leaks, spills, mechanical failure, migration from deep geologic zones, well casing failures and human error. Water and soil contamination would impact health and safety by exposing people, livestock, and wildlife to the chemicals described in Nature and Types of Effects, and exposure to those chemicals would result in the negative health effects also described in that section. With increased development in the analysis area, the likelihood of water contamination would increase and if drilling fluids used in the development of the Unit were to contaminate local water sources, endocrine disrupting chemicals that interact with other water contaminants could have additive effects.

### 4.4.2 Socioeconomics

***Methods of Analysis***
Social and economic analysis is focused on the two-county study area (Gunnison and Delta Counties) as defined in **Chapter 3**. Although impacts may occur in surrounding counties and throughout the state, it was determined that the majority of impacts would occur within Delta and Gunnison Counties due to the location of the Unit and current population base.

Direct impacts on employment during drilling and production phases, as well as estimated costs of drilling and production are provided based on estimates from SGI. Estimates of production and related tax and royalty revenue based on full build-out were also supplied from SGI.

Revenues from minerals royalties, severance taxes, and property use taxes were calculated based on estimated production and estimated well head price, as described in **Section 3.4.2**, Socioeconomics. The analysis of potential changes in tax revenues is based on the federal mineral royalty of 12.5 percent of sales value and 5 percent of taxable value for state severance taxes (Colorado severance tax rates depend on production value but are 5 percent for production valued over $300,000).

Impacts on other land uses are discussed quantitatively and qualitatively where applicable. Economic impacts from recreation are discussed in terms of expenditures of residents from outside the local area only. This is was based on the assumption that expenditures of residents of the primary study area would occur in the region regardless of the BLM’s actions that impact recreational opportunities; however, changes in nonresident recreation patterns would alter the amount of money entering the primary study area. Information on the origin of visitors to recreational areas is typically not available.

Secondary project spending was analyzed using the IMPLAN economic impact analysis software (2010) and data. All model numbers are presented in 2014 dollar value, and estimates from SGI for labor and employment costs are based on 2014 dollar values. The model represents the area where local direct economic effects would occur and where all the local secondary effects would develop (i.e., Gunnison and Delta Counties). All IMPLAN data displayed are in terms of the estimated impacts within the two-county study area. Effects of the project are also likely to occur in other counties in Colorado and the region. It should be noted that actual economic impacts and jobs created would vary based on the production schedule, technology employed, market conditions, and other factors. Modeling is intended to provide a comparison of impacts by alternatives rather than represent a detailed forecast of actual economic impacts.

In addition to the assumptions included in **Chapter 2**, the following assumptions are applied for socioeconomic impact analysis

- Wells completed during the planning period will produce throughout the planning period.
- Average well head price for natural gas in 2012 was is $2.66/MCF (thousand cubic feet; EIA 2013b). Estimates from SGI predict natural gas prices of $4.50/MCF until 2017 and $5.50/MCF thereafter. Natural gas prices are volatile and actual average price is likely to change. Data are provided for comparative purposes only.
- Production estimates for drilled holes are based on SGI model numbers for composite coalbed methane and sandstone wells and Mancos wells models from 2015 to 2036.
- All data are displayed in 2014 dollar values. Data converted to 2010 model year dollars for input into IMPLAN model using standard deflator values.
- Percent of spending in the local economy dictated by IMPLAN- model regional percentage of local spending by sector.
- Assumes current rate of severance taxes and royalty charges and distribution.
- Unless otherwise stated it is assumed that the distribution of well type for a typically well pad with five wells is one sandstone, one coal, and three Mancos shale.

Key indicators for impact analysis include the following:

- Local area employment levels
- County and local area population
- Local government fiscal conditions
- Local area property values
- Changes to other area land uses including but not limited to hunting, agriculture, and livestock grazing
- Quality of life factors including but not limited to air, water quality, traffic, crime, and social environment

***Nature and Type of Effects***

*Employment, Population and Income*

Components of the proposed action that are likely to affect the local economy include those that result in changes to level of employment in the area and related population levels, and those that impact spending on local materials and supplies.

The aspects that are most likely to affect project-related employment, labor, and related project spending are the number of wells drilled, technology employed in drilling, the number of producing wells, and production levels. The primary differences between the alternatives are the length, pace, and intensity and timing of the development phase, and the intensity of the production phase, which is mainly determined by the total number of wells and restrictions applied to the timing of production.

The effect of project spending on the socioeconomic study area would depend on whether project employment and spending occurs locally or over a wider geographical area. For the Unit, SGI estimates that employment would be stationed in Grand Junction, Montrose, Delta, Paonia, Hotchkiss, Glenwood Springs, and Gunnison, Colorado. The specific employment needs and project spending would change over time depending on the development phase and would affect the overall distribution of project spending; highest spending and highest levels of economic contributions are generally within the drilling phase.

Population levels would be impacted directly by project activities when temporary or permanent population increases occur in the project area as a result of labor for project work. Further indirect increases can occur when project spending and employment results in additional employment needs in service and support industries. In Pennsylvania, a 1 percent increase in total employment directly linked to the oil and gas energy sector is associated with a 0.5 percent increase in county population (Farren et al. 2013). There is potential for housing and rental prices to be indirectly impacted by gas drilling should a housing shortage result in increased demand for a limited number of homes and increased prices. In Williston, North Dakota, where the national shale boom is most pronounced, the flood of workers into the small and remote region has placed a strain on housing availability and cost. One report states that the rental price for a two bedroom apartment rose from $350 to $2,000 (Oldham 2012). However, a recent review of housing impacts in Pennsylvania from 2007 to 2011 indicates that shale development is generally not associated with significant adverse effects on housing affordability and availability (Farren et al. 2013). There is some indication that temporary workers favor long-term hotels and may drive the construction of these facilities in areas with sustained drilling activity. Counties can also rely on the housing stock of neighboring counties to make up for any lack in housing availability when commuting is feasible

*Specific Economic Sectors*

Potential impacts on other land uses in the area include impacts on ranching/livestock grazing, recreation and hunting, and agriculture.

Level of grazing on BLM-administered lands and on private lands in the project area may decrease should proposed areas of disturbance include areas within current grazing allotments. Reduction of permitted or billed levels of AUMs would result in economic impacts on individual permittees, ranchers, and local businesses supporting ranching and livestock operations. Based on IM 2003-131, SGI would be required to work with any other surface owners to mitigate or compensate for damages from the proposed operations. Impacts on particular allotments are discussed in **Section 4.3.1**, Livestock Grazing.

Estimates in 2007 dollars indicate that big game hunting in Colorado resulted in expenditures of $106 per day for in-state hunters and $216 per day for out-of-state hunters (CDOW 2008). Expenditures primarily included food, lodging and transportation. In addition, the area's hunting and fishing opportunities supported approximately 912 jobs in Delta and Gunnison counties. In general, visitation to the socioeconomic project area is anticipated to increase over the next 20 years, following trends in population growth, therefore increases in contributions from hunting and other recreational activities on project area lands would be likely (approximately 2.5 and 4.5 percent per year for the UFO as a whole utilizing Colorado State Demography Office population projects). However, should project activities exclude hunting from the area, reduce the availability of game, reduce the quality of habitat in the project area for large-game, or degrade the hunting experience for those hunting in the area, then hunting trips in the area could be reduced causing the economic contribution of this activity to the area to also be reduced.

In general, impacts of BLM management activities are likely to occur should changes in visitation by hunters or other recreational visitors from outside the area occur. The reasoning is that if local recreational visitors reduce visits to the project area, they are likely to visit other local recreational areas within the socioeconomic study area, and no overall loss in income to the local economy would occur. In contrast, loss of visitors from outside the region would reduce overall contributions to the local economy.

Impacts are also possible from changes in visitation to the West Elk Loop Scenic. Economic impacts from scenic byway travel are difficult to determine, but one 2001 Colorado study estimated an approximant $50 - $188 Visitor group spending per day and $32,500 annual visitor spending per mile (Petraglia and Weisbrod 2001). Should project activities such as increased truck traffic, dust or changes to the visual setting impact the level of visitor use of the West Elk Scenic Byway (State Highway 133) contributions to local communities would be decreased. Approximately 6.4 miles of the Byway cross the Bull Mountain Unit.

Potential impacts on agriculture and agricultural tourism consist of two main components, 1) impacts due to changes to water quality or quantity, soil quality or other factors that resulting in a decrease in quantity or quality of the product produced and, 2) impacts due to a perceived degradation of the area’s quality of product that resulted in decreased sales and/or visitation.

Rumbach (2010) analyzed the potential impact of shale gas drilling on the New York tourism industry. He questioned whether drilling would permanently damage the “brand” of a region as a pristine and picturesque destination as well as the brand image for agricultural products from a shale drilling area. While quantitative analysis is lacking in Rumbach’s paper and other literature, there is some indication that increased truck traffic and visual impacts of drilling rigs may impact visitor experience. Local organic farmers and wineries express similar concerns as noted in recent new articles (for example, Taylor 2013; Jaffee 2012). In a letter submit to the BLM related to leasing of North Fork parcels for oil and gas development, the Paonia Chamber of commerce stated, "Many of our farmers are very concerned that the mere perception of polluted air, soil, and water will drive away agricultural customers in search of other quality vendors…Our hospitality industry and community at large is concerned about the potential impacts on our growing agro-tourism economy and the West Elk Scenic and Historic Byway Tourism Loop, of which we have just received recognition and funds to promote as a 'healthy community travel destination.”.

*Public Revenues*
Fiscal effects on local governments are extrapolated from the economic impacts, from projections of the value of the gas that is produced and from value of oil and gas property.

Federal mineral royalties are collected at a rate of 12.5 percent of total sales value of the production from federal-owned mineral estate, as described in Section 3.4.2, Socioeconomics. Approximately 50 percent of royalties' revenue is transferred to the Colorado State Treasurer. This portion, in turn, is distributed to counties, cities, and school districts based on senate bill 08-218. Increased production would therefore result in increased contributions to local communities and counties.

Taxes collected on production include severance tax, as well as less significant contributions to the Oil & Gas Conservation Fund Levy and the Oil & Gas Environmental Response Fund (taxed at a maximum of $0.0017 of market value at wellhead). Colorado state severance taxes on natural gas extraction are graduated, ranging from 2 percent for gross income under $25,000 to 5 percent for income of $300,000 and over. Some deductions apply for, example for ad valorem taxes paid. Severance tax revenues are distributed with 50 percent to the Colorado Department of Natural Resources to fund water conservation, wildlife, and environmental programs and the remaining 50 percent to Local Impact Fund Department of Local Affairs. Of the amount that goes to the Local Impact Fund Department of Local Affairs, 70 percent goes to local government projects and 30 percent is directly distributed to local communities.

Property taxes are also assessed on both residential and business property as well as machinery and equipment. Assessed values are derived by multiplying the actual value of the property by 7.96 percent for residential property and by 29 percent for other property times the local tax rate. Property taxes also include ad-valorem taxes, paid by the producer on the value of oil and gas production. Gunnison County ad-valorem taxes for primary production are determined based on appraisal value of 87.5 percent of prior year sales. Property taxes collected would benefit Gunnison County, local communities and school districts in Gunnison County, but would not directly impact Delta County. Changes in both residential and non-residential property value as a result of project activities would impact local community funds available, by increasing or decreasing assessed value and taxes paid. Sales tax would be generated based on current tax rate in local Counties and municipalities as discussed in Chapter 3. Increased supplies purchase in the local area directly or indirectly in support of drilling and production would also increase local tax revenue.

*Public Services*
Potential impacts on public services include increased demand for community social services, such as police and fire departments, first responders, and local hospitals and associated costs. Such cost increases resulting from gas drilling have been documented in the Rocky Mountains and the east coast (Haefele and Morton 2009; Kelsey and Ward 2010). Impacts are generally

dependent on the number of temporary workers required to relocate to the local area during drilling operations, with the higher the level of workers relocating, the greater the strain on services.

Impacts on roads may also occur due to increased traffic that occurs as a result of drilling, particularly that involving large trucks. In a 2014 study, the estimated road-reconstruction costs associated with a single horizontal well range from $13,000 to $23,000, or $5,000-$10,000 per well if state roads with the lowest traffic volumes are excluded (Abramzon et al 2014). In Rio Blanco County Colorado, a $17,700 per well fee was suggested to off-set the costs of road infrastructure maintenance (RPI 2008). Increased taxes (severance and property) could mitigate these cost pressures; however, there may not be complete compensation.

*Community Social Conditions*

As discussed in Chapter 3, survey of residents in the project area as well as comments received during scoping and on the draft EA demonstrate that area residents have varying viewpoints on the most important values for local communities and the desired conditions for these communities (BLM 2009 and 2010). Some participants and commenters note importance of jobs that the energy industry brings to the area, stating that decent paying jobs in Delta and Montrose are important. In other communities, particularly in the North Fork Valley, residents noted that local area is economically and socially dependent on healthy lands and noted clean air, water, as well as small town atmosphere, as key values (BLM 2009 and 2010). These residents are concerned that development would result in changes to these characteristics, reduce the quality of life for current residents, and result in reduction of retirees and other with non-labor income choosing to live in the area. In all areas surveyed, sustained growth was noted as an important in maintaining communities' social setting, therefore any should project activities result in unchecked growth could change local community character. Recent surveys of area residents conducted by the North Fork Heart and Soul Project (North Fork Heart and Soul 2014), a group of local citizens, generally support these findings. Values that were seen as most important for the community based on a survey of 1,600 residents are summarized as follows:

- Rural and natural environment that has an abundance of resources and opportunities for healthy living, quality food, work, recreation, and connection to the land
- Small town feel and sense of community
- Steady economy with work opportunities and the ability to grow traditional and emerging economic sectors
- Freedom to live the way we choose, our independence and our personal responsibility to our communities
- Honoring traditions and heritage while looking to the future

*Property Value*

The impact on property values from oil drilling is uncertain. On the one hand, increased property valuations of large tracts may be expected due to potential income from gas drilling, and an influx of transient workers will probably increase the demand for and value of rental properties

(Bennet 2013). In contrast, real or perceived concerns about local water quality, air quality and/or visual setting may decrease residential property values or impact ability to sell properties. In addition, some studies indicate that the ability to obtain homeowners insurance or mortgages may be impacted, particularly by hydraulic fracturing occurring on a property.

Two common methods used to estimate economic values for ecosystem or environmental services that directly affect real estate prices include hedonic pricing studies and contingent valuation studies. Hedonic pricing recognizes that the price of a home is impacted by both by internal characteristics of the good being sold and external factors affecting it (i.e. surrounding location, local air and water quality etc.). Continent valuation studies examine how much money people would be willing to pay (or willing to accept) to maintain the existence of (or be compensated for the loss of) an environmental feature.

Hedonic pricing studies and contingent valuation studies have examined the impact of wells in close proximity to residential properties. Recently conducted contingent valuation surveys in Texas and Florida show a 5 to 15 percent reduction in bid value for homes within 1 mile of theoretical hydraulic fracturing scenarios, with the exact reduction dependent on the petroleum-friendliness of the venue and proximity to the drilling site (Throupe et al. 2013). Similarly, a 2010 study found a 3 to 14 percent decrease in values, with impacts dissipating at around 2,000 meters from the well-head. Muehlenbachs, Spiller, and Timmins (2012) hedonic price study demonstrated that the risk of groundwater contamination from natural gas extraction leads to a significant reduction in house prices—a 26 percent reduction for housing on well water compared with an increase in property value for those properties on public water supply. They further found that “these reductions offset any gains to the owners of groundwater-dependent properties from lease payments or improved local economic conditions, and may even lead to a net drop in prices.” Property values details are provided in **Appendix K**, Economic Impact Analysis Methodology – Technical Report.

*Non-Market Effects*

In addition to the impacts discussed above, project activities may impact factors such as open spaces and clean air and water that have value in terms of the preservation for future generations, or in their value as providing ecosystem services as discussed in Chapter 3. Conducting willingness to pay surveys for non-use values or determining values for ecosystem services was not within the scope of this project; therefore, discussion of non-market impacts is qualitative in nature.

***Effects Common to All Alternatives***

Development would occur to some extent under all alternatives. Additional labor requirements and associated impacts on population and income, as well as indirect impacts on property values and social setting could occur under all alternatives, the intensity of impacts for the drilling phase would be dictated by the pace and scale of development and for the production phase, by the rate of production.

*Alternative A*

Alternative A includes the construction and operation of 55 natural gas wells, 11 well pads, 1 water disposal well, and associated roads and production facilities, including 1 compression station. This scenario assumes that new development will only occur on private surface with private minerals.

Employment, Income and Population

Average number of direct employment for different project phases, based on estimates provided by SGI, are included in **Table 4-56**, Bull Mountain Unit Estimated Direct Labor Requirements and Costs - Alternative A. It should be noted that numbers for the development phase represent estimated annual maximums; employment in any one year may vary based on exact rate of drilling. In addition to employees directly employed by SGI and as SGI contractors, additional companies would be hired to supply workers (vendors) to construct locations, roads, and pipelines as well as for drilling and completing the wells. Vendors would also perform surveys (civil and resource); stormwater BMP installation, maintenance, and inspections; and well site maintenance. Peak period of employment in the Bull Mountain Unit under Alternative A would likely occur about 1 year after initiation, after some wells are online and drilling continues on others. While total number of well pads constructed and well pads drilled varies by alternative, the pace of development is estimated to be the same for all alternatives (27 wells drilled per year). As a result, the duration of employment and total labor cost per phase would differ for alternatives, but the number of employees for a given year of drilling would be similar across alternatives.

**Table 4-56**
**Bull Mountain Unit Estimated Direct Labor Requirements and Costs - Alternative A**

| Project Phase | SGI Employees | Direct Labor Costs | Contract Employees | Direct Labor Costs | Vendors* |
|---|---|---|---|---|---|
| Drilling 2015-2017 | 15 | $1,996,800 | 6 | $399,360 | 264 |
| Production 2018-2038 | 6 | $798,720 | 3 | $199,680 | 25 |

Source: SGI 2014, *IMPLAN 2014
Assumes an average of 27 wells drilled per year per common assumptions in Chapter 2. Production estimates based on a total of 55 wells. All employment number in average annual monthly jobs, rounded to whole numbers.
*Note that vendors are not directly employed by SGI and represent estimates based on SGI vendor costs

SGI predicts that employment would be approximately 80 percent from within the Rocky-Mountain region, including areas with recent oil and gas development such as Grand Junction and Denver, Colorado, as well as Farmington, New Mexico. The amount of employees drawn from within the socioeconomic study area would be smaller and determined by the skill set of available workers. The outflow of labor earnings due to jobs held by non-residents would be especially high during the development phase. It should also be noted that job numbers represent new hires; however, an increase in new hires does not directly equate to an increase in the total employment count in an area. The new hires count is simply an indication of hiring activity in an industry.

Total production employment would be reduced as compared to employment for the drilling phase. With the exception of workers needed for construction of compression stations and periodic work-overs, employment for production phase would be more stable and consistent.

In addition to direct employment, project activities would result in additional secondary employment. Secondary employment is the multiplier effect resulting from additional employment created by purchases of goods and services, additional employment of suppliers (indirect employment), and household spending due to project-related income (induced employment).

Total employment estimates are summarized in **Table 4-57**, Bull Mountain Unit Direct and Indirect Annual Contributions - Alternative A. In addition, some development is likely to start while drilling is ongoing, however, the numbers in the table below do not account for this small amount of additional labor. In a given year of drilling, approximately 280 direct workers and 471 total jobs in the two-county study area would be supported by the proposed drilling operations, including SGI direct employees, contract employees and vendor employees. Additional jobs outside of the socioeconomic project area would also be supported. It should be noted that all employment values are estimates only and are provided for the purposes of comparison with the proposed action and modified proposed action. As discussed in the Nature and Type of Effects section above, actual level of employment for the project overall and at any given time will depend on the rate of production, type of technology employed in drilling wells, the number of wells drilled per pad, and other factors.

**Table 4-57**
**Bull Mountain Unit Direct and Indirect Annual Contributions - Alternative A**

| Project Phase | Direct Employment including Vendors | Total Employment | Direct Contributions | Total Contributions |
|---|---|---|---|---|
| Drilling 2015-2017 | 285 | 471 | $89,775,488 | $101,797,900 |
| Production 2018-2038 | 34 | 49 | $3,687,102 | $5,082,004 |

Source: SGI 2014, IMPLAN 2014
Assumes maximum build-out and an average of 27 wells drilled per year. Includes estimate SGI, contract and vendor employment. Based on 2014 vendor costs. Total employment and contributions include direct, indirect and induced value added. All employment numbers reported in average annual monthly jobs

Due to the presence of natural gas drilling and skilled workers in the region, it is likely that much of the labor required can be drawn from the available workers in the region and would not require permanent relocation to the two-county study area. Based on the number of workers required during drilling under Alternative A, it is unlikely that the labor required for this alternative will result in significant population increases; local employment change represents a less than 1 percent population change. The level of anticipated labor required would likely be filled by those currently unemployed, local residents in the oil and gas industry and experts in the field from within and outside the region. A percentage of those employed would not permanently reside in the two-county study area due to variety of reasons, such as the industry's requirement for rotational and transient crews;  housing availability (scarcity of appropriate type or price);. lifestyle preferences (invested elsewhere); or economic expectations (job permanence or job mobility). Out-of-town workers would reduce the amount of household goods and services consumed and housing investment spent locally. Impacts would likely be limited to the drilling phase as short-term employment would lead to temporary residency by job-holders instead of permanent immigration. Workers that cannot locate accommodation may be able to find temporary housing in towns in surrounding counties. For example, Montrose is located a little more than an hour driving distance from the Unit. As discussed in Chapter 3, within a 25-mile radius surrounding Delta, there are two RV parks and 16 hotels and over 50 additional hotels and other short-term lodging in population centers within a 100-mile radius of the Unit (tripadvisor.com 2014).

Rental vacancy rate for apartments or homes as of 2012 was approximately 4.5 percent in Delta County and 16 percent in Gunnison County (US Census Bureau 2012). As previously stated, SGI estimates that employment would be stationed not only locally in Delta, Paonia, Hotchkiss, but also in Montrose, Grand Junction, Glenwood Springs, and Gunnison. Based on vacancy rates and availability of hotel rooms as compared with the number of anticipated workers, area rental vacancies and hotels should be able to accommodate needs. Average income for the natural resources and mining sector in 2012 was $77,012 and $54,586 for Gunnison and Delta Counties respectively. This average income was significantly higher than average annual wage for both Gunnison and Delta Counties (116 percent and 63 percent higher than average wage, respectively; Headwater Economics 2013). Based on estimates provided by SGI, the direct labor costs from SGI and contract employees in the two-county study area under Alternative A would average approximately $133,120 annually per job including overhead costs for SGI employees and $66,560 for contractors during drilling and approximately $116,688 per job, including overhead costs for SGI employees and $62,233 for contractors during the production phase. Note that the high estimates per job would not be typical of earnings for all jobs. Higher income for workers in the gas industry raise the average income per job; however, the overall distribution of income would likely be concentrated on the lower end of the income spectrum due to work at lower-paid industry jobs and jobs at local trade and service establishments resulting from secondary employment. Also note that vendor labor income is not included here.

<u>Specific Economic Sectors</u>
Impacts on private land utilized for livestock grazing cannot be quantified but may result in increased time or costs for ranchers if lands are made unavailable for grazing, additional fencing is required, increased herding is required, fences are left open resulting in unwanted disbursement. See section in **Section 4.3.1**, Livestock Grazing for additional details.

Within the two-county study area, recreation, including hunting, may be impacted by ongoing development due to disturbance of big game habitat. Because the exact number of recreation visitor days in baseline conditions or under Alternative A is not available for the project area, impacts on recreation cannot be quantified. Under Alterative A, as discussed **Section 5.3.3**, Recreation, visitor experience of those hunting and recreating may be impacted by ongoing drilling operations on private lands, both in terms of visual impacts and experience. However, due to development being limited to private minerals, fragmentation of habitat for large game would be minimized under Alternative A, and economic impacts on hunting would be the lowest under this alternative.

As discussed in **Section 4.3.5**, Transportation and Access, Alternative A would result in a less than 1 percent increase in traffic; however, truck traffic may increase by up to 11 percent, which may result in decreased motorists' enjoyment of State Highway 133 as a scenic byway, particularly during the well pad construction phase.  Reduction of visitor use would decrease this contribution to the local economy as discussed under *Nature and Type of Impacts*, with impacts most likely to occur during the drilling phase on the 6.4 miles of the West Elk Loop Scenic Byway within Bull Mountain Unit. For example, if a 5 percent reduction in visitor use or spending occurred, this could relate to loss of $10,400 annually based on a per mile base rate of $32,000 spending per mile and 6.4 miles in the project area as discussed in *Nature and Type of Impacts*. Impacts would likely be lowest under this alternative due to lower level of proposed development.

Agriculture and agricultural tourism may be impacted by changes to water quality (refer to **Section 4.2.4**, Water Resources for details of impacts on water quality). Due to minimal change to water quantity and quality anticipated, direct impacts on agricultural operations are likely to be limited. As noted in the Nature and Type of Effects section, increased drilling may relate to a change to visitors experience of the area as well as the perceived quality of agricultural products from the area, but literature and data are lacking to verify this impact or quantitatively analyze potential impacts. Comments were submitted during public scoping and on the draft EA that provide some indication of the potential impacts on local companies. Owners of the Desert Weyr Farm near Paonia stated that they have seen a 10 percent decrease in revenues, which they attribute to concerns about the quality of the visitor experience to the farm or the quality of products due to ongoing oil and gas development and potential for expanded development. Representative of the Terror ditch company are concerned that increased levels of chemicals may threaten the ability of local farms to obtain organic certification. Due to the lack of development of federal lands or federal minerals under this Alternative, impacts would be limited to development of private minerals and private lands, where the BLM has no role in the decisions relate to scale and nature of development.

<u>Public Revenues</u>
As described under the Nature and Type of Effects section, public revenues would be influenced by anticipated production increases under Alternative A.

Existing wells in the Unit have seen steady increases in production since the initial production year of 2010. **Table 2-3**, Bull Mountain Unit Annual Production Rates, illustrates the past amounts of gas produced each year in the Unit. Average rate of gas production is estimated based on SGI models by well type. As a point of reference, total production for Gunnison County in 2012 was 2,072,000 MCF (Colorado Oil and Gas Conservation Commission 2013). Average rate of gas production is estimated for future years based on SGI models by well type. Tax estimates based on multipliers of net estimated revenue as described in **Appendix K**. Note that production and well head prices are model estimates only and actual production and price would vary depending on the resource and market conditions under all alternatives. Well head price in this analysis is estimated at $4.50/MCF for the first 3 project years and $5.50/MCF thereafter. Annual averages for well head prices have historically been volatile, ranging from a high of $7.97/MCF to a low of $0.19/MCF over the past 40 years (EIA 2013b). Production data and tax revenues should be viewed as estimates and used for the purpose of comparing alternatives only.

Estimated impacts from Alternative A on local fiscal conditions are included in **Table 4-58**, Impacts on Local Fiscal Conditions –Alternative A.

**Table 4-58**
**Impacts on Local Fiscal Conditions - Alternative A**

| Year | Severance Tax (Thousand $) | Al Valorem Tax (Thousand $) |
|---|---|---|
| 2015 | $1,890 | $1,134 |
| 2016 | $3,683 | $2,210 |
| 2017 | $6,176 | $3,781 |
| 2018-2036 | $113,643 | $69,577 |
| Total | $125,392 | $76,702 |

Source: SG Interests 2014
Severance tax includes the Oil & Gas Conservation Fund Levy and the Oil & Gas Environmental Response Fund
Assumes maximum build-out and an average of 27 wells drilled per year. Tax estimates based on multipliers of net estimated revenue. Note that amounts represent taxes collected not taxes distributed.

Severance tax: As detailed in *Nature and Type of Impacts*, Colorado state severance tax is graduated, ranging from 2 percent for income under $25,000 to 5 percent for income of $300,000 and over. Severance tax revenues are distributed with 50 percent to the Colorado Department of Natural Resources and the remaining 50 percent to Local Impact Fund Department of Local Affairs. Of the amount that goes to the Local Impact Fund Department of Local Affairs, 70 percent goes to local government projects, and 30 percent is directly distributed to local communities. Based on projected production and well head price, severance tax collected under Alternative A is displayed in Table 4-58.

Federal Mineral Royalties: As discussed in **Section 3.4.2**, Socioeconomics, and Nature and type of impacts, production from federal mineral estate would result in collection of royalty revenues, a portion of which would be distributed back to local area counties and communities. Under Alternative A, royalty revenue would be limited to ongoing drilling on federal leases, with the majority of drilling likely occurring on private lands, at least in the near term, due to lack of the MDP.

Property Tax: Under all Alternatives, development is likely to result in an increase in Non-residential property, particular oil and gas property as well as ad-valorem tax on oil and gas production. Changes in residential property values may be mixed, and are discussed in further detail below. Property taxes in Delta County would not be directly affected by project activities but could be impacted by any related change in property values. Based on projected production and ad-valorem tax collected under Alternative A is displayed in Table 4-58.

Other Taxes: Sales tax revenues under Alternative A would be increased, with level of impacts dependent on the quantity and cost of local materials purchased for project construction and operations. It is likely that much of the specialized equipment would not be locally available and would not contribute to local taxes.

Lodging tax revenues may be increased as a result of temporary workers residing in the area; the exact amount would depend on the county and city in which workers stayed. Length of stay and exact number of employees requiring temporary housing cannot be determined at the planning level.

Public Services
As noted in nature and type of impacts, population increase can strain public services. Impacts could occur on the following:

- Law enforcement
- Emergency Response
- Public schools
- Domestic Water and Wastewater Treatment

However, due to the population change of less than 1 percent in the project area, impacts are likely to be restricted to the drilling phase and would be limited in nature under Alternative A. Impacts are most likely to occur in short term increases in emergency services due to construction work.

As discussed in **Section 4.3.5**, increased heavy vehicle traffic would likely result in the need to increase road maintenance. Alternative A would increase the overall average annual daily traffic on the segment of Highway 133 by less than 1 percent over a 6-year timeframe. The average annual daily trips associated with trucks could, however, increase by up to 11 percent compared to existing truck-related traffic levels. SGI would implement a road maintenance plan for all roads used for project-related purposes. Maintenance would include inspections, reduction of ruts and holes, and replacement of surfacing materials as needed.

Estimated costs for road maintenance associated with the development of 55 wells range from $275,000 to over 1.27 million based on previous studies as discussed under *Nature and Type of Impacts*. SGI's road maintenance plan and taxes collected from oil and gas operations are intended offset the costs of maintenance, but may not fully compensate for costs.

Community Social Conditions
Delta and Gunnison County combined are anticipated to increase in population by over 30,000 by 2040, an increase of 62 percent (Colorado Division of Local Government, State Demography Office 2012). The proposed project would have negligible contributions to population increases, therefore changes to social setting due to population increases would not be realized. The nature and type of impacts on social conditions would be as discussed under Nature and Type of Effects above. Due to the lack of approval of an MDP under this alternative, the scale and pace of development are difficult to determine and would be largely impacted by the market for natural gas. Development under Alternative A is limited to development of private land with private minerals, and the BLM has no role in the decisions relate to scale and nature of development.

Studies of impacts of project activities were conducted to model both near-field and far-field impacts on air quality. As discussed in **Section 4.2.1**, Air Quality, near-field pollutant impacts would be below the NAAQS or CAAQS, and would not exceed the PSD Class II increments with the exception of annual $NO_2$ impacts, which could exceed the annual increment value.

As a result, local residents' health and quality of life related to air quality are not likely to be significantly impacted by project activities for any alternative.

As discussed in **Section 4.2.4**, Water Resources, the amount of water required for project construction activities is small compared with the discharge in Muddy Creek. Water requirements could be greatly reduced by implementing closed-loop drilling methods, recycling fracturing water, and by using waterless fracturing methods. The potential impacts from drilling on water quality would be least among the alternatives, since Alternative A involves construction of the fewest new wells. In terms of water quality, the quality of water could be degraded by accidental spills or releases of hazardous substances stored or used at the project sites, such as hydraulic oil and fuel used in heavy equipment, chemical additives used in well stimulation, or waste fluids stored in tanks or pits, transported by truck, or conveyed in pipelines. Following Colorado Department of Public Health and Environment (CDPHE) guidelines, and applying standard lease stipulations, described under Table 2-10, would reduce risk of contamination of water resources under all alternatives. Approval of drilling plans would provide protection measure to minimize impacts on water quality, which is of concern for area residents using well water who would be particularly affected by impacts on ground and drinking water. All wells would have a surface casing to prevent contaminates migration to the aquifer.

It should be recognized that even if project activities do not directly result in significant changes in air or water quality, residents and visitors perception of the air and water quality may be influenced by the presence of development activities.  A national study in 2010 found that among Americans who are very or somewhat aware of hydraulic fracturing, more than 69 percent are "very" or "somewhat" concerned about related water quality issues (Civil Society Institute 2010). In comments received during on the draft EA, commenters expressed ongoing concerns about risks to irrigation water due to accidental contamination, particularly for irrigation water in the Muddy River; such concerns are likely to be present with any level of development.

Additionally,  comments from local business owners involved in natural homes and alternative energy noted they have already experienced a decrease in business related to uncertainly about development and related impacts on the social setting.

<u>Property Values</u>

Changes to residential property values may occur but are likely to have impacts only on those properties immediately adjacent to the proposed development. In the project area, 37 of 44 residents are within 1 mile of existing and proposed well pads where the 40 acre analysis area is utilized, the majority of these are within 0.5 miles of proposed well sites. The greatest potential for impacts would occur on these 37 properties, although impacts may occur on a wider scale in the region. As described in the Nature and Type of Impacts section, the literature on property values demonstrates both increases and decreases in value, depending on water supply source, exact proximity to wells, siting and other factors, therefore the exact impacts on values cannot be determined and would vary based on site specific location and water source.

<u>Non-Market Effects</u>

Due to the assumption under Alternative A that development is limited to private lands and private minerals, while some changes may occur to open space and associate non-market values, impacts are likely to be lowest under this Alternative.

*Alternative B*

In addition to the existing developments, Alternative B would construct up to 36 new well pads on federal mineral estate, up to 146 new natural gas wells and up to 4 new water disposal wells. The quantity and combination of CBNG and shale gas wells on each pad is not known at this time and would also be determined at the APD stage. It is estimated that drilling activities would occur for approximately 6 years. Additionally, it is estimated that approximately 16 miles of new road construction, 53 miles of improvements to existing roads for access, 21 miles of new pipeline construction, and up to 4 new compressor stations would be constructed.

<u>Employment, Population, and Income</u>

Based on estimates provided by SGI, employment directly by SGI and by contract employees for the drilling phase is estimated to be 15 SGI employees and 6 contractors. Employment for the production phase is estimated to be 23 SGI employees and 10 contractors. As under Alternative A, it should be noted that a substantial portion of the project workforce (approximately 264 for drilling phase and 61 for the production phase) would be from vendor's employees. SGI and vendor employment estimates are included in **Table 4-59**, Bull Mountain Unit Direct Employment and Labor Costs - Alternative B.

These numbers do not include additional material costs for construction of compressor stations as well as roads, estimated at $2,025,250 direct costs. A portion of materials would be sourced from local retailers or supplies while a portion would be purchased in other locations and brought to the site location. Road materials for example, are likely to be obtained from local quarry sites and therefore the costs of these materials contributing to the local economy (See **Table 4-60**, Bull Mountain Unit Direct and Indirect Annual Contributions - Alternative B).

**Table 4-59**
**Bull Mountain Unit Direct Employment and Labor Costs - Alternative B**

| Project Phase | Direct Employment (SGI) | Direct Labor Costs | Direct Employment (Contract) | Direct Labor Costs | Direct Employment (Vendor)* |
|---|---|---|---|---|---|
| Drilling 2015-2020 | 15 | $1,996,800 | 6 | $399,360 | 264 |
| Production 2021-2040 | 23 | $2,496,000 | 10 | $665,600 | 61 |

Source: SGI 2014, *IMPLAN 2014
Assumes maximum build-out and an average of 27 wells drilled per year. All employment numbers reported in average annual monthly employees. *Note that vendors are not directly employed by SGI and represent estimates based on SGI vendor costs..

**Table 4-60**
**Bull Mountain Unit Direct and Indirect Annual Contributions - Alternative B**

| Project Phase | Direct Employment including Vendors | Total Employment | Direct Contributions | Total Contributions |
|---|---|---|---|---|
| Drilling 2015-2020 | 285 | 471 | $89,775,488 | $101,797,900 |
| Production 2021-2040 | 94 | 136 | $10,024,831 | $13,804,839 |

Source: SGI 2014, IMPLAN 2014.
Assumes maximum build-out and an average of 27 wells drilled per year. All employment number in reported in average annual monthly employees. Includes estimated SGI and contract and vendor costs. Based on 2014 vendor costs.

In total, minimal population increases from employment from drilling would be as discussed under Alternative A, but would occur for a longer period of time. As under Alternative A, it is estimated that the project would result in a less than 1 percent temporary increase in population in the area.

Specific Economic Sectors

Type of impacts on range, hunting, agriculture and tourism would be similar to those described under Nature and Type of Effects and under Alternative A. Under Alternative B, the increase in proposed development would result in an increased level of impacts on these land uses.

For recreation including hunting, the reduction in visitation to the area has not been quantified; therefore the specific economic impacts cannot be determined. Hunters could, however, expect less success under this alternative than any other alternative, which could result decreased visits and a resultant loss of income for local area outfitters, retailers, and service providers. As discussed under the Nature and Type of Effects, hunters' spending includes lodging, food, and fuel. Impacts would be most pronounced over the short-term, when construction activities are anticipated to result in the greatest disturbance of big game. Long-term impacts on the local economy could occur should hunters decide to hunt on other area lands in long-term. The level of impact would depend on if hunters and other visitors chose to recreate elsewhere in the two-county area, or chose to travel to another county for recreation.

Similarly, impacts on the visitation level and visitor experience for West Elk Loop Scenic Byway is highest under Alternative B due to higher level of proposed development. For example, if a 10 percent reduction in visitor use or spending occurred, this could relate to loss of $20,500 annually based on a per mile rate of $32,000 spending per mile and 6.4 miles in the planning area as discussed in *Nature and Type of Impacts*.

For livestock grazing, it is estimated that a reduction in approximately 5 percent of federal lands available for grazing would occur. As federal surface acres limited in the project area (440 acres) the impacted acres and related economic impacts are negligible. Additional acres of privately owned land currently utilized for grazing may become unavailable, however the acres impacted and the related economic impacts cannot be quantified here.

Impacts on agriculture would occur if the project resulted to changes in water quality or quantity. However, as discussed in **Section 4.2.4**, Water Resources, the amount of water required for project construction activities is small compared to the discharge in Muddy Creek and water quantify should not be impacted. While risk of spills or erosion is increased under this alternative, design features as defined in **Appendix C** (including but not limited to specific measures for surface disturbing activities (COAs 3-18), natural gas drilling and exploration (COAs 33-36), hazardous substances (COAs 43-52), protection of water resources (COAs 53-55), and reclamation (COAs 72-78)) would limit the likelihood of water contamination. Overall impacts on the organic farming industry and related agri-tourism cannot be quantified. However, if the increased development in the Unit results in a real or perceived impact on the environmental quality or crops grown in the area, the sales and tourism from local farms would be impacted.

In addition, the visual impacts of a greater number of gas wells alongside Highway 133 and other areas road, increased truck traffic are likely to impact the quality of the visitor experience for those seeking a quiet, pastoral, small town setting.

Public Revenues

Alternative B would result in increased contributions to local, state and public revenues, as described in detail below. Impacts would be similar in nature to that described under Alternative A, but increased due to the drilling of additional wells, and anticipated higher levels of production in the long term.

Severance tax: Assuming a maximum build out and based on a natural gas price of $4.50/1,000 MCF until 2017 and $5.50/1,000 MCF thereafter, the Proposed Action would generate an estimated $313 million in severance taxes from 2015-2036 (SGI 2014). Estimated severance taxes collected are displayed in **Table 4-61**, Impacts on Local Fiscal Conditions- Alternative B.

Federal Mineral Royalties: Under Alterative B, drilling and production of federal minerals would occur as detailed in Chapter 3. The proposed Action would generate an estimated $973 million in royalties from 2015-2036 (SGI 2014). See **Table 4-61**.

Property Tax: As discussed under Alternative A, development is likely to result in an increase in Non-residential property, particular oil and gas property as well as ad-valorem tax on oil and gas production. Changes in residential property values may be mixed, and are discussed in further detail below. Property taxes in Delta County would not be directly affected by project activities but could be impacted by any related change in property values. Based on modeled production rates and natural gas prices as stated under severance taxes, ad-valorem taxes are estimated at $188 million from 2015 to 2036. See **Table 4-61**.

**Table 4-61**
**Impacts on Local Fiscal Conditions - Alternative B**

| Year | Severance Tax (Thousand $) | Ad-Valorem Tax (Thousand $) | Federal Mineral Royalties (Thousand $) |
|---|---|---|---|
| 2015 | $1,890 | $1,134 | $5,901 |
| 2016 | $3,683 | $2,210 | $11,496 |
| 2017 | $8,243 | $4,946 | $25,728 |
| 2018 | $13,088 | $7,853 | $40,852 |
| 2019 | $16,823 | $10,094 | $52,510 |
| 2020-2036 | $275,631 | $157,223 | 837,678 |
| TOTAL | $313,326 | $187,996 | $973,259 |

Source: SG Interests 2014
Assumes maximum build-out and an average of 27 wells drilled per year.
Severance tax includes the Oil & Gas Conservation Fund Levy and the Oil & Gas Environmental Response Fund
Tax estimates based on multipliers of net estimated revenue. Note that amounts represent taxes collected not taxes distributed.

Other Taxes

As discussed under Alternative A, sales tax and lodging tax revenue are likely to increase under Alternative B, exact level of increase would be determined by quantity and cost of local materials purchased for project construction and operations and exact number of employees requiring temporary housing, location of this housing and the length of stay. Revenue increases are likely to be largest under Alternative B due to the increased number of wells drilled and the longer length of the drilling period.

Public Services
A strain on local services may occur as discussed under Nature and Type of Effects and Alternative A. Due to the longer length that temporary workers would be required for drilling required under this Alternative, the level of strain on resources is likely to be increased under Alternative B. However, total population increase in the project area would remain under 1 percent, therefore all impacts would be minimized. In addition, impacts are likely to be limited to the 6-year drilling phase, as workers would not permanently relocate to the project area. Impacts are most likely to occur in short term increases in emergency services due to construction work and increased traffic.

As discussed in section 4.3.5, Transportation and Access, average annual daily trips associated with trucks could increase by up to 21 percent compared to existing truck-related traffic levels, and 10 percent more than Alternative A. Taxes collected from oil and gas operations are intended offset the costs of maintenance, but may not fully compensate for costs. Estimated costs for road maintenance from development of 146 new well could range from $130,000-$3.36 million based on previous studies as discussed under *Nature and Type of Impacts*.

Across all jurisdictions, Alternative B may stimulate demand for services and impose costs to deliver before generating the offsetting revenues As ad-valorem taxes are collected on prior year sales, monies for road repair or increased emergency responders for example, may not be immediately available, Even if revenues would eventually exceed the costs of service, some local governments and service providers may experience short-term adverse fiscal impacts due to the project.

Community Social Conditions
As discussed under Nature and Type of Effects and Alternative A, influx of temporary workers can change the character of rural towns, particularly if a large number of these workers are from outside of the area. As the same rate of development is proposed for all alternatives, the level of workers required, and anticipated temporary population increase would be the same as discussed under Alternative A. Under Alternative B, however, the drilling phase would continue for a longer period of time (6 as opposed to 3 years) therefore the temporary workers would remain in the areas longer, and more may relocate.

The exact level of impact would be affected by the rate of development and the percentage of workers from outside the region, both of which are difficult to determine at the MDP analysis level. Anticipated population increases for all phases are less than 1 percent, substantially below that observed by Smith et al (2001) to result in boomtown impacts that dramatically altered the character of an area, therefore changes to local community setting due to population increases are likely to be minimal.

As described in **Section 4.2.1**, Air Quality, there is potential for impacts from $PM_{10}$ and $PM_{2.5}$ at receptors less than 328 feet from the source of development activities. However, additional dust control measures would be adopted to minimize these impacts; therefore, air quality should not be impacted, and local residents' health and quality of life related to air quality are not likely to be significantly impacted by project activities.

In terms of water quality and quantity changes that may impact local communities, impacts are not anticipated, but may occur under any alternative. The rate of construction is the same for Alternatives A, B, and C, water augmentation requirements would be the same for all three alternatives, except that the augmentation would continue for a longer time under Alternative B than under Alternative A. Construction would occur at the same rates as under Alternative A and over a larger area, increasing the chance of spills and release of chemicals as well as erosion. Compliance with existing regulatory requirements (including implementation of design features in **Appendix C** for water management (COAs 53-55) and hazardous substances (COAs 43-52, and SPCC plans) would greatly reduce the potential for spills and releases. Overall, hydraulic fracturing is not anticipated to impact potable groundwater resources under any alternative.

As discussed under Alternative A, even if air and water quality are not significantly impacted by project activities, local residents or visitors may still have concerns over perceived impacts from development. Impacts would be as described under Alternative A and *Nature of Type of Impacts*, but due to the increased level of development under B, likelihood of increased concern for area visitors and residents, and related impacts on quality of life would be highest under this Alternative.

Property Values

As under Alternative A, changes to residential property values may occur, and are increased with increased drilling activity. Impacts are most likely to occur to residences within 1 mile of existing and proposed wells. This alternative includes all 44 properties in the Unit. As discussed under Alternative A, there is uncertainty in the literature about the degree to which drilling impacts property values; therefore, the exact level of impacts is uncertain.

Non-Market Effects

The greatest potential for impacts on non-market values occurs under Alternative B due to the highest proposed level of development. Impacts on quality of life are discussed under *Community Social Conditions*, above. Under this alternative, up 925 acres would be disturbed in the short-term and over 315 acres in the long-term within the unit. While lands would eventually be restored, the benefit of non-developed lands for future use or enjoyment would be lost in these areas, and fragmentation of the remaining portion of the project area could further impact the non-use values.

Based on analysis in **Section 4.2.4**, Water Resources and **4.2.1**, Air Quality, air or water quality impacts would be minimized by the implementation of design features a described in **Appendix C**, particularly measures limiting surface-disturbing activities and associated dust and erosion (COAs 3-18) as well as measures for road construction and maintenance (COAs 19-24), natural gas drilling and exploration (COAs 33-36), hazardous substances (COAs 43-52), and protection of water resources (COAs 53-55). While impacts on air and water would be limited and significant impacts are not anticipated, the potential for contamination of air or water from a leak or spill is present under any alternative where development occurs. It should be noted that if degradation to air, water or land quality did occur, additional loss of ecosystem service benefits would occur, the cost to replace these services provided or mitigate for the loss should be recognized.

*Alternative C*

Impacts on socioeconomics under Alternative C would be similar to those described under Alternative B. However, Alternative C provides additional design features and modifications to management actions to mitigate impacts of gas development on wildlife populations, vegetation resources, water quality, air quality, and soil resources. For example, as described in Table 2-10, Alternative C includes measures for dust abatement and vapor emissions. Alternative C also includes requirements for an annual Operations Plan, including development phasing to avoid impacts on wintering big game species. Impacts of potential restrictions on time of use and additional design features on drilling and gas production cannot be quantified here, but it can be assumed that such measures would increase the time required for drilling operations and decrease average production levels as compared with Alternative B.

Employment, Population, and Income

Due to the identical number of wells as under Alternative B, the same number of SGI and contract laborers would likely be required for drilling and well completion. Due to the more clustered pattern of development and reduced infrastructure, labor needs as well as vendor costs would likely be reduced in duration from those levels in the proposed action. Labor required for production would be similarly reduced. The exact level would depend on the rate and intensity of development which cannot be determined here.

Specific Economic Sectors

Type of impacts on range, hunting, agriculture and tourism would be similar to those described under the Nature and Type of Effects and under Alternative A. Under Alternative C, the increase in proposed development would result in increased levels of impacts on these land uses. Additional design features, discussed in Table 2-10, and potential timing restrictions for big game wintering habitat would reduce the extent impacts to some degree.

The reduction in recreation visitation to the area, including hunting, has not been quantified; therefore, the specific economic impacts cannot be determined. Timing restriction for wildlife would reduce the level of impacts on local big game herds, thereby at least partially mitigating the impact on quality and wildlife habitat and the related economic impacts from loss of hunting opportunities.

Impacts on livestock grazing, agriculture, and tourism including the scenic byway use would be as described under Alternative B; however, the intensity of impacts would be reduced due to the reduction in anticipated infrastructure and more clustered development.

Public Expenditures and Revenues

Under Alternative C, Gunnison County government and the School Districts would experience an increase in tax and royalty revenues as discussed under Alternative B; however, the amount realized would be proportionately less due to additional design features, discussed in Table 2-10, and potential timing restrictions for big game wintering habitat that are likely to reduce overall production.

<u>Public Services</u>
A strain on local services may occur as discussed under nature and type of impacts and Alternative B. Impacts are likely to be limited to the 6-year drilling phase and reduced in scale as compared to Alterative B due to potentially reduced workforce in the more clustered development strategy under Alternative C.

<u>Community Social Conditions</u>
Impacts on social conditions would be similar to those described under Alternative B, but the level of impacts would be reduced due to the lower level of temporary workers required and presence of fewer overall well pads. All additional design features employed under Alternative C, described in Table 2-10, have the potential to reduce impacts on visual setting, water, and air quality thereby reducing the overall effect that the project may have on the quality of life for local area residents.

<u>Property Values</u>
Approximately 41 of 44 homes are located within 1 mile of a well pad; therefore, impacts could occur as discussed under Alternative B, but at a slightly reduced scale.

<u>Non-Market Effects</u>
Impacts would be as discussed under Alternative B. Level of potential impacts would be somewhat reduced due to the concentration of development on fewer well pads and seasonal restrictions.

*Cumulative*
The cumulative impact analysis area used to analyze cumulative impacts on socioeconomics and environmental justice is the two-county study area. Trends discussed in **Chapter 3** are likely to continue with similar impacts; energy development in the two-county study area currently including oil and gas development and coal mining, primarily on the North Fork of the Gunnison river area. Out of approximately 124,100 currently leased acres in the North Fork Valley, 45 active wells exist. Of these, approximately half (27 wells) were completed in the 9 years since 2005, or an average of 3 wells per year within the Unit. A lease sale EA was completed in 2012 for an additional 22 parcels consisting of 29,891 acres of federal land and approximately 860 acres of split-estate land; it is unclear how many of these leases would be developed. There are currently 17 APDs pending in the area. The North Fork Valley also has coal leases of nearly 40,000 acres, of which 1,600 acres are disturbed.

The BLM UFO Reasonable Foreseeable Development Scenario for Oil and Gas (BLM 2012b) indicates that Oil and Gas development in the UFO is likely to increase over the next 20 years. It is important to note that 25 percent of the federal fluid mineral estate in the UFO is already leased for fluid mineral development, including all of the parcels that would be developed by SGI under this MDP. Assuming that drilling outside the Unit boundary continues at a similar pace to current development, very little additional drilling activity is expected except for the proposed project and the No Action Alternative. Cumulative analysis, therefore, focuses on this proposed development. As discussed under Alternative A, Direct and Indirect Impacts, Alternative A has been defined with specific numbers of additional well pads and associated roads, pipelines, and other ancillary facilities to support a particular level of gas exploration and extraction activity on private lands, as a way of fixing the baseline for comparison the alternative in time. It has further been assumed, for purposes of comparison, that Alternative A would not proceed under either of the project alternatives. In practice, however, the future actions described under Alternative A are independent of the project alternatives and would likely be implemented concurrently or at any time, in addition to the project alternatives. For this reason, the combined Alternative A and Alternative B must be evaluated with regard to the cumulative impacts of both actions. As described in Table 4-1, up to 201 new gas wells (including federal and private mineral estate) may be developed under all alternatives. Drilling rate under all alternatives is assumed to remain at approximately 27 wells per year as discussed under direct and indirect impacts. However, the total development timeframe may impact the exact number of wells per year and the number of temporary workers require at any given point in time, as described below. Total production impacts and overall impacts on other land uses and social structure would be greater than that defined for Alternatives A or B alone, as discussed in detail below.

Under Alternative A, the MDP would not be approved, and development of federal gas resources in the Unit would continue to occur on a piecemeal basis whenever it did occur. Near-term development of federal gas resources in the project area would be the lowest of any other alternative, with reduced contributions to federal royalties. Extraction of private mineral estate may proceed sooner under Alternative A. Total time frame for development may be as long as 10 years under this alternative (Table 4-1), due to the inefficiencies of processing individual APDs. Fewer wells are likely to be drilled than maximum estimates of 27 per year, therefor; temporary employee needs in any given year may be reduced as compared to that discussed in direct and indirect impacts. While population increases would remain less than 1 percent population change for the area, extending the need for temporary employees in the area for drilling operations could result in impacts on area temporary housing, services, and social values. Conversely, presence of drilling operations in the area for an extended time frame could represent employment opportunities for residents in the region; 80 percent are anticipated to be drawn from within the Rocky-Mountain region. Cumulative impacts of the production phase would consist of up to 128 direct and indirect employees (including vendors) and 185 total employees (including direct, indirect and induced jobs), although the production timeframe for individual wells would vary and total production numbers in a given year would likewise be variable. Total population changes would remain low and long-term impacts on housing and services are not anticipated. As discussed under direct and indirect impacts, potential impacts on other land uses including livestock grazing, hunting, recreation, and agriculture may occur. When both private and federal mineral estate are taken into account, the potential for impacts on these other land uses is increased.

Under Alternatives B and C, federal gas development would occur according to the MDP and may be more efficient. Predicted time frame for development would be approximately 6 years (Table 4-1). Drilling on federal and non-federal lands with the MDP in place would likely result in drilling at the maximum level of 27 wells per year or slightly above; therefore, temporary employee needs for this 6 year period would be at maximum levels discussed under direct and indirect impacts (i.e., 285 total direct employment including vendors). Production impacts would be as described under Alterative A cumulative, above, as the total number of wells developed would be the same, however, full production may occur earlier with MDP development. Contributions to federal royalty revenues may also be increased the near-term as federal mineral development may be simplified under B and C. In addition, adaptation of mitigation measures including BMPs, RDFs, and voluntary seasonal winter timing limitations under Alternatives B and C could reduce impacts of development on other land uses, particularly for federal lands.

Overall, while the alternative selected may impact the pace and timing of development as well as the priority of developing federal or private mineral estate, development would continue under all alternatives. In the long-term, the amount of development of federal gas resources in the Unit is expected to be similar under all alternatives. Level of development proposed under all alternatives would represent a significant increase in the drilling activity and potentially gas production, compared to previous years, with the exact rate of development dependent on market prices. While the exact level of labor required at any given time cannot be forecasted, increased energy development can increase the impacts of changes in social structure, population, and housing availability in local communities, particularly if simultaneous drilling periods occur requiring high levels of temporary labor in area communities. Development could also add to the changes in the scenic values, air, and water quality and other non-market commodities. The intensity of development in the oil and gas sector is determined by pace and timing, which, to a large degree, is determined by public policy and also market forces, including national and international energy demand.

### 4.4.3 Environmental Justice

***Methods of Analysis***

As described in **Section 3.4.3**, Environmental Justice, low income and minority populations for the purpose of environmental justice analysis are defined as 1) the aggregate minority population or low income population of the affected area exceeding 50 percent or 2) the aggregate minority or low income population percentage of the affected area being “meaningfully greater” than the minority population percentage in than comparable identified here as 20 percentage points or greater difference from the state level.

Impacts on environmental justice could occur if anticipated future actions were to result in actions that could lead to:

- A potential reduced income/employment to these communities
- An impediment to economic development in low-income or minority communities
- Disproportionate potential for human health and safety impacts on low-income or minority communities

***Effects Common to All Alternatives***

As detailed in Section 3.4.2, no county or census tract level populations in the project area meet CEQ definitions for low income or minority populations. As such, the proposed action and alternatives are not likely to have disproportionate adverse effects on low income or minority populations. Public outreach for this EIS has included efforts to involve members of the community from all socioeconomic classes, and all relevant ethnic and racial backgrounds.

*Cumulative*

The cumulative impact analysis area is discussed in the Cumulative section of socioeconomic impacts, above. No significant cumulative impacts on environmental justice would occur under any alternative because there are no minority or low income populations in the project area per CEQ guidelines.

## 4.5 Irreversible and Irretrievable Commitment of Resources and Relationship of Short-term Uses of the Environment to Long-term Productivity

This section includes a summary table of the irreversible and irretrievable commitments of resources and the relationship between short-term uses of the environment and long-term productivity as required in 40 CFR 1502.16.

### 4.5.1 Irreversible and Irretrievable Commitment of Resources

A resource commitment is considered irreversible when direct and indirect impacts from its use limit future use options. Irreversible commitments apply primarily to nonrenewable resources, such as cultural resources, and to those resources that are renewable only over long periods of time, such as soil productivity. A resource commitment is considered irretrievable when the use or consumption of the resource is neither renewable nor recoverable for future use. Irretrievable commitment applies to the loss of production, harvest, or natural resources. **Table 4-62**, Irreversible and Irretrievable Commitment of Resources, summarizes the findings. The management actions, BMPs, and additional mitigation measures described above would be implemented to ensure that all natural resources are conserved to the maximum extent practicable.

**Table 4-62**
**Irreversible and Irretrievable Commitment of Resources**

| Resource | Irreversible and Irretrievable Commitment of Resources |
|---|---|
| Cultural Resources | Cultural resources are nonrenewable and, once damaged or destroyed, are not recoverable. Therefore, if a cultural resource is damaged or destroyed during energy development, that particular cultural location, resource, or object would be irretrievable. |
| Energy and Minerals | Gas development would result in the consumption of natural gas, condensate, and water, as well as salable minerals such as sand and gravel used in road construction. |
| Paleontological Resources | Paleontological resources are nonrenewable and, once damaged or destroyed, cannot be recovered. Therefore, if a paleontological resource (specimen, assemblage, or site) is damaged or destroyed during development, this scientific resource would become irretrievable. |
| Soils | Grading, construction, maintenance, and other surface-disturbing activities on sensitive, protective soil surface layers such as biotic crusts and desert pavement, which take very long periods to form, are effectively irretrievable. Increases in erosion due to disturbance of these surfaces will persist for lengthy, unknown periods. Implementation of BMPs will reduce erosion in these and other areas, assuming that channel head-cutting or other severe erosion does not become established. |
| Vegetation | Most energy development projects would cause the irreversible loss of vegetation that would otherwise have been available for wildlife to use. While every effort would be made to recover native vegetation and habitat, full restoration of preexisting conditions is not assured. |
| Visual Resources | The introduction of any new manmade line, form, color, or texture into an existing landscape will cause a change, however slight or great, in the existing visual resource inventory conditions (even if the VRM objectives are met), and for the most part, is generally irreversible because few manmade footprints upon the landscape that result from the spread of a growing civilization are ultimately removed completely. |

### 4.5.2 Relationship of Short-term Uses of the Environment to Long-term Productivity

This section compares the potential temporary effects of the actions analyzed in this EIS on the environment with the potential effects on its long-term productivity. The BLM must consider the degree to which the proposed action or alternatives would sacrifice a resource value that might benefit the environment in the long term, for some temporary value to a project proponent or the public. **Table 4-63**, Relationship of Short-term Uses of the Environment to Long-term Productivity, summarizes the findings.

Environmental protection measures described in the management actions, BMPs, and additional mitigation measures would be employed to reduce disturbances and reclaim or improve vegetation cover, soil, and wildlife habitat on these lands. While the degree of reclamation is unknown, to the extent that disturbances can be reclaimed, other productive use of these lands would not be precluded in the long term.

**Table 4-63**
**Relationship of Short-term Uses of the Environment to Long-term Productivity**

| Resource | Relationship of Short-term Uses of the Environment to Long-term Productivity |
|---|---|
| Air Quality and Greenhouse Gases | Short-term construction activities would impact air quality; long term production and continued development activities would contribute to the regional impacts on air quality . |
| Fish and Wildlife | There may be some loss of existing vegetation, soil, and habitat available for wildlife, but mitigation measures are intended to avoid most high quality wildlife habitat. Full recovery of these lands and restoration of any lost habitat or associated wildlife is not assured. |
| Livestock Grazing | Where undeveloped land is used for facilities, some grazing uses could continue within a project site. A project's use of the environment has very little adverse impact on the maintenance and enhancement of long-term productivity as construction areas would be reclaimed. |
| Soils | The alternatives would cause removal of vegetation and disturbance of soil resources. While every effort would be made to restore soil conditions, full restoration of preexisting conditions is not assured and would take many years. In particular, grading, construction, maintenance, and other surface-disturbing activities on sensitive, protective soil surface layers such as biotic crusts, which take very long periods to form, are effectively irretrievable. Increases in erosion due to disturbance of these surfaces will persist for lengthy, unknown periods. Implementing mitigation measures and BMPs would reduce erosion in these and other areas, assuming that channel head-cutting or other severe erosion does not become established. |
| Special Status Species | There would be some loss of habitat under the alternatives, but at least Alternatives B and C have been designed to avoid habitat important to special status species; therefore, the project should not significantly contribute to the population decline in special status species, lead to federal listing of species, or lead to species extinction. |
| Vegetation | There would be some loss of existing vegetation, but most of the Unit has vegetation cover that is common to the region, so a project would not result in the loss of rare resources. |

# Chapter 5
## Consultation and Coordination

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# CHAPTER 5
# CONSULTATION AND COORDINATION

## 5.1 INTRODUCTION

During the NEPA process for this EIS, the BLM formally and informally consulted and coordinated with other federal agencies, state and local governments, Indian tribes, and the interested public.

The following sections of this chapter describe the public involvement, consultation, and coordination process, including key consultation and coordination activities undertaken to ensure the BLM's compliance with, in both the spirit and intent, 40 CFR, Parts 1501.7, 1502.19, and 1503.

## 5.2 NOTICE OF INTENT AND PUBLIC COMMENTS

Throughout the public involvement process for this EIS, the BLM has sought information from individuals and organizations with knowledge of or concern for resources in the Bull Mountain Unit MDP. The process included a thorough and ongoing public participation process.

Two scoping periods were conducted for the Bull Mountain Unit MDP EA. The first was conducted from October 28, 2008, to December 12, 2008; and the second was conducted from September 17, 2009, to November 13, 2009. The preliminary EA was available for a 30-day public comment period from March 23 to April 23, 2012.

A Notice of Intent (NOI) to prepare an EIS was published in the *Federal Register* on April 3, 2013 (78 *Federal Register* 20133-20134, April 3, 2013). It notified the public of the BLM's intent to prepare an EIS, provided information on the EA previously completed for the project, and included an overview of the proposed action and a list of BLM-identified preliminary issues.

The preliminary issues were as follows: air quality; water quality and supply; threatened, endangered, and sensitive wildlife species; wildlife and wildlife habitat; recreation and visual resources; socioeconomics; and transportation.

In addition, the BLM notified the public of the public involvement through media outlets, postcards, emails, and the BLM's website. A project newsletter issued on May 2, 2013, provided information on the kickoff of the EIS and future opportunities for public involvement.

Comments received during the initial EIS comment period largely fell into several key categories: environmental, socioeconomic, stakeholder involvement, cumulative impact analyses, impact mitigation, alternatives to be analyzed, and coordination with ongoing regional and state planning (see list in Section 1.8, Key Issues Addressed in this EIS). The scoping summary report and copies of all written comments submitted by mail, email, or in person are available from the BLM Uncompahgre Field Office.

Public participation will be ongoing throughout the remainder of the Bull Mountain Unit MDP EIS process. One substantial part is the opportunity for members of the public to comment on this Draft EIS during the comment period. In the Final EIS, the BLM will respond to all substantive comments received during the 45-day comment period. It will issue a ROD after the release of the Final EIS.

## 5.3 Consultation and Coordination with Agencies and Tribal Governments

Various federal laws require the BLM to consult with American Indian tribes, the State Historic Preservation Office (SHPO), the USFWS, and the EPA during the NEPA decision making process. This section documents the specific consultation and coordination undertaken during The Draft EIS development.

### 5.3.1 Government-to-Government Consultation with Native American Tribes

The federal government works on a government-to-government basis with Native American tribes. This relationship was formally recognized on November 6, 2000, with Executive Order 13175 (*Federal Register*, Volume 65, page 67249). As a matter of practice, the BLM coordinates with all tribal governments, associated native communities, native organizations, and tribal individuals whose interests might be directly and substantially affected by activities on public lands. In addition, Section 106 of the NHPA requires federal agencies to consult with Indian tribes for undertakings on tribal lands and for historic properties of significance to the tribes that may be affected by an undertaking (36 CFR, Part 800.2[c][2]). BLM Manual 8120 (BLM 2004a) and BLM Handbook H-8120-1 (BLM 2004b) provide guidance for Native American consultations.

The BLM has given substantial consideration to the proper conduct of government-to-government consultations for this project in order to provide for multiple opportunities for tribal consultation. It has provided tribes with multiple ongoing opportunities to comment and receive information on and participate in the Bull Mountain Unit MDP EIS.

Executive Order 13175 stipulates that, during the NEPA process, federal agencies consult tribes identified as "directly and substantially affected." The BLM contacted the following tribal governments early in the EIS process:

- Southern Ute Indian Tribe
- Ute Mountain Ute Tribe

- Ute Tribe of the Uintah and Ouray Reservation

The Tribal governments were informally consulted during the earlier EA process and have been kept abreast of the project status during regular coordination meetings. In February 2014, the BLM sent formal letters to the tribes inviting them to serve as cooperating agencies for the EIS and initiating formal consultation, in accordance with the NHPA and other legal authorities. Although no tribes requested formal status as cooperating agencies, some tribal governments responded with a request to be kept informed of the EIS's progress. The tribes are on the EIS's mailing list to receive updates and notification of the availability of the Draft EIS.

Government-to-government consultation for the Bull Mountain Unit MDP EIS is ongoing via phone and email. The BLM will continue to consult with interested tribes and to keep all tribal entities informed about the NEPA process for the EIS. In addition, the BLM will continue to implement government-to-government consultation on a case-by-case basis for site-specific energy development projects on BLM-administered lands and mineral estate within the project area.

### 5.3.2 Colorado State Historic Preservation Officer Consultation

In accordance with the requirements of Section 106 of the NHPA, the BLM is coordinating with and soliciting input from the Colorado SHPO. The BLM and the SHPO are following the coordination protocols in the Colorado Protocol relating to EISs; the protocol provides for a phased consultation process related to historic, traditional, and cultural resources for an EIS and subsequent activities that could tier from a ROD. In accordance with these procedures, the BLM wrote to the SHPO on September 10, 2013. The letter introduced the Bull Mountain Unit MDP EIS and specified the need to consult on information about potential development actions. The SHPO formally responded to the letter on September 19, 2013, expressing interest but no specific concerns.

Any formal comments submitted by the SHPO will be addressed in the Final EIS. As the BLM continues to develop the Final EIS, it will formally consult with the SHPO on the potential effects on cultural resources from the proposed alternative. The BLM will finalize SHPO consultation before the ROD is signed.

### 5.3.3 US Fish and Wildlife Service Consultation

Consultation with the USFWS is required under Section 7(c) of the ESA before the BLM begins any project that may affect federally listed or endangered species or its habitat. This proposed action is considered to be a major project; the Draft EIS describes potential impacts on threatened and endangered species as a result of management actions proposed in the alternatives. The BLM has been in consultation with the USFWS regarding water depletion concerns and potential lynx habitat near the project area.

Once the BLM has determined their preferred alternative, the BLM will prepare a draft biological assessment that evaluates the impacts of the activities on federally listed threatened and endangered species. The BLM will submit the draft biological assessment to the USFWS for review. For each listed species, the BLM will determine if the implementation of the Final EIS "may affect" the species that was the subject of the consultation. At that point, the USFWS may either concur with the determination via memorandum or prepare a biological opinion. The

USFWS's response to this consultation process (either the memorandum or the biological opinion) will be included in the Final EIS.

### 5.3.4 US Environmental Protection Agency

NEPA regulations require that EISs be filed with the EPA (40 CFR, Part 1506.9). The draft Bull Mountain Unit MDP EIS was submitted to the EPA, as required by CEQ regulations.

## 5.4 Cooperating Agencies

A cooperating agency is any federal, state, or local government agency or Native American tribe that enters into a formal agreement with the lead federal agency to help develop an environmental analysis. Cooperating agencies and tribes "work with the BLM, sharing knowledge and resources, to achieve desired outcomes for public lands and communities within statutory and regulatory frameworks."

The benefits of enhanced collaboration among agencies in preparing NEPA analyses are as follows:

- Disclosing relevant information early in the analytical process
- Applying available technical expertise and staff support
- Avoiding duplication with other federal, state, tribal, and local procedures
- Establishing a mechanism for addressing intergovernmental issues

Seven agencies are working with the BLM as cooperating agencies and are listed below:

- US EPA, Region 8
- GMUG National Forest
- Gunnison County
- Delta County
- Delta Conservation District
- Colorado the Department of Natural Resources (including the Division of Parks and Wildlife)
- Colorado Department of Public Health and Environment

Interactions with the cooperating agencies have included periodic briefings and reviews of preliminary, internal draft sections of text. The BLM will continue to engage these cooperating agencies throughout the preparation of the EIS.

# Chapter 6
## List of Preparers

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# CHAPTER 6
# LIST OF PREPARERS

This EIS was prepared by an interdisciplinary team of staff from the BLM, Environmental Management and Planning Solutions, Inc. (EMPSi), with their supporting subcontractors Carter Lake Consulting and Alpine Archaeology. The following is a list of people that prepared or contributed to the development of the EIS.

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## References

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# CHAPTER 7
# REFERENCES


Abramzon, S., C. Samaras, A. Curtright, A. Litovitz, and N. Burger. 2014. Estimating the Consumptive Use Costs of Shale Natural Gas Extraction on Pennsylvania Roadways. Journal of Infrastructure Systems, 10.1061/(ASCE)IS.1943-555X.0000203. 06014001.

Abt Associates. 2012. Modeled Attainment Software, User's Manual. Abt Associates Inc., Bethesda, MD. October. (http://www.epa.gov/ttn/scram/guidance/guide/MATS-2-5-1_manual.pdf).

Ackerman, D. J. and Brooks. 1986. Reconnaissance of Ground Water Resources in the North Fork Gunnison River Basin, Southwest Colorado. USGS Water Resources Investigation Report 85-4230.

American Speech and Hearing Association (ASHA). 2008. Noise Levels. Available at Internet Web site: http://www.asha.org/public/hearing/disorders/noise.htm.

Appel, Cynthia L. and David L. Butler. 1991. Effects of a Landslide Complex on Sediment Discharges and Loads in the Muddy Creek Drainage Basin and Deposition into Paonia Reservoir, West-Central Colorado, 1986-87. U.S. Geological Survey Water-Resources Investigations Report 90-4173.

Ausbrooks, S. M. and S. Horton. 2012. Disposal of Hydrofracking-Waste Fluid by Injection into Subsurface Aquifers Triggers Earthquake Swarm in Central Arkansas with Potential for Damaging Earthquakes. PowerPoint Slide Presentation. Arkansas Geological Survey and the University of Memphis Center for Earthquake Research and Information.

Bamberger, M. and R. E. Oswald. 2012. *Impacts of Gas Drilling on Human and Animal Health.* New Solutions, Vol. 22(1) 51-77.

Barber, J. R., K. M. Fristrup, C. L. Brown, A. R. Hardy, L. M. Angeloni, and K. R. Crooks. 2009a. The costs of chronic noise exposure for terrestrial organisms. Trends in Ecology and Evolution 25 (3): 180-189.

_____. 2009b. Conserving the wild life therein – Protecting park fauna from anthropogenic noise. Park Science 26 (3), Winter 2009-2010.

Baron, J. S. 2006. Hindcasting Nitrogen Deposition to Determine and Ecological Critical Load. Ecological Applications, 16(2), 2006, pp 433-439.

Bennet, A. 2013. The Impact of Hydraulic Fracturing On Housing Values In Weld County, Colorado: A Hedonic Analysis. Thesis in Fulfilment of Degree of Master of Science Colorado State University Fort Collins, Colorado. Summer 2013

Beranek, L. L., editor. 1988. Noise and vibration control (revised edition). Institute of Noise Control Engineering, Washington, DC.

Berry, J. 2011. Hydrology and Surface Water Report for Bull Mountain Unit Master Development Plan. WWC Engineering. Sheridan WY.

Broderdorp, K. 2006-2011. Personal communication. Wildlife Biologist. US Fish and Wildlife Service, Western Colorado Field Office. Grand Junction, Colorado (reference from the EA).

Bureau of Land Management (BLM). 1984. Manual 8400—Visual Resource Management. Rel. 8-24, April 5, 1984. BLM, Washington, DC.

_____. 1985. BLM Manual 9113

_____. 1986a. Handbook H-8410-1- Visual Resource Inventory. Rel. 8-28, January 17, 1986. BLM, Washington, DC.

_____. 1986b. Handbook H-8431-1, Visual Resource Contrast Rating. Rel. 8-30, January 17, 1986. BLM, Washington, DC.

_____. 1989. Uncompahgre Basin Resource Management Plan and Record of Decision. BLM, Montrose District, Uncompahgre Basin Resource Area, CO. July 1989. Available at http://www.blm.gov/co/st/en/fo/ufo/uncompahgre_rmp.html. Last accessed, February 12, 2014.

_____. 1997. BLM Standards for Public Land Health and Guidelines for Livestock Grazing Management in Colorado. BLM, Colorado State Office, Lakewood, CO. February 3, 1997.

_____. 2005. Washington Office Instruction Memorandum 2005-247, "National Environmental Policy Act (NEPA) Compliance for Oil, Gas, and Geothermal Development". Available at http://www.blm.gov/wo/st/en/info/regulations/Instruction_Memos_and_Bulletins/ national_instruction.html. Last accessed, February 12, 2014.

_____. 2007a. North Fork Land Health Assessment 2006-2007. Uncompahgre Field Office, BLM.BLM. 2013. Soil Survey Staff, Natural Resources Conservation Service, United States Department of Agriculture. Soil Survey Geographic (SSURGO) Database for Paonia County, CO. Available online at http://soildatamart.nrcs.usda.gov. Accessed June 2013.

_____. 2007b. Environmental Assessment Piceance Development Project CO-110-2005-219-EA. Online at: http://www.blm.gov/pgdata/etc/medialib/blm/co/information/nepa/white_river_field/completed_2007_documents.Par.71869.File.dat/co11005219ea.pdf. Accessed September 2010.

_____. 2007c. BLM Onshore Oil and Gas Order #1: Onshore Oil and Gas Operations; Federal and Indian Oil and Gas Leases; Approval of Operations. Available at http://www.blm.gov/wo/st/en/prog/energy/oil_and_gas/Onshore_Order_no1.html. Last accessed, February 12, 2014.

_____. 2008a. BLM NEPA Handbook, H-1790-1. Available at http://www.blm.gov/wo/st/en/info/regulations/Instruction_Memos_and_Bulletins/blm_handbooks.html. Last accessed February 12, 2014.

_____. 2008b. Instruction Memorandum 2008-166—Technical Correction to the Bureau of Land Management's (BLM) National Environmental Policy Act (NEPA) Handbook, August 1, 2008. BLM, Washington, DC.

_____. 2009. Community Assessment of the Uncompahgre Planning Area. BLM, Uncompahgre Field Office, Montrose, CO. 224 pp

_____. 2010a. Renewable Energy Potential Report. BLM, Uncompahgre Field Office, Montrose, CO. May 2010

_____. 2010b. Analysis of the Management Situation for the BLM Uncompahgre Planning Area. Online at: http://www.blm.gov/pgdata/etc/medialib/blm/co/field_offices/uncompahgre_field/rmp/rmp_docs.Par.60566.File.dat/AMS%20Final%20Web%20071210.pdf. Accessed September 2010.

_____. 2010c. Socioeconomic Baseline report prepared for the Uncompahgre Resource Management Plan. BLM, Uncompahgre Field Office, Montrose. CO. October 2010.

_____. 2011a. Meteorological observations collected at Pine Ridge Colorado Site, Remote Automated Weather Station, US Bureau of Land Management, Online at http://www.raws.dri.edu.

_____. 2011b. PowerPoint Presentation, "Coal and Fluid Minerals Potential Presentation." Presented for the Cooperating Agencies on June 23, 2011 by Rob Ernst.

_____. 2011c. BLM Recreation Management Information System for fiscal years 2007-2011 Uncompahgre Field Office.

_____. 2012a. Bull Mountain Unit Master Development Plan, Preliminary Environmental Assessment. DOI-CO-150-2009-0005 EA. Available at http://www.blm.gov/co/st/en/BLM_Information/nepa/ufo/Bull_Mountain_EIS.html. Last accessed February 12, 2014.

_____. 2012b. Reasonable Foreseeable Development Scenario for Oil and Gas for the Uncompahgre Field Office, Colorado. Prepared by BLM Wyoming State Office, Reservoir Management Group for BLM, Uncompahgre Field Office, Montrose, CO. February 2012.

_____. 2013a. 2013. Hydraulic Fracturing White Paper. BLM Wyoming State Office. July 5, 2013.

_____. 2013b. Bull Mountain Unit MDP Scoping Summary Report. Available at http://www.blm.gov/co/st/en/BLM_Information/nepa/ufo/Bull_Mountain_EIS.html. Last accessed February 12, 2014.

_____. 2013c. Programmatic Environmental Analysis for Integrated Weed Management Treatments. Environmental Assessment. DOI-BLM-S050-2012-0029 EA. Available at http://www.blm.gov/pgdata/etc/medialib/blm/co/information/nepa/uncompahgre_field/fy2013_nepa_docs.Par.78980.File.dat/12-29%20EA%20Programmatic%20Intregrated%20Weed%20Treatments%20Final.pdf. Last accessed May 8, 2014.

_____. 2013d. BLM GIS of historical fire data. Accessed by Kelly Homstad, May 2013.

_____. 2013e. Socioeconomic Baseline report prepared for the Bull Mountain Unit Master Development Plan EIS. BLM, Uncompahgre Field Office, Montrose, CO. August 2013.

_____. 2013f. Instruction Memorandum No. 2013-131. Guidance on Estimating Nonmarket Environmental Values. September 12, 2013.

_____. 2013g. Draft BLM Manual 3180-1, Unitization [Exploratory]. Available from BLM Uncompahgre Field Office, Montrose, CO.

_____. 2014a. Modeling Protocol Colorado Air Resource Management Modeling Study (CARMMS), Bureau of Land Management, Colorado State Office, Lakewood, Colorado. January.

_____. 2014b. Colorado Air Resource Management Modeling Study (CARMMS), Preliminary Results for the High Development Scenarion (Draft), Bureau of Land Management, Colorado State Office, Lakewood, Colorado. May.

Bureau of Land Management Geographic Information System (BLM GIS). 2014. GIS data used in conjunction with SG Interests data to form the alternatives, and GIS data on file with BLM's eGIS server, including Bull Mountain Unit, VRM and VRI, existing roads, OHV designations, Colorado HUC 5 watersheds and others. Department of the Interior, BLM, Colorado Uncompahgre Field Office. Data was edited from June 2013 – June 2014.

Burton, T. A., E. R. Cowley, and S. J. Smith. 2008. Monitoring Stream Channels and Riparian Vegetation – Multiple Indicators. Version 5.0. US Department of the Interior. Bureau of Land Management. Idaho State Office. Boise, Idaho.

Church, Minette C., Steven G. Baker, Bonnie J. Clark, Richard F. Carrillo, Jonathon C. Horn, Carl Späth, David R. Guilfoyle, and E. Steve Cassells. 2007. Colorado History: A Context for Historical Archaeology. Colorado Council of Professional Archaeologists, Denver.

Civil Society Institute. 2010. Fracking and Clean waters: A Survey of Americans. Conducted for the Civil Society Institute by infogroup ORC. December 21, 2010.

Clevenger, A.P., Purroy, F.J., and M.A. Campos. 1997. Habitat assessment of a relict brown bear *Ursus arctos* population in northern Spain. Biological Conservation 80:17-22.

Colorado Department of Public Health and Environment (CDPHE). 2009a. Regulation 31- The Basic Standards and Methodologies for Surface Water (amended 10/13/09, effective 11/30/09). Online at http://www.cdphe.state.co.us/regulations/wqccregs/. Accessed September 2010.

_____. 2009b. Regulation 41 - The Basic Standards for Ground Water (amended 10/13/09, effective 11/30/09). Online at http://www.cdphe.state.co.us/regulations/wqccregs/. Accessed September 2010.

_____. 2010a Regulation 35 - Classifications and Numeric Standards for Gunnison and Lower Dolores River Basins (amended 2/8/10, effective 6/30/10). Online at http://www.cdphe.state.co.us/regulations/wqccregs/. Accessed March 2014.

_____. 2010b. Regulation 93 - Colorado's Section 303(d) List of Impaired Waters and Monitoring and Evaluation List (amended 3/9/10, effective 4/30/10). Online at: http://www.cdphe.state.co.us/regulations/wqccregs/ . Accessed September 2010.

_____. 2012. Colorado 2011 Air Quality Data Report. Air Pollution Control Division, Colorado Department of Public Health and Environment, October 2012.

_____. 2013. Colorado Department of Public Health and Environment, Air Pollution Control Division, Letter from Nancy Chick to Susan Connell, Carter Lake Consulting, Summary of background concentration estimates for the Bull Mountain Unit area, June 12 2013.

Colorado Department of Revenue. 2014. Colorado Sales and Use Tax by County. DR 1002. March 12, 2014.

Colorado Department of Transportation. 2012a. Online Transportation Information System. Traffic Data Explorer. Internet Website: http://dtdapps.coloradodot.info/Otis/HighwayData#/ui/2/0/criteria/133A/15.359/42.956. Accessed on June 17, 2013.

_____. 2012b. Statistics. http://www.coloradodot.info/library/statistics/2011%20Fatals.pdf/view & http://www.coloradodot.info/library/statistics/08-09-fatality-data.xls/view. Accessed on June 17, 2013.

_____. 2012c. Online Transportation Information System. Traffic Data Explorer. Internet Website: http://dtdapps.coloradodot.info/Otis/TrafficData#ui/1/2/0/criteria/133A/0/68.821/true/true/. Accessed on June 17, 2013.

Colorado Division of Local Government 2012. Federal Mineral Lease and State Severance Tax Direct Distribution. Internet Web site: http://dola.colorado.gov/dlg/fa/dd/history.html#data. Accessed June 20, 2013.

Colorado Division of Local Government, State Demography Office. 2012. State Demography Office Home Page. Internet Web site: http://www.dola.state.co.us/demog/index.html. Accessed June 21, 2013.

Colorado Division of Reclamation Mining and Safety. 2013. County Operator Mining Data. 2012. Monthly Coal Summary Reports. Internet Web site: http://mining.state.co.us/Coal%20Reports.htm. Accessed June 25, 2013.

Colorado Division of Water Resources (CDWR). 2010. Revised Memorandum: Submittals to the Division of Water Resources for approval of substitute water supply plans and well permits for oil and gas wells that produce ground water while producing oil or gas. From Kevin G. Rein, Assistant State Engineer. March 24.

_____. 2010. Colorado Decision Support System. Online at: http://cdss.state.co.us/DNN/default.aspx. Accessed September 2010.

Colorado Division of Wildlife (CDOW), now Colorado Parks and Wildlife. 2008. The Economic Impacts of Hunting, Fishing and Wildlife Watching in Colorado. Prepared for CDOW by BBC Research Consulting, Denver, CO. September 26, 2008.

Colorado Geological Survey (CGS). 2011. Map of Physiologic Provinces of Colorado, Modified from Fennemand and Johnson. 1:3,000,000. Online at: http://geosurvey.state.co.us/geology/topography/Pages/Physiographic.aspx.

Colorado Oil and Gas Conservation Commission (COGCC). 2006. Results of Noise Survey. Revised 09/19/2006.

_____. 2009. Section 800 Series: Aesthetic and Noise Control Regulations. Available at Internet Web site: http://cogcc.state.co.us/. April 1, 2009.

_____. 2013a. Colorado Oil and Gas Conservation Commission's Colorado Oil and Gas Information System Production Data Inquiry web site: http://cogcc.state.co.us/cogis/ProductionSearch.asp Last accessed June 19, 2013

_____. 2013b. Colorado Oil and Gas information System. Internet Web site: http://cogcc.state.co.us/cogis/. Accessed June, 2013.

Colorado Partners in Flight (CPIF). 2013. Physiographic Region 62: Southern Rocky Mountains Purple Martin (*Progne subis*). Available online. http://www.rmbo.org/pif/bcp/phy62/aspen/puma.htm

Colorado Parks and Wildlife (CPW). 2007. Data Analysis Unit D-51 South Grand Mesa Mule Deer Management Plan: Game Management Units 411, 52, and 521. December 2007.

_____. 2009. Moose Management Plan: Data Analysis Unit M-5. Colorado Parks and Wildlife. April 2009. Available online: http://wildlife.state.co.us/SiteCollectionDocuments/DOW/Hunting/BigGame/DAU/Moose/FinalM-5DAUPlan4-15-09.pdf.

_____. 2010. Success of the Colorado Division of Wildlife's Lynx Reintroduction Program. Available online: http://wildlife.state.co.us/SiteCollectionDocuments/DOW/Research/Mammals/ColoradoLynxReintroductionAssessment_090710.pdf

_____. 2011. Compensatory Mitigation and Mitigation Banking Implementation Strategy for Oil and Gas White Paper. Durango, CO. August 2011.

_____. 2012a. Deer: Genus *Odocoileus*. Internet web site: http://wildlife.state.co.us/WildlifeSpecies/Profiles/Mammals/Pages/Deer.aspx. Accessed on June 17, 2013.

_____. 2012b. Elk: *Cervus elaphus*. Internet web site: http://wildlife.state.co.us/WildlifeSpecies/Profiles/Mammals/Pages/Elk.aspx. Accessed on June 17, 2013.

_____. 2012c. Black Bear: *Ursus americanus.* Internet web site: http://wildlife.state.co.us/WildlifeSpecies/Profiles/Mammals/Pages/BlackBear.aspx. Accessed on June 17, 2013.

_____. 2013a. Moose: *Alces alces.* Internet web site: http://wildlife.state.co.us/WildlifeSpecies/Profiles/Mammals/Pages/Moose.aspx. Accessed on June 17, 2013.

_____. 2013b. Black Bear Data Analysis Unit Management Plan Grand Mesa DAU B-17. Colorado Parks and Wildlife. January 2013. Available online: http://wildlife.state.co.us/SiteCollectionDocuments/DOW/Hunting/BigGame/DAU/Bear/B17DAUplan-GrandMesa.pdf.

Colorado State Forest Service. 2012. Colorado Wildfire Risk Assessment Portal. Internet web site: http://www.coloradowildfirerisk.com/home/risk. Accessed June 7, 2013.

Colorado State University Extension (CSUE). 2013. Gunnison County Noxious Weeds. Internet Web site: http://www.gunnison.colostate.edu/agri/weeds/absinthwormwood.shtml. Accessed June 17, 2013.

Colorado Tourism Office. 2011. The Economic Impact of Travel on Colorado. 1996-2011, Prepared for Colorado Tourism Office, Office of Economic Development and International Trade Denver, Colorado. Prepared by Dean Runyan Associates. November 2012.

Cornell Lab of Ornithology. 2009. All about birds: bird guide. Internet web site: http://www.allaboutbirds.org/guide/. Accessed May 15, 2009.

Council on Environmental Quality. 1997. Environmental Justice - Guidance Under the National Environmental Policy Act. December 10, 1997.

Crompton, J.L. 2000. The Impact of Parks and Open Space on Property Values and the Property Tax Base. National Recreation and Park Association, Ashburn, VA.

Dare, M., M. Carrillo, and C. Speas. 2011. Cutthroat trout (*Oncorhynchus clarkii*) Species and Conservation Assessment for the Grand Mesa, Uncompahgre, and Gunnison National Forests. Grand Mesa, Uncompahgre, and Gunnison National Forests, Delta, Colorado.

Delta County. 2012. Lodging Tax Revenue. 2012.

_____. 2013. Delta County Joint Education District 50 data. Accessed June 26, 2013.

Delta County Independent. 2012. June 12, 2012 article

Denver Post. 2013. Elk Creek Mine in Somerset will go idle. Aldo Svaldi. December 2, 2013.

Department of Fisheries and Oceans (DFO). 2007. Directional Drilling. Online at http://www.dfo-mpo.gc.ca/oceans-habitat/habitat/modernizing-moderniser/epmp-pmpe/qc/pdf/drill_e.pdf. Accessed December 2013.

Department of Interior and United States Department of Agriculture (DOI and USDA). 2007. Surface Operating Standards and Guidelines for Oil and Gas Exploration and Development. BLM/WO/ST-06/021+3071/REV 07. Bureau of Land Management. Denver, Colorado. 84 pp. Available at http://www.blm.gov/wo/st/en/prog/energy/ oil_and_gas/best_management_practices/gold_book.html. Last accessed, February 12, 2014.

Digiuio, D. C., R. T. Wilkin, C. Miller, and G. Oberley. 2011. Investigation of Ground Water Contamination near Pavillion, Wyoming. Draft. US EPA Office of Research and Development. EPA 600/R-00/000. December.

Doherty K. E., D. E. Naugle, B. L. Walker, and J. M. Graham. 2008. Greater Sage-Grouse Winter Habitat Selection and Energy Development. Journal of Wildlife Management 72(1): 187-195.

Ellis, M. S. and V. L Freeman. 1984. Geologic Map and Cross Sections of the Carbondale 30’ x 60’ Quadrangle West-Central Colorado. US Geological Survey Coal Investigations Map C-97-A. 1:100,000.

Ellsworth, W. L. 2013. Injection-Induced Earthquakes. Science 341, 1225942. DOI: 10.1126/science.1225942

Energy Information Administration (EIA). 2011. Annual Energy Outlook 2011. Available at http://www.eia.gov/forecasts/archive/aeo11/index.cfm. Last accessed August 5, 2014.

ENVIRON, Alpine Geophysics and University of North Carolina. 2012. Western Regional Air Partnership (WRAP) West-wide Jump Start Air Quality Modeling Study (WestJumpAQMS) WRF Application/Evaluation. Prepared for Tom Moore WRAP. January 20, 2012.

ENVIRON. 2013. The Mesoscale Model Interface Program (MMIF) Version 3.0, Draft Users Manual. Prepared for Environmental Protection Agency Office of Air Quality Planning and Standards, Air Quality Assessment Division, Air Quality Modeling Group, Research Triangle Park, North Carolina. September 30, 2013.

Environment and Energy (journalist Mike Soraghan). 2014. Oil and Gas: Spills up 17 percent in U.S. in 2013. Available online: http://www.eenews.net/energywire/stories/1059999364. Accessed May 23, 2014.

Environmental Protection Agency (EPA). 1993. Superfund's Standard Default Exposure Factors for the Central Tendency and Reasonable Maximum Exposure. Preliminary Review Draft.

_____. 2004. Evaluation of Impacts to Underground Sources of Drinking Water by Hydraulic Fracturing of Coalbed Methane Reservoirs. US EPA, Office of Ground Water and Drinking Water, Drinking Water Protection Division, Prevention Branch, Washington, DC.

_____. 2005. Guideline on Air Quality Models. Updated 2005. Environmental Protection Agency Office of Air Quality Planning and Standards, Research Triangle Park, North Carolina. Published in Federal Register, Vol. 70, No. 216, November 9, 2005.

_____. 2010 Primary Distinguishing Characteristics of Level III Ecoregions of the Continental United States, revised July 2010. Internet Web site: http://www.epa.gov/wed/pages/ecoregions/level_iii_iv.htm. Accessed on June 17, 2013.

_____. 2011a. 40 CFR Part 98, Mandatory Reporting of Greenhouse Gases, Final Rule. Published in Federal Register Vol. 75, No. 242, Friday, December 17, 2010. (air resources)

_____. 2011b. Draft Investigation of Ground Water Contamination near Pavillion, Wyoming. EPA 600/R-00/000. December. Available online at http://www2.epa.gov/region8/pavillion (water)

_____. 2011c. Air Toxics Database, Table 2, Acute Dose-Response Values for Screening Risk Assessments (12/19/2011). Office of Air Quality Planning and Standards (OAQPS). Technology Transfer Network Air Toxics Website. (http://www.epa.gov/ttn/atw/ toxsource/Table2.pdf). (air resources)

_____. 2011d. EPA Ecoregions. Last updated on June 20, 2011. Internet Web site: http://www.epa.gov/wed/pages/ecoregions.htm. Accessed on June 17, 2013. (vegetation)

_____. 2012a. Air Toxics Database, Table 1, Prioritized Chronic Dose-Response Values (5/7/2012). Office of Air Quality Planning and Standards (OAQPS). Technology Transfer Network Air Toxics Website. (http://www.epa.gov/ttn/atw/toxsource/ Table1.pdf). (air resources)

_____. 2012b. Air Toxics Database, Table 1, Prioritized Chronic Dose-Response Values (5/7/2012). Office of Air Quality Planning and Standards (OAQPS). Technology Transfer Network Air Toxics Website. (http://www.epa.gov/ttn/atw/toxsource/ Table1.pdf).

_____. 2012c. Oil and Natural Gas Sector: New Source Performance Standards and National Emission Standards for Hazardous Air Pollutants Reviews; Final Rule, Fed Reg, Vol. 77, No. 159, Thursday, August 16, 2012, pp. 49490- 49600

_____. 2013a. Envirofacts -Multisystem Search. Internet web site: http://www.epa.gov/enviro/facts/multisystem.html. Accessed June 21, 2013.

_____. 2013b. Envirofacts- List of Facilities Reporting to BR in Envirofacts. Internet web site: http://iaspub.epa.gov/enviro/brs_query_v2.brs_main?fac_search=0&fac_value=&fac_search_type=1&postal_code=&location_address=&add_search_type=1&city_name=&county_name=gunnison&state_code=co&naic_code_desc=&naic_code=&yvalue=2011&mopt=0&mmopt=&wst_search=0&keyword1=&keyword2=&keyword3=&RValue1=&RValue2=&RValue3=&CValue1=&CValue2=&CValue3=&page=1&total_rows_found=&last_fac_name=

_____. 2013c. Plant Information, Gunnison Energy Corp – 1-34 Well Site. Internet web site: http://oaspub.epa.gov/enviro/afs_reports.detail_plt_view?p_state_county_compliance_src=0805100068&p_plant_id=. Accessed June 21, 2013.

_____. 2013d. Topic Searches. Internet web site: http://www.epa.gov/enviro/facts/topicsearch.html#water. Accessed on June 21, 2013.

_____. 2013e. Facility Detail Report; Aspen Leaf Lateral Pipeline. Internet web site: http://iaspub.epa.gov/enviro/fii_query_dtl.disp_program_facility?p_registry_id=110040434009. Accessed June 21, 2013.

_____. 2013f. Envirofacts, Search Results. Interactive internet web site: http://www.epa.gov/emefdata/em4ef.html?ve=8,38.66682052612305,-107.03172302246094&pText=Gunnison. Accessed June 21, 2013.

_____. 2013g. EPA’s Study of Hydraulic Fracturing and Its Potential Impact on Drinking Water Resources. Internet web site: http://www2.epa.gov/hfstudy. Accessed on August 6, 2013.

_____. 2013h. Clean Air Status and Trends Network (CASTNET). Accessed online: http://java.epa.gov/castnet/viewsiteinfo.do. Accessed June.

_____. 2013i. NO2/NOx In-Stack Ratio (ISR) Database (8/26/2013). Office of Air Quality Planning and Standards (OAQPS). Technology Transfer Network, Support Center for Regulatory Atmospheric Modeling Website. (http://www.epa.gov/ttn/scram).

_____. 2014a. Superfund Network. Accessed online: http://www.epa.gov/superfund/community/pdfs/toolkit/risk_communication-attachment6.pdf. Accessed March 2014.

_____. 2014b. Greenhouse Gas Reporting Program. Accessed online: http://www.epa.gov/climatechange/ghgemissions/usinventoryreport.html. March.

Farren, M., A. Weinstein, M. Partridge, and M. Betz. 2013. Too Many Heads and Not Enough Beds:Will Shale Development Cause a Housing Shortage? Ohio State University. Swank Program in Rural-Urban Policy Summary and Report. June 2013

_____. 2014. Fens. Internet Web site: http://water.epa.gov/type/wetlands/fen.cfm. Accessed on July 16, 2014.

Fausold, C. J. and R. J. Lilieholm. 1996. The economic value of open space. Land Lines 8(5):1–4. September 1996.

Federal Highways Administration (FHWA). 2000. Comprehensive Truck Size and Weight Study to Congress

_____. 2011. Noise Effect on Wildlife. Internet Web site: http://www.fhwa.dot.gov/environment/noise/noise_effect_on_wildlife/effects/wild01.cfm#content. Accessed May 29, 2013.

Federal Land Managers Air Quality Related Values Workgroup (FLAG) 2010. Federal Land Managers' Air Quality Related Values Workgroup (FLAG) Phase I Report – Revised (2010). U.S. Forest Service-Air Quality Program, National Park Service-Air Resources Division, U.S. Fish and Wildlife Service-Air Quality Branch. October 2010.

Fenneman, N. M., and D.W. Johnson. 1946. Physiographic Divisions of the Conterminous U.S. U.S. Geological Survey (USGS), Washington, D.C., GIS version after Fenneman’s is available http://water.usgs.gov/GIS/dsdl/physio.gz.

Foreman T. T., D. Sperling, J. A. Bissonette, A. P. Clevenger, C. D. Cutshall, V. H. Dale, L. Fahrig, R. France, C.R. Goldman, K. Heanue, J. A. Jones, F. J. Swanson, T. Turrentine, and T. C. Winter. 2003. Road Ecology. Island Press, Washington, D.C. 481 pp.

Forest Service 2000. Screening Methodology for Calculating ANC Change to High Elevation Lakes, User's Guide. U.S. Department of Agriculture (USDA) Forest Service, Rocky Mountain Region. January 2000.

_____. 2003. GIS purple martin colony data. Data received from BLM Kenneth Holsinger June 20th 2013.

_____. 2008a. GIS database for lynx habitat in Colorado. Regional Office, Lakewood, CO.

_____. 2008b. National Visitor Use Monitoring Results, National Summary Report. Last updated October 2008.

_____. 2010. Lake water chemistry provided by the USDA Forest Service, April 2010. Available online: www.fs.fed.us/armdata.

Fox, D., A. M. Bartuska, J. G. Byrne, E. Cowling, R. Fisher, G. E. Likens, S. E. Lindberg, R. A. Linthurst, J. Messer, and D. S. Nichols. 1989. A Screening Procedure to Evaluate Air Pollution Effects on Class I Wilderness Areas. General Technical Report RM-168. U.S.D.A. Forest Service, Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colorado. 36 pp.

FracFocus. 2012. Hydraulic Fracturing Fluid Product Component Information Disclosure, Federal 11-89-17 1, Gunnison County, Colorado. Job Date: June 9, 2012. Available online at: http://www.fracfocusdata.org/DisclosureSearch/StandardSearch.aspx. Accessed on January 10, 2014.

Freddy, D. J., W. M. Bronaugh, and M. C. Fowler. 1986. Responses of mule deer to disturbance by persons afoot and snowmobiles. Wildlife Society Bulletin 14:63–68.

Freethey, G. W., and G. E. Cordy, 1991, Geohydrology of Mesozoic Rocks in the Upper Colorado River Basin in Arizona, Colorado, New Mexico, Utah, and Wyoming, Excluding the San Juan Basin.

Giezentanner, K. I. 2008. Final Environmental Assessment, Management Indicator Species (MIS) Forest Plan Amendment, to the 2002 Land and Resource Management Plan- 2002 Amendment for the White River National Forest. White River National Forest, Glenwood Springs, CO.

Godwin, L. H. 1968. Geologic map of the Chair Mountain quadrangle, Gunnison and Pitkin Counties, Colorado. USGS Geologic Quadrangle: GQ-704

Greubel, Rand A., Jaclyn Mullen, Matthew J. Landt, Jonathon C. Horn, and Alan D. Reed. 2010. Class I Cultural Resource Overview of the Bureau of Land Management's Uncompahgre Field Office, Western Colorado. Prepared by Alpine Archaeological Consultants, Inc., Montrose, Colorado. Submitted to Bureau of Land Management, Uncompahgre Field Office, Montrose, Colorado.

Gunnison County. 2012 Financial Report. December 31, 2012.

_____. 2013. Gunnison County Land Use Resolution. Available at www.gunnisoncounty.org/documentcenter/view/1829. Last accessed, February 12, 2014.

Gunnison County Board of County Commissioners. 2003. Temporary Regulations for Oil and Gas Operations (Amended May 2004). Online at http://www.gunnisoncounty.org/planning_pdf/TEMP%20OIL%20AND%20GAS%20REGS%20Amended%20May%2018,%202004.pdf?download=TEMP%20OIL%20AND%20GAS%20REGS%20Amended%20May%2018,%202004.pdf. Accessed September 2010.

Gunnison County Public Works Department. 2013. Numerical List of County Maintained/Plowed Roads. http://www.gunnisoncounty.org/public_pdf/Numer-CntyMantainedRoads.pdf?download=Numer-CntyMantainedRoads.pdf. Accessed on June 17, 2013.

Haefele, M., P. Morton, and N. Culver. 2007. Natural Dividends: Wildland Protection and the Changing Economy of the Rocky Mountain West. Washington, D.C. The Wilderness Society.

Headwaters Economics. 2013. Economic Profile System Human Dimensions Toolkit - Socioeconomic Profiles produced for Delta and Gunnison Counties. Internet Web site: http://www.headwaterseconomics.org/eps/. Data for Economic Profile System accessed June, 20 2013 and March 12, 2014..

Hebblewhite, M. 2008. A literature review of the effects of energy development on ungulates: Implications for central and eastern Montana. Report prepared for Montana Fish, Wildlife and Parks, Miles City, MT. 125 pp.

Hedge, Allen. 2011. Acoustic Environment. DEA3500. Cornell University. January 2011.

Hettinger, R. D., and M. A. Kirshbaum. 2002. Stratigraphy of the Upper Cretaceous Mancos Shale (Upper Part) and Mesaverde Group in the Southern Part of the Uinta and Piceance Basins.

Holzman, D. C. 2011. *Methane Found in Well Water Near Fracking Sites.* Environmental Health Perspectives, Vol. 119, No. 7, p. A289.

IMPLAN. 2014. MIG, Inc., IMPLAN System (data and software 2010), 502 2nd Street, Suite 301, Hudson, WI 54016.

Ingelfinger, F. and F. Anderson. 2004. Passerine Response to Roads Associated with Natural Gas extraction in a Sagebrush Steppe Habitat. Western North American Naturalist. 64:385-395.

Intergovernmental Panel on Climate Change (IPCC). 2007. Climate Change 2007: Synthesis Report. Adopted at the IPCC Plenary XXVII, Valencia, Spain, 12-17 November, 2007. 52 pages.

Jaffee, Mark. 2012. Denver Post. Colorado North Fork Valley residents, businesses fighting prospect of fuel leases. Posted March 18, 2012.

Johnson, R.C. 1989. Geologic History and Hydrocarbon Potential of the Late Cretaceous-Age, Low Permeability Reservoirs, Piceance Basin, Western Colorado., in Evolution of Sedimentary Basins - Uinta and Piceance Basins. U.S. Geological Survey Bulletin 1787: E

Kassotis C. D., D. E. Tillitt, J. W. Davis, A. M. Hormann, and S. C. Nagel. 2013. *Estrogen and Androgen Receptor Activities of Hydraulic Fracturing Chemicals and Surface and Ground Water in a Drilling-Dense Region.* The Endocrine Society.

Kelsey T. W. and M. W. Ward. 2010. Natural Gas Drilling Effects on Municipal Governments Throughout Pennsylvania’s Marcellus Shale Region, 2010, Penn State Cooperative Extension, 2011.

Kowalski, D. 2010. CPW, Aquatic Research Scientist. Personal communication regarding greenback cutthroat trout.

La Plata County. 2002. Final La Plata County Impact Report. La Plata County, Colorado. October 2002.

Latousek, T. 1995. Paonia Reservoir. Online at: http://www.usbr.gov/projects//ImageServer?imgName=Doc_1305126167556.pdf. Accessed on June 17, 2013.

Lobeck, A. K. 1975. Physiographic Diagram of North America. The Geographical Press, N.J.

McKenzie, L. M., R. Z. Witter, L. S. Newman, and J. L. Adgate. 2012. *Human health risk assessment of air emissions from development of unconventional natural gas resources*. Science of the Total Environment. May 1, 2012. Volume 424: 79-87.

Menakis, J. P., D. Osborne, and M. Miller. 2003. Mapping the cheatgrass-caused departure from historical natural fire regimes in the Great Basin, USA. USDA Forest Service Proceedings RMRS-P-29. p. 281-288.

Millward, Sara. 2013. Class II Cultural Resources Inventory of the Bull Mountain Unit Study Area, Gunnison County, Colorado. Prepared by Alpine Archaeological Consultants, Inc., Montrose, Colorado. Prepared for EMPSi, Boulder, Colorado. Submitted to the Bureau of Land Management, Uncompahgre Field Office, Montrose, Colorado.

Morgan, M. L. 2008. Colorado’s Earthquake and Fault Map, Showing Locations of Historical Earthquakes and Known or Suspected Geologically Young Faults. Colorado Geological Survey. 1:1,150,000. Online at: http://geosurvey.state.co.us/hazards/Earthquakes/Documents/Earthquake_Map_2008.pdf.

Muehlenbachs, L., E. Spiller, and C. Timmins. 2012. Shale Gas Development and Property Values: Differences Across Drinking Water Sources. National Bureau of Economic Research. Working Paper 18390. http://www.nber.org/papers/w18390.

National Cooperative Soil Survey. 2013. Last updated on April 15, 2013. Internet Web site: http://soils.usda.gov/partnerships/ncss/Accessed on June 17, 2013.

National GAP Analysis Program (GAP). 2013. GIS species data portal range data for purple martin. Internet Web Site: gapanalysis.usgs.gov/species/data/download Accessed on June 20th, 2013.

National Hydrography Dataset (NHD). 2013. GIS data for streams. Received via email from BLM UFO Ken Holsinger May 10th, 2013.

Natural Diversity Information Source (NDIS). 2010. GIS data for bald eagle, mule deer, elk. Colorado Parks and Wildlife, biologists, district managers and researchers. A division of the Colorado Department of Natural Resources. Accessed via the BLM's eGIS server June 2013.

Natural Resources Conservation Service (NRCS). 1993. Soil Survey Division Staff. 1993. Soil survey manual. Soil Conservation Service. U.S. Department of Agriculture Handbook 18.Accessed on December2013. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/survey/?cid=nrcs142p2_054262

_____. 2011. SNOTEL data, Booth station, Gunnison County, 2010-2011 Water Years.

_____. 2012. National soil survey handbook, title 430-VI. Available online at http://soils.usda.gov/technical/handbook/. Accessed on June 17, 2013.

_____. 2013a. United States Department of Agriculture. Soil Survey Geographic (SSURGO) Database for Paonia County, CO. Available online at http://soildatamart.nrcs.usda.gov. Accessed June 2013.

_____. 2013b. GIS data for soil survey co679, with farmland, erosion, and representative slope attributes added using the NRCS Soil Data Viewer. US Department of Agriculture. Data available at www.soildatamart.nrcs.usda.gov. Last accessed June 11, 2013.

Nicholson, C., and R. L. Wesson. 1990. Earthquake Hazard Associated with Deep Well Injection – A Report to the U.S. Environmental Protection Agency. U.S Geological Survey Bulletin 1951.

Nietvelt, C. G. 2002. The effects of roads on wildlife: bibliography. Report prepared for U.S. Forest Service Bridger-Teton National Forest, Jackson, Wyoming. 73 pp.

North Fork Heart and Soul Project 2014. What Matters Most to the Future of the North Fork Valley- A White Paper. February 2014.

North Fork River Improvement Association (NFRIA). 2010. North Fork of the Gunnison River Watershed Plan Update. Online at: http://npscolorado.com/NFRIAWatershed_Action_Plan.pdf. Accessed on June 17, 2013.

Office of Governor Matt Mead. 2013. Wyoming to Lead Further Investigation of Water Quality Concerns Outside of Pavillion with Support of EPA. Press Release June 20, 2013. Available online at: http://governor.wy.gov/media/pressReleases/Pages/WyomingtoLeadFurtherInvestigationofWaterQualityConcernsOutsideofPavillionwithSupportofEPA.aspx

Oldham, J. 2012. North Dakota oil boom brings blight with growth as costs soar. Bloomberg News. Internet website: http://www.bloomberg.com/news/2012-01-25/north-dakota-oil-boom-brings-blight-with-growth-as-costs-soar.html.Accessed January 6, 2014.

Otak, Inc. 2009. Visual Resource Inventory. Prepared for the U.S. Department of the Interior. Bureau of Land Management. Uncompahgre Field Office. Montrose, Colorado. September 2009.

Ouren, D. S., C. Haas, C. P. Melcher, S. C. Stewart, P. D. Ponds, N. R. Sexton, L. Burris, T. Fancher, and Z. H. Bowen. 2007. Environmental Effects of Off-Highway Vehicles on Bureau of Land Management Lands: A Literature Synthesis, Annotated Bibliographies, Extensive Bibliographies, and Internet Resources. US Department of the Interior, US Geological Survey, Open-File Report 2007-1353. 225 p.

Petraglia and Weisbrod 2001. A Review of Impact Studies Related to Scenic Byway Designation. Prepared by Economic Development Research Group, Inc for the National Scenic Byways Resource Center. March 2001.

Petterson, E. S. 2012. Biological Opinion. Wildlife and Aquatic Resources Report for the Bull Mountain Unit Master Development Plan. *Prepared for*: Bureau of Land Management, Uncompahgre Field Office *and* SG Interests, I LTD. Rocky Mountain Ecological Services, Inc. Glenwood Springs, CO. 195pp.

Pitman, J. K., C. W. Spencer, and R. M. Pollastro. 1988. Petrograhy Mineralogy, and Reservoir Characteristics of the Upper Cretaceous Mesaverde Group in the East-Central Piceance Basin, Colorado. in Evolution of Sedimentary Basins - Uinta and Piceance Basins. U.S. Geological Survey Bulletin 1787: G.

Radle, A. L. 2007. The effect of noise on wildlife: a literature review. Accessed online at the World Forum for Acoustic Ecology Online Reader. Internet web site: http://interact.uoregon.edu/MediaLit/wfae/library/articles/radle_effect_noise_wildlife.pdf.

Reed, Alan D., and Michael D. Metcalf. 1999. Colorado Prehistory: A Context for the Northern Colorado River Basin. Colorado Council of Professional Archaeologists, Denver.

Rosenberger, R. S., and R. G. Walsh. 1997. “Nonmarket Value of Western Valley Ranch Land Using Contingent Valuation.” Journal of Agricultural and Resource Economics 22(2): 296–309

Rost, G. and J. Bailey. 1979. Distribution of mule deer and elk in relation to roads. The Journal of Wildlife Management 43(3): 634-641.

RPI Consulting. 2008 Road & Bridge Department Impact Fee Support Study. Prepared for Rio Blanco County, Colorado. April 2008.

Ruediger, B., J. Claar, S. Gnidek, B. Holt, L. Lewis, S. Mighton, B. Naney, G. Patton, T. Rinalki, J. Trick, A. Vandehey, F. Wahl, N. Warren, D. Wenger, and A. Williamson. 2000 (updated 2003). Canada Lynx Conservation Assessment and Strategy. USDA Forest Service, USDI Fish and Wildlife Service, USDI Bureau of Land Management, and USDI National Park Service. Forest Service Publication #R1-00-53, Missoula, MT. 142p.

Ruggiero, L. F., K. B. Aubry, S. W. Buskirk, G. M. Koehler, C. J. Krebs, K. S. McKelvey and J. R. Squires, eds. 1999. Ecology and conservation of lynx in the United States. Univ. Colorado Press and USDA Rocky Mtn. Res. Stn., USDA Gen. Tech. Rep. RMS-GTR-30WWW. 480 pp.

Rumbach, A. 2010. “Natural Gas Drilling in the Marcellus Shale: Potential Impacts on the Tourism Economy of the Southern Tier.” Prepared for the Southern Tier Central Planning Board (Corning, New York)

Rutqvist, J., A. P. Rinaldi, F. Cappa, and G. J. Moridis. 2013. Modeling of Fault Reactivation and Induced Seismicity During Hydraulic Fracturing of Shale-Gas Reservoirs. Journal of Petroleum Science and Engineering. April 28. Online at: http://www2.epa.gov/sites/production/files/2013-12/documents/fault-reactivation.pdf

San Juan Institute of Natural and Cultural Resources. 2009. Colorado Breeding Bird Atlas. Fort Lewis College, Durango, Colorado. Internet web site: http://www.cobreedingbirdatlasii.org/. Accessed: May 15, 2009.

Saros, J. E., D. W. Clow, T. Blett, and A. P. Wolfe. 2010. “Critical nitrogen deposition loads in high- elevation lakes of the western U.S. inferred from paleolimnological records”. Water, Air & Soil Pollution, DOI 10.1007/s11270-010-0526-6.

Sawyer, H., Kauffman M. J., and R. M. Nielson. 2009. Influence of well pad activity on winter habitat selection patterns of mule deer. Journal of Wildlife Management 73:1052-1061.

Sawyer, H., Nielson, R., Lindzey, F., and L. Mcdonald. 2006. Winter habitat selection of mule deer before and during development of a natural gas field. Journal of Wildlife Management 70(2), 396-403. 2006

Schmidt, C. W. 2011. *Blind Rush?: Shale Gas Boom Proceeds amid Human Health Questions.* Environmental Health Perspectives, Vol. 119, No. 8, pp. A348-A353.

SG Interests. 2013. GIS data describing the alternatives. SG Interests, Houston, TX. Data layers developed received April 2013 – December 2013.

_____. 2014. Project labor, cost, production and tax revenue estimates provided on January 24, 2014. Updated information provided May 23, 2014.

Smith, M. D., R. S. Krannich, and L. M. Hunter. Growth, Decline, Stability, and Disruption: A Longitudinal Analysis of Social Well-Being in Four Western Rural Communities. Rural Sociology, 66: 425–450. doi: 10.1111/j.1549-0831.2001.tb00075.x

Spackman, S. B., J. C. Jennings, C. Dawson, M. Minton, A. Kratz, and C. Spurrier. 1997. Colorado rare plant field guide. Prepared for the BLM, USFS, and USFWS by the Colorado Natural Heritage Program.

Speas, C. 2010. US Forest Service, Wildlife, Fisheries, and Rare Plants Program Manager. Personal communication regarding greenback cutthroat trout. January 26, 2010.

Stover, B. K., 1986, Surficial-Geologic Map of the Muddy Creek Landslide Complex, Gunnison County, Colorado, April 15, 1986. Colorado Geological Survey, Open-File Report 86-5.

Taylor, O. J. 1987. Hydrologic System of Piceance Basin. Oil Shale, Water Resources, and Valuable Minerals of the Piceance Basin, Colorado: The Challenge and Choices of Development. U.S. Department of Interior U.S. Geological Survey Professional Paper 1310. U.S. Government Printing Office. Washington D.C. 1987.

Taylor, Phil. 2013. Rising wineries, organic farms clash with BLM over leasing in energy-rich western Colorado. EE News. January 28, 2013.

Throupe, R., R.A. Simons, and X. Mao. 2013. A review of hydro ‘‘fracking’’ and its potential effects on real estate. Journal of Real Estate Literature. Volume 21, Number 2, 2013

Trautner Geotech LLC. 2011. Geologic Hazard Assessment of the Bull Mountain Geographical Area Plan Environmental Assessment Project Site. Prepared for SG Interests, Ltd.

Tripadvisor.com. 2014. Hotel rooms in Delta, Glenwood Springs and Grand Junction. Internet website: http://www.tripadvisor.com/Hotels. Accessed May 19, 2014.

Tweto, O. 1979. Geologic Map of Colorado. Colorado Geological Survey Miscellaneous Investigations MI-16. 1:500,000.

_____. 1983. Geologic Sections Across Colorado (Section C-C’). Colorado Geological Survey Miscellaneous Investigations MI-1416. 1:500,000.

United States Bureau of Labor Statistics. 2014. Local Areas annual unemployment rates. Internet web site: http://data.bls.gov/cgi-bin/dbdown. Accessed May 12, 2014.

United States Census Bureau. 2000. 2000 Census Summary Data (SF1, SF2). Internet Web site: http://www.census.gov/prod/cen2000. Accessed on June 20, 2013

_____.2010a. 2010 Census Summary Data (SF1, SF2). Internet Web site: http://www.census.gov/prod/cen2010. Accessed on June 20, 2013.

_____. 2010b. Poverty Thresholds for 2011. Internet Web Site: http://www.census.gov/hhes/www/poverty/threshld/thresh08.html. Accessed June 25, 2013.

_____. 2011. American Community Survey Data for 2007-2011, Internet Web Site: http://www.census.gov/acs/www/. Accessed June 20, 2013.

_____. 2012. Gunnison and Delta Counties. American Community Survey Housing data 2008-2012. Internet Web site:http://factfinder2.census.gov/faces/tableservices/jsf/pages/ productview.xhtml?src=bkmk. Accessed May 19, 2014.

United States Department of Agriculture, National Agricultural Statistical Service (USDA NASS). 2007. 2007 Agricultural Census County Summary Highlights – Colorado. Last updated December 2009. Internet Web site: http://www.agcensus.usda.gov/Publications/ 2007/Full_Report/Volume_1,_Chapter_2_County_Level/Colorado/st08_2_001_001.pdf. Accessed on June 19, 2013.

____. 2014. 2012 Agricultural Census- Colorado State and County Data. Released May 2014.

United States Department of Commerce, Bureau of Economic Analysis (BEA) 2012. Regional Economic Information System Data from tables Ca25N, Ca30, Ca1-3, and Ca05N. Updated 2012. Internet Web site: http://www.bea.gov/regional/index.htm#state. Accessed June 20, 2013.

United States Energy Information Administration (EIA). 2013a . Colorado Energy Profile. Internet Web Site: http://tonto.eia.doe.gov/state/state_energy_profiles.cfm?sid=CO. Accessed June 25, 2013.

_____. 2013b. U.S. Natural Gas Wellhead Price (Dollars per Thousand Cubic Feet). Internet Web Site: http://www.eia.gov/dnav/ng/hist/n9190us3A.htm. Accessed December 30, 2013.

United States Fish and Wildlife Service (USFWS). 1998. Greenback Cutthroat Trout Recovery Plan. Region 6 US Fish and Wildlife Service Denver, CO. March 1998. Available online: http://warnercnr.colostate.edu/~kurtf/400web/Field%20trip%20assignment/Native%20cutthroat/GBNRecoveryPlan.pdf.

_____. 1999. Final programmatic biological opinion for Bureau of Reclamation's operations and depletions, other depletions, and funding and recovery program actions in the upper Colorado River above the confluence with the Gunnison River. USFWS, Grand Jct. CO. July 1999.

_____. 2008. Birds of Conservation Concern. US Fish and Wildlife Service Division of Migratory Bird Management. Arlington, Virginia. December 2008.

_____. 2009. Greenback Cutthroat Trout (*Oncorhnychus clarki stomias*) 5-Year Review: Summary and Evaluation. USFWS Colorado Field Office. Lakewood, CO. May 2009. Available online: http://ecos.fws.gov/docs/five_year_review/doc2414.pdf.

_____. 2010. Endangered and Threatened Wildlife and Plants; 12-Month Finding on a Petition To List Astragalus microcymbus and Astralagus schmolliae as Endangered or Threatened. Federal Register / Vol. 75, No. 240 / Wednesday, December 15, 2010 / Proposed Rules.

_____. 2012. Greenback Cutthroat Trout Recovery Team: Study Reveals Secrets of Colorado's Cutthroats. Available online: http://www.fws.gov/mountain-prairie/pressrel/2012/09242012_GBCT.pdf.

_____. 2013. Rocky Mountain Success Story: Canada Lynx Returns. Available online: http://www.fws.gov/news/blog/index.cfm/2013/2/1/Rocky-Mountain-Success-Story-Canada-Lynx-Returns.

United States Geological Survey (USGS). N.d. Professional Paper 1411-C.

_____. 2001a. Bull Mountain, Colorado, 7.5-minute topographic quadrangle map (water).

_____. 2001b. Chair Mountain, Colorado, 7.5-minute topographic quadrangle map (water).

_____. 2001c. Somerset, Colorado, 7.5-minute topographic quadrangle map (water).

_____. 2008. Seismic Hazard Map of Western U.S., showing Peak Ground Acceleration (PGA) with 2% probability of exceedence in 50 years. Online at: http://earthquake.usgs.gov/hazards/products/conterminous/2008/update_201001/maps/2008.WUS.0p00.1150.2475.pdf.

_____. 2010. National Water Information System – Water Quality Samples for Colorado. Online at http://nwis.waterdata.usgs.gov/co/nwis/qwdata?search_criteria=search_site_no&submitted_for m=introduction. Accessed September 2010. (water)

_____. 2011. Paonia Reservoir, Colorado, 7.5-minute topographic quadrangle map.

_____. 2013. need reference, from ch 3 water; National Water Information System (http://waterdata.usgs.gov/co/nwis/).

_____. 2014. Record Number of Oklahoma Tremors Raises Possibility of Damaging Earthquakes. 2014. Available online: http://earthquake.usgs.gov/regional/ceus/products/newsrelease_05022014.php. Accessed May 23, 2014.

Upper Colorado River Endangered Fish Recovery Program 2013 2012-2013 Highlights. Available online: http://www.coloradoriverrecovery.org/general-information/general-publications/briefingbook/2012-2013Highlights.pdf.

Van Dyke, F. B., R. H. Brocke, H. G. Shaw, B. B. Ackerman, T. P. Hemker, and F. G. Lindzey. 1986. Reactions of mountain lions to logging and human activity. The Journal of Wildlife Management 50:95-102.

Van Reyper, G. 2006. Bureau of Land Management TES [threatened, endangered, sensitive] species descriptions. Uncompahgre Field Office, Montrose, CO, updated 2009/ 2010. Unpublished document.

Visibility Information Exchange Web System (VIEWS). 2013. Regional Haze Summary Data. Means for Best, Middle, and Worst 20% Visibility Days. Accessed online: http://views.cira.colostate.edu/web/Trends/. Accessed June.

Warpinski, M. 2013. Understanding Hydraulic Fracture Growth, Effectiveness, and Safety Through Microseismic Monitoring. http://dx.doi.org/10.5772/55974 . Accessed on January 13, 2014.

Weinhold, B. 2012. Energy Development Linked with Earthquakes. Environmental Health Perspectives Vol. 120, No. 10. October 2012.

Westbrooks, R. 1998. Invasive plants, changing the landscape of America: Fact book. Federal Interagency Committee for the Management of Noxious and Exotic Weeds (FICMNEW). Washington, DC.

Western Governors' Association, 1998. WGA Open Land Initiative. Economic Benefits of Open Space: April 1998. http://www.westgov.org/wga/intiatives/tpl/ecogen.htm

Western Regional Climate Center (WRCC). 2013. Historical climate data for Redstone 4 W, Colorado. Online at http://www.wrcc.dri.edu. Accessed June 2013.

Wiggins, D. 2005. Purple Martin (*Progne subis*): a technical conservation assessment. USDA Forest Service, Rocky Mountain Region. Available online: http://www.fs.fed.us/r2/projects/scp/assessments/purplemartin.pdf.

Wilbert, M., J. Thomas, and N. W. Culver. 2008. Analysis of Habitat Fragmentation from Oil and Gas Development and its Impacts on Wildlife: A Framework for Public Land Management Planning. The Wilderness Society, Ecology and Economics Research Department. May 20, 2008.

Wilson, Weston. 2004. Letter to Senators Allard and Campbell and Representative DeGette, Colorado Representatives, regarding errors in EPA hydraulic fracturing study. October 8, 2004.

Wright Water Engineers, Inc. 2003. Characterization and Assessment of Water Resources on the Southeastern Flank of the Grand Mesa, Delta, Gunnison and Mesa Counties, Colorado. January.

WWC Engineering (WWC) 2011. Water Resources Technical Report. Sheridan, Wyoming. June 2011. (water)

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# Glossary

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# GLOSSARY

**100-year floodplain.** The area inundated by a flood event with a one percent chance of occurring in any given year.

**Abandoned nest.** A nest that was occupied by breeding birds earlier in the breeding season but was abandoned at some point during breeding (e.g., failed eggs, death of young).

**Active nest site.** A raptor nest site that is currently occupied by a pair of breeding raptors.

**Actual use.** The amount of animal unit months consumed by livestock based on the numbers of livestock and grazing dates submitted by the livestock operator and confirmed by periodic field checks by the BLM.

**Adaptive management.** A type of natural resource management in which decisions are made as part of an ongoing science-based process. Adaptive management involves testing, monitoring, and evaluating applied strategies, and incorporating new knowledge into management approaches that are based on scientific findings and the needs of society. Results are used to modify management policy, strategies, and practices.

**Administrative access.** Administrative access pertains to travel on routes that are limited to authorized users (typically motorized access). These are existing routes that lead to developments that have an administrative purpose, where the BLM or a permitted user must have access for regular maintenance or operation.

**Air basin.** A land area with generally similar meteorological and geographic conditions throughout. To the extent possible, air basin boundaries are defined along political boundary lines and include both the source and receptor areas.

**Air pollution.** Degradation of air quality resulting from unwanted chemicals or other materials occurring in the air.

**Air quality classes.** Classifications established under the Prevention of Significant Deterioration portion of the Clean Air Act, which limits the amount of air pollution considered significant within an area. Class I applies to areas where almost any change in air quality would be significant; Class II applies to areas where the deterioration normally accompanying moderate well-controlled growth would be insignificant; and Class III applies to areas where industrial deterioration would generally be insignificant.

**Airshed.** A subset of air basin, the term denotes a geographical area that shares the same air because of topography, meteorology and climate.

**Allotment.** An area of land in which one or more livestock operators graze their livestock. Allotments generally consist of BLM lands but may include other federally managed, state-owned, and private lands. An allotment may include or more separate pastures. Livestock numbers and periods of use are specified for each allotment.

**Allotment management plan.** A concisely written program of livestock grazing management, including supportive measures if required, designed to attain specific, multiple-use management goals in a grazing allotment. An AMP is prepared in consultation with the permittee(s), lessee(s), and other affected interests. Livestock grazing is considered in relation to other uses of the range and to renewable resources, such as watershed, vegetation, and wildlife. An AMP establishes seasons of use, the number of livestock to be permitted, the range improvements needed, and the grazing system.

**All-terrain vehicle.** A motorized vehicle that is less than 50 inches in width and is capable of operating on roads, trails, or designed areas that are not maintained. A wheeled vehicle, other than a snowmobile, that has a wheelbase and chassis of 50 inches in width or less, generally has a dry weight of 800 to 1200 pounds or less, and travels on three or more low-pressure tires.

**Alluvial soil.** A soil developing from recently deposited alluvium and exhibiting essentially no horizon development or modification of the recently deposited materials.

**Alluvium.** Clay, silt, sand, gravel, or other rock materials transported by moving water. Deposited in comparatively recent geologic time as sorted or semi-sorted sediment in rivers, floodplains, lakes, and shores, and in fans at the base of mountain slopes.

**Alternate nest (inactive nest) site.** A raptor nest site that has been used in the past by and within the territory of a breeding pair of raptors. The nest site still maintains the characteristics of a nest structure and habitat features of a nest site but is not currently in use.

**Ambient air quality.** The state of the atmosphere at ground level as defined by the range of measured and/or predicted ambient concentrations of all significant pollutants for all averaging periods of interest.

**Ambient noise.** The all-encompassing noise level associated with a given environment, being a composite of sounds from all sources.

**Animal unit month (AUM).** The amount of forage necessary for the sustenance of one cow or its equivalent for a period of one month.

**Aquatic**. Living or growing in or on the water.

**Assets.** Term utilized to describe roads, primitive roads, and trails that comprise the transportation system. Also the general term utilized to describe all BLM constructed "Assets" contained within the Facility Asset Management System.

**Atmospheric deposition.** Air pollution produced when acid chemicals are incorporated into rain, snow, fog, or mist and fall to the earth. Sometimes referred to as "acid rain" and comes from sulfur oxides and nitrogen oxides, products of burning coal and other fuels and from certain industrial processes. If the acid chemicals in the air are blown into the area where the weather is wet, the acids can fall to earth in the rain, snow, fog, or mist. In areas where the weather is dry, the acid chemicals may become incorporated into dust or smoke.

**Attainment area.** A geographic area in which levels of a criteria air pollutant meet the health-based National Ambient Air Quality Standard for that specific pollutant.

**Attenuation.** The reduction of sound intensity and energy as a function of distance traveled.

**Avoidance area.** *See "right-of-way avoidance area" definition.*

**Backcountry.** Lands that is remote from development and typically difficult to access.

**Bank-full stage.** The water surface elevation that just fills the active channel to the top of its banks and at a point where the water begins to overflow onto a floodplain.

**Best management practice (BMP)**. A method, process, or activity, or usually a combination of these, that are determined by a State or a designated planning agency to be the most effective and practicable means (including technological, economic, and institutional considerations) of managing or controlling particular conditions or circumstances. BMPs are a suite of voluntary, accepted measures that may or may not be applied to or enforced for any given project.

**Big game.** Indigenous, ungulate (hoofed) wildlife species that are hunted, such as elk, deer, bison, bighorn sheep, and pronghorn antelope.

**Biodiversity (biological diversity).** The variety of life and its processes, and the interrelationships within and among various levels of ecological organization. Conservation, protection, and restoration of biological species and genetic diversity are needed to sustain the health of existing biological systems. Federal resource management agencies must examine the implications of management actions and development decisions on regional and local biodiversity.

**Biological Opinion.** A document prepared by USFWS stating their opinion as to whether or not a federal action will likely jeopardize the continued existence or adversely modify the habitat of a listed threatened or endangered species.

**Biological soil crust.** A complex association between soil particles and cyanobacteria, algae, microfungi, lichens, and bryophytes that live within or atop the uppermost millimeters of soil.

**BLM Sensitive Species.** Those species that are not federally listed as endangered, threatened, or proposed under the ESA, but that are designated by the BLM State Director under 16 USC 1536(a)(2) for special management consideration. By national policy, federally listed candidate species are automatically included as sensitive species. Sensitive species are managed so they will not need to be listed as proposed, threatened, or endangered under the ESA.

**Candidate species.** Taxa for which the USFWS has sufficient information on their status and threats to propose the species for listing as endangered or threatened under the ESA, but for which issuance of a proposed rule is currently precluded by higher priority listing actions. Separate lists for plants, vertebrate animals, and invertebrate animals are published periodically in the Federal Register (BLM Manual 6840, Special Status Species Manual).

**Categorical Exclusion.** A category of actions (identified in agency guidance) that do not individually or cumulatively have a significant effect on the human environment, and for which neither an environmental assessment nor an environmental impact statement is required (40 CFR 1508.4), but a limited form of NEPA analysis is performed.

**Chemical vegetation treatment**. Application of herbicides to control invasive species/noxious weeds and/or unwanted vegetation. To meet resource objectives the preponderance of chemical treatments would be used in areas where cheatgrass or noxious weeds have invaded sagebrush steppe.

**Classified surface water supply segment.** A “public water system,” as defined by the State of Colorado, beginning at the surface water point of intake and extending 5 miles upstream.

**Clean Air Act of 1963 (as amended).** Federal legislation governing air pollution control.

**Climate change.** Any significant change in measures of climate (such as temperature, precipitation, or wind) lasting for an extended period (decades or longer). Climate change may result from:

- Natural factors, such as changes in the sun's intensity or slow changes in the Earth's orbit around the sun
- Natural processes within the climate system (e.g., changes in ocean circulation)
- Human activities that change the atmosphere's composition (e.g., driving automobiles) and the land surface (e.g., deforestation, reforestation, urbanization, and desertification).

**Closed loop system:** a mechanical and chemical system which allows an operator to drill a well without using a reserve pit. In a closed-loop drilling system, the reserve pit is replaced with a series of storage tanks that separate liquids and solids, some of which are re-used and some of which are disposed of. The recovered drilling fluid is stored in 500-barrel tanks and re-used in active mud systems; consequently, drilling fluid is moved from well-to-well and reconditioned by the dewatering equipment and mud products. The solid wastes are transferred off-site for disposal at oilfield waste disposal facilities.

**Collaboration.** A cooperative process in which interested parties, often with widely varied interests, work together to seek solutions with broad support for managing public and other lands. Collaboration may take place with any interested parties, whether or not they are a cooperating agency.

**Collaborative partnerships.** Refers to people working together, sharing knowledge and resources, to achieve desired outcomes for public lands and communities within statutory and regulatory frameworks.

**Common use area.** Areas designated to sell various mineral materials (e.g., gravel or moss rock) to the public through purchase of a permit from the BLM Field Office.

**Condition of approval.** Condition or provision (requirement) under which an application for a permit to drill or sundry notice is approved.

**Conformance.** A proposed action shall be specifically provided for in the land use plan or, if not specifically mentioned, shall be clearly consistent with the goals, objectives, or standards of the approved land use plan.

**Conservation agreement.** A formal signed agreement between the USFWS or National Oceanographic and Atmospheric Administration-Fisheries and other parties that implement specific actions, activities, or programs designed to eliminate or reduce threats to, or otherwise improve the status of, a species. Conservation agreements can be developed at a state, regional, or national level and generally include multiple agencies at both the state and federal level, as well as tribes. Depending on the types of commitments the BLM makes in a conservation agreement and the level of signatory authority, plan revisions or amendments may be required before the conservation agreement is signed or subsequently in order to implement the conservation agreement.

**Conservation strategy.** A strategy outlining current activities or threats that are contributing to the decline of a species, along with the actions or strategies needed to reverse or eliminate such a decline or threats. Conservation strategies are generally developed for species of plants and animals that are designated as BLM sensitive species or that have been determined by the USFWS or National Oceanographic and Atmospheric Administration-Fisheries to be federal candidates under the ESA.

**Controlled surface use (CSU).** CSU is a category of moderate constraint stipulations that allows some use and occupancy of public land while protecting identified resources or values and is applicable to fluid mineral leasing and all activities associated with fluid mineral leasing (e.g., truck-mounted drilling and geophysical exploration equipment off designated routes, construction of wells and/or pads). CSU areas are open to fluid mineral leasing but the stipulation allows the BLM to require special operational constraints, or the activity can be shifted more than 200 meters (656 feet) to protect the specified resource or value.

**Cooperating Agency.** Assists the lead federal agency in developing an environmental assessment or environmental impact statement. These can be any agency with jurisdiction by law or special expertise for proposals covered by NEPA (40 CFR 1501.6). Any tribe or Federal, State, or local government jurisdiction with such qualifications may become a cooperating agency by agreement with the lead agency.

**Corridor.** A strip of land that aids in the movement of species between disconnected core areas of their natural habitat.

**Criteria pollutant.** The US EPA uses six "criteria pollutants" as indicators of air quality, and has established for each of them a maximum concentration above which adverse effects on human health may occur. These threshold concentrations are called National Ambient Air Quality Standards. The criteria pollutants are ozone, carbon monoxide, nitrogen dioxide, sulfur dioxide, particulate matter and lead.

**Critical habitat.** An area: A) designated by the USFWS that is occupied by a threatened or endangered species "on which are found those physical and biological features (1) essential to the conservation of the species, and (2) which may require special management considerations or protection;" or B) on which are found those physical and biological features essential to the conservation of a species that may require special management consideration or protection.

**Crucial habitat types.** The environment essential to plant or animal biodiversity and conservation at the landscape level. Crucial habitats include, but are not limited to, ecological emphasis areas, severe winter range, winter concentration areas, reproduction areas, and movement corridors.

**Crucial winter range.** That part of the overall range where 90 percent of the individuals are located during the average five winters out of 10 from the first heavy snowfall to spring green-up, or during a site-specific period of winter as defined for each Colorado Parks and Wildlife Data Analysis Unit.

**Cultural resources**. Locations of human activity, occupation, or use. Cultural resources include archaeological, historic, or architectural sites, structures, or places with important public and scientific uses, and locations of traditional cultural or religious importance to specified social and/or cultural groups.

**Cultural resources inventory.** An inventory to assess the potential presence of cultural resources. There are three classes of surveys:

**Class III.** An intensive field inventory designed to locate, from surface and exposed profile indications, all cultural resource sites in an area. Upon its completion, no further cultural resources inventory work is normally needed.

**Cumulative effects.** The direct and indirect effects 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.

**Cyanobacteria.** A blue-green algae or bacteria that obtain its energy through photosynthesis.

**Decision Area.** Lands and federal mineral estate within the planning area that are administered by the BLM.

**Degraded vegetation.** Areas where the plant community is not complete or is under threat. Examples include missing components such as perennial forbs or cool season grasses, weed infestations, or lack of regeneration of key species such as sagebrush or cottonwoods trees.

**Design feature(s).** Specific means, measures or practices that make up the proposed action and alternatives. They include construction activities, operating procedures, and stipulations, as well as measures that reduce or avoid adverse environmental impacts. See BLM NEPA Handbook, H-1790-1, pages 44-45 and 61.

**Designated roads and trails.** Specific roads and trails identified by the BLM (or other agency) where some type of motorized/nonmotorized use is appropriate and allowed, either seasonally or year-long (H-1601-1, BLM Land Use Planning Handbook).

**Direct impacts.** Direct impacts are caused by an action or implementation of an alternative and occur at the same time and place.

**Directional drilling.** A drilling technique whereby a well is deliberately deviated from the vertical in order to reach a particular part of the oil- or gas-bearing reservoir. Directional drilling technology enables the driller to steer the drill stem and bit to a desired bottom hole location. Directional wells initially are drilled straight down to a predetermined depth and then gradually curved at one or more different points to penetrate one or more given target reservoirs. This specialized drilling usually is accomplished with the use of a fluid-driven downhole motor, which turns the drill bit. Directional drilling also allows multiple production and injection wells to be drilled from a single surface location such as a gravel pad, thus minimizing cost and the surface impact of oil and gas drilling, production, and transportation facilities. It can be used to reach a target located beneath an environmentally sensitive area (Alaska Department of Natural Resources, Division of Oil and Gas 2009).

**Disruptive activities.** Human-caused disturbances that induce stress on a population, community, or ecosystem and cause potential loss of species fitness (survival, reproduction, and recruitment) within crucial habitats or other sensitive areas during specified time periods; may or may not entail surface disturbance. This does not include regular background levels of activity, such as hiking, cross country skiing or livestock grazing, that individuals would be accustomed to. Examples of disruptive activities include:

- Commercial recreation activities, especially large groups
- Abnormally loud or sustained noise
- Road maintenance

**Diversity.** The relative abundance of wildlife species, plant species, communities, habitats, or habitat features per unit of area.

**Domestic well.** A well serving up to three single-family dwellings, irrigating one acre or less of lawn and garden, and providing water for the individual's domestic animals and livestock.

**Easement.** A right afforded a person or agency to make limited use of another’s real property for access or other purposes.

**Ecologic functionality.** These levels include successional processes that are in place, energy and nutrients that are being cycled effectively, and soil that is being appropriately stabilized. An area can be functioning at a basic level of ecologic functionality without meeting land health standards.

**Ecosystem diversity.** The variety of habitats, living communities, and ecological processes in the living world. Ecosystem diversity refers to the diversity of a place at the level of ecosystem. Inherent in ecosystem diversity are both biotic (living) and abiotic (non-living) components. The term differs from biodiversity, which refers to variation in species rather than ecosystems.

**Emergency stabilization.** Planned actions to stabilize and prevent unacceptable degradation to natural and cultural resources, to minimize threats to life or property resulting from the effects of a fire, or to repair/replace/construct physical improvements necessary to prevent degradation of land or resources. Emergency stabilization actions must be taken within one year following containment of a wildfire.

**Endangered species.** Any species that is in danger of extinction throughout all or a significant portion of its range (BLM Manual 6840, Special Status Species Manual). Under the ESA in the US, “endangered” is the more-protected of the two categories. Designation as endangered (or threatened) is determined by USFWS as directed by the ESA.

**Endangered Species Act of 1973 (ESA) (as amended).** Designed to protect critically imperiled species from extinction as a consequence of economic growth and development untempered by adequate concern and conservation. The Act is administered by two federal agencies, USFWS and the National Oceanic and Atmospheric Administration. The purpose of the Act is to protect species and also the ecosystems upon which they depend (16 USC 1531-1544).

**Enhance.** Increase or improve in value, quality or desirability.

**Environmental assessment.** A concise public document prepared to provide sufficient evidence and analysis for determining whether to prepare an environmental impact statement or a finding of no significant impact. It includes a brief discussion of the need for the proposal, alternatives considered, environmental impact of the proposed action and alternatives, and a list of agencies and individuals consulted.

**Environmental impact statement (EIS).** A detailed statement prepared by the responsible official in which a major federal action that significantly affects the quality of the human environment is described, alternatives to the proposed action are provided, and effects are analyzed (BLM National Management Strategy for OHV Use on Public Lands).

**Exclusion area.** *See "right-of-way exclusion area" definition.*

**Exemplary (vegetation).** An area of vegetation that does not show signs of degradation and which may serve as a comparison to illustrate what the vegetation potential is for a given type of environment. Exemplary vegetation meets A-ranked viability criteria as described by the Colorado Natural Heritage Program.

**Existing routes.** The roads, trails, or ways that are used by motorized vehicles (e.g., jeeps, all-terrain vehicles, and motorized dirt bikes), mechanized uses (mountain bikes, wheelbarrows, game carts), pedestrians (hikers), and/or equestrians (horseback riders) and are, to the best of BLM's knowledge, in existence at the time of RMP/EIS publication.

**Extremely rare vegetation communities.** Unique combinations of plant species as identified by terminology and a classification system from the Colorado Natural Heritage Program. These are identified as Potential Conservation Areas with moderate or better Biodiversity Significance and fair or better Viability.

**Federal Land Policy and Management Act of 1976 (FLPMA).** Public Law 94-579, October 21, 1976, often referred to as the BLM's "Organic Act," which provides most of the BLM's legislated authority, direction policy, and basic management guidance.

**Federal mineral estate.** Subsurface mineral estate owned by the US and administered by the BLM.

**Fire frequency.** A general term referring to the recurrence of fire in a given area over time.

**Fire Regime Condition Classification System.** Measures the extent to which vegetation departs from reference conditions, or how the current vegetation differs from a particular reference condition.

**Fire severity.** Degree to which a site has been altered or disrupted by fire; loosely, a product of fire intensity and residence time.

**Fire suppression.** All work and activities connected with control and fire-extinguishing operations, beginning with discovery and continuing until the fire is completely extinguished.

**Flowback pit:** surface pits to hold the recycled water for use during completion.

**Fluid minerals.** Oil, gas, coal bed natural gas, and geothermal resources.

**Fluvial.** Of or pertaining to rivers or produced by the action of rivers or streams.

**Forage.** All browse and herbaceous foods that are available to grazing animals.

**Forage base.** The amount of vegetation available for wildlife and livestock use.

**Four-wheel drive vehicle.** A passenger vehicle or truck having power available to all wheels. Any motorized vehicle that has generally higher clearance than a passenger car and has traction on all four wheels.

**Fragile soils.** Soils having a shallow depth to bedrock, minimal surface layer of organic material, textures that are more easily detached and eroded, or are on slopes over 35 percent.

**Fugitive dust.** Significant atmospheric dust arises from the mechanical disturbance of granular material exposed to the air. Dust generated from these open sources is termed "fugitive" because it is not discharged to the atmosphere in a confined flow stream. Common sources of fugitive dust include unpaved roads, agricultural tilling operations, aggregate storage piles, and heavy construction operations.

**Functional/structural group.** A group of species that perform similar roles or functions in the ecosystem and are grouped together on an ecological site basis because of factors such as similar shoot or root structure, rooting depth, woody or non-woody stems, plant height, photosynthetic pathways, nitrogen fixing ability, and life cycle.

**Functioning at risk.** Riparian-wetland areas that are in functional condition, but that have an existing soil, water, or vegetation attribute that makes them susceptible to degradation.

**Geographic Information System (GIS).** A system of computer hardware, software, data, people, and applications that capture, store, edit, analyze, and display a potentially wide array of geospatial information.

**Geomorphic balance.** Stream channel size, sinuosity, slope, and substrate are appropriate for its landscape setting and geology.

**Geophysical exploration.** Efforts to locate deposits of oil and gas resources and to better define the subsurface.

**Green completion.** Methods that minimize the amount of natural gas and oil vapors that are released to the environment when a well is being flowed during the completion phase of a well.

**Groundwater.** Water held underground in soil or permeable rock, often feeding springs and wells.

**Guzzler.** General term covering guzzler, wildlife drinker, or tenaja. A natural or artificially constructed structure or device to capture and hold rain water, and make it accessible to small and/or large animals. Most guzzlers involve above or below ground piping, storage tanks, and valves. Tenajas are natural depressions in rock, which trap and hold water. To some guzzlers, steps or ladders are sometimes added to improve access and reduce mortality from drowning.

**Habitat.** An environment that meets a specific set of physical, biological, temporal, or spatial characteristics that satisfy the requirements of a plant or animal species or group of species for part or all of their life cycle.

**Habitat management plan.** A written and approved activity plan for a geographical area which identifies habitat management activities to be implemented in achieving specific objectives of planning decisions.

**Hazardous material.** A substance, pollutant, or contaminant that, due to its quantity, concentration, or physical or chemical characteristics, poses a potential hazard to human health and safety or to the environment if released into the workplace or the environment.

**Healthy aquatic community.** Varies by species and numbers of target species present, and channel type, and is characterized by: proper amounts of sediment/silt; a diversity of instream habitat complexity; the development/maintenance of undercut bank habitats'; adequate canopy cover; appropriate holding habitat (pools/minimum pools depth) commensurate with the identified Rosgen channel type; reduced diurnal water temperature fluctuations; appropriate width to depth ratios; and represented by a healthy biological community (fish and macroinvertebrate diversity and abundance reflect water quality attaining a biological minimum).

**High-power communication site.** Sites that include broadcast types of uses (e.g., television, AM/FM radio, cable television, broadcast translator).

**High wind event.** The period of time and location covered by National Weather Service high wind warning; or when there are sustained surface winds greater than 40 miles per hour lasting more than an hour or winds over 58 miles per hour that are occurring for an unspecified period of time.

**Historic resources**. Any prehistoric or historic district, site, building, structure, or object included in, or eligible for inclusion in, the National Register of Historic Places.

**Horizontal drilling.** A more-specialized type of directional drilling that allows a single well bore at the surface to penetrate oil- or gas-bearing reservoir strata at angles that parallel or nearly parallel the dip of the strata. The well bore is then open and in communication with the reservoir over much longer distances. In development wells, this can greatly increase production rates of oil and gas or volumes of injected fluids. Horizontal drilling may involve underbalanced drilling, coiled tubing, bit steering, continuous logging, multilateral horizontals, and horizontal completions. Lateral step-outs are directional wells that branch off a main borehole to access more of the subsurface. Conditions for successful horizontal wells include adequate pre-spud planning, reservoir descriptions, drillable strata that will not collapse, and careful cost control (Alaska Department of Natural Resources, Division of Oil and Gas 2009).

**Impact.** The effect, influence, alteration, or imprint caused by an action.

**Impairment.** The degree to which a distance of clear visibility is degraded by man-made pollutants.

**Inactive nest site.** *See "alternate nest (inactive nest) site" definition.*

**Indicators.** Factors that describe resource condition and change and can help the BLM determine trends over time.

**Indirect impacts.** 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.

**Intermittent stream.** An intermittent stream is a stream that flows only at certain times of the year when it receives water from springs or from some surface sources such as melting snow in mountainous areas. During the dry season and throughout minor drought periods, these streams will not exhibit flow. Geomorphological characteristics are not well defined and are often inconspicuous. In the absence of external limiting factors, such as pollution and thermal modifications, species are scarce and adapted to the wet and dry conditions of the fluctuating water level.

**Invertebrate.** An animal lacking a backbone or spinal column, such as insects, snails, and worms. The group includes 97 percent of all animal species.

**K factor.** A soil erodibility factor used in the universal soil loss equation that is a measure of the susceptibility of soil particles to detachment and transport by rainfall and runoff. Estimation of the factor takes several soil parameters into account, including soil texture, percent of sand greater than 0.10 millimeter, soil organic matter content, soil structure, soil permeability, clay mineralogy, and coarse fragments. K factor values range from .02 to .64, the greater values indicating the highest susceptibilities to erosion.

**Key wildlife habitat.** Specific areas within the geographic area occupied by a species in which are found those physical and biological features 1) essential to the conservation of the species, and 2) which may require special management considerations or protection.

**Lacustrine.** Pertaining to, produced by, or inhabiting a lake environment.

**Land health condition.** A classification for land health which includes these categories: “Meeting Land Health Standard(s)” and “Not Meeting Land Health Standard(s)”.

- **Meeting Land Health Standard(s):** Lands for which health indicators are currently in acceptable condition such that basic levels of ecological processes and functions are in place. This rating includes the following subcategories:
- **Fully Meeting Standard(s):** Lands for which there are no substantive concerns with health indicators
- **Exceeding Standard(s):** Lands for which health indicators are in substantially better conditions than acceptable levels.
- **Meeting Standard(s) with Problems:** Lands which have one or more concerns with health indicators to the degree that they are categorized as meeting the Land Health Standards, but have some issues which make them at risk of becoming “not meeting.”
- **Not Meeting Land Health Standard(s):** Lands for which one or more health indicators are in unacceptable conditions such that basic levels of ecological processes and functions are no longer in place.

- **Land health trend** is used to describe these classes further. It includes these categories: upward, static, and downward.

- **Upward Trend:** lands which have shown improving indicator conditions over time.

- **Static Trend:** lands which have shown no clear improvement or decline in indicator conditions over time.

- **Downward Trend:** lands which have shown declining indicator conditions over time.

**Land health improvement projects.** Activities that are directed at increasing the levels and/or vigor of desirable species within the plant community so that it reaches a higher level of functioning. Activities include restoration or revegetation of areas of degraded vegetation; removal of weeds, and repair or retirement and rehabilitation of developments which are contributing to vegetation degradation.

**Landscape scale.** An approach that examines or considers issues at an extensive scale rather than the individual site scale. The term landscape refers to the scale of the approach (landscape as an area), rather than as a topic of interest.

**Land treatment.** All methods of artificial range improvement arid soil stabilization such as reseeding, brush control (chemical and mechanical), pitting, furrowing, and water spreading.

**Land use plan.** A set of decisions that establish management direction for land within an administrative area, as prescribed under the planning provisions of FLPMA; an assimilation of land use plan level decisions developed through the planning process outlined in 43 CFR 1600, regardless of the scale at which the decisions were developed. The term includes both RMPs and management framework plans (H-1601-1, BLM Land Use Planning Handbook).

**Land use plan decision.** Establishes desired outcomes and actions needed to achieve them. Decisions are reached using the planning process in 43 CFR 1600. When they are presented to the public as proposed decisions, they can be protested to the BLM Director. They are not appealable to Interior Board of Land Appeals.

**Late season.** Late summer or fall grazing.

**Leasable minerals.** Those minerals or materials designated as leasable under the Mineral Leasing Act of 1920. These include energy-related mineral resources such as oil, natural gas, coal, and geothermal, and some non-energy minerals, such as phosphate, sodium, potassium, and sulfur. Geothermal resources are also leasable under the Geothermal Steam Act of 1970.

**Lease.** Section 302 of the Federal Land Policy and Management Act of 1976 provides the BLM's authority to issue leases for the use, occupancy, and development of public lands. Leases are issued for purposes such as a commercial filming, advertising displays, commercial or noncommercial croplands, apiaries, livestock holding or feeding areas not related to grazing permits and leases, native or introduced species harvesting, temporary or permanent facilities for commercial purposes (does not include mining claims), residential occupancy, ski resorts, construction equipment storage sites, assembly yards, oil rig stacking sites, mining claim occupancy if the residential structures are not incidental to the mining operation, and water pipelines and well pumps related to irrigation and nonirrigation facilities. The regulations establishing procedures for processing these leases and permits are found in 43 CFR 2920.

**Lease notice.** Provides more-detailed information concerning limitations that already exist in law, lease terms, regulations, or operational orders. A lease notice also addresses special items that lessees should consider when planning operations but does not impose additional restrictions. Lease notices are not an RMP-level decision, and new lease notices may be added to fluid mineral leases at the time of sale. Lease notices apply only to leasable minerals (e.g., oil, gas, geothermal) and not to other types of leases, such as livestock grazing.

**Lease stipulation.** A modification of the terms and conditions on a standard lease form at the time of the lease sale.

**Lentic.** Pertaining to standing water such as lakes and ponds.

**Limited area.** An area restricted at certain times, in certain areas, and/or to certain vehicular use. These restrictions may be of any type, but can generally be accommodated within the following type of categories: Numbers of vehicles; types of vehicles; time or season of vehicle use; permitted or licensed use only; use on existing roads and trails; use on designated roads and trails; and other restrictions (43 CFR 8340.0-5).

**Locatable minerals.** Minerals subject to exploration, development, and disposal by staking mining claims as authorized by the Mining Law of 1872, as amended. This includes deposits of gold, silver, and other uncommon minerals not subject to lease or sale.

**Long-term effect.** The effect could occur for an extended period after implementation of the alternative. The effect could last several years or more.

**Low-power communication site.** Sites that include to non-broadcast uses (e.g., commercial or private mobile radio service, cellular telephone, microwave, local exchange network, passive reflector).

**Management decision.** A decision made by the BLM to manage public lands. Management decisions include both land use plan decisions and implementation decisions.

**Master development plan**. Information common to multiple planned wells, including drilling plans, Surface Use Plans of Operations, and plans for future production.

**Mechanical transport**. Any vehicle, device, or contrivance for moving people or material in or over land, water, snow, or air that has moving parts.

**Mechanical vegetation treatment**. Includes mowing, chaining, chopping, drill seeding, and cutting vegetation to meet resource objective. Mechanical treatments generally occur in areas where fuel loads or invasive species need to be reduced prior to prescribed fire application; when fire risk to resources is too great to use naturally started wildland fires or prescribed fires; or where opportunities exist for biomass utilization or timber harvest. Mechanical treatments may also be utilized to improve wildlife habitat conditions.

**Mechanized uses.** Equipment that is mechanized, including but not limited to mountain bikes, wheelbarrows, and game carts.

**Mexican spotted owl suitable breeding habitat.** Vegetation characteristics described in the current Mexican spotted owl recovery plan in areas where Mexican spotted owl breeding has been confirmed.

**Mineral.** Any naturally formed inorganic material, solid or fluid inorganic substance that can be extracted from the earth, any of various naturally occurring homogeneous substances (as stone, coal, salt, sulfur, sand, petroleum, water, or natural gas) obtained usually from the ground. Under federal laws, considered as locatable (subject to the general mining laws), leasable (subject to the Mineral Leasing Act of 1920), and salable (subject to the Materials Act of 1947).

**Mineral entry.** The filing of a claim on public land to obtain the right to any locatable minerals it may contain.

**Mineral estate.** The ownership of minerals, including rights necessary for access, exploration, development, mining, ore dressing, and transportation operations.

**Mineralize.** The process where a substance is converted from an organic substance to an inorganic substance.

**Mineral materials (salable minerals, salable mineral materials).** Common varieties of mineral materials such as soil, sand and gravel, stone, pumice, pumicite, and clay that are not obtainable under the mining or leasing laws but that can be acquired under the Materials Act of 1947, as amended.

**Mineral patent.** A claim on which title has passed from the federal government to the mining claimant under the Mining Law of 1872.

**Minimum impact suppression tactics**. The use of fire management tactics commensurate with the fire's potential or existing behavior while producing the least impact on the resource being protected.

**Mining claim.** A parcel of land that a miner takes and holds for mining purposes, having acquired the right of possession by complying with the Mining Law and local laws and rules. A mining claim may contain as many adjoining locations as the locator may make or buy. There are four categories of mining claims: lode, placer, millsite, and tunnel site.

**Mining Law of 1872.** Provides for claiming and gaining title to locatable minerals on public lands. Also referred to as the "General Mining Laws" or "Mining Laws."

**Mitigation.** Alleviation or lessening of possible adverse effects on a resource by applying appropriate protective measures or adequate scientific study. Mitigation may be achieved by avoidance, minimization, rectification, reduction, and compensation.

**Mitigation measure(s).** Mitigation includes specific means, measures or practices that would reduce or eliminate effects of the proposed action or alternatives. Mitigation may be used to reduce or avoid adverse impacts, whether or not they are significant in nature. Measures or practices are only termed mitigation measures if they have not been incorporated into the proposed action or alternatives. If mitigation measures are incorporated into the proposed action or alternatives, they are called design features. See **Design feature(s)** definition above. BLM NEPA Handbook, H-1790-1, and 40 CFR 1508.20.

**Modification.** A change to the provisions of a lease stipulation, either temporarily or for the term of the lease. Depending on the specific modification, the stipulation may or may not apply to all sites within the leasehold to which the restrictive criteria are applied.

**Motorized vehicles or uses.** Vehicles that are motorized, including but not limited to jeeps, all-terrain vehicles (all-terrain vehicles, such as four-wheelers and three-wheelers), trail motorcycles or dirt bikes, and aircrafts.

**Multiple-use.** The management of the public lands and their various resource values so that they are used in the combination that will best meet the present and future needs of the American people; making the most judicious use of the land for some or all of these resources or related services over areas large enough to provide sufficient latitude for periodic adjustments in use to changing needs and conditions; the use of some land for less than all of the resources; a combination of balanced and diverse resource uses that takes into account the long-term needs of future generations for renewable and nonrenewable resources, including recreation, range, timber, minerals, watershed, wildlife and fish, and natural scenic, scientific and historical values; and harmonious and coordinated management of the various resources without permanent impairment of the productivity of the land and the quality of the environment with consideration being given to the relative values of the resources and not necessarily to the combination of uses that will give the greatest economic return or the greatest unit output (FLPMA) (BLM Manual 6840, Special Status Species Manual).

**Municipal watershed.** A watershed area that provides water for use by a municipality as defined by the community and accepted by the State.

**National Environmental Policy Act of 1969 (NEPA).** Public Law 91-190. Establishes environmental policy for the nation. Among other items, NEPA requires federal agencies to consider environmental values in decision-making processes.

**National Register of Historic Places.** A listing of architectural, historical, archaeological, and cultural sites of local, state, or national significance, established by the Historic Preservation Act of, 1966 and maintained by the National Park Service.

**Native cutthroat trout.** Native populations include what current science and genetics tell us are Colorado River cutthroat or greenback cutthroat trout.

**Native vegetation.** Plant species that were found here prior to European settlement, and consequently are in balance with these ecosystems because they have well developed parasites, predators, and pollinators.

**Naturalness.** Consistent with what would occur without human intervention. For vegetation structure, naturalness implies a pattern similar to what fire and climate would produce across the landscape.

**Natural processes.** Fire, drought, insect and disease outbreaks, flooding, and other events that existed prior to European settlement, and shaped vegetation composition and structure.

**Non-energy leasable minerals.** Those minerals or materials designated as leasable under the Mineral Leasing Act of 1920. Non-energy minerals include resources such as phosphate, sodium, potassium, and sulfur.

**Nonfunctional condition.** Riparian-wetland areas that clearly are not providing adequate vegetation, landform, or woody debris to dissipate energies associated with flow events, and thus are not reducing erosion, improving water quality.

**No surface occupancy (NSO).** A major constraint where use or occupancy of the land surface for fluid mineral exploration or development and all activities associated with fluid mineral leasing (e.g., truck-mounted drilling and geophysical exploration equipment off designated routes, construction of wells and/or pads) are prohibited to protect identified resource values. Areas identified as NSO are open to fluid mineral leasing, but surface occupancy or surface-disturbing activities associated with fluid mineral leasing cannot be conducted on the surface of the land. Access to fluid mineral deposits would require horizontal drilling from outside the boundaries of the NSO area.

**Noxious weeds.** A plant species designated by federal or state law as generally possessing one or more of the following characteristics: aggressive and difficult to manage; parasitic; a carrier or host of serious insects or disease; or nonnative, new, or not common to the US.

**Off-highway vehicle (OHV) (off-road vehicle).** Any motorized vehicle capable of, or designated for travel on or immediately over land, water or other natural terrain, excluding: (1) any non-amphibious registered motorboat; (2) any military, fire, emergency, or law enforcement vehicle while being used for emergency purposes; (3) any vehicle whose use is expressly authorized by the authorized officer, or otherwise officially approved; (4) vehicles in official use; and (5) any combat or combat support vehicle when used for national defense emergencies (43 CFR 8340.0-5).

**Off-highway vehicle area designations.** BLM-administered lands in the CFO are designated as Open, Limited, or Closed for OHV use.

- **Limited.** An area restricted at certain times, in certain areas, and/or to certain vehicular use. These restrictions may be of any type, but can generally be accommodated within the following type of categories: Numbers of vehicles; types of vehicles; time or season of vehicle use; permitted or licensed use only; use on existing roads and trails; use on designated roads and trails; and other restrictions (43 CFR 8340.0-5).

- **Closed.** An area where off-road vehicle use is prohibited. Use of off-road vehicles in closed areas may be allowed for certain reasons; however, such use shall be made only with the approval of the authorized officer (43 CFR 8340.0-5).

- **Open.** Generally denotes that an area is available for a particular use or uses. Refer to specific program definitions found in law, regulations, or policy guidance for application to individual programs. For example, 43 CFR 8340.0-5 defines the specific meaning of "open" as it relates to OHV use.

**Open area.** *See "Off-highway vehicle area designations – Open" definition.*

**Ordinary high water mark.** That line on the shore established by the fluctuations of water and indicated by physical characteristics such as clear, natural line impressed on the bank, shelving, changes in the character of soil, destruction of terrestrial vegetation, the presence of litter and debris, or other appropriate means that consider the characteristics of the surrounding areas.

**Outstandingly remarkable value (ORV).** Values among those listed in Section 1(b) of the Wild and Scenic Rivers Act of 1968: "scenic, recreational, geological, fish and wildlife, historical, cultural, or other similar values..." Other similar values that may be considered include ecological, biological, or botanical.

**Overstory.** That portion of a plant community consisting of the taller plants on the site; the forest or woodland canopy.

**Ozone.** A faint blue gas produced in the atmosphere from chemical reactions of burning coal, gasoline, and other fuels and chemicals found in products such as solvents, paints, and hairsprays.

**Paleontological resources.** The physical remains or other physical evidence of plants and animals preserved in soils and sedimentary rock formations. Paleontological resources are important for correlating and dating rock strata and for understanding past environments, environmental change, and the evolution of life.

**Particulate matter (PM).** One of the six "criteria" pollutants for which the US EPA established National Ambient Air Quality Standards. Particulate matter is defined as two categories, fine particulates, with an aerodynamic diameter of 10 micrometers ($PM_{10}$) or less, and fine particulates with an aerodynamic diameter of 2.5 micrometers or less ($PM_{2.5}$).

**Passenger vehicle.** Two-wheel-drive, low-clearance vehicles.

**Perennial stream.** A stream that flows continuously. Perennial streams are generally associated with a water table in the localities through which they flow.

**Permitted access.** *See "administrative access" definition.*

**Permitted use.** The forage allocated by, or under the guidance of, an applicable land use plan for livestock grazing in an allotment under a permit or lease and expressed in AUMs (43 CFR 4100.0-5) (from H-4180-1, BLM Rangeland Health Standards Manual).

**Permittee.** A person or company permitted to graze livestock on public land.

**Project Area.** The geographical area for which EISs are developed. The Bull Mountain MDP EIS area boundary defines the area assessed in this EIS, and encompasses approximately 19,700 acres in Delta County in southwestern Colorado.

**Issues**. Concerns, conflicts, and problems with the existing management of public lands. Frequently, issues are based on how land uses affect resources. Some issues are concerned with how land uses can affect other land uses, or how the protection of resources affects land uses.

**Potential Fossil Yield Classification (PFYC) system.** A system used by the BLM to classify geologic units based on the relative abundance of vertebrate fossils or scientifically significant invertebrate or plant fossils and their sensitivity to adverse impacts, with a higher class number indicating a higher potential.

**Potential vegetation group.** Potential vegetation types grouped on the basis of a similar general moisture or temperature environment.

**Prehistoric resources.** Any material remains, structures, and items used or modified by people before Euro-Americans established a presence in the region.

**Prescribed fire.** A wildland fire originating from a planned ignition to meet specific objectives identified in a written, approved, prescribed fire plan for which NEPA requirements (where applicable) have been met prior to ignition.

**Prevention of significant deterioration.** An air pollution permitting program intended to ensure that air quality does not diminish in attainment areas.

**Proper functioning condition.** A term describing stream health that is based on the presence of adequate vegetation, landform and debris to dissipate energy, reduce erosion and improve water quality.

**Proper functioning condition for lentic areas.** A riparian-wetland areas are functioning properly when adequate vegetation, landform, or debris is present to: dissipate energies associated with wind action, wave action, and overland flow from adjacent sites, thereby reducing erosion and improving water quality; filter sediment and aid floodplain development; improve flood-water retention and ground-water recharge; develop root masses that stabilize islands and shoreline features against cutting action; restrict water percolation; develop diverse ponding characteristics to provide the habitat and the water depth, duration, and temperature necessary for fish production, waterbird breeding, and other uses; and support greater biodiversity.

**Proper functioning condition for lotic areas.** A riparian-wetland area is considered to be in proper functioning condition when adequate vegetation, landform, or large woody debris is present to:

- Dissipate stream energy associated with high waterflow, thereby reducing erosion and improving water quality
- Filter sediment, capture bedload, and aid floodplain development
- Improve flood-water retention and ground-water recharge
- Develop root masses that stabilize streambanks against cutting action
- Develop diverse ponding and channel characteristics to provide the habitat and the water depth, duration, and temperature necessary for fish production, waterfowl breeding, and other uses
- Support greater biodiversity

**Proposed critical habitat.** Those areas officially proposed for designations as critical habitat by the Secretary of Interior or Commerce.

**Proposed species.** A species for which a proposed rule to add the species to the federal list of threatened and endangered species has been published in the Federal Register.

**Public land.** Land or interest in land owned by the US and administered by the Secretary of the Interior through the BLM without regard to how the US acquired ownership, except lands located on the Outer Continental Shelf and land held for the benefit of Indians, Aleuts, and Eskimos (H-1601-1, BLM Land Use Planning Handbook).

**Public water supply.** As defined by the state of Colorado, a “public water system” is a system for the provision to the public of water for human consumption through pipes or other constructed conveyances, if such system has a least fifteen service connections or regularly serves an average of at least 25 individuals daily at least 60 days out of the year.

**Range improvement project.** An authorized physical modification or treatment which is designed to improve production of forage; change vegetation composition; control patterns of use; provide water; stabilize soil and water conditions; restore, protect and improve the condition of rangeland ecosystems to benefit livestock, wild horses and burros, and fish and wildlife. This definition includes, but is not limited to: structures, treatment projects and use of mechanical devices, or modifications achieved through mechanical means.

**Raptor.** Bird of prey with sharp talons and strongly curved beaks, such as hawks, owls, falcons, and eagles.

**Rare vegetation.** Unique combinations of plant species as identified by terminology and a classification system from the Colorado Natural Heritage Program (CNHP). These are defined using CNHP’s Global Rarity Ranks denoting scarcity on a global level and include the rankings of G1 and G2.

**Reasonable foreseeable development scenario.** The prediction of the type and amount of oil and gas activity that would occur in a given area. The prediction is based on geologic factors, past history of drilling, projected demand for oil and gas, and industry interest.

**Recharge areas.** Headwaters of perennial streams, contributing watersheds to springs and/or seeps, floodplains, all stream channels, municipal watersheds, and source water protection areas.

**Reclamation.** Returning disturbed lands to a form and productivity that will be ecologically balanced and in conformity with a predetermined land management plan.

**Recreation experiences.** Psychological outcomes realized either by recreation-tourism participants as a direct result of their on-site leisure engagements and recreation-tourism activity participation or by nonparticipating community residents as a result of their interaction with visitors and guests within their community or interaction with the BLM and other public and private recreation-tourism providers and their actions.

**Recreation management zones.** Subunits within an SRMA managed for distinctly different recreation products. Recreation products are composed of recreation opportunities, the natural resource and community settings within which they occur, and the administrative and service environment created by all affecting recreation-tourism providers, within which recreation participation occurs.

**Recreation opportunities.** Favorable circumstances enabling visitors' engagement in a leisure activity to realize immediate psychological experiences and attain more lasting, value-added beneficial outcomes.

**Recreation setting character conditions.** The distinguishing recreational qualities of any landscape, objectively defined along a continuum, ranging from primitive to urban landscapes, expressed in terms of the nature of the component parts of its physical, social, and administrative attributes. These recreational qualities can be both classified and mapped. This classification and mapping process should be based on variation that either exists (for example, setting descriptions) or is desired (for example, setting prescriptions) among component parts of the various physical, social, and administrative attributes of any landscape. The recreation opportunity spectrum is one of the tools for doing this.

**Recreation settings.** The collective distinguishing attributes of landscapes that influence and sometimes actually determine what kinds of recreation opportunities are produced.

**Rehabilitate.** Returning disturbed lands as near to its predisturbed condition as is reasonably practical or as specified in approved permits.

**Required Design Features.** Specific means, measures or practices that make up the proposed action and alternatives and would be required as part of future project designs. Design features could be identified as the impact analysis is being conducted, especially those that would reduce or eliminate adverse effects after the initial formulation of alternatives. In this situation, design features may be added to the proposed action or alternatives. Standard operating procedures, stipulations, and best management practices are usually considered design features. If any means, measures, or practices are not incorporated into the proposed action or alternatives, they are considered mitigation measures.

**Reserve pit:** A pit dug on a well pad used for temporary storage for waste fluids during oil and gas drilling and completion. Reserve pits are backfilled when the well is put into production and reclaimed.

**Resource Advisory Council.** A council established by the Secretary of the Interior to provide advice or recommendations to BLM management. The Southwest Colorado RAC covers issues within the UFO.

**Resource management plan (RMP).** A land use plan as prescribed by the Federal Land Policy and Management Act that establishes, for a given area of land, land-use allocations, coordination guidelines for multiple-use, objectives, and actions to be achieved.

**Restore/restoration.** The process of returning disturbed areas to a natural array of native plant and animal associations.

**Retard.** Measurably slow attainment of any identified objective level that is worse than the objective standard. Degradation of the physical/biological process or conditions that determine objective standards would be considered to retard attainment of specific objective standard.

**Revegetate/revegetation.** The process of putting vegetation back in an area where vegetation previously existed, which may or may not simulate natural conditions.

**Right-of-way (ROW).** BLM-administered lands authorized to be used or occupied for specific purposes pursuant to a right-of-way grant, which are in the public interest and which require ROWs over, on, under, or through such lands.

**Right-of-way avoidance area.** An area identified through resource management planning to be avoided but may be available for ROW location with special stipulations. A ROW avoidance area is comparable to the SSR restriction applied to other resources.

**Right-of-way exclusion area.** An area identified through resource management planning that is not available for ROW location under any conditions. A ROW exclusion area is comparable to the NGD stipulation applied to other resources.

**Riparian/aquatic system.** Interacting system between aquatic and terrestrial situations. Identified by a stream channel and distinctive vegetation that requires or tolerates free or unbound water.

**Riparian area.** A form of wetland transition between permanently saturated wetlands and upland areas. Riparian areas exhibit vegetation or physical characteristics that reflect the influence of permanent surface or subsurface water. Typical riparian areas include lands along, adjacent to, or contiguous with perennially and intermittently flowing rivers and streams, glacial potholes, and the shores of lakes and reservoirs with stable water levels. Excluded are ephemeral streams or washes that lack vegetation and depend on free water in the soil.

**Riparian zone.** An area one-quarter mile wide encompassing riparian and adjacent vegetation.

**Road.** A linear route declared a road by the owner, managed for use by low-clearance vehicles having four or more wheels, and maintained for regular and continuous use.

**Roadless.** The absence of roads that have been constructed and maintained by mechanical means to ensure regular and continuous use.

**Routes.** Multiple roads, trails and primitive roads; a group or set of roads, trails, and primitive roads that represents less than 100 percent of the BLM transportation system. Generically, components of the transportation system are described as "routes."

**Salinity.** Refers to the solids such as sodium chloride (table salt) and alkali metals that are dissolved in water.

**Saturated soils.** Occur when the infiltration capacity of the soil is exceeded from above due to rainfall or snowmelt runoff. Soils can also become saturated from groundwater inputs.

**Scoping process.** An early and open public participation process for determining the scope of issues to be addressed and for identifying the significant issues related to a proposed action.

**Season of use.** The time during which livestock grazing is permitted on a given range area, as specified in the grazing lease.

**Seeding.** Seeding is a vegetation treatment that includes the application of grass, forb, or shrub seed, either aerially or from the ground. In areas of gentle terrain, ground applications of seed are often accomplished with a rangeland drill. Seeding allows the establishment of native species or placeholder species and restoration of disturbed areas to a perennial-dominated cover type, thereby decreasing the risk of subsequent invasion by exotic plant species. Seeding would be used primarily as a follow-up treatment in areas where disturbance or the previously described treatments have removed exotic plant species and their residue.

**Setting character.** The condition of any recreation system, objectively defined along a continuum, ranging from primitive to urban in terms of variation of its component physical, social, and administrative attributes.

**Severe winter range.** That part of the overall range where 90 percent of the individuals are located when the annual snowpack is at its maximum and/or temperatures are at a minimum in the two worst winters out of ten. Severe winter range is defined for each Colorado Division of Wildlife Data Analysis Unit.

**Short-term effect.** The effect occurs only during or immediately after implementation of the alternative.

**Sole-source aquifer.** Defined by the US EPA as an aquifer supplying at least 50 percent of the drinking water consumed in the area overlying the aquifer, where the surrounding area has no alternative drinking water source(s) that could physically, legally, and economically supply all those who depend upon the aquifer for drinking water.

**Source water protection area.** The area delineated by a state for a public water supply or including numerous suppliers, whether the source is ground water or surface water or both.

**Special status species.** BLM special status species are: (1) species listed, candidate, or proposed for listing under the ESA; and (2) species requiring special management consideration to promote their conservation and reduce the likelihood and need for future listing under the ESA that are designated as BLM sensitive by the BLM State Director(s). All federally listed candidate species, proposed species, and delisted species in the five years following delisting are conserved as BLM sensitive species.

**Split estate.** Lands on which the mineral estate is owned by someone other than the surface estate owner. For example, the surface is in private ownership and the mineral resources are publicly held and managed by the federal government.

**Stabilize.** The process of stopping further damage from occurring.

**Standard.** A description of the physical and biological conditions or degree of function required for healthy, sustainable lands (e.g., land health standards). To be expressed as a desired outcome (goal).

**Standard lease terms and conditions.** Areas may be open to leasing with no specific management decisions defined in a Resource Management Plan; however, these areas are subject to lease terms and conditions as defined on the lease form (Form 3100-11, Offer to Lease and Lease for Oil and Gas; and Form 3200-24, Offer to Lease and Lease for Geothermal Resources).

**State-listed noxious weed species.** Noxious weed species listed by the State of Colorado:

- **List A** species are designated by the Commissioner for eradication.
- **List B** weed species are species for which the Commissioner, in consultation with the state noxious weed advisory committee, local governments, and other interested parties, develops and implements state noxious weed management plans designed to stop the continued spread of these species.
- **List C** weed species are species for which the Commissioner, in consultation with the state noxious weed advisory committee, local governments, and other interested parties, will develop and implement state noxious weed management plans designed to support the efforts of local governing bodies to facilitate more effective integrated weed management on private and public lands. The goal of such plans will not be to stop the continued spread of these species but to provide additional education, research, and biological control resources to jurisdictions that choose to require management of List C species.

**State implementation plan.** A detailed description of the programs a state will use to carry out its responsibilities under the Clean Air Act. State implementation plans are collections of the regulations used by a state to reduce air pollution.

**Stationary source.** Refers to a stationary source of emissions. Prevention of Significant Deterioration permits are required for major new stationary sources of emissions that emit 100 tons or more per year of carbon monoxide, sulphur dioxide, nitrogen dioxide, ozone, or particulate matter.

**Stipulation (general).** A term or condition in an agreement or contract.

**Stipulation (oil and gas).** A provision that modifies standard oil and gas lease terms and conditions in order to protect other resource values or land uses and is attached to and made a part of the lease. Typical lease stipulations include No Surface Occupancy (NSO), Timing Limitations (TL), and Controlled Surface Use (CSU). Lease stipulations are developed through the land use planning (RMP) process.

**Streamside management zone.** Land adjacent to a waterbody where activities on land are likely to affect water quality.

**Surface-disturbing activities.** Surface-disturbing activities are those that normally result in more than negligible (immeasurable, not readily noticeable) disturbance to vegetation and soils on public lands and accelerate the natural erosive process. Surface disturbances could require reclamation and normally involve use and/or occupancy of the surface, causing disturbance to soils and vegetation. They include, but are not limited to: the use of mechanized earth-moving equipment; truck-mounted drilling, stationary drill rigs in unison, and geophysical exploration equipment off designated routes; off-road vehicle travel in areas designated as limited or closed to off-road vehicle use; construction of facilities such as range facilities and/or improvements, power lines, pipelines, oil and gas wells and/or pads; recreation sites; new road and trail construction; and use of pyrotechnics and explosives. Surface disturbance is not normally caused by casual-use activities. Activities that are not considered surface-disturbing include, but are not limited to, livestock grazing, cross-country hiking or equestrian use, dispersed camping, installing signs, minimum impact filming, vehicular travel on designated routes, and general use of the land by wildlife.

**Sustained yield.** The achievement and maintenance in perpetuity of a high-level annual or regular periodic output of the various renewable resources of the public lands consistent with multiple uses.

**Terrestrial.** Living or growing in or on the land.

**Threatened species.** Any species that is likely to become endangered within the foreseeable future throughout all or a significant portion of its range (BLM Manual 6840, Special Status Species Management). Under the ESA in the US, “threatened” is the lesser-protected of the two categories. Designation as threatened (or endangered) is determined by USFWS as directed by the ESA.

**Tier 1-4 Emission Standards.** The first federal standards (Tier 1) for new nonroad (or off-road) diesel engines were adopted in 1994 for engines over 37 kW (50 hp), to be phased-in from 1996 to 2000. On August 27, 1998, the EPA signed the final rule that introduced Tier 1 standards for equipment under 37 kW (50 hp) and increasingly more stringent Tier 2 and Tier 3 standards for all equipment with phase-in schedules from 2000 to 2008. The Tier 1-3 standards are met through advanced engine design, with no or only limited use of exhaust gas aftertreatment (oxidation catalysts). On May 11, 2004, EPA signed the final rule introducing Tier 4 emission standards, which are phased-in over the period of 2008-2015. The Tier 4 standards require that emissions of particulate matter and NOx be further reduced by about 90%. Such emission reductions can be achieved through the use of control technologies—including advanced exhaust gas aftertreatment—similar to those required by the 2007-2010 standards for highway engines. For complete tables of Tier 1 – 4 emission standards, see the EPA website: http://www.epa.gov/otaq/nonroad-diesel.htm (last accessed 10/13/2014).

**Timing Limitation (TL).** The TL stipulation, a moderate constraint, is applicable to fluid mineral leasing, all activities associated with fluid mineral leasing (e.g., truck-mounted drilling and geophysical exploration equipment off designated routes, construction of wells and/or pads), and other surface-disturbing activities (i.e., those not related to fluid mineral leasing). Areas identified for TL are closed to fluid mineral exploration and development, surface-disturbing activities, and intensive human activity during identified time frames. This stipulation does not apply to operation and basic maintenance activities, including associated vehicle travel, unless otherwise specified. Construction, drilling, completions, and other operations considered to be intensive in nature are not allowed. Intensive maintenance, such as workovers on wells, is not permitted. TLs can overlap spatially with NSO, NGD, CSU, SSR, as well as with areas that have no other restrictions. Administrative activities are allowed at the discretion of the Authorized Officer.

**Total dissolved solids.** Salt, or an aggregate of carbonates, bicarbonates, chlorides, sulfates, phosphates, and nitrates of calcium, magnesium, manganese, sodium, potassium, and other cations that form salts.

**Total maximum daily load.** An estimate of the total quantity of pollutants (from all sources: point, nonpoint, and natural) that may be allowed into waters without exceeding applicable water quality criteria.

**Traditional cultural properties.** A property that derives significance from traditional values associated with it by a social or cultural group, such as an Indian tribe or local community. A traditional cultural property may qualify for the National Register of Historic Places if it meets the criteria and criteria exceptions at 36 CFR 60.4 (see National Register Bulletin 38).

**Traditional use.** Longstanding, socially conveyed, customary patterns of thought, cultural expression, and behavior, such as religious beliefs and practices, social customs, and land or resource uses. Traditions are shared generally within a social and/or cultural group and span generations. Usually traditional uses are reserved rights resulting from treaty and/or agreements with Native American groups.

**Trail.** A linear route managed for human-power (e.g., hiking or bicycling), stock (e.g., equestrian), or off-highway vehicle forms of transportation or for historical or heritage values. Trails are not generally managed for use by four-wheel drive or high-clearance vehicles.

**Transmission.** The movement or transfer of electric energy over an interconnected group of lines and associated equipment between points of supply and points at which it is transformed for delivery to consumers, or is delivered to other electric systems. Transmission is considered to end when the energy is transformed for distribution to the consumer.

**Transportation system.** The sum of the BLM's recognized inventory of linear features (roads, primitive roads, and trails) formally recognized, designated, and approved as part of the BLM's transportation system.

**Trespass.** Any unauthorized use of public land.

**Tribal interests.** Native American or Native Alaskan economic rights such as Indian trust assets, resource uses and access guaranteed by treaty rights, and subsistence uses.

**Understory.** That portion of a plant community growing underneath the taller plants on the site.

**Upland game birds.** Non-waterfowl game birds usually hunted with pointing breed, flushing spaniels, and retrievers. Upland game birds include grouse, chukar, quail, snipe, doves, pigeons, ptarmigan, and wild turkey.

**Utility corridor.** Tract of land varying in width forming passageway through which various commodities such as oil, gas, and electricity are transported.

**Valid existing rights.** Documented, legal rights or interests in the land that allow a person or entity to use said land for a specific purpose and that are still in effect. Such rights include but are not limited to fee title ownership, mineral rights, rights-of-way, easements, permits, and licenses. Such rights may have been reserved, acquired, leased, granted, permitted, or otherwise authorized over time.

**Vegetation manipulation.** Planned alteration of vegetation communities through use of mechanical, chemical, seeding, and/or prescribed fire or managed fire to achieve desired resource objectives.

**Vegetation structure.** The stage of plant community development, encompassing age of stand, height of vegetation, and spatial distribution of plants.

**Vegetation treatments.** Management practices which change the vegetation structure to a different stage of development. Vegetation treatment methods include managed fire, prescribed fire, chemical, mechanical, and seeding.

**Vegetation type.** A plant community with immediately distinguishable characteristics based upon and named after the apparent dominant plant species.

**Vertebrate.** An animal having a backbone or spinal column. Includes jawless fishes, bony fishes, sharks and rays, amphibians, reptiles, mammals, and birds.

**Viewshed.** The panorama from a given viewpoint that encompasses the visual landscape, including everything visible within a 360-degree radius.

**Visibility (air quality).** A measure of the ability to see and identify objects at different distances.

**Visual resource management (VRM).** The inventory and planning actions taken to identify visual resource values and to establish objectives for managing those values, and the management actions taken to achieve the visual resource management objectives.

**Visual resource management classes.** Define the degree of acceptable visual change within a characteristic landscape. A class is based on the physical and sociological characteristics of any given homogeneous area and serves as a management objective. Categories assigned to public lands are based on scenic quality, sensitivity level, and distance zones. Each class has an objective that prescribes the amount of change allowed in the characteristic landscape (from H-1601-1, BLM Land Use Planning Handbook).

The four classes are described below:

- **Class I** provides for natural ecological changes only. This class includes primitive areas, some natural areas, some wild and scenic rivers, and other similar areas where landscape modification activities should be restricted.
- **Class II** areas are those areas where changes in any of the basic elements (form, line, color, or texture) caused by management activity should not be evident in the characteristic landscape.
- **Class III** includes areas where changes in the basic elements (form, line, color, or texture) caused by a management activity may be evident in the characteristic landscape. However, the changes should remain subordinate to the visual strength of the existing character.
- **Class IV** applies to areas where changes may subordinate the original composition and character; however, they should reflect what could be a natural occurrence within the characteristic landscape.

**Visual resources.** The visible physical features on a landscape, (topography, water, vegetation, animals, structures, and other features) that comprise die scenery of the area.

**Visual sensitivity.** Visual sensitivity levels are a measure of public concern for scenic quality and existing or proposed visual change.

**Volatile organic compounds.** Chemicals that produce vapors readily at room temperature and at normal atmospheric pressure. Volatile organic compounds include gasoline, industrial chemicals such as benzene, solvents such as toluene and xylene, and tetrachloroethylene (perchloroethylene, the principal dry cleaning solvent).

**Waiver.** A permanent exemption from a lease stipulation. The stipulation no longer applies anywhere within the leasehold.

**Watershed.** Topographical region or area delineated by water draining to a particular watercourse or body of water.

**Watershed condition indicators.** An integrated suite of aquatic, riparian, and hydrologic condition measures that is intended to be used at the watershed scale.

**Wilderness.** A congressionally designated area of undeveloped federal land retaining its primeval character and influence, without permanent improvements or human habitation, that is protected and managed to preserve its natural conditions and that (1) generally appears to have been affected mainly by the forces of nature, with human imprints substantially unnoticeable; (2) has outstanding opportunities for solitude or a primitive and unconfined type of recreation; (3) has at least 5,000 acres or is large enough to make practical its preservation and use in an unimpaired condition; and (4) may also contain ecological, geological, or other features of scientific, educational, scenic, or historic value. The definition is contained in Section 2(c) of the Wilderness Act of 1964 (78 Stat. 891).

**Wilderness characteristics.** Wilderness characteristics attributes include the area’s size, its apparent naturalness, and outstanding opportunities for solitude or a primitive and unconfined type of recreation. They may also include supplemental values. Lands with wilderness characteristics are those lands that have been inventoried and determined by the BLM to contain wilderness characteristics as defined in section 2(c) of the Wilderness Act.

**Wilderness Study Area (WSA).** A designation made through the land use planning process of a roadless area found to have wilderness characteristics, as described in Section 2(c) of the Wilderness Act of 1964.

**Wildland fire.** Wildland fire is a general term describing any non-structure fire that occurs in the wildland. Wildland fires are categorized into two distinct types:

- **Wildfires:** Unplanned ignitions or prescribed fires that are declared wildfires
- **Prescribed fires:** Planned ignitions

**Wildland-urban interface (WUI):** The line, area or zone where structures and other human development meet or intermingle with undeveloped wildland or vegetative fuels.

**Winter concentration area:** That part of winter range where densities are at least 200 percent greater than the surrounding winter range density during the same period used to define winter range in the average five winters out of ten. Winter concentration areas are defined for each Colorado Division of Wildlife Data Analysis Unit.

**Xeroriparian area.** An area or vegetative community that exists in arid environments and is characterized by dry washes exposed to only intermittent flows of water (ephemeral streams) associated with discrete precipitation events.

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# Appendix A

## Well Pad Site Suitability Models and Methodology

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# APPENDIX A
# WELL PAD SITE SUITABILITY MODELS AND METHODOLOGY

In an effort to efficiently develop the Bull Mountain Unit (the Unit) for extraction of natural gas, SG Interests (SGI) recognized Geographic Information Systems (GIS) as an ideal tool for locating potentially suitable sites within the Unit boundary. GIS is commonly employed for large-scale spatial analysis for its ability to compare, analyze and summarize a variety of phenomena across broad geographic areas. For the Bull Mountain Unit, SG utilized the technology to reveal sites that respect specific environmental, regulatory, and cost constraints. In order to enhance the quality of topographic and other data available for the project area, and thus the efficiency of selecting appropriate sites for well pads and ancillary facilities, SG contracted to acquire LiDAR (Light Detection and Ranging) data. LiDAR is a remote sensing technology that employs aerial lasers to determine distances, elevations, and other properties.

LiDAR was used to record individual points, one meter apart, which were then classified according to whether they reflect a point on the ground, vegetation, building or structure, or other element. Those points classified as ground points were used to produce a bare-earth model depicting the Unit's topography absent of any above-ground features. Similarly, those points classified as vegetation points produced data accurately depicting existing canopy cover, stand densities, and vegetation height. The high density of points allowed vertical accuracies of +/- 6 inches and horizontal accuracies of +/- 1.5 feet.

Site-suitability models combine a number of data sets across a given area to produce a final composite that ranks the appropriateness of the end use for all areas of a site. For the Bull Mountain Unit, the data included baseline LiDAR topographic and vegetation data, as well as site-specific information collected/delineated in the field (i.e., wetland and riparian areas) and/or information obtained from publicly available sources (e.g., Colorado Division of Wildlife habitat data). All data used in the analyses were grid data sets, or cells with a 10-foot pixel resolution, meaning each cell in the grid data represented a 10-foot x 10-foot area on the ground, or 100 square feet. The analyses utilized the following data sets to develop criteria for each site-suitability study:

1. Slope (steepness of the terrain)
2. Sensitivity to visual impacts from SH 133 and County Road 265 travel corridors
3. Proximity to existing road networks
4. Proximity to existing natural-gas pipeline systems
5. Proximity to delineated wetlands and wetland buffer zones
6. Proximity to stream networks and stream buffer zones
7. Proximity to known streams containing native cutthroat trout lineages
8. Soil erosion factors
9. Vegetated areas and open meadows

A series of five successive site-suitability models was run using eight different weighting factors to study the project area under separate scenarios, each of which prioritized different criteria. After the values for the individual data sets were determined and the weights assigned, the data sets were composited. The resulting data ranked each 10-foot x 10-foot cell in the grid on a scale of 0–9 with zero representing the least-suitable areas and 9 indicating areas of high suitability for well pad location and construction. In 2009, SGI presented this technique to the BLM, and with BLM-requested modifications, proceeded with this technique. **Table A-1**, Criteria and Weighting Factors for Well Pad Site Selection, Alternatives B and C, shows the criteria and weighting factors for Alternative B, the Proposed Action (Model 5 results) and Alternative C, Modified Action.

**Table A-1**
**Criteria and Weighting Factors for Well Pad Site Selection, Alternatives B and C**

| Data Element | Criteria | Value (1–9) | Weight | |
|---|---|---|---|---|
| | | | Alternative B | Alternative C |
| Slope | 0–4 % | 9 | 30% | 20% |
| | 4–8 % | 8 | | |
| | 8–12% | 7 | | |
| | 12–15% | 6 | | |
| | 15–20% | 5 | | |
| | 20–33% | 4 | | |
| | 33–45% | 3 | | |
| | 45–60% | 2 | | |
| | 60+% | 0 | | |
| Viewshed areas | Not visible | 9 | 30% | 10% |
| | Visible from CR 265 – bare surface | 7 | | |
| | Visible from CR 265 – vegetation | 6 | | |
| | Visible from Hwy 133 – bare surface | 4 | | |
| | Visible from Hwy 133 – vegetation | 3 | | |
| Colorado Cutthroat Trout Streams | >300’ from stream | 9 | 0% | 0% |

**Table A-1**
**Criteria and Weighting Factors for Well Pad Site Selection, Alternatives B and C**

| Data Element | Criteria | Value (1–9) | Weight Alternative B | Weight Alternative C |
|---|---|---|---|---|
| Hydrology/wetlands | >500' from pond, stream or wetland | 9 | 10% | 5% |
| | >300' and <500' from pond or stream | 4 | | |
| | <300' from pond or stream or <500' from wetland | 1 | | |
| | In pond, stream bed or wetland | 0 | | |
| Meadows, vegetation canopy | Within open meadow (non-native pasture) | 9 | 1% | 0% |
| | Within canopied area | 4 | | |
| Soil types | Kw (erosion) factor | | 4% | 15% |
| | 0.1 | 9 | | |
| | 0.15 | 8 | | |
| | 0.2 | 6 | | |
| | 0.24 | 5 | | |
| | 0.37 | 4 | | |
| Distance from existing roads | <500' | 9 | 15% | 35% |
| | 500–1,000' | 8 | | |
| | 1,000–1,500' | 7 | | |
| | 1,500–2,000' | 6 | | |
| | 2,000–2,500' | 5 | | |
| | >2,500' | 3 | | |
| | In road bed | 0 | | |
| Distance from existing pipelines | <500' | 9 | 10% | 15% |
| | 500–1,000' | 8 | | |
| | 1,000–1,500' | 7 | | |
| | 1,500–2,000' | 6 | | |
| | 2,000–2,500' | 5 | | |
| | 2,500–3,500' | 4 | | |
| | 3,500–5,000' | 3 | | |
| | 5,000–7,500' | 2 | | |
| | >7,500' | 1 | | |
| | In pipeline ROW | 0 | | |

Based on the results of each model, 145 suitable well pad locations were identified. The number of locations was narrowed to the 50 most suitable sites that would adhere to defined environmental and regulatory constraints while also effectively draining the Unit of the natural-gas resource. The reduction was achieved by compiling statistics on the 145 identified suitable locations, followed by a more detailed review of each individual well pad. The statistics gathered for each well pad allowed all locations to be quickly ranked and evaluated by model suitability, impacts to hydrology zones, and overall length of roads and pipelines. After review of the compiled statistics, the 50 well pad locations with the best suitability values, least amount of road construction, and minimized slope and hydrology impacts were chosen as a foundation for Alternative B. Those 50 locations were then inspected in the field in much greater detail to gain a better understanding of the following site-specific impacts and how each well pad would contribute to Alternative B as a whole:

- The distance to adjacent well pad locations was considered in the refinement process to achieve a more uniform distribution across the entire Bull Mountain Unit that would effectively drain the natural-gas resource.
- Surface topography was studied to more accurately determine well pad placement and feasibility.
- Surrounding habitat and migration corridors were considered to reduce adverse impacts to local species.
- Wetlands and hydrology data sets were cross-referenced to refine the location of well pads near sensitive buffer zones.
- Existing road networks and slope data were checked on the ground to better understand accessibility of the proposed site and feasibility of road construction.
- Additionally, a number of visual studies were employed to minimize or eliminate impacts to critical viewsheds as determined by existing landowner surface-use agreements and primary travel corridors within the Unit.

All of these factors were combined and considered at each identified location, and the well pad was either eliminated or included in Alternative B. Minor changes were made to individual well pads as required. Existing and proposed well pad locations are shown in **Table 3-35** and **Figure 3-20**.

# Appendix B

## Construction, Drilling, Completion, and Reclamation

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# APPENDIX B
# CONSTRUCTION, DRILLING, COMPLETION, AND RECLAMATION

The following information is largely the same as that presented in the EIS. However, the appendix provides some additional details for each phase of development in order to complete details on development process to the public. If there are any inconsistencies, statements in the body of the Draft EIS will take precedence over this appendix.

## CONSTRUCTION, DRILLING, AND COMPLETION ACTIVITIES FOR NATURAL GAS WELLS

All federal actions undertaken as a result of the No Action Alternative or either action alternative are subject to approval by the BLM prior to implementation.

**Access Road Construction —** Development of natural gas wells would require the upgrade of existing two-track roads and construction of new access roads to link the well sites with the existing road system in the Bull Mountain Unit. The roads would generally have a 16-foot-wide driving surface (approximately 25-foot disturbed area). Access roads would be constructed using standard crown-and-ditch specifications. The new roads and improved existing road surfaces would be composed of an appropriate volume of roadbase compacted using a roller and water. Gravel sources would be checked for possible weed issues, and treated as necessary. Upgrade and graveling of these roads would occur as necessary to maintain the post-construction surface quality.

The maximum disturbance width for roads would vary depending on the slope of the native topography. For this analysis, LiDAR data was used to model road disturbances. Cut-and-fill widths were broken down into slope classifications (**Table B-1**) for the area around well pads and on either side of access roads, based on observed instances in the Unit (erring on the side of overstating the actual impacts).

**Table B-1**
**Modeled Cut-and-Fill Widths for Well Pads and Roads**

| Well Pads | | Roads | |
|---|---|---|---|
| **% Slope** | **Distance (in feet)** | **% Slope** | **Distance (in feet)** |
| 0-5 | 15 | 0-20 | 6 |
| 5-10 | 40 | 20-25 | 8 |
| 10-15 | 65 | 25-30 | 12 |
| 15-20 | 100 | 30-40 | 32 |
| 20-25 | 150 | No roads placed on slopes > 40% | |
| 25-30 | 230 | | |

Based on the cut-and-fill values, areas around well pads and roads were buffered in order to provide adequate data for this analysis. While pipelines would see interim cut-and-fill activities, the pipeline rights-of-way would be reclaimed, and no long-term changes in topography would occur.

Construction equipment and techniques employed by SGI and its contractors would be in compliance with the BLM Surface Operating Standards and Guidelines for Oil and Gas Exploration and Development, also known as The Gold Book (2007) standards for the industry. Heavy equipment and support vehicles would be required (bulldozer, grader, track hoe, front-end loader, and heavy- and light-duty trucks). Clearing of vegetation and blading of soil materials would be limited to areas of construction; bladed vegetation and topsoil materials would be windrowed for future redistribution during interim and final reclamation. Woody debris would be separated from topsoil and, when practical, used on cut-and-fill slopes as natural erosion control.

The road would be constructed with appropriate drainage and erosion-control features/structures (e.g., cut-and-fill slope and drainage-ditch stabilization, relief and drainage culverts, water bars, wing ditches, and rip-rap). Sand and gravel materials for all uses would be obtained from local permitted, commercial sources. Gravel would be obtained from weed-free sources, if available. Any incidental noxious weeds brought in with gravel would be treated on an annual basis. Water would be used in initial road construction and sand/gravel surfacing to improve workability of the soil and the sand and gravel. Water needed for access road construction would be obtained from nearby sources (per agreements with landowners), or would be under the guidance of SGI's Water Augmentation Plan, as outlined below.

**Waters Used for Construction, Drilling, and Hydraulic Fracturing** — Water is needed for a variety of activities associated with development of the Unit, including dust abatement on roads, moistening of soils and gravels for compaction of well pad surfaces, production of drilling muds (to help lubricate the bore hole and circulate drill-bit cuttings), cementing the casing, and hydraulic fracturing and well stimulation. Water is also sometimes used to hydraulically test pipeline integrity (see "pressure testing" section in the pipe installation section). Approximately 3,000 barrels (bbls) of water would be required for drilling and for cement preparation for each well, which would total approximately 50 acre-feet of water for 150 wells. Water for drilling and cementing would be pumped to the well site and stored for operations or would be trucked in. The 50 acre-feet of water used for the drilling/completion, and additional water for construction (dust abatement and soil compaction) would be considered a "consumptive use" in that the water could not be re-used for other purposes. Water used for drilling/completion must be injected into a disposal well or, hauled off-site to an approved disposal facility. SGI plans to re-use water where possible due to the expense of water. Flowback fluids to be used during the same drilling season may be stored in the McIntyre Flowback Pits, which are permitted and lined ponds located on private lands within the Unit (see **Well Pad Construction**).

In 2009 SGI developed a Water Augmentation Plan granted by the District Court – Water Division 4 (Case # 09CW16), and regulated through the State Division of Water Resources (Water Division 4) for augmenting waters consumptively used from the Muddy Creek basin in order to maintain instream flows. Agricultural waters were re-appropriated for maintaining instream flow requirements under this Plan. If necessary, water would be purchased from landowners or trucked in from private and/or other sources near Paonia or Somerset.

**Well Pad Construction** — A leveled area would be graded by a bulldozer after upgrade/construction of an access road to the well site. Standard cut-and-fill construction techniques and machinery (bulldozer and/or grader) would be used. Vegetation would be cleared and all available topsoil to a depth of 8 – 12 inches would be stockpiled and segregated from subsoils over the entire disturbed surface to create the well pad area. The well pad would be surfaced using “pit run,” which generally consists of rock less than 6 inches in diameter. The area within the anchor bolt pattern and around tank batteries or facilities would also be surfaced with a top dressing of ¾-inch road base. Pit run and road base would both be trucked in to the site from local gravel pits near Delta, Paonia, or other local areas. If the well location requires only minimal grading, 8 inches of topsoil would be salvaged from beneath the operations area and stockpiled in contiguous berms or stockpiles at the edges of the well pad to facilitate future reclamation. Stockpiled topsoil would be protected against wind and water erosion and seeded with approved seed mix concurrent with cessation of well pad construction and earth-moving operations. Native seed mixes would be encouraged.

SGI would use a closed-loop system for drill cuttings and fluids when possible or when conditions require such use. If such rigs are not available or appropriate for the specific drilling operation, or if they become cost-prohibitive due to increased demand, SGI would use a lined reserve pit system (sizes vary with well type and site conditions, but typically 50 x 150 feet), which would be constructed on the well pad to receive drill cuttings and fluids. The reserve pits would be lined with a minimum 24-mil plastic and would be fenced on three sides during drilling and completion operations, with the fourth side fenced during cleanup. Bird netting would be installed over the pit and silt fencing would be installed around the base of the fences. Two (2) feet of freeboard is required as per Onshore Oil and Gas Order #7 at all times. Any reserve pits which are left open over the winter months would be fenced to keep big game and wildlife off of the pits. Pits would have a 2-foot unlined berm in addition to the minimum 2 feet of freeboard around them to prevent snowmelt on the pad from flowing into pits.

**Well Drilling and Casing —** Following construction of the access road and well pad, a mobile Tier-2 type drilling rig would be transported to the well site and erected on the well pad. A conventional rig would be used for coalbed methane natural gas wells (CBNG) and vertical shale wells, which would be drilled vertically, and would operate 24 hours per day. Directional drilling equipment would be used for directional shale gas wells, and would operate 24 hours per day.

Additional equipment and materials needed for directional drilling operations would be trucked in to the well site.

Drilling would begin by digging a rectangular pit, called a cellar, then lined with metal, where the hole would be drilled. The cellar would provide space for the casing head spools and blowout preventers (BOPs) that would be installed under the rig. Drilling operations normally include (1) keeping a sharp bit on the bottom drilling as efficiently as possible, (2) adding a new joint of pipe as the hole deepens, (3) tripping the drill string out of the hole to put on a new bit as needed and running it back to the bottom, and (4) installing steel casing and cementing the casing in the hole. The target depth of the holes would vary by well site, but is estimated to be approximately 3,500 to 10,000 feet. For the intermediate and production hole sections a low-solids, non-dispersed gel system would be used during this phase of drilling.

Completion of well-drilling operations would involve the placement and cementing of well casing. The casing and cementing program would be conducted as approved to protect and/or isolate all usable water zones, potentially productive zones, lost circulation zones, abnormally pressured zones, and any prospectively valuable deposits of minerals. Placement of steel casing ("casing the hole") would entail the insertion of continuous sections of steel pipe into the drill hole. The casing would extend from the bottom of the hole to the surface. Casing would be set in the hole, one joint at a time, threading one piece into a collar on the next. The wells would be completed with conductor casing to a depth of at least 80 feet; then with surface casing to at least 400 feet, intermediate casing to approximately 3,000–5,500 feet, then with production casing to the target well depth. Casing programs are dependent on the target depth and individual well casing plan.

The casing would be cemented into place in stages by pumping a slurry of dry cement and water into the casing head, down through the casing string to the bottom of a string stage, and then up through the spacing between the casing and the well bore (annulus) back up to the surface. A plug would be pushed to the bottom of the well bore to remove any residual cement from the inside walls of the casing. Sufficient cement would be pumped into the annulus to fill the space, where it would be allowed to harden. A cement bond log would be run on the well bore to ensure that no voids remain in the annulus. Cementing the annulus around the casing pipe restores the original formation isolation by posing a barrier to the vertical migration of fluids or gasses between rock formations within the annulus of the borehole, protects the well by preventing formation pressures from damaging the casing, and retards corrosion by minimizing contact between the casing and corrosive formation fluids. Each well may have multiple strings, and each string is cemented independently.

All drilling operations and other well site activities would be conducted in compliance with applicable BLM rules and regulations including Gold Book standards and Colorado Oil and Gas Conservation Commission (COGCC) rules and regulations. All wells, whether exploration or development, drilling, producing, suspended, or abandoned, shall be identified in compliance with 43 CFR 3162.6. Pressure tests are required before drilling out from under all casing strings set and cemented in place. Blowout preventer controls must be installed prior to drilling out the surface shoe and prior to starting workover or completion operations. Blowout preventers will be inspected and tested at regular intervals to insure good mechanical working order.

Trucks would be used to transport drilling components to the work site. Rig components are designed for portability and are easily loaded and unloaded and mostly self-contained on the mobile drill rig. Auxiliary equipment for the supply of electricity, compressed air, and/or water (i.e. large diesel generators) would be trucked in for drilling operations. Drill pipe, drill bits, cement, water, wire rope, and other supplies would be trucked to the well pad and stored temporarily until used. Traffic would consist of support equipment, contractor vehicles, construction personnel, and material delivery. Well pad activity would involve backhoes, front-end loaders, boom and winch trucks, delivery trucks, welding machinery, and personal conveyance vehicles.

Materials generated during drilling would include drill cuttings, drilling fluids, and additives used to maintain circulation and reduce borehole caving. Drilling fluids and mud additives would be recirculated into the well during drilling. Drill cuttings would be extracted from the drilling mud and placed in the reserve pit. Drilling fluids could be transported to another drilling location for reuse; stored in reserve pits on a well pad. COGCC requires that reserve pits be dried out and reclaimed within six months of completion of drilling activities, with exceptions. Mud products on site during the drilling process include bentonite, barite, soda ash, lime, polymer, lignite, and lost circulation material.

**Well Completion and Stimulation —** After drilling and casing of the well, a completion program would be initiated to stimulate production of natural gas and to determine gas and water production characteristics. A mobile completion rig (also called a “workover rig”) similar to the drill rig may be used to complete each well. The well completion process, lasting 8–10 days, includes perforating the well’s steel casing and cement, hydraulically fracturing the producing formation(s), and installing a series of valves and fittings on the wellhead. Hydraulic fracturing does not always require the presence of a workover rig.

Well casing perforation involves the creation of holes in the casing wall to provide a flow path into the wellbore. The holes through the cement and well casing allow pumped fluids to enter the formations and stimulate the inflow of natural gas and produced water. Hydraulic fracturing is then used to stimulate production by increasing the permeability of the producing formation(s). Water volumes needed for hydraulic fracturing would be highly variable depending on the number of stages, well depth, and type of engineered completion. The fluid is pumped under high pressure downward through the casing and out through the perforations in the casing. The pressurized fluid enters the formation and fractures it. Following the hydraulic fracturing of the well, a percentage of the fluid, consisting primarily of produced water, may be returned to the surface. This percentage of return varies between wells. Even though the produced water and gas can flow into the casing after it is perforated, a small-diameter pipe, called tubing, is placed in the well to serve as a way for the produced water to be brought to the surface. Typically, the start of the tubing is placed below the perforated interval to allow any fluids collecting at the bottom of the well to be pumped up through the tubing to the surface. The tubing in the well is suspended from the wellhead, so as the well production flows up, the production from the well can be controlled by opening and closing valves on the wellhead.

Should drilling fluids fill the reserve pits to a level approaching two feet from the top, water or other materials would be removed from the pits to allow for additional volume as necessary.

Excess produced water would either be stored on the pad in containers, returned to the McIntyre Flowback Pits off the location site, or hauled/piped to a water-disposal well for reinjection. Portable above-ground poly pipelines would be utilized for temporary delivery of flowback waters in areas lacking buried steel pipelines.

There would be minimal venting of gas at the well site during completion. This venting could occur during backflowing of hydraulic fracturing fluids to the surface. This gas would most likely be flared. The flowing back of a well is necessary to purge it of fluids used in the completion process. During the process of flowing back the well, slight amounts of gas are produced. Any gas flowing back with the water is separated and vented to the atmosphere. The venting would only occur during the recovery of the water and last for a matter of days. Any gas venting would be in accordance with BLM’s Notice to Lessees 3000-4A.

Should any well not prove productive, the well and location would be abandoned and reclaimed in accordance with applicable BLM requirements stipulated in COAs for the well, and according to the surface-use plan submitted with the APD. Reclamation would involve recontouring the well pad to blend with the natural topography, even redistribution of segregated topsoil, seeding, and monitoring to ensure revegetation is successful. Reclamation efforts would continue until all related COAs were met. Removal or burial of any surfacing material used to complete the well pad would be according to BLM Gold Book standards.

**Flowback Pits.** In order to minimize the consumptive use of water for completion operations, SGI is in the process of constructing four flowback pits on private surface lands to temporarily store fresh water and produced water prior to and after completion operations, per the regulatory guidance and permitting of COGCC. Temporary storage areas (flowback pits) would reduce the amount of water transportation trucking traffic, on-site storage of water on pads in frack tanks, and subsequent removal of waters between hydraulic fracturing operations. At this time flowback pits are permitted as follows: two pits on Rock Creek Ranch (T11N, R90W, Section 24) immediately north of SGI’s existing Federal 11-90-24-2 WDW, and two additional pits on Rock Creek Ranch lands in T11N, R90, Section 26. Since all four flowback pits would be located on lands previously owned by the McIntyre Ranch, they are referenced as follows:

| | Dimensions | Fluid Volume Capacity |
|---|---|---|
| 1. McIntyre Flowback Pit 1 | 130’ x 200’ x 12’ deep (10’ fluid depth) | 31,463 barrels |
| 2. McIntyre Flowback Pit 2 | 110’ x 230’ x 12’ deep (10’ fluid depth) | 29,720 barrels |
| 3. McIntyre Flowback Pit 3 | 150’ x 600’ x 14’ deep (12’ fluid depth) | 144,247 barrels |
| 4. McIntyre Flowback Pit 4 | 150’ x 600’ x 14’ deep (12’ fluid depth) | 144,247 barrels |

The locations of the flowback pits were developed based on placement on acceptable topography (to reduce cut-and-fill needs), distance from surface waters, and proximity to other facilities and infrastructure (water pipelines and roads). Temporary surface poly piping would be used to transport water between the flowback pits and the well site and/or the existing gathering system.

Water would be delivered to the flowback pits through surface poly pipe and the existing water pipelines for temporary storage prior to hydraulic fracturing operations. Temporary water pumps would draw water from the flowback pits into the temporary surface pipes and existing water pipelines (in order to reduce truck-based fluid hauling). Water would be mixed with sands and chemicals on a pad site prior to injection into a wellbore.

After hydraulic fracturing operations for a well are complete, used fluids would be flowed back out of a well bore, filtered on the pad site, and then pumped into transportation trucks (to be trucked to a flowback pit) or pumped into an existing water pipeline and/or temporary surface poly pipe for delivery to a flowback pit for temporary storage. These used fluids could then be re-used for additional hydraulic fracturing operations during the same season.

Flowback pit construction involves the salvaging of topsoils, the excavation of the pit itself, and compaction of the pit interior. Pits will then be lined with 24-mil (minimum thickness) felt-backed liners, which will be anchored around the edges. At least 2-feet of pit freeboard will be required at all times. Bird-netting would be stretched over the pits to prevent bird entry. Year-round wildlife fencing and silt fencing would be required around all flowback pits to prevent terrestrial wildlife entry into a full or empty flowback pit. Additionally, flowback pit sites would have fencing around the entire perimeter and be gated to prevent livestock entry onto the flowback pit site itself. The flowback pits will be lined with a multi-layered liner system with built-in leak detection prior to the final liner. There will also be surface and groundwater monitoring stations as part of the COGCC's permitting and compliance process. The flowback pits are located on private lands within the Unit, on Rock Creek Ranch, which is an affiliate of SGI Interests.

**Surface Facilities —** Installed surface facilities for each well would include the wellhead, and may include artificial lift, separator, water transfer, tank batteries, wellhead compression, and gas-metering facilities. If artificial lift is used, the driver may be natural gas or electric powered. Facilities would occupy less than one acre on the site. All long-term facility structures would be painted in accordance with BLM Gold Book standards. Separated, produced water from each well would be transported or pumped through in-ground water lines to an approved disposal well. Disposal of produced water would be in accordance with a plan approved by the BLM as provided for in Onshore Oil and Gas Order No. 7, Disposal of Ground Water and the COGCC.

Compression in the field may be necessary as wells come online. One screw compressor would be located at the southern terminus of the Bull Mountain Pipeline in T11S R90W Section 10. This compressor would be located on private land outside the Bull Mountain Unit boundary, but would compress gas produced in the unit. A second screw compressor would be located in T11S R90W Section 24 within the Bull Mountain Unit just northeast of the Federal 11-90-24 #1 well. Both units would have hospital-grade mufflers.

**CONSTRUCTION OF PIPELINES**

Pipeline corridors within the Unit would vary depending on the pipeline size (diameter) and terrain. Construction corridor widths could be up to 75 feet wide, and the permanent corridor retained for potential future repairs, etc. would be 30 feet. However, in many areas the surface disturbance from construction could be as narrow as 15 feet wide (such as when crossing wetlands).


**Photo 1: Wetland area with narrowed corridor following reclamation and replanting with local native species, per ACOE guidance [SPK-2009-01336].**

For this analysis an average 50-foot-wide construction disturbance corridor and a 30-foot-wide permanent corridor were used. Final surface disturbances would be reassessed as necessary when final designs are permitted through the appropriate regulatory agencies.


**Photo 2: The same wetland area after two growing seasons.**

In certain areas (wetland crossing areas in particular) the corridor work area would be reduced in width to approximately 20 feet (**Photos 1 and 2**) to minimize impacts to riparian areas and wetlands. Above-ground pipeline facilities would be located within the 30-foot permanent easement where pipelines cross roads, and where vehicle access to above-ground facilities is required.

Surveys would be performed to identify the centerline of the pipeline and the boundaries on both sides of the easement corridor. The following sections describe the various pipeline construction phases, which are typical for a project of this type.

**Clearing and Grading —** Clearing, grading, and other disturbance of soil and vegetation would be limited to the minimum area required for safe construction operations within the approved corridor and extra workspaces. Per COGCC and Colorado Parks and Wildlife (CPW) recommendations, root systems of trees would be left in place where feasible through the use of grinding machines and where they would not pose a safety concern for workers or an impediment to equipment or rubber-tired vehicle access. The herbaceous vegetation crown would be maintained to the extent possible where blading of the corridor and extra workspaces are not necessary. Once the clearing process has removed any obstacles or debris, grading would follow to remove the topsoil and surface rock, and stockpile it within the edge of the easement for redistribution following construction.

All brush and other materials that are cleared would be windrowed within the easement or in temporary use areas. Following construction, these materials may be dispersed over the corridor to impede future access along the easement, except if co-located with an existing road. Trees and rocks would be strategically placed on the easement to impede future access.

**Photo 3: Pipeline trench parallel (co-located) to existing road**

**Photo 4: Reclaimed pipeline corridor adjacent to road**

**Trenching (Photos 3 and 4) —** Construction methods used to excavate a trench would vary depending on soil, terrain, and related factors. Where possible, rotary trenching machines would be used. In situations such as steep slopes, unstable soils, high water tables, or deep or wide trench requirements, conventional tracked backhoes (trackhoes) would generally be used.

Measures would be taken to ensure that access is provided for property owners or tenants to move vehicles, equipment, and livestock across the trench where necessary. Adequate precautions would also be taken to ensure that livestock are not prevented from reaching water sources because of the open trench. These would include contacting livestock operators, providing adequate crossing facilities, or other measures as needed.

**Highway Crossings.** Crossing methods and construction requirements would be according to Colorado Department of Transportation permit stipulations and general conditions.

**Pipe Installation —** Pipe installation would include stringing, bending for horizontal or vertical angles in the alignment, welding the pipe segments together, x-ray inspection, coating the joint areas to prevent corrosion, and then lowering-in and padding.


**Photo 5: Typical corridor with steel gas-gathering pipe**

- ***Stringing***. Line pipe would be trucked directly from the manufacturer or a contractor storage yard to the corridor. Each individual joint of pipe would be unloaded, and strung parallel to the trench. Sufficient pipe for road or stream crossings and steep slopes would be stockpiled at staging areas near the crossings or slope. Stringing operations would be coordinated with trenching and installation activities to properly manage the construction time at a particular tract of land. Gaps would be left at access points across the trench to allow crossing of the corridor.

- ***Bending***. After the joints of pipe are strung along the trench but before the joints are welded together, individual joints of the pipe would be bent if necessary to accommodate horizontal and vertical changes in direction. Field bends would be made utilizing a hydraulically operated bending machine. Where the deflection of a bend exceeds the allowable limits for a field-bent pipe, factory (induction) bends would be installed.

- ***Welding***. After the pipe joints are bent, the pipe would be lined up end-to-end and clamped into position. The pipe would then be welded in conformance with 49 CFR Part 192, Subpart E. “Welding of Steel Pipelines” and API 1104, “Standard for Welding Pipelines and Related Facilities,” latest edition.

- ***X-Ray Inspection***. Welds would be visually inspected by a qualified inspector using non-destructive radiographic methods according to DOT requirements. A specialized contractor, certified to perform radiographic inspection, would be employed to perform this work. Any defects would be repaired or cut out as required under the specified regulations and standards.

- ***Coating.*** To prevent corrosion, the pipe would be externally coated with fusion-bonded epoxy coating prior to delivery. Power Crete-coated pipe would be installed in all bore locations. After welding, field joints would be sandblasted, flocked, and coated with a synergy coating. Before the pipe is lowered into the trench, the pipeline coating would be visually inspected and tested with an electronic detector, and any faults or scratches would be repaired.

- ***Lowering-In and Padding***. Once the welding and inspection has been completed, a section of the pipe would be lowered into the trench. Sideboom tractors would be used to lift the pipe, position it over the trench, and lower it into place. Inspection would be conducted to verify that minimum cover is provided, the trench bottom is free of rocks or other debris, external pipe coating is not damaged, and the pipe is properly fitted and installed into the trench. Specialized machines would be used to sift soil fines from the excavated subsoils to provide rock-free pipeline padding and bedding. In rocky areas, padding material or a rock shield would be used to protect the pipe.

- ***Backfilling***. Backfilling would begin after a section of the pipe has been successfully placed in the trench and final inspection has been completed. Backfill would be conducted using a bulldozer, rotary auger backfiller, padding machine, or other suitable equipment. Backfilling of the trench would generally use the subsoil previously excavated from the trench, except in rocky areas where imported select fill material may be needed. Backfill would be graded and compacted by tamping or walking-in with a wheeled or tracked vehicle. Compaction would be performed to 95% maximum density as determined by AASHTO T-99 at all county road crossings. Backfill of trenches would not be performed where the soil is frozen to the extent that large consolidated masses have formed that would not “break down.” The contractor would then re-spread the topsoil to return the surface to its original grade. Any excavated materials or materials unfit for backfill would be utilized or properly disposed of in conformance with applicable laws or regulations.

- The construction contractor would place a mound over the trench approximately 6 inches high to account for subsidence.

- ***Pressure Testing*.** The entire pipeline would be tested in compliance with USDOT regulations (49 CFR Part 192). Prior to filling the pipeline for a pressure test, each section of the pipeline would be cleaned by passing reinforced poly pigs through the interior of the line. Incremental segments of the pipeline would then be filled with compressed water or air to the desired maximum pressure, and held for the duration of the test (8 hours minimum). The compressed air would be discharged into the atmosphere following the completion of the test. Notification to all nearby residents as well as the Gunnison County Dispatch Center would be made prior to the pressure test and blowdown Water discharge, if necessary, would occur into upland areas, on gentle slopes, and would be conducted in accordance to the conditions and stipulations in CDPHE’s Colorado Discharge Permit System for Hydrostatic Testing of Pipelines Tanks and Similar Vessels. These conditions and stipulations require permit-specific sampling, testing, filtering or mitigation, reporting, and a plan to prevent soil erosion or impacts to surface waters.

#### Construction, Drilling, and Completion Activities Unique to Water-Disposal Wells

SGI proposes to develop four water-disposal wells. Locations for these wells were chosen based on the number of gas-producing wells in a given area which would be generating water to be reinjected, and on proximity to major road systems to facilitate year-round accessibility.

**Well Pad Construction** — Pad construction would follow the method used for natural gas wells, except that the lined reserve pit would be approximately 50’ x 150’ in size.

**Installation of Overhead Electrical Lines —** Overhead electrical lines would be installed by the Delta Montrose Electrical Association (DMEA) to connect the water-disposal well facilities to existing power lines. The new lines would be installed on a direct route representing the shortest distance from existing lines to the well site subject to review of and mitigation for visual impacts. Electrical power would be used for long-term operation of lights, water heaters, and ancillary needs at the well. In most, but not all cases, well pumps would not use electricity, and would be run by natural gas-powered pumps. Existing two-track roads occur in the areas where the power lines would be constructed; therefore, no new road construction would be necessary. Wooden power poles would be erected by DMEA’s service trucks. Some Gambel’s oak, aspen, and other taller shrubs may need to be pruned back for construction, and each power pole hole would disturb approximately eight square feet of vegetation during excavation of the hole and setting of the power poles. There would be no prescriptive clearing of the corridor for power lines. One electrical wire would run to each pad site.

Power line construction would take place following successful completion of each water-disposal well.

**Well Drilling and Casing —** For each water-disposal well, a 24-inch-diameter hole would be drilled for the first 40 feet; and the size of the hole would be gradually reduced with decreasing diameters of casing strings until the hole reaches its target depth, estimated at 10,000 feet. The disposal region is estimated to be between 9,300 and 9,500 feet. Once the casing strings are set and the outside annulus is cemented in place for each string of casing, the casing walls and cementing would be perforated using explosive charges. Multiple disposal zones would be perforated in order to allow produced water to flow into any of the available receiving formations, and allow for redundancy in receiving formations.

Three and 1/2–inch tubing would be run down the casing to the top of the target disposal zones. The tubing would be landed in a packer set approximately 100 feet above the uppermost completed injection zone. A packer set has rubberized rings, which when activated seal off the bottom of the casing, preventing disposal waters from migrating up the insides of the casing. Above the packer set, the annulus between the tubing and inner casing walls would be filled with packer fluid. Pressure would be monitored at the surface to detect any loss of packer fluid into surrounding formations and to detect migration of injected water upward into non-target annulus zones, as well as to insure tubing, packer, and casing integrity.

The disposal wells may be completed in the Entrada or Maroon Formations. A water-based mud system would be used for drilling of the surface hole, and a low-solids, non-dispersed gel system would be used for the intermediate and production hole sections of the water-disposal well.

**Well Completion and Stimulation —** Similar to traditional wells, a workover rig would be used to complete the well. This process includes perforating the well’s steel casing, and may include hydraulic fracturing of the formation if necessary to improve its ability to accept injected water. This supplemental fracturing could also recur later in the life of the well. Hydraulic fracturing would follow standard industry and regulatory procedures, as under producing wells.

**Surface Facilities —** Surface facilities for water-disposal wells would include the wellhead, water-injection pump and housing, and approximately six (6) to eight (8) 400-bbl holding tanks and one 90-bbl facility drain tank. Water storage tanks would be heated during the winter months to prevent ice formation in the tanks and lines. The injection pumps for the water-disposal well would be powered by electricity supplied by overhead or buried electrical lines or by natural gas. Facilities would occupy less than one acre on the well pad, which would be 1.38 acres following interim reclamation. All long-term facility structures would be painted in accordance with BLM Gold Book standards.

**Treatment of Water to be Disposed —** Water to be injected into the well would first be piped into the holding tanks to allow sediments to settle out. The water would then pass through a series of filters to remove solids larger than 10 microns in diameter. Accumulated solids from the settling and filtration process would be periodically removed from the holding tanks and trucked to an approved off-site disposal facility. Chemical treatment of water would reduce scaling or deposition of minerals in the receiving formation, which would otherwise shorten the life of the disposal zones. Chemicals used for treatment would likely include acids, which would keep any minerals in suspension and retard scaling. Disposal of produced water would be in accordance with a plan approved by the BLM as provided for in Onshore Oil and Gas Order No. 7, Disposal of Ground Water and COGCC rules and regulations.

### MAINTENANCE AND OPERATIONAL ELEMENTS COMMON TO ALL WELLS

**Maintenance and Workover Operations —** During the normal life of these wells, routine production and maintenance operations would be conducted on a daily basis to ensure that equipment is functioning properly. A well operations technician (referred to in the industry as a "pumper") would visit the well pads on a daily basis in a pickup truck to monitor various operating conditions such as gas and water production rates, pipeline pressure, separator pressure, etc., to determine if abnormal conditions exist and make or schedule necessary repairs. Maintenance of the well pad would also include monitoring the establishment of desirable vegetation, repair of any erosion occurring on the location, and control of noxious or invasive weeds. In the case of the water-disposal wells, routine maintenance ensures that the well can continue to accept injections of produced water efficiently.

Periodically, a workover on one of the wells may be required. A workover ensures that the well is maintained in good condition and that it is capable of delivering production from the formation as efficiently as possible. Workovers can include repairs to the well bore equipment (casing, tubing, rods, or pump), the wellhead, or the formation itself. These workovers may require venting pressure relief, generating brief periods of noise. Repairs generally occur during daylight hours only and may be completed in one day, or may require several days. The frequency for this type of work cannot be accurately projected since workovers vary by well, depending on the circumstances. One workover per five years per well is anticipated for purposes of this EA analysis. The operator must obtain BLM approval prior to conducting a workover that is within the scope of federal jurisdiction.

**Chemical Use and Spill / Waste Management —** The Proposed Action would use a variety of chemicals including solvents, lubricants, paints, and additives. A list of chemicals used during drilling, completion, and production is included in **Appendix G**. The listing identifies the chemical, its common application, and potentially hazardous components.

Drilling solids or cuttings would be produced. The cuttings are the bits of waste rock produced by the drill bit cutting through the various formations at intervals beginning 3–4 feet from the surface and ending at the top of the target zone. After drilling is complete, closure of the reserve pit will be completed according to the appropriate regulatory requirements (see pit closure section below).

Emptied steel and plastic drums for materials such as caustic soda, citric acid, lubricating oil, methanol, and drilling additives would require disposal. Empty metal or plastic drums would be returned to the supplier of the product. Any waste lubricating oil would be disposed of properly by a third-party contractor.

SGI has prepared and implemented an Emergency Response Plan for containment and control of oil and chemicals used in the Bull Mountain Unit, as well as fire prevention and protection and emergency reporting. Procedures outlined in the Plan are applicable to all SGI personnel and subcontractors. In accordance with the Plan, SGI personnel are trained to conduct routine inspections of the containment areas and to promptly contain and clean up any accidental spills. SGI's Emergency Response Plan can be provided upon request to their Montrose office.

### RECLAMATION

Incorporating desirable vegetation into the disturbed surfaces increases the opportunity to generate a viable seed bank, competes for nutrients in the topsoil against undesirable vegetation, and minimizes increased erosion potential.

**Interim Reclamation —** The goal of interim reclamation is to maintain soil productivity during the production phase. All surfaces not needed for long-term operations would be recontoured and seeded as per the BLM (**Table B-2**). SGI's preferred upland native seed mix complies with BLM, and Gunnison County goals and objectives. Any disturbances to BLM lands would be reseeded with a BLM-approved seed mix.

Reclamation areas would include, but not be limited to: fill slopes, trenches, wing ditches, edges of disturbance, temporary-use areas no longer needed, and embankments. SGI's seed mix does not contain forbs or shrub species due to interim noxious weed treatments, which would likely kill off any seeded forbs and shrubs.

**Table B-2**
**BLM-Recommended Seed Mix for Temporary Stabilization/Vegetation Cover**
**(Drill rates; use double if broadcast seeding method is used)**

| Common name | Scientific name | Variety | Lbs. PLS/ Acre | # PLS/lb. | Total # of Seeds | % of Mix |
|---|---|---|---|---|---|---|
| Western Yarrow | *Achillea millefolium* | Occidentalis | 0.25 | 2,770,000 | 692,500 | 0.42 |
| Mountain brome | *Bromus marginatus* | Garnet | 2.00 | 90,000 | 180,000 | 0.11 |
| Western Wheatgrass | *Pascopyrum smithii* | Arriba | 4.00 | 110,000 | 440,000 | 0.27 |
| Slender wheatgrass | *Elymus trachycaulus* | Pryor | 2.00 | 159,000 | 318,000 | .20 |
| | | **Total pounds/acre** | **8.25** | | | |
| | | **Seeds/square foot** | **37** | | | |

Seed availability may vary, so not all species may be available at the time they are needed. However, major species are generally available. The rates shown above are for drilled seeding only. Rates will be doubled if the seed is to be aerially broadcast, hand broadcasted or applied via hydroseeding. If availability is a concern, the operator will request the use of a BLM-approved alternate seed mixture.

Upon well completion, the well location and surrounding area would be cleared of all unused tubing, materials, trash, and debris. The portion of the well pad not required for production, the reserve pit, areas around buried pipeline, roadside ditches, and portions of the road corridor not used as a running surface would then be backfilled, leveled, and recontoured to match the adjacent terrain, unless the operator submits an APD for an additional well on the same pad within one drilling season. Stockpiled topsoil, as well as remnant vegetation (e.g. uprooted sagebrush, oak brush, etc.) would be spread over these areas, and then seeded with BLM-approved seed mix. Any remaining stockpiled topsoil not needed for final recontouring would also be stabilized and reseeded. Prior to reseeding, all disturbed areas would be scarified and left with as rough and uneven a surface as is practicable. The appropriate amount of seed would be applied across the disturbed areas.

The reserve pit would be cleaned out, backfilled, and reclaimed within 6 months from the date of well completion, weather permitting. Prior to any dirt work associated with reserve pit restoration, the reserve pits would be as dry as possible. Per COGCC requirements, cuttings within the pit would be tested by an EPA-approved laboratory, and cuttings would then be trucked to an approved and permitted disposal facility or otherwise disposed of in accordance with state and federal regulations. Prior to backfilling the reserve pit, the fence surrounding the pits and all debris in the pits would be removed. The pit liner would be completely removed and hauled to an approved and permitted disposal facility. After backfilling the pit void with clean fill dirt, salvaged topsoil would be placed on top of the backfill material. Results of cuttings pit testing on federal well sites would be made available to the BLM.

Upon completion of backfilling, leveling, and recontouring, the stockpiled topsoil would be evenly spread over the portion of the well pad not required for production, the reserve pit, and the access road cut and shoulder, unless the operator submits an APD for an additional well on the same pad within one drilling season. Care would be taken not to dilute the topsoil with the underlying subsoil materials. These temporarily disturbed areas would then be reseeded. Any remaining topsoil not needed for final recontouring would also be stabilized and reseeded. Prior to reseeding, all disturbed areas would be scarified and left with a rough surface. The appropriate amount of seed would be applied across the disturbed areas. The seeded area would then be covered with certified weed-free mulch, and a tackifier may be applied. On steeper slopes and in wetland areas, fully biodegradable erosion-control blankets may be used.

Revegetation efforts would be considered satisfactory when soil erosion resulting from the operation has been stabilized, and a vegetation cover equal to 70 percent of pre-existing or seeded-in vegetation is re-established (both cover and diversity of species as evidenced by pre- and post construction photo-point monitoring and/or vegetation plots/transects. SGI would monitor interim and final reclamation progress at one, three, and five-year intervals.

Reseeding would be required if satisfactory interim reclamation progress is not being made at year one or year three monitoring intervals, or if final reclamation is not achieved by year five.

BLM places the following requirements on seed mixes which are put on BLM lands.

1. Use the following minimum PLS (Pure Live Seed) tolerances:

| PLS tested % | Tolerance % points |
|---|---|
| 81–100 | -7 |
| 61–80 | -6 |
| 41–60 | -5 |
| 21–40 | -4 |
| 0–20 | -3 |

2. All seed must comply with BLM and Colorado weed seed guidelines. There should be no prohibited species seed, and no more than allowable levels of restricted species seed. In addition, there should be no more that 0.5% total weed seed, less than 2% other seed, and no trash larger than ¼” in length. Seed shall not be stored in burlap bags.

3. The BLM requires additional seed tests on seeding projects that are greater than 20 acres and/or require over 200 pounds of seed. For these seeding projects, the project proponent should have the seed supply company store the purchased seed prior to mixing, and pull samples to be sent to a certified laboratory, such as Colorado State Laboratory at the following address, or another lab selected by the BLM. Seed test results must comply with the criteria listed above before seed is mixed, shipped, and applied to the project area:

   Colorado State Laboratory
   Colorado State University
   Department of Soil and Crop Sciences
   Fort Collins, CO 80523

4. Copies of seed tags and test results for all seed applied, regardless of project size, must be submitted to the BLM.

5. Only State-certified weed-free mulch shall be used.

6. Seed would preferably be broadcast in the fall, and certified weed-free straw mulch would be spread over the seed. A starch-based tackifier may be used to secure the seed and straw mulch in place. Use of a temporary seed mix may occur if stabilization is needed through the summer months.

7. A Reclamation Status Report will be submitted to the BLM annually for all actions that require disturbance of surface soils on BLM mineral estate as a result of the Proposed Action. This report will provide a rolling total of interim and final reclamation, and will enable the BLM to track the total amount of unreclaimed surface disturbance within the project area at any given time. When a new APD is submitted, BLM will review this

report and determine if the proposed amount of new surface disturbance is within the total estimated disturbance for the Proposed Action. If the proposed new disturbance exceeds this total, a new action-specific EA could be required.

**Final Reclamation and Abandonment —** Each well would produce through its economic life, which is assumed to be approximately 40 years. At the end of its useful life, SGI or subsequent operators would reclaim and revegetate the well pads. When a proposal to develop a federal well is submitted to BLM, site-specific reclamation plans would be included with the proposal. Development of a site-specific reclamation plan in conjunction with federal wells would include consultation between the BLM, the landowner, and the operator. The following minimum standards would be applied:

- All surface equipment would be removed.
- Removal or burial of surfacing material would comply with BLM Gold Book standards.
- Wells would be plugged using the standards outlined below.

a. Open Hole: A cement plug would be placed to extend at least from 50 feet below the bottom (except as limited by total depth (TD) or plugged back total depth (PBTD) to 50 feet above the top of (1) any zones encountered during drilling that contain fluid with a potential to migrate; (2) lost circulation zones; and (3) any potential valuable minerals, including noncommercial hydrocarbons, coal, and oil shale. Extremely thick sections may be secured by placing 100-foot plugs across the top and bottom of the formation. Lost circulation zones may require alternate methods. In the absence of productive zones or minerals that otherwise require placement of cement plugs, long sections of open hole shall be plugged at least every 3,000 feet. Such plugs shall be placed across in-gauge sections of the hole.

b. Cased Hole: a cement plug shall be placed opposite all open perforations and extend a minimum of 50 feet below (except as limited by TD or PBTD) to 50 feet above the perforated interval. In lieu of the cement plug, a bridge plug is acceptable, provided: (1) the plug is set as close as practical above the open perforations; (2) the perforations are isolated from any open hole below; and (3) the plug is capped; if the cap is placed through tubing, a minimum of 50 feet of fill-up is required; if placed by bailer, a minimum of 35 feet of fill-up is needed. If production casing is cut and recovered, a cement plug shall be placed to extend at least 50 feet above and below the stub. An additional cement plug shall be placed to extend a minimum of 50 feet above and below the shoe of the surface casing (or intermediate string, as appropriate). The exposed hole resulting from the casing removal must be secured as required above.

c. Annular Space: no annular space that extends to the surface shall be left open to the drilled hole below. If this condition exists, a minimum of the top 50 feet of annulus shall be plugged with cement.

d. Testing: The first plug below the surface plug shall generally be tested by either tagging the plug with the working pipe string or pressuring to a minimum pump (surface) pressure of 1,000 psig with no more than a 10 percent drop during a 15-minute period (cased hole only). If the integrity of any other plug is questioned, it must be tested in the same manner. Also, any cement plug that is the only isolating medium for a freshwater interval or a zone containing a valuable mineral deposit should be tested by tagging with the drill string. Tagging the first plug below the surface plug will not be necessary where water flows or valuable mineral deposits have not been encountered.

e. Surface Plug: A cement plug of at least 50 feet shall be placed in the smallest casing that extends to the surface. The top of this plug shall be placed as near the eventual casing cut-off point as possible.

f. Mud: Each interval between the plugs shall be filled with mud of sufficient density to exert hydrostatic pressure exceeding the greatest formation pressure encountered while drilling such interval. In the absence of other information at the time plugging is approved, a minimum mud weight of 9 pounds per gallon shall be specified.

g. Surface Cap: All casing shall be cut off at the base of the cellar or 3 feet below final restored ground level (whichever is deeper). The casing shall be filled from the cement plug to the surface with suitable material (cement, sand, gravel, etc.). The well bore must then be covered with a metal plate at least 0.25-inch thick, welded in place, or a 4-inch pipe, extending 4 feet above the contoured ground surface and embedded in cement as specified by the Authorized Officer. The well location and identity shall be permanently inscribed on the pipe or plate.

# Appendix C

## Best Management Practices and Conditions of Approval

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# APPENDIX C
# BEST MANAGEMENT PRACTICES AND CONDITIONS OF APPROVAL

All federal actions undertaken as a result of the No Action, Proposed Action, and Modified Action Alternatives are subject to approval by the BLM prior to implementation.

In the process of acquiring permission to drill to a federal oil and gas lease, leaseholders submit an Application for Permit to Drill (APD) to the BLM Field Office that manages the lands where their lease is located. Included with the APD are:

- Subsurface – a drilling plan that contains a description of the leaseholder's drilling program, geologic data, expected hazards, and proposed mitigation measures to address such hazards

- Surface – a plan of operations that describes the locations of the drill pad, access road, pipeline(s), facilities, details of pad construction, methods for containment and disposal of waste material, and plans for reclamation of the surface.

When the BLM has completed the necessary environmental and technical review of the proposal contained in the APD, the BLM may approve the APD as submitted or, more typically, approve the APD subject to Conditions of Approval (COAs).

## CONDITIONS OF APPROVAL

COAs are attached to an approved APD to ensure environmental protection, safety, and/or conservation of the mineral resource. They arise from a variety of controlling authorities such as the Federal Land Policy and Management Act (FLPMA), the National Environmental Policy Act (NEPA), the Endangered Species Act (ESA), and the National Historic Preservation Act (NHPA). The COAs attached to an APD can be general in nature or site-specific, and will vary from one BLM Field Office to another. Typically, a Field Office develops COAs over a number of years of active management of oil and gas development. Often the Field Office RMP provides either a listing of potential COAs or the best management practices (BMPs) that might guide development of site-specific COAs in that area. They can address topics as wide-ranging as protection of wildlife habitat or archeological and paleontological sites, noise reduction, wildfire suppression, or management of invasive species. However, the 1989 RMP does not contain specific COAs. The list of COAs that will be used by the Uncompahgre Field Office (UFO) when considering APDs is presented in the standard format for attachments to an approved APD.

**General Requirements**

1. The operator will comply with all applicable federal and state laws and regulations including, but not limited to: Onshore Orders, BLM Gold Book Standards, the RMP currently in effect, the Clean Air Act, the Clean Water Act, the Threatened and ESA, the NHPA, and Colorado Oil and Gas Conservation Commission (COGCC) regulations.

2. The operator will comply with all current lease stipulations. Any conflicts will be resolved with the landowner on a case-by-case basis at the APD stage.

**Surface-Disturbing Activities**

3. The operator shall notify the BLM Authorized Officer at least 48 hours prior to initiation of construction.

4. The operator will monitor precipitation and snowpack levels in areas with slopes greater than 30 percent to help predict future mass movement of the soil mantle.

5. Site-specific slope-stability studies will be conducted in areas of potential geologic hazard prior to design and construction of new access roads, pipelines, and well pads, and appropriate mitigation will be included for potential movement of soils and rock.

6. The topsoil (consisting of O and A horizons) will be removed from pad locations during construction, stockpiled in berms, and saved for interim and long-term reclamation and revegetation. Stockpiled topsoil and spoil piles will be separated to prevent mixing during reclamation efforts.

7. Stockpiled soil and disturbed earthen surfaces necessary to build up well pad sites, such as cut/fill slopes, will be seeded with BLM-approved interim seed mix upon cessation of pad construction activities to control erosion, and reduce generation of dust. In addition, all stockpiled soil and soil disturbed areas will be maintained noxious weed free.

8. The operator shall use only certified weed-free seed and erosion-control materials.

9. Stockpiled topsoil that will potentially remain in place for more than one (1) growing season will be clearly identified, seeded, and maintained noxious weed free. Silt fences or other sedimentation control devices will be used on downgradient sides of these piles until stable.

10. Use of erosion-control blankets with plastic netting shall not be permitted.

11. Following seeding, any woody debris cleared during initial construction will be pulled back over the recontoured/partially reshaped areas to act as flow deflectors and sediment traps.

12. The application of gypsum to soil surfaces as a soil remediation technique will not be permitted on BLM-administered surfaces.

13. Pipeline corridors will be recontoured to pre-construction contours as soon as construction activities cease unless otherwise approved by the BLM.

14. Erosion and sediment control measures shall be maintained until stream banks, drainages and adjacent upland areas are stabilized.

15. Sedimentation shall be captured in catchment basins or other sedimentation control devices in order to protect surface waters.

16. The well pad surface and surfacing material will be maintained until implementation of final reclamation activities where it would be removed or buried in the cut portion of the location.

17. Dust-abatement measures will be applied to roads and pad locations. The operator can select and inform the BLM of chosen dust abatement. At a minimum, the application of fresh water will be acceptable. Other examples include: magnesium chloride, emulsified asphalt, gravel, or other dust palliatives to decrease the application frequency normally required when using fresh water only.

18. The operator shall take all reasonable measures to prevent and suppress fires in the area of operations. Fire restrictions/guidelines during periods of high wildfire danger will be followed.

**Road Construction and Maintenance**

19. The speed limit on access roads will be 20 miles per hour (mph) unless otherwise posted.

20. Vehicle traffic is limited to the bladed/traveled road surface and existing parking areas, pullouts, etc. No new pullouts, off-road parking, or staging areas will be allowed unless specifically authorized by the BLM.

21. The operator shall provide timely road maintenance and cleanup on the access roads.

22. The operator shall provide for erosion-resistant surface drainage prior to fall rain or snow.

23. The operator shall provide promptly remove slide material when it is obstructing road surface and ditchline drainage; save all soil or material useable for reclamation and stockpile for future reclamation needs; use remaining slide material for needed road improvement or place it in a stable waste area; avoid sidecasting of slide material where it can damage, overload, saturate embankments, or flow into downslope drainage courses; reestablish vegetation in areas where more than 50 percent of vegetation has been destroyed due to side casting.

24. During wet weather conditions, no mud blading will be allowed. When road conditions are such that vehicles create ruts deeper than four inches, travel activities will be temporarily suspended.

**Tanks and Pits**

25. All produced liquids shall be contained in a pit or tank, including the dehydrator vent/condensate line effluent. All drill cuttings will be kept in an approved lined pit on the pad of the well being drilled, or hauled to an approved disposal site

26. Berms or other secondary containment devices shall be constructed around fluid storage tanks and shall enclose an area sufficient to contain and provide secondary containment for 150 percent of the largest single tank (COGCC Rule 603e[12]).

**Pipeline and Power Line Construction**

27. Buried pipelines will provide a minimum cover of 36 inches through normal terrain. The pipeline will be buried deep enough to avoid problems with irrigation ditches, canals, potential irrigation areas, and existing pipelines, as designated by the Authorized Officer. In rocky areas, a minimum cover of 24 inches will be provided. In areas next to or crossing access roads, the pipeline shall be buried with a minimum of four feet of cover in alluvial areas and three feet of cover in rocky areas.

28. Water bars or dikes shall be constructed on all buried pipeline corridors, and across the full width of the disturbed area.

29. Slopes within the disturbed area shall be stabilized by non-vegetative practices designed to hold the soil in place and minimize erosion. Vegetative cover shall be reestablished to increase water infiltration into the soil and provide additional protection from erosion.

30. When erosion is anticipated, sediment barriers shall be constructed to slow runoff, allow deposition of sediment, and prevent it from leaving the site. In addition, straining or filtration mechanisms may also contribute to sediment removal from runoff.

31. Woody debris will be pulled back over recontoured areas (woody debris will not account for more than 20 percent of total surface cover) to help stabilize soils, trap moisture, and provide cover for vegetation.

32. Power line and ancillary structure design shall adhere to guidance provided in "Suggested Practices for Avian Protection on Power lines: State of the Art."

**Natural Gas Drilling and Exploration**

33. Freshwater aquifers shall be protected while drilling mineral exploration and development wells.

34. Casing design will be determined by evaluating well conditions and planned completion operations and will be approved by BLM and COGCC.

35. Mechanical Integrity Tests (MIT) will be performed per COGCC and EPA requirements.

36. All wells, whether exploration or development, drilling, producing, suspended, or abandoned, shall be identified in compliance with 43 CFR 3162.6. Pressure tests are required before drilling out from under all casing strings set and cemented in place. Blowout preventer controls must be installed prior to drilling out the surface shoe and prior to starting workover or completion operations. Preventers will be inspected and tested at regular intervals to insure good mechanical working order.

**Protection of Archaeological and Cultural Resources**

37. Any National Register of Historic Places-eligible sites located in proposed disturbance areas shall be avoided by all project-related disturbance, including well pad and water-disposal units, pipelines, and access roads. Should avoidance not be possible then the Operator, in consultation with the BLM and the State Historic Preservation Office and with input from other interested parties per 36 CFR Part 800.6 and the Statewide Protocol Section VII shall develop a mitigation plan designed to eliminate the adverse effects. These additional mitigation measures will be developed in accordance with best management practices and COAs.

38. If subsurface cultural resources are unearthed during operations, activity in the vicinity of the cultural resource will cease and the Authorized Officer will be notified immediately. Pursuant to 43 CFR 10.4 the holder of this authorization must notify the Authorized Officer by telephone, with written confirmation, immediately upon the discovery of human remains, funerary items, sacred objects, or objects of cultural patrimony. Further, the Operator must stop activities in the vicinity of the discovery and protect it for 30 days or until notified to proceed by the Authorized Officer.

39. If any evidence of human skeletal remains is encountered during a project on BLM-administered lands, the operator shall not disturb these remains and shall immediately notify the Authorized Officer. Work shall not resume until the Authorized Officer has given permission. Human remains shall not be moved, excavated, or in any way disturbed by the operator.

40. The operator will be responsible for informing all persons associated with this project that they will be subject to prosecution for knowingly disturbing Native American shrines, historic and prehistoric archaeology sites, or for collecting artifacts of any kind, including historic items and/or arrowheads and pottery fragments from federal lands.

**Protection of Visual Resources**

41. Downlighting will be used for all production facilities.

**Rangeland Management**

42. The operator will be responsible for excluding livestock grazing from all reclaimed portions of well pads until resource objectives are met.

**Hazardous Substances**

43. The operator will not transport, handle, store, load, or dispose of any hazardous substance in such a manner as to pollute water supplies or waterways, or cause damage or injury to land, including humans, desirable plants, and animals.

44. The use or storage of hazardous materials, chemicals, fuels, lubricating oils, and concrete coating and refueling activities is prohibited within 200 feet of any surface water or wetland unless otherwise approved by the BLM.

45. To mitigate contamination of local groundwater, harmful substances (e.g., diesel fuel) will not be allowed to contact soils. Impermeable matting will be used under equipment to intercept such contaminants prior to contact with soils.

46. Signs will be posted on-site that identify potential hazards associated with site operation, including chemical hazards.

47. Material Safety Data Sheets for any treatment chemicals will be maintained on-site during the construction phase. Equipment operators will be required to wear appropriate personal protective equipment to minimize exposure to these hazards.

48. Drainage control will be constructed around the perimeter of the well location during the drilling and work-over phase of the operation to contain any accidental spill of motor fuel. The well pad will be designed in such a manner as to prevent off-site runoff water from entering the pad.

49. Compaction and construction of the berms surrounding containers, tanks, or tank batteries will be designed to prevent lateral movement of fluids through the utilized materials, prior to storage of fluids. All load lines and valves will be placed inside the berm.

50. To prevent the entry of hazardous substances into surface waters:

    a. Chemical treatments within the riparian areas shall be applied by hand and shall be applied only to specific targets.

    b. Leave a 25-foot buffer along surface waters when chemicals are being applied through ground application with power equipment.

    c. Always refer to chemical label instructions for additional guidance on use near water and required buffer zones.

51. A portable toilet will be installed at each well site during construction and drilling.

52. As part of the Emergency Response Plan, the operator will develop a field-wide Integrated Spill Prevention, Control and Countermeasure Plan per EPA regulations, approved and stamped by a Professional Engineer. Otherwise, individual spill prevention, containment, and countermeasure plans will be written for all facilities subject to EPA regulation. Under these plans, spill containment and cleanup will occur immediately and any contaminated materials will be removed to the nearest approved landfill. Any fuel spills will be immediately reported to the Authorized Officer, and copies of all characterization and remediation spill data and reports will be filed within two days with the Authorized Officer.

**Protection of Water Resources**

53. The operator will obtain necessary federal and state permits for protection of water resources, and will comply with US Army Corps of Engineers Nationwide Permit conditions and Colorado Department of Public Health and Environment Water Quality Control Division regulations.

54. Fresh-water aquifers beneficial for human consumption and livestock encountered during the drilling process will be properly sealed in accordance with federal and COGCC requirements to reduce potential for contamination.

55. The operator will utilize the following measures to mitigate impacts on surface water resources:

    a. Install temporary equipment bridges across flowing surface waters.

    b. Place topsoil and spoil at least 10 feet away from the water's edge.

    c. Bury pipeline at least four feet below the bottom of each drainage.

    d. Cross streams during periods of low flow and complete the crossing within 24 hours, as feasible.

    e. Remain in compliance with State Water Commission regulations and requirements for water usage and reporting.

**Protection of Wildlife and Wildlife Habitat**

56. The operator will consult with the US Fish and Wildlife Service and the BLM if any threatened or endangered species are discovered on or adjacent to project development areas.

57. Bear-resistant dumpsters and trash receptacles shall be installed at all facilities.

58. All food items shall be stored in a central location, or stored individually in bear-resistant food boxes. Feeding of any wildlife shall be prohibited.

59. The bringing of dogs or other domestic animals onto facility locations shall be prohibited.

60. The operator shall install screens on all heater-treaters and other exhaust systems to prevent nesting bird activity and bird mortality.

61. All lethal and non-lethal injury events that involve migratory birds will be reported to a BLM official immediately.

62. From May 15 to July 15, no surface-disturbing activities shall occur in order to protect breeding migratory birds. This restriction is relaxed if surveys determine no nests or nestlings will be directly disturbed by construction activities. In the event that the proposed construction is delayed, resurveys shall be conducted if surface disturbance

occurs on or after May 15 of the following year. Operator shall provide documentation of nesting bird surveys conducted by a qualified biologist prior to construction.

63. The operator shall report spills that might affect wildlife (in particular spills that impact water) to the local Colorado Parks and Wildlife District Wildlife Manager within 24 hours of detection.

64. Screened water-suction hoses shall be utilized to exclude fish when drawing water from streams, ponds, and lakes.

65. Wildlife crossovers (trench plugs) with ramps shall be installed on each side of trenches at maximum 0.25-mile intervals and at well-defined game trails to facilitate passage of big game across the open trench and to allow trapped wildlife to escape the trench.

**Management of Invasive, Non-native Species**

66. The operator will monitor for and control noxious or invasive weeds throughout the construction and production phases. Noxious weed control is mandatory on the well pads, pipelines, and access roads used by the lessee/operator for the life of the project. Monitoring and compliance should be performed in coordination with routine maintenance activities and in accordance with state law and BLM regulations.

67. The operator and the operator’s contractors will clean trucks and equipment at wash-stations in nearby towns or at the contractor’s yard (off-site) to ensure that all equipment and vehicles shall be clean of all dirt and debris that can harbor weed seed.

68. The operator and the operator’s contractors will disinfect heavy equipment, hand tools, boots and any other equipment used previously in a river, lake, pond, or wetland, by routinely cleaning equipment using 140° Fahrenheit water and high-pressure sprayers to remove dirt, mud, and foreign debris before equipment is brought on-site.

69. All disturbances, pads, roads (private and public) pipelines, and pullouts will be maintained noxious-weed-free to deter any further weed spread. If gravel is to be used only gravel that is free of Colorado State A and B listed noxious weed species will be used.

70. Use of pesticides/herbicides shall comply with the applicable federal and state laws. Pesticides/herbicides shall be used only in accordance with their registered uses and within limitations imposed by the Secretary of the Interior. Prior to the use of pesticides/herbicides, the operator shall obtain from the Authorized Officer written approval of the operator’s treatment plan showing the type and quantity of material to be used, pest(s) to be controlled, method of application, location of storage and disposal of containers, and any other information deemed necessary by the Authorized Officer. The plan should be submitted no later than March 1 of any calendar year to cover the proposed activates for the next growing season. Emergency use of pesticides/herbicides shall be approved in writing by the Authorized Officer prior to such use.

71. To enhance effectiveness and prevent transport into streams, apply chemicals during appropriate weather conditions (generally calm and dry) and during the optimum time for control of the target pest or weed.

**Reclamation**

72. Interim reclamation of well pads and final reclamation of pipeline corridors will commence with the removal of debris and waste materials (other than *de minimus* amounts) including, but not limited to concrete, sack bentonite, and other drilling mud additives; sand, plastic, pipe and cable; and equipment associated with drilling, re-entry, or completion operations.

73. To mitigate additional soil erosion at the well pad and potential increased sediment and salt loading to nearby surface waters, all disturbed areas affected by drilling or subsequent operations, except areas reasonably needed for multi-well drilling and/or production operations, shall be reshaped and reclaimed as early and as nearly as practicable to their original condition.

74. The operator will ensure stockpiled topsoil is evenly distributed over the top of spoil used in recontouring/partial-reshaping efforts.

75. Exposed slopes shall be revegetated, with a native seed mix or approved seed mix, at a density and a pattern that replicate what was removed during construction. Non-native seed mix can create visual impacts through strong color and texture contrast with the surrounding native vegetation.

76. Final reclamation actions shall be initiated within 6 months of the termination of operations unless otherwise approved in writing by the Authorized Officer.

77. Reclamation of pipeline routes will begin following pipe installation and will be completed within six months unless otherwise approved by the BLM. Pipeline corridors will be reclaimed in the same fashion as other pipeline routes, even in cases where additional pipelines are expected to be located.

78. The operator will be responsible for achieving a reclamation success rate for interim reclamation and final abandonment of sufficient vegetative ground cover from reclaimed plant species within three growing seasons after the application of seed, as determined by the BLM.

79. In preparation for final reclamation of a well site following operator abandonment, if the working surface and entrance to a well pad has been surfaced with gravel or similar materials, the material must be removed from the well location or buried deep within the recontoured cut to prevent possible surface exposure.

80. Fill material shall be pushed into cut areas and up over backslopes. Leave no depressions that will trap water or form ponds.

81. Reclaimed areas will be seeded with a BLM-approved seed mixture, and all slopes exceeding five percent will be protected using best available management practices such as biodegradable matting, surface roughening techniques, aggressive revegetation efforts, etc., to provide additional protection to topsoil, retain soil moisture, and help promote desired vegetative growth.

82. Disk or rip compacted soils to prepare seed. Seed may be drilled or broadcast as determined by the BLM on contour at a depth no greater than 0.5 inch. In areas that cannot be drilled, seed will be broadcast at double the seeding rate and efforts will be made to ensure broadcast seed is in contact with soil.

83. Stockpiled topsoil segregated from spoil piles will be replaced in its respective original position (last-out, first-in) to minimize mixing of soil horizons.

84. Natural drainage patterns will be restored and stabilized with a combination of vegetative (seeding) and non-vegetative (straw bales, woody debris, straw wattles, biodegradable fabrics, etc.) techniques.

85. The disturbed area will be left in a condition that provides drainage with no additional maintenance.

86. Woody debris will be pulled back over recontoured areas (woody debris will not account for more than 20 percent of total surface cover) to help stabilize soils, trap moisture, and provide cover for vegetation.

87. Monitoring and additional reclamation efforts will persist until reclamation is proven successful (as determined by the BLM).

88. A Reclamation Status Report will be submitted to the UFO annually for all actions that require disturbance of surface estate soils on BLM mineral estate as a result of the Proposed Action. Actions may include, but are not limited to, well pad and road construction, construction of ancillary facilities, or power line and pipeline construction. The Reclamation Status Report will be submitted by December of each calendar year, and will include the well number, legal description, project description (e.g., well pad or pipeline), reclamation status (e.g., interim or final), whether the well pad or pipeline has been revegetated and/or recontoured, date seeded, photos of the reclaimed site, estimate of acres seeded, and seeding method (e.g., disk-plowed, drilled, or both). Internal and external review of this plan and the process used to acquire the necessary information will be conducted annually, and new information or changes in the reporting process will be incorporated into the plan.

## BEST MANAGEMENT PRACTICES

The BLM describes BMPs as “state-of-the-art mitigation measures applied to oil and natural gas drilling and production to help ensure that energy development is conducted in an environmentally responsible manner.” The aim of BMPs is to protect wildlife, air quality, landscapes, and other natural resources as energy resources are developed. BMPs tend to be general principles for resource protection and are not in themselves regulatory in nature.

BLM policy is that all "Field Offices consider BMPs in National Environmental Policy Act (NEPA) documents to mitigate anticipated impacts on surface and subsurface resources, and also to encourage operators to actively consider BMPs during the application process." (Instruction Memorandum No. 2004-194; June 22, 2004).

Another important source of information on BMPs is the publication *Surface Operating Standards and Guidelines for Oil and Gas Exploration and Development* (commonly referred to as The Gold Book), which was developed to assist operators on the requirements for obtaining permit approval and conducting environmentally responsible oil and gas operations on federal lands.

BMPs are often expressed in natural gas leaseholders' plans of development, proposed actions, surface use plans, reclamation plans, or attached to approved Applications for Permit to Drill, as COAs, which are described below.

Following is a master list that may be used as COAs in the UFO when considering APDs. The list will be adapted as needed for site-specific use. The operator will select items from the list to be attached to the APD. Additional items found by the BLM to be applicable as a result of an onsite inspection, discussion with the landowner, and/or to meet BLM's minimum standards will be attached to the APD as COAs. Many of the items listed will not be used on a specific APD if not warranted. If, on the other hand, conditions call for requirements that are not on the list, BLM specialists can add new COAs. The operator can also suggest alternate measures that could accomplish the same or a better result. The list is presented in the standard format used for attachment to an approved APD.

**Surface-Disturbing Activities**

89. Surface-disturbing activities shall avoid riparian/wetland habitat unless otherwise approved by BLM. Any loose rock occurring in the vicinity will be scaled prior to construction if it presents a safety hazard.

90. Where feasible and consistent with future plans and operations and considering safety concerns, all tanks and production facilities will be situated on the access road side of the well pad in order to maximize the coverage by interim reclamation upon the area necessary to create the well pad. Erosion-control measures will be implemented on earthen fill slopes of the well pad and all disturbed areas with earthen slopes greater than five percent as needed and until stable. (If the exposed disturbed surface is entirely of rock, erosion-control measures implemented by the operator must ensure that erosion is reduced and offsite transport of sediment is controlled.) The operator will reestablish pre-construction stream bed and bank contours, revegetate stream banks, and install erosion-control fabric to stabilize the stream banks Facilities and improvements associated with existing rights-of-way will be avoided to the extent possible. If they cannot be avoided, caution would be taken to ensure no impacts on facilities or disruption of use occurs.

**Road Construction and Maintenance**

91. Roads will be located so as to minimize their influence on riparian areas and, when stream crossing is necessary, design the approach and crossing perpendicular to the

channel. Locate the crossing where the channel is well-defined, unobstructed, and straight unless otherwise approved by BLM.

92. Locate roads on stable positions (e.g., ridges, natural benches, and flatter transitional slopes near ridges and valley bottoms) unless otherwise approved by BLM. Implement extra mitigation measures when crossing areas of unstable or fragile soils.

93. Unless otherwise approved by BLM, avoid headwalls, midslope locations on steep, unstable slopes, seeps, old landslides, slopes in excess of 40 percent, and areas where the geologic bedding planes or weathering surfaces are inclined with the slope.

94. Locate roads to minimize heights of cut banks unless otherwise approved by BLM. Avoid high, steeply sloping cut banks in highly fractured bedrock.

95. Locate roads on well-drained soil types and attempt to avoid wet areas unless otherwise approved by BLM.

96. Sloping the road base to the outside edge for surface drainage is normally recommended for local spurs or minor collector roads where volume traffic low and lower traffic speeds are anticipated. This is also recommended in situations where long intervals between maintenance will occur and where minimum excavation is wanted. Out-sloping is not recommended on gradients greater than 8 to 10 percent.

97. No berms will be allowed on the outside edge of the road where runoff is channeled.

98. Sloping the road base to the inside edge is an acceptable practice on roads with gradients of more than 10 percent and where the underlying soil formation is very rocky and not subject to appreciable erosion or failure.

99. Minimize excavation through use of balanced earthwork, narrowing road width, and end hauling (not side casting soil) where slopes are greater than 40 percent.

100. Avoid establishment of vegetation where it inhibits drainage from the road surface or where it restricts safety or maintenance.

101. When roads are located in low-lying areas, ensure that the road surface is constructed above the adjacent ground surface.

102. Avoid side casting where it will adversely affect water quality or weaken stabilized slopes. Conduct roadside brushing in a way that prevents disturbance to root systems (i.e., avoid using excavators for brushing); cut roadside vegetation rather than pulling it out and disturbing the soil.

103. If necessary, construct drainage dips as follows to control erosion:

| Grade | Spacing |
|---|---|
| 2 % | Every 200 feet |
| 2-4 % | Every 100 feet |
| 4-5 % | Every 75 feet |
| 5+ % | Every 50 feet |

104. Limit activities of mechanized equipment within stream channels.

105. Place permanent stream crossing structures on fishery streams before heavy equipment moves beyond the crossing area. Where this is not feasible, install temporary crossings to minimize stream disturbance.

**Tanks and Pits**

106. Reserve pits will be sealed in such a manner as to prevent leakage of the fluids by using an impermeable synthetic liner at least 12 mils in thickness. The bottom of the pit shall be smooth and free of any sharp rocks. If the pit has a rocky bottom, it shall be bedded with a material such as sand or certified weed-free straw or hay, to avoid the possibility of puncturing the liner. Reserve pits will be surrounded by wildlife fencing and be covered with bird netting.

107. The operator will install and maintain wildlife fencing around all tanks and facilities.

108. The operator shall install netting to exclude birds and bats. The netting will be applied within 24 hours after drilling activities have begun. The netting shall be retained and maintained for as long as there are liquids in the pit. The integrity of the netting must also be periodically checked by the operator for sagging due to snow accumulation if a pit must stay open through the winter.

109. A minimum of two feet of freeboard from liner top to fluids/cuttings level will be maintained in pits at all times.

110. Prior to the onset of winter, the operator shall remove fluids from any pits allowed to remain open over the winter months in order to reduce or eliminate the potential of spring snowmelt to exceed the two-foot freeboard (below the top of the liner) minimum at any time.

111. The operator shall skim and eliminate oil from unfenced produced water ponds and reserve pits daily until fences are installed. Once fences are installed, the pit shall be kept reasonably free from surface accumulation of liquid hydrocarbons that will retard evaporation.

112. Fencing around ponds, tanks, and facilities will meet with the minimum Gold Book standards.

113. The operator shall treat wastewater pits and/or any associated pit containing water with Bti (*Bacillus thuringiensis v. israelensis*), commonly known as Mosquito Dunks, or take other effective action to control mosquito larvae that may spread West Nile Virus to wildlife or domestic livestock.

114. Reserve pits shall be dried out and reclaimed within six months of completion of drilling activities. Any water remaining in the reserve pit shall be disposed of in an approved disposal facility. All enhanced evaporation of the reserve pit fluids shall have prior approval of the Authorized Officer. Before reclamation of the reserve pit proceeds, it will be dry and solid. This can be accomplished naturally or by artificial solidification. The reserve pit solids will not be squeezed out of the pit. The liner shall be removed to an approved disposal site. There will be a minimum of two feet of overburden on the reserve pit prior to replacing the topsoil and seeding.

**Pipeline and Power Line Construction**

115. Operator will attempt to use an existing road where one is adjacent to the pipeline route and can be used as a working surface.

116. Pipeline corridors will use areas adjoining or adjacent to previously disturbed areas whenever possible, rather than traverse undisturbed communities.

117. Construction of pipeline crossings will occur during low-flow periods in streams occupied by fish or as per the conditions of the US Army Corps of Engineers permit.

    a. A flume, or plastic tube will be used to redirect flows around the trench site to maintain water flows and habitat connectivity.

    b. Flumes will be the preferred method of maintaining flow, but pumps may be used in certain situations if allowed by the US Army Corps of Engineers.

118. The operator will reclaim crossing sites using native wetland vegetation to stabilize the sites as soon as possible as per the US Army Corps of Engineers stipulations.

119. Pipelines installed beneath stream crossings shall be buried at a minimum depth of four feet below the channel substrate to avoid exposure by channel scour and degradation. Following burial, the channel grade and substrate composition shall be returned to pre-construction conditions.

120. Poles and transmission line locations will be selected to achieve the minimum practicable adverse impact on visual quality.

**Natural Gas Drilling and Exploration**

121. For dry holes or plugged and abandoned wells in sensitive areas where above-ground markers are not desired, all casing shall be cut-off at the base of the cellar or three feet below final restored ground level (whichever is deeper). The well bore shall then be covered with a metal plate two-foot by two-foot and at least 0.25-inch thick. The plate

will be welded in place. The plate must be permanently inscribed with the identity requirements of 43 CFR 3162.6d.

**Protection of Visual Resources**

122. Facilities shall be properly placed within the landscape to use natural topography and vegetation to screen proposed activity and to reduce the amount of exposed cut/fill slopes.

123. In some areas it may be appropriate to feather and undulate the edge between the removed vegetation and the remaining existing vegetation.

**Rangeland Management**

124. A cattle guard and/or gate will be placed at the time of fence construction where a well access road bisects the fenceline that surrounds a well pad's disturbance imprint. Once reclaimed plant species are fully established on disturbed sites as determined by the BLM (e.g. desired plant community, Public Land Health Standards), the fence and cattle guard will be completely removed by the operator. This will allow for reclaimed plant species to establish without grazing pressure from livestock.

**Protection of Water Resources**

125. The operator will implement an instream flow requirement established by the BLM on Muddy Creek below the confluence with East and West Muddy creeks. The purpose of this requirement is to protect and perpetuate beneficial uses for tributaries to North Fork Gunnison River, including Muddy Creek, as designated by the Colorado Department of Public Health and Environment. The designated beneficial uses include Aquatic Life Cold 1, Recreation E, Water Supply, and Agriculture. It is anticipated that the instream flow requirement will be implemented only in rare occasions, because as specified above, SGI intends to utilize wells and its existing surface water rights to meet water demands before implementing any new surface water diversions from tributaries to Muddy Creek.

126. Locate trench dewatering discharges away from surface waters and wetlands (considering local topography, vegetation, and soils) unless otherwise approved by the BLM, and direct trench dewatering discharges onto a well-vegetated, stable surface and utilize a section of geotextile fabric or plywood to prevent scouring during discharge as per the Stormwater Management Plan or construction dewatering permit conditions.

127. Minimize duration of trench dewatering discharges by scheduling dewatering operations immediately prior to lowering in, tie-ins, or backfilling. Minimizing trench disturbance (i.e., additional digging) to the extent practicable until the majority of the water is pumped out.

128. Install energy-dissipating devices and/or filter bags to prevent scour, erosion, suspension of sediment, and damage to vegetation. Monitor discharge rates to ensure effectiveness of the energy-dissipating devices.

**Protection of Wildlife and Wildlife Habitat**

129. No surface-disturbing activities shall occur from December 1 through April 30 in those portions of the Unit mapped as winter concentration and sever winter range, in order to protect wintering big game on those federal leases with a big game protection timing restriction and according to conditions contained in these documents. This restriction would not apply to production and routine maintenance activities. The following activities are not considered “routine” and would be restricted.

    a. Heavy construction requiring the use of cranes, backhoes, bulldozers or other heavy equipment

    b. Drilling and completion operations

    c. Workover rigs

    d. Multiple water-hauling trips to one site in a day

    Exceptions or variances to this restriction will be considered and evaluated according to UFO policies. Exceptions and variances to standard restrictions and protection measures must be requested in writing to the BLM Authorized Officer. Such requests are evaluated on a case-by-case basis after consultation with Colorado Parks and Wildlife and may be granted by a BLM Authorized Officer depending on animal or herd status, topographic characteristics, site context, weather severity, and other factors, provided species and habitats are adequately protected. Any modifications to prescribed restrictions, and the rationale behind those decisions, will be documented in the project case file(s). In some cases, site characteristics and/or conditions may warrant expanding buffer distances to ensure adequate protection of species.

**Reclamation**

130. Recontoured surfaces will undulate and mimic the native landforms unless otherwise approved by the BLM and meet existing grades at a slope that is similar to that which they are joining.

131. In split estate situations, the BLM-approved seed mix is recommended for reclamation purposes in the Surface Use Plan of an APD. Consideration will be given to requests by private landowners to utilize alternate seed mix designs, selection and application of which must still comply with the following minimum BLM standards:

    a. The seed shall contain no noxious, prohibited, or restricted weed seeds and shall contain no more than 0.5 percent by weight of other weed seeds. Seed may contain up to 2.0 percent of “other crop” seed by weight, including the seed of other agronomic crops and native plants; however, a lower percentage of other crop seed is recommended.

    b. Methods such as broadcast seeding or hydroseeding will apply seed mix at double the rate required of drill seeding.

c. Seed tags or other official documentation shall be supplied to the designated UFO Natural Resource Specialist upon completion of each seeding activity necessary during the life of the project.

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# Appendix D
## Master Surface Use Plan of Operations

# APPENDIX D
# MASTER SURFACE USE PLAN OF OPERATIONS

This Master Surface Use Plan of Operations (Master SUPO) would be used in preparation of the Surface Use Plan of Operations component of future Applications for Permit to Drill (APDs) associated with development in the Bull Mountain Unit.

The SUPO for an individual APD must specifically address all of the following elements as required in Federal Onshore Order 1. A "complete" SUPO will also include any design features and/or best management practices (BMPs) chosen by the operator to mitigate the impacts of developing a well pad, access road, facilities and utility corridors.

At a minimum the elements of an APD SUPO will be carefully reviewed by the BLM to ensure that proposed operations and reclamation:

- Describe or show the procedures, equipment, and materials to be used by the operator to facilitate the proposal.
- Are conducted to minimize adverse effects to surface and subsurface resources, prevent unnecessary surface disturbance, and in conformance with currently available technology and practice.
- Are consistent with all applicable Federal and State laws and regulations including, but not limited to: Onshore Orders, BLM Gold Book Standards, the RMP currently in effect, The Clean Air Act, the Clean Water Act, the Threatened and Endangered Species Act, the National Historic Preservation Act, and the Colorado Oil and Gas Conservation Commission (COGCC) regulations.
- Comply with all current lease stipulations.
- Take appropriate measures as specified in Orders and Notices to Lessees to protect the public from any hazardous conditions resulting from operations.

- Identify the private surface owner (if developing on split estate lands) and engage the private surface owner at the earliest possible opportunity and subsequently throughout the life of the authorization.
- Identify and select a drill pad size that is appropriate.
- Site selection, siting of facilities, and/or conducting of operations is appropriate and at a minimum excludes areas subject to mass soil movement, riparian areas, floodplains, lakeshores, and/or wetlands, unless approved otherwise.
- Ensure that any pits proposed comply with appropriate standards for installation, use, removal and closure.
- Structures, facilities, improvements, and equipment are maintained in a safe condition.
- Provide a sufficiently detailed reclamation plan designed to:
    - Return the area to productive use,
    - Meets the objectives of the Bull Mountain EIS and Uncompahgre Resource Management Plan
    - Help facilitate the identification of needed Conditions of Approval (COAs).
    - Ensures interim reclamation is performed on the disturbed areas no longer needed after drilling is complete.
    - Ensures at the time of Final Reclamation that all pads, pits, and roads are reclaimed to a satisfactorily revegetated, save and stable condition (Unless an agreement is made with the landowner to keep a road or pad in place).
    - Recognize that activities to reestablish vegetation, such as seeding, etc. must be completed within the time period approved by the BLM.

As much as possible, the information below responds to the elements in the SUPO component of an APD as described in Federal Onshore Order 1 in terms of existing infrastructure and suggests what may be expected in a forthcoming site specific APD SUPO. However, this Master SUPO does not identify or specify any design features or BMPs. Those can be found in the following appendices associated with the Bull Mountain Unit Master Development Plan Environmental Impact Statement:

- Appendix B – Construction, Drilling, Completion, and Reclamation
- Appendix C – Best Management Practices and Conditions of Approval
- Appendix I – Noxious Weed Management Plan

## D.1 SURFACE USE PLAN OF OPERATIONS ELEMENTS OF THE APD

The following elements are to be included in the SUPO attached to an APD.

### D.1.1 Diagrams, Geospatial Data and Maps

SUPO information required of Onshore Order 1 may be shown on the same map if it is appropriately labeled or on separate diagrams or maps. Any elements of the SUPO that may include corresponding maps will comply with the following criteria:

- All maps must be of a scale no smaller than 1:24,000 unless otherwise stated in the order.
- Geospatial vector and rater data must include appropriate attributes and metadata.
- Georeferenced raster images must be from the same source as hardcopy plats and maps submitted in the APD package.
- Diagrams with cuts and fills must be surveyed, designed, drawn, digitized, and certified by licensed professional engineers.

### D.1.2 Existing Roads

To reach the facilities and well locations in the Bull Mountain Unit from Paonia, travel north on State Highway 133 approximately 27 miles to its intersection with Gunnison County Road 265. Turn NW on CR 265. Private access roads to individual well sites intersect CR 265.

All existing roads regardless of type within the Bull Mountain Unit are depicted in Figure D-1 below.

A map showing the proposed well site and its access route will be included in each specific APD. This map will show access to the well site from a locatable public access point. Locations of all existing and proposed road structures (e.g., culverts, bridges, and low water crossings) will also be shown.

Plans for maintenance of access roads will be provided in the surface use plans submitted with individual well APD.

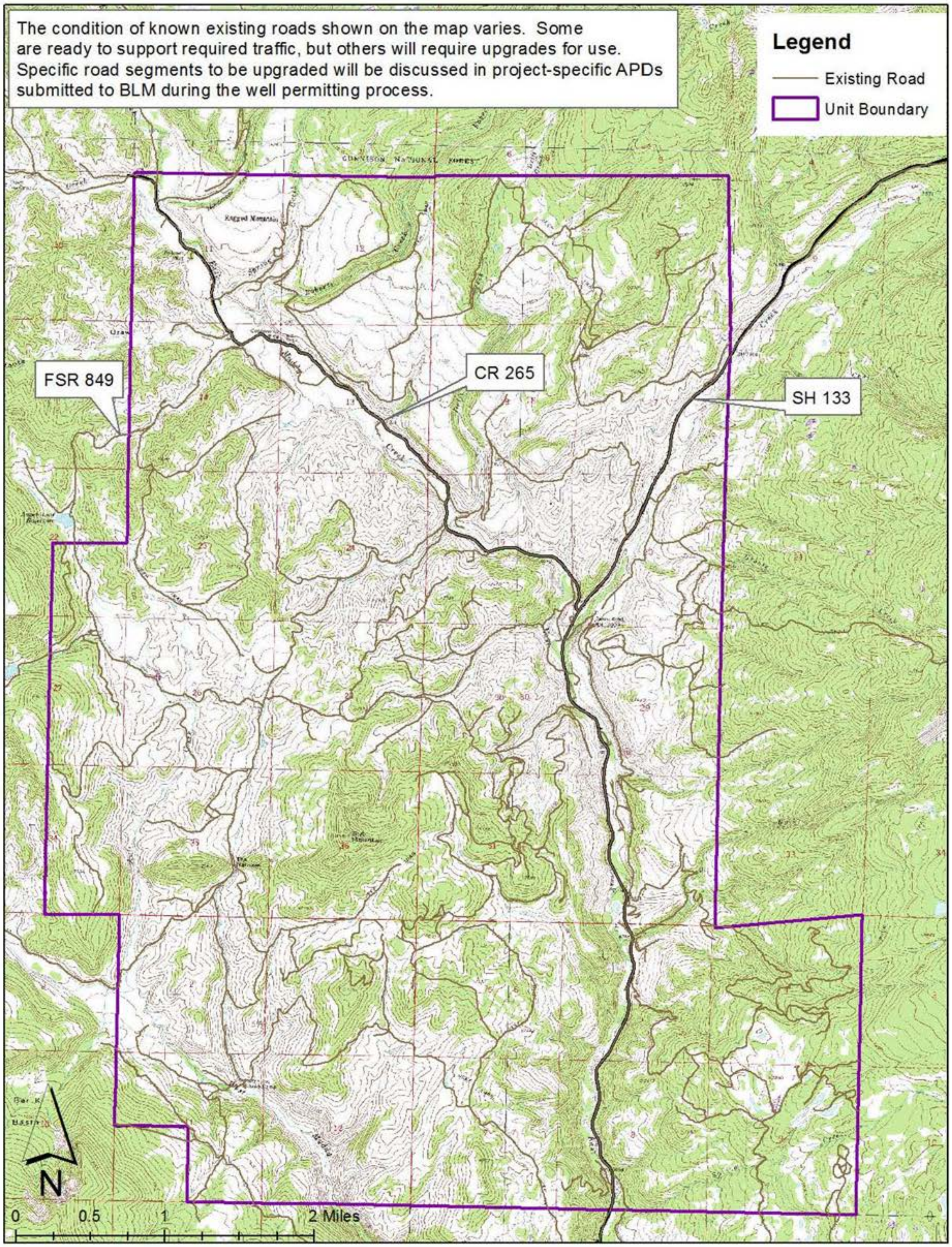
## D.2 NEW OR RECONSTRUCTED ACCESS

Specific temporary and permanent access roads will be identified in individual APDs when they are submitted for processing. Roads that will require reconstruction will be identified on these maps and documents.

Roads will be designed based upon the class or type of road, the safety requirements, traffic characteristics, environmental conditions, and the vehicles the road is expected to carry.

The SUPO in each specific APD will describe for all road construction or reconstruction: Road width, maximum grade, crown design, turnouts, drainage and ditch design, on-site and offsite erosion control, revegetation of disturbed areas, location and size of culverts and/or bridges, fence cuts and/or cattle guards, major cuts and fills, source and storage of topsoil, type of surfacing materials, if any, that will be used.

**Figure D-1. Existing Roads in the Bull Mountain Unit**

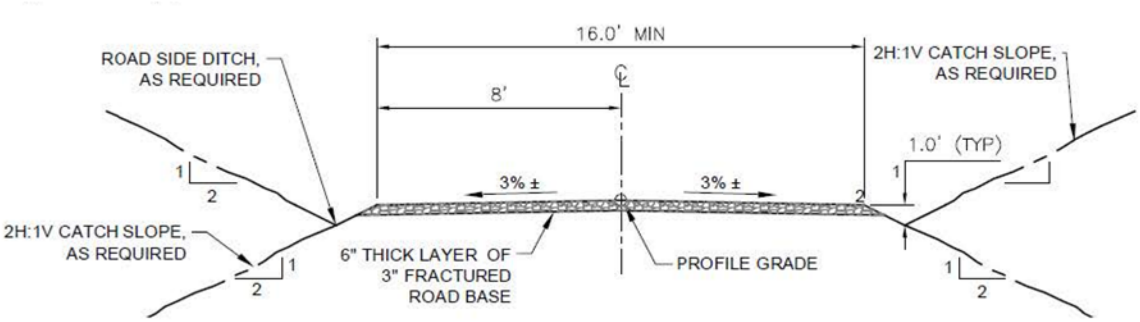


For example:

When road construction or reconstruction is required, SGI will describe the changes as follows:

- Road width: typically 12 foot - 18 foot for straight lengths, wider as needed for design vehicle turning radius.
- Maximum grade: up to 12 percent or higher in shorter segments when needed.
- Crown design: See typical drawing below.
- Any turnouts: intervisible where needed.
- Drainage and road ditch design: See typical cross section below.
- Erosion control features: See typical drawing.
- Revegetation of disturbed area: According to landowner agreements and/or BLM direction.
- Location and sizes of culverts and/or bridges: Gold Book specifications to be followed.
- Location of fence cuts and/or cattleguards: This is site specific and will be included in each APD.
- Description of significant cuts and fills: This is site specific and will be included in each APD.
- Source and storage of topsoil: This is site specific and will be included in each APD. The BLM typically stipulates the salvage of six to eight inches of topsoil for use in reclamation.
- Type of road surfacing materials: Typically three inches fractured road base. Approximately six to eight inches of roadbase would be used in road construction and reconstruction.

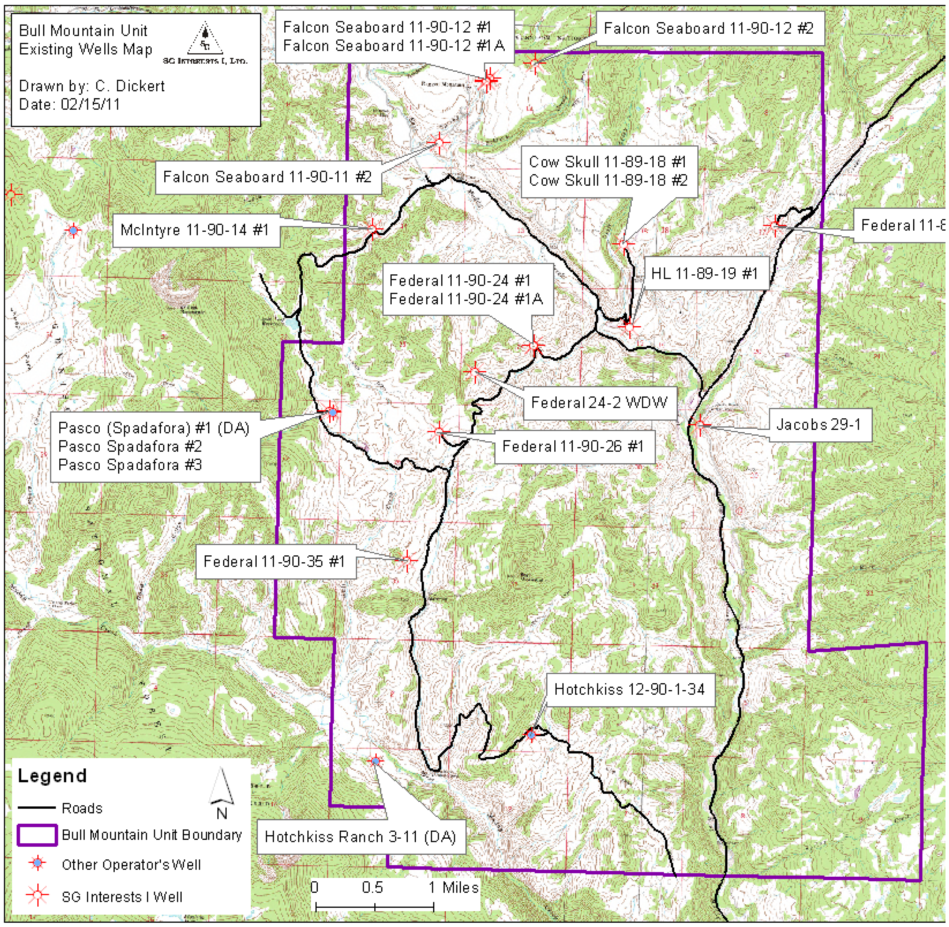
**Figure D-2. Typical Access Road Cross-section**



## D.3 LOCATION OF EXISTING WELLS

Existing wells in the Bull Mountain Unit are shown in the following map (**Figure D-3**, Existing Wells in the Bull Mountain Unit). This map includes all wells that have been drilled in the unit including abandoned wells. At the time of submittal of an individual APD, SGI will include a map of all known wells within one mile of the proposed location whether it is within or outside the unit. The intent of the order is to show the status of wells in proximity to the proposed location. The map will have a legend symbolizing the well(s) status.

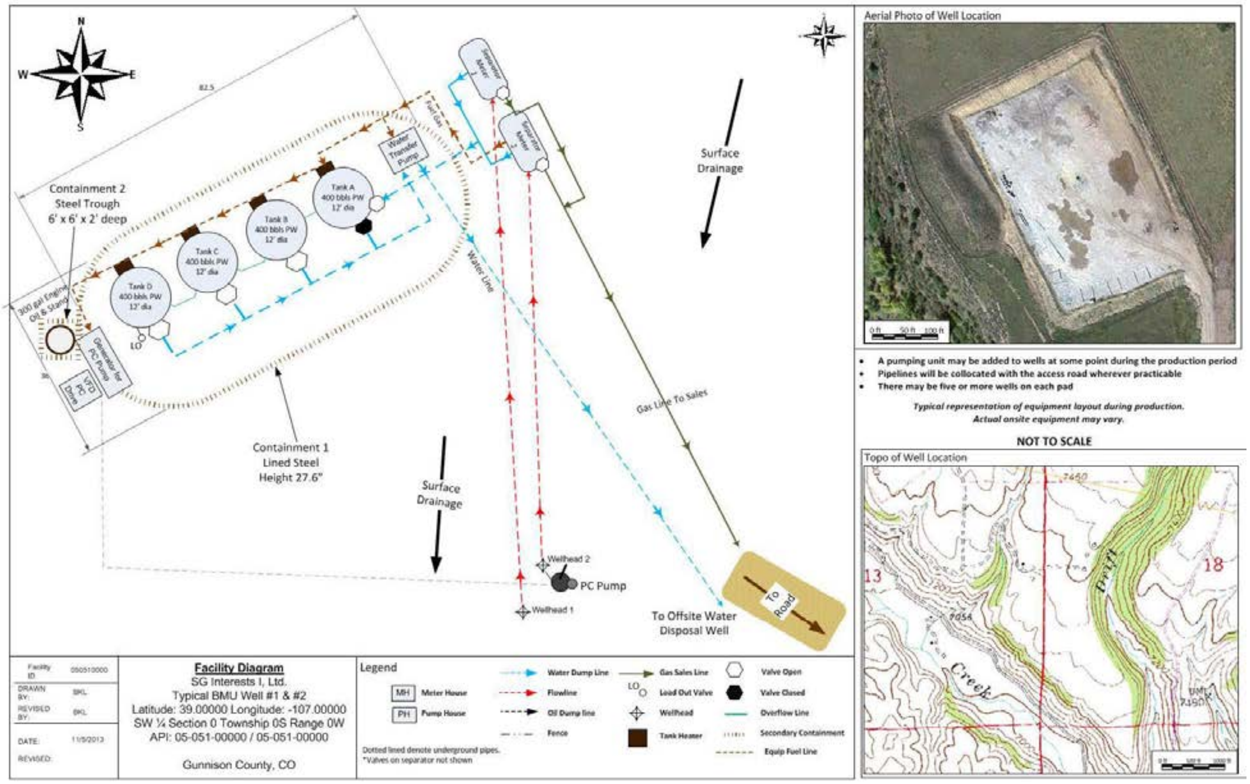
**Figure D-3. Existing Wells in the Bull Mountain Unit**



## D.4 LOCATION OF EXISTING OR PROPOSED PRODUCTION FACILITIES

For each APD submitted, a map of the existing and proposed facilities associated with the specific project being permitted will be submitted to BLM (see typical facility layout in **Figure D-4**, Typical Well Site Facilities). It may be necessary to add well head compression or a pump jack to one or more wells located at a site. SGI also anticipates that one or more meter houses may be on each well pad and, pumps, generators, and other equipment will be proposed and permitted as needed.

**Figure D-4. Typical Well Site Facilities**




## D.5 LOCATION AND TYPE OF WATER SUPPLY

With each APD, SGI will specifically identify the source, access route, and transportation method for all water anticipated for use in drilling the proposed well. Any newly constructed or reconstructed access roads or pipelines crossing Federal lands that are needed to transport the water will be provided in the APD. Any site-specific information included in and APD will generally reflect the following:

- Fresh water may be obtained from one or more of the following sources:
    - Purchased from a landowner
    - Drawn from free-flowing water sources and augmented from Bainard Reservoir according to the terms of SGI's approved Augmentation Plan
    - Drawn from free-flowing sources when there is no call on this water

  - Purchased from a permitted commercial supplier

- Recycled water would be obtained from the following source:

  - SGI has constructed McIntyre Flowback Pits 3 and 4, which are fully operational and has permitted a second water recycling facility called the McIntyre Flowback Pits 1 and 2 (see **Figure D-5**, Location of the McIntyre Flowback Pits in the Bull Mountain Unit).

Estimated water volumes needed for completion per well type are shown below. These volumes may consist of fresh water and/or recycled water from the McIntyre Flowback Pits.

| Well Type | Estimated Water Usage |
| --- | --- |
| Vertical Mancos Well<br>S-Shaped Mancos Well<br>Directional Mancos Well | 18,000 BBL per stage with an average of 3 stages per well. |
| Vertical Coal Well<br>S-Shaped Coal Well<br>Directional Coal Well | 1,800 BBL for Cameo Coal and 1,500 BBL for South Canyon Coal |
| Vertical Cozzette or Corcoran Well<br>S-Shaped Cozzette or Corcoran Well<br>Directional Coal Well | 2,300 BBL each for Cozzette and/or Corcoran |
| Horizontal Corcoran or Cozzette Well | 30,000 BBL |
| Horizontal Shale Well | 250,000 BBL |
| Deep Water Disposal Well | 2,500 BBL per fracture with two fractures possible |

## D.6 CONSTRUCTION MATERIALS

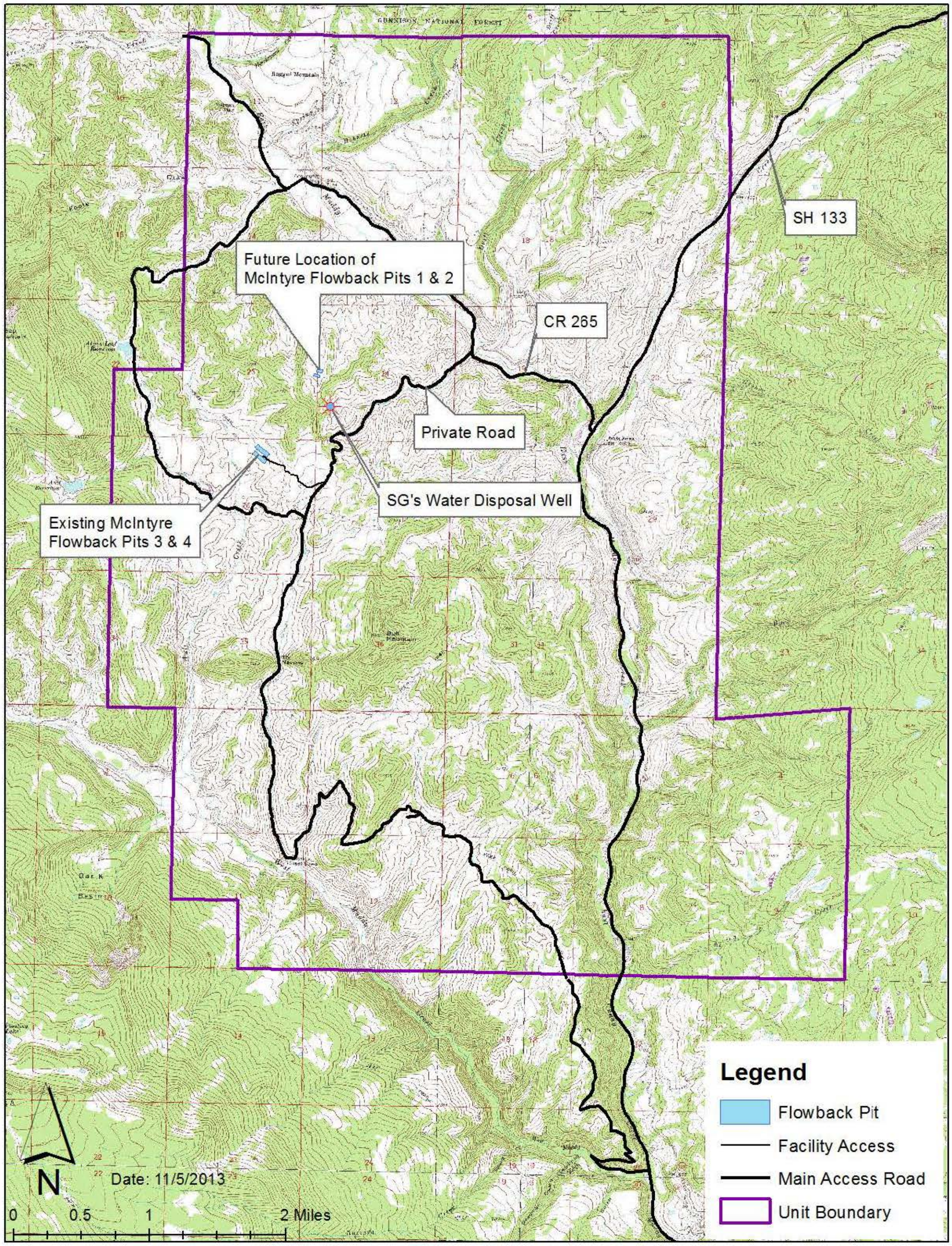
The types and uses of construction materials will vary according to the specific conditions at an individual well site. Subsequent wells that will be collocated on existing well pads will require less construction materials than those wells that will be first on a new well pad. Wells added to existing well pads may require additional gravel to be added to the road and well pad to support the expected drilling traffic.

## D.7 METHODS FOR HANDLING WASTE

Projects in the Bull Mountain Unit will be covered by SGI's Integrated Spill Prevention, Control, and Countermeasure Plan. The goal of this plan is to prevent spills from occurring due to SGI's operations, control spills if they do occur and safely and effectively clean spills up. Projects will be added to the plan as they are being permitted. The integrated plan requires regular inspections and documentation of those inspections as well as a flowline maintenance program and other inspection, reporting and record-keeping duties. If there is a spill associated with this project, it will be reported as per state and federal law. Gunnison County will be notified as well according to applicable permit conditions and existing regulations.

Construction stormwater discharge is permitted through SGI's general Colorado Department of Public Health and Environment stormwater permit and specific locations are covered in SGI's field-wide stormwater management plan (available separately).

**Figure D-5. Location of the McIntyre Flowback Pits in the Bull Mountain Unit**



If SGI is unable to reuse produced water and flowback fluids from any particular well location, these fluids will be disposed of responsibly in order to avoid the contamination of freshwater resources or land. In most cases, unusable and/or excess flowback and produced water is transported and disposed of in licensed underground injection control wells in the Bull Mountain Unit.

SGI may also dispose of produced water or flowback fluids at industrial disposal facilities in compliance with applicable state and federal regulations. Offsite disposal would require trucking of these fluids. Currently, SGI has in operation one deep water injection well, the Federal 24-2 WDW and one permitted but not drilled water disposal well, the Eck 2 WDW. Four (4) additional water injection wells are proposed (Chapter 2, Alternative B).

If a reserve pit is deemed necessary, the SUPO of an individual APD will describe plans for constructing and lining of the reserve pit

## D.8 ANCILLARY FACILITIES

No camps or airstrips are planned at this time. If these ancillary facilities are needed in the future, the location of the facility will be shown on a map and the construction method and materials needed for the facility will be described in the individual APD.

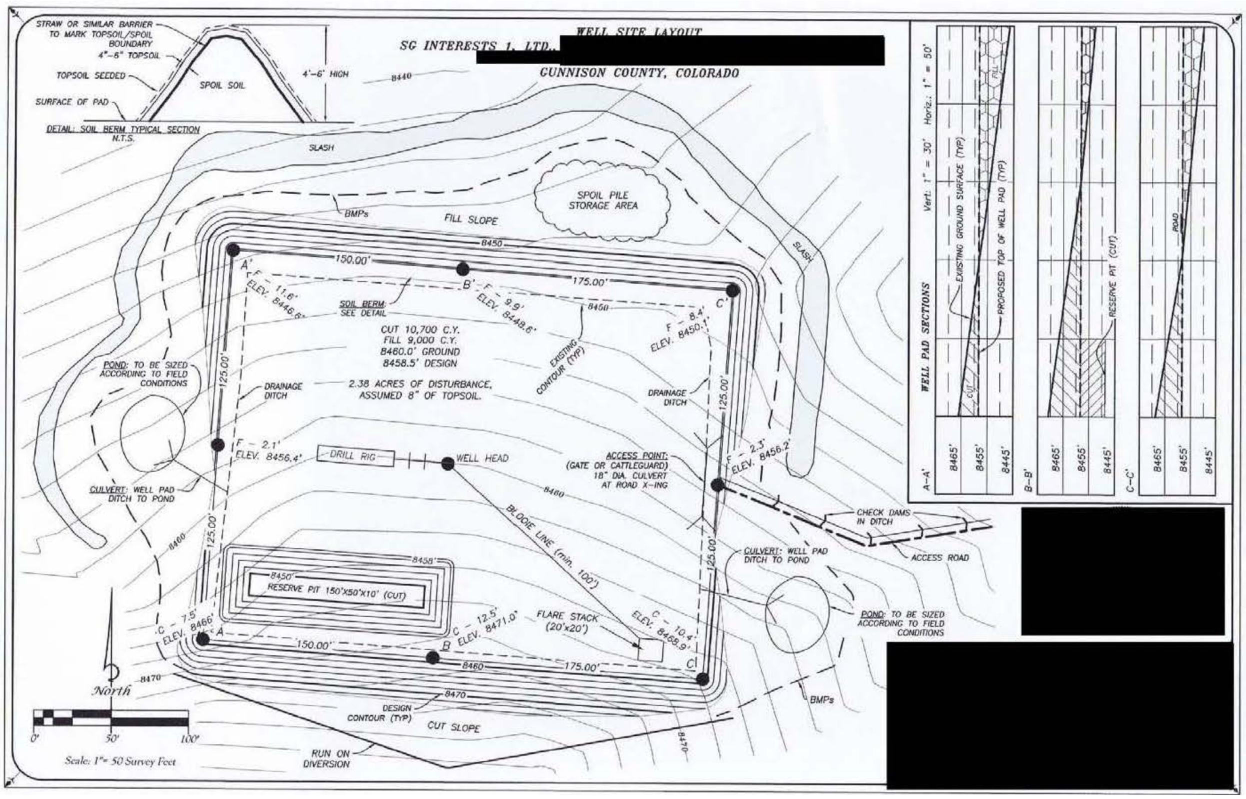
SGI may need another storage yard located on private property to store materials and equipment. It would be approximately 250’ X 400’ in size. It would be located in section 14 T11S R90W on property owned by Rock Creek Ranch I, Ltd. an entity owned by the principals of SGI (see Chapter 2, Alternative B).

## D.9 WELL SITE LAYOUT

For each APD submitted, SGI will provide a well site layout drawing. This drawing will be of a scale not less than 1 inch = 50’ and prepared under the supervision of a licensed professional surveyor or professional engineer and will be certified as such. Elements of this drawing will include the location and orientation of the well pad, reserve pit/blooie lines/flare pit (including cuts and fills), access road entry points, cross sections of the well pad with regards to topography, cuts and fills in relation to the topography, orientation and proposed location of the drilling rig, dikes and ditches, and topsoil/spoil pile locations. A typical well site layout is shown in **Figure D-6**, Typical Well Site Layout.

SGI also anticipates that temporary facilities on the typical well pad may include a total of three trailers during drilling operations for the drilling superintendent, the company representative, and the mud logger and mud engineer. These temporary facilities will be used 24 hours per day during drilling operations.

**Figure D-6. Typical Well Site Layout**




## D.10 PLANS FOR SURFACE RECLAMATION

For each APD, SGI will submit a plan for surface reclamation and stabilization of all disturbed areas. This plan will cover both interim and final reclamation. In cases where the proposed APD describes an additional well on an existing authorized location, SGI will identify that an existing reclamation plan may be in place and ensure that any modification to the existing reclamation plan as a result of the additional APD(s) is presented in the SUPO.

The following topics may be included in the reclamation plan of an individual APD as appropriate:

- Plan for recontouring the disturbed land
- A drainage plan for use during operations
- Plan for separation and storage of topsoil and subsoil
- Approximate cut and fill volumes of areas to be reclaimed (including pit areas)
- Plan for redistribution of topsoil over area to be reclaimed
- Any necessary soil treatments or plantings
- Planned seed mix

- Planned weed control
- Plan for reclamation of associated project areas such as pipeline routes and access roads

These projects will be constructed in compliance with SGI's stormwater discharge permit from Colorado Department of Public Health and Environment. A Stormwater Management Plan has been written for this permit that contains general practices and BMPs for drainage and erosion control (available separately).

Reclamation plans written for specific projects at the time of permitting may be amended at final abandonment if site-specific conditions warrant revision. At the time of the onsite and if future modifications to an existing reclamation plan are necessary, SGI will work with the surface owner and public agencies depending on the specifics of the reclamation project to choose a seed mix.

| **Example of a BLM recommended seed mix for federal projects in the unit.** | | | |
|---|---|---|---|
| **Species** | **Cultivar** | **Desired % of Planting** | **PLS lbs. per acre** |
| Western Wheatgrass | Arriba | 15 | 1.5 |
| Slender Wheatgrass | San Luis | 15 | 1.05 |
| Bottlebrush Squirreltail | | 15 | 1.2 |
| Mountain Brome | | 15 | 1.8 |
| Big Bluegrass | | 10 | 0.3 |
| Canada Wildrye | | 10 | 1.1 |
| American Vetch | | 3 | 0.75 |
| Rocky Mountain Penstemon | | 6 | 0.12 |
| Western Yarrow | | 6 | 0.06 |
| Mountain Big Sagebrush | | 5 | 0.05 |
| **Total** | | **100** | **7.93** |

## D.11 SURFACE OWNERSHIP

Public record contact information for each landowner (or public agency) directly affected by the project will be provided in the Surface Use Plan of Operations submitted with each APD. Those directly affected by a project are landowners who own property on which a well will be located, an access road will cross, and those over which a pipeline route will cross. SGI will make a good faith effort to provide each landowner a copy of the Surface Use Plan of Operations. SGI will certify that this effort was made for each project.

## D.12 OTHER INFORMATION

SGI will address any other requests for information contained in relevant orders and notices in this section. Site specific information that may be helpful in processing individual APDs will also be noted here.

SGI has a noxious weed management plan for the Bull Mountain Unit that is available upon request. This Noxious Weed Management Plan identifies measures to be taken by SGI and its contractors to minimize the spread and establishment of noxious weeds and non-native invasive species.

Measures identified in this plan apply to work within the project area defined as well pads, pipeline rights-of-way, access roads, temporary use areas, and other areas used in association with the natural gas development within the Bull Mountain Unit and adjacent areas in Gunnison County. All noxious weeds as defined by Gunnison County and the state of Colorado (Colorado Weed Management Act CRS Title 35, Article 5.5 as amended) will be controlled.

The purpose of this plan is to prescribe methods to treat existing weed infestations, prevent introduction and spread of infestations during construction, and monitor and treat infestations after construction is complete.

In addition to selecting the site-specific BMPs related to each element of the SUPO, additional BMPs and design features that further address the following issues and resources may be included here in future APDs:

- Common siting and surface disturbing BMPs on well pads, roads, and pipelines
- Natural gas drilling and exploration
- Noise
- Protection of archaeological and cultural resources
- Protection of water resources
- Wildlife
- Invasive, non-native species

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# Appendix E

## Master Drilling Plan

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# APPENDIX E
# MASTER DRILLING PLAN

This Master Drilling Plan is for use in preparation of the Drilling Plan component of future Applications for Permit to Drill (APDs) in the Bull Mountain Unit.

Onshore Order No. 2 details the uniform national standards for the minimum levels of performance expected from lessees and operators when conducting drilling operations and for abandonment. The Drilling Plan, sometimes referred to as the 9 Point Drilling Plan, provides the BLM information necessary to ensure that drilling is conducted with appropriate regard for protection of public health and safety, the environment (including subsurface resources such as groundwater), correlative rights and maximum economic recovery of hydrocarbons. The Drilling Plan is submitted in conjunction with the Surface Use Plan of Operations as part of a complete APD package. The elements of an individual APD will be carefully reviewed by the BLM to ensure that proposed operations are adequate.

Drilling plans in the Bull Mountain Unit may address seven different well types or categories:

- Unconventional, vertical and/or short reach directional, Cameo/South Canyon coalbed natural gas (CBNG) wells with relatively shallow total vertical depths (i.e.; those above approximately 4,500 feet Proposed Total Depth – True Vertical Depth (PTD-TVD))

- Unconventional, long reach horizontal, CBNG wells with relatively shallow total vertical depths (i.e.; those above approximately 4,500 feet PTD-TVD)

- Conventional, vertical and/or short reach directional, Cozzette/Corcoran sandstone gas wells with moderate total vertical depths (i.e.; those approximately 4,500 feet - 5,750 feet PTD-TVD)

- Conventional, long reach horizontal, Cozzette/Corcoran sandstone gas wells with moderate total vertical depths (i.e.; those approximately 4,500 feet - 5,750 feet PTD-TVD)

- Unconventional, vertical and/or short reach directional, Mancos shale gas wells with relatively deep total vertical depths (i.e.; approximately 5,750 feet - 8,500 feet PTD-TVD)

- Unconventional, long reach horizontal, Mancos shale gas wells with relatively deep total vertical depths (i.e.; approximately 5,750 feet - 8,500 feet PTD-TVD)

- Vertical, Entrada/Maroon/Dakota water disposal wells with very deep total vertical depths (i.e.; greater than approximately 8,500 feet PTD-TVD)

The Drilling Plan component of an individual APD must specifically address all of the following elements as required in Federal Onshore Order No. 2. A "complete" Drilling Plan will also include any design features/BMPs chosen by the operator to mitigate potential impacts. As much as possible, the information below responds to the elements in the Drilling Plan component of an APD as described in Federal Onshore Order No. 2 and suggests what may be expected in a forthcoming site specific APD. However, this Master Drilling Plan may not identify or specify all design features or BMPs. Those may be found in the following appendices associated with the Bull Mountain Unit Master Development Plan Environmental Impact Statement:

Appendix B – Construction, Drilling, Completion, and Reclamation

Appendix C – Best Management Practices and Conditions of Approval

## DRILLING PLAN ELEMENTS OF THE APD

### 1. Geologic Information

Values in the table represent the general range for approximate measured depth to formation tops and estimates for depth and thickness to potential producing and water disposal zones in the Bull Mountain Unit. A complete list will be expected in a submitted drilling plan. Specific measurements included in APDs will differ because formation depths vary throughout the unit.

*A. Estimated Formation Tops*

**Table E-1**
**Estimated Depth, Formation Tops[1]**

| Formation/Group | Depth of Top (feet) |
|---|---|
| Wasatch | Surface |
| Ohio Creek | 2400 |
| Mesa Verde | 2700 |
| South Canyon | 3270-3870 |
| Cameo Coal | 3760-4360 |
| Rollins Sandstone | 3580-5400 |
| Cozzette | 4570-5180 |
| Corcoran | 4740-5380 |
| Mancos Shale | 4940-5000 |
| Entrada | 8900 |
| Maroon | 9300 |

[1] General range for measured depth to formation tops in the Bull Mountain Unit. Specific measurements included on APDs will differ.

*B. Estimated Depth and Thickness of Formations*

The BLM will also expect to see similar information for useable water and other mineral bearing zones.

**Table E-2**
**Estimated Depth and Thickness of Target Formations [1]**

| Name | Depth (feet) | Thickness (feet) |
|---|---|---|
| South Canyon | 3270-3870 | 100 |
| Cameo Coal | 3760-4360 | 100 |
| Cozzette - Corcoran | 4570-5380 | 300 |
| Mancos | 4940-5000 | 3,000 |
| Maroon (primary disposal target) | 9300 | 100 |
| Entrada (possible disposal target) | 8900 | 200 |

[1] Estimates for depth and thickness of formations with gas that have been targeted to date.

## 2. Well Control Requirements

Blowout preventer (BOP) and related equipment (BOPE) shall be installed, used, maintained and tested in manner necessary to assure well control and shall be in place and operational prior to drilling the surface casing shoe unless otherwise approved by the APD.

*A. Minimum Specifications for Pressure Control Equipment*

BOP equipment and accessories will meet or exceed BLM requirements outlined in 43 CFR Part 3160. A 3000 or a 5000 psig double ram hydraulic BOP will be used (a diagram of the specific device will be attached; see typical diagrams in **Attachment 1**, Typical Pressure Control Mechanisms) for the intermediate portion of the well (generally 400 feet – 5400 feet). Maximum anticipated surface pressure is 2300 - 2500 pounds per square inch gauge (psig). Accessories to the BOP will meet BLM requirements for the system used. The accumulator system capacity will be sufficient to close all BOPE with a 50 percent safety factor. Fill line, kill line and line to choke manifold will be 2". BOP's will be function tested every 24 hours and will be recorded on IADC log. Surface casing will be tested to 1500 psig for 30 minutes. Accessories to BOPE will include upper and lower Kelly cocks with handles, stabbing valve to fit drill pipe on floor at all times, string float at bit, 3000 or 5000 psig choke manifold with 3 inch adjustable and 3 inch positive chokes, and pressure gauge.

## 3. Casing and Cementing Program

The proposed casing and cementing programs shall be conducted to protect and/or isolate all usable water zones, lost circulation zones, abnormally pressured zones and any prospectively valuable deposits of minerals. Any isolating medium other that cement shall receive approval prior to use. The casing setting depth shall be calculated to position the casing seat opposite a competent formation that will contain the maximum pressure to which it will be exposed during normal drilling operations. Determination of casing setting depth shall be based on all relevant factors including; presence/absence of hydrocarbons, fracture gradients, usable water zones, formation pressures, lost circulation zones, other minerals, or other unusual characteristics. Design criteria, loading assumptions and safety factors for burst, collapse and tension will be included along with the casing design. All indications of usable water encountered shall be reported.

Cementing descriptions will include the amount, type of cement including additives for each slurry, density, yield cement height and any excess cement volume that the operator anticipates needing to achieve that cement height. If stage cementing is going to be done, placement of the DV tool should be listed.

*A. Casing Program*

Typical casing details and well bore diagrams are included in **Attachment 2**. Specific programs will be submitted to BLM with each APD.

*B. Cementing Program*

Typical cementing program details are included in the well bore diagrams in Attachment 2. Specific programs will be submitted to BLM with each APD. Please note that these wellbore diagrams show a cemented casing string on all horizontal completions. This is the method SG Interests has used so far, however, the horizontal section of the well may not always be cemented. In the event this section is not cemented, a packer system that swells would be used.

A differential valve (DV) tool will usually be used to help ensure cement is circulated to surface. In coal and

Cozzette/Corcoran wells the DV tool will be run in the production string. In vertical and horizontal shale wells the DV tool will be run in the intermediate string. In water disposal wells a DV tool will be run in the intermediate and production strings.

Surface casing cement is calculated to return to the surface (100 percent excess volume). After the cement job is pumped, a one inch pipe is run on the outside of the casing and +/- 50 sacks of cement are used to top off the annulus. If the cement does not circulate back to the surface, a temperature log is run to find the top of cement. At this point, corrective measures are taken if necessary.

**Table E-3** provides an example of a typical casing and cementing program for a horizontal shale well:

**Table E-3**
**Typical Casing and Cementing Program, Horizontal Shale Well**

| String | Size of Hole (inches) | Size of Casing (inches) | Weight Per Foot (lbs) | Grade | Setting Depth (MD, feet) | Sacks Cement | Cement Bottom (feet) | Cement Top (feet) |
|---|---|---|---|---|---|---|---|---|
| Conductor | 26 | 20 | 106.5 | X-42/A-53 | 80 | 100 | 80 | Surface (0’) |
| Surface | 16 | 13.375 | 54.5 | J-55 | 400 | 260 | 400 | Surface (0’) |
| 1st Inter. | 12.125 | 9.625 | 40.0 | J-55 | 5,500 | 1,280 | 5,500 | Surface (0’) |
| 2nd Inter. | 8.5 | 7 | 29.0 | P-110 | 9,074 | 355 | 9,074 | 5,300 |
| Prod. Lnr. | 6.125 | 4.50 | 13.5 | P-110 | 12,727 – 8,110 | 235 | 12,727 | 8,100 |

**Table E-4** provides an example of a casing and cementing program for a vertical coalbed methane well in the Bull Mountain Unit.

**Table E-4**
**Typical Casing and Cementing Program, Vertical Coalbed Methane Well**

| String | Size of Hole (inches) | Size of Casing (inches) | Weight per Foot (lbs) | Grade | Setting Depth (feet) | Sacks Cement | Cement Bottom (feet) | Cement Top (feet) |
|---|---|---|---|---|---|---|---|---|
| Surface | 12.25 | 9.625 | 24 | J-55 | 300 | 210 | 300 | Surface |
| Production | 8.5 | 5.5 | 17 | J-55 | 3,600 | 1st stage: 220<br>2nd stage: 300 + 100 | 3,600 | Surface |

## 4. Mud Program Requirements

The characteristics, use and testing of drilling mud and the implementation of related drilling procedures shall be designed to prevent the loss of well control. Sufficient quantities of mud materials shall be maintained or readily accessible for the purpose of assuring well control.

*Mud Program*

In general, a fresh water based spud mud system (FW) will be used for the surface hole. Primary product used will be gel for viscosity control. A low-solids, non-dispersed gel system (LSND) will be used throughout the intermediate hole as well as the production hole. Products used may include but not be limited to Barite for weighting material, gel for viscosity control, lime for alkalinity control, low viscosity polyanionic cellulose (Pac LV) for fluid loss, Desco for rheological control and to reduce gel strengths, and lost circulation materials (LCM) such as fibers, saw dust or walnut shells. Solids control equipment will include shakers and a centrifuge. Fluid densities will be maintained as low as possible to drill with minimal over-balance to reduce the possibility of losing returns and/or of differentially sticking the drill sting. Hole conditions and drilling parameters will be monitored closely for indications of increases in formation pressures. Fluid densities will be adjusted accordingly. Optimum hydraulics will be maintained to provide maximum hole cleaning and minimize washout of the wellbore. Rheological properties will be adjusted for optimum bit hydraulics, penetration rates and minimize drag forces on the wellbore. Hole conditions and mud properties will be optimized prior to running logs, running casing and cementing. Adequate amounts of lost circulation and weighting material will be on location if needed as well as sorbitive agents to handle potential spills of fuel or lubricants. The maximum mud weight (12.2 pounds per gallon) was experienced at intermediate casing point (+/-5,400 feet).

**Table E-5**
**Drilling Mud Program**

| Depth (feet) | Type | Weight (parts per gallon) | Viscosity (seconds per quart) | Water loss (cubic centimeters) | Solids |
|---|---|---|---|---|---|
| 0 – 400 | FW | ± 8.5 – 8.70 | 30 – 40 | NC | <7% |
| 400 – 5,400 | LSND | ± 8.7 – 12.2 | 40 – 70 | 6 – 8 | <7% |
| 5,400 – Total depth | LSND | ± 9.0 – 10.0 | 40 – 70 | 6 – 8 | <7% |

[1] Due to the rapid speed of drilling through the first 400 feet, combined with short turnaround time to setting of surface casing, the amount of water loss in this segment cannot be controlled.

In some cases, oil-based drilling mud may be used. This mud may be used only on part of the well bore. Oil-based mud is a 85 percent diesel and 15 percent water mixture.

## 5. Drill Stem Testing Requirements

*Testing, Coring, and Logging Program*
Generally, no drill stem tests or cores are planned (these could be added to a specific well drilling plan submitted with an APD). Open hole logs to include gamma ray, induction, caliper, and density logs generally from 5400 feet to 400 feet and gamma ray, induction, caliper, density and formation micro image logs generally from TD to 5400 feet.

## 6. Special Drilling Operations

*Anticipated Drilling Conditions*
Lost circulation is possible. If encountered, lost circulation material will be maintained on location. Intermediate casing will be set at approximately 5400 feet to isolate potential shallower lost circulation zones. Both the intermediate and long strings will have two stage cementing jobs performed. No hydrogen sulfide ($H_2S$) is expected in new wells in the unit. $H_2S$ been not been encountered in the drilling of any previous wells.

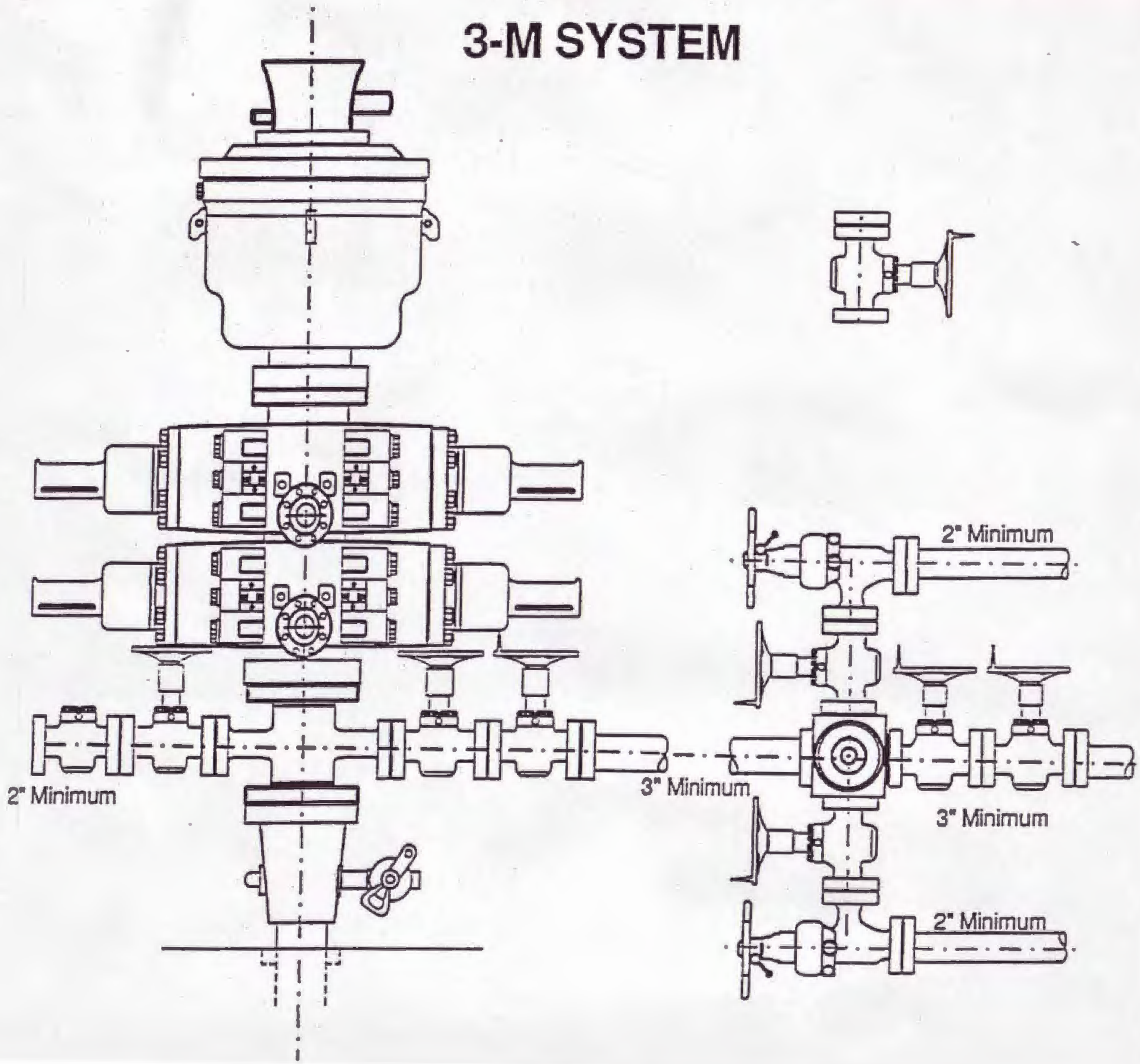
## 7. Other Facets of the Proposal

*Operations*
When an individual APD is submitted to BLM, the anticipated spud date will be included in this section, along with the estimated drilling time frame. Average drilling and completion durations for each well type are shown on the well bore diagrams (**Attachment 2**, Typical Well Bore Diagrams). Completion details will also be included in this section, such as approximate timeframe for completion. All gas wells will require hydraulic fracturing. All horizontal gas wells will have multiple completion stages. **Attachment 2** includes general examples of well bore diagrams.

# ATTACHMENT 1:

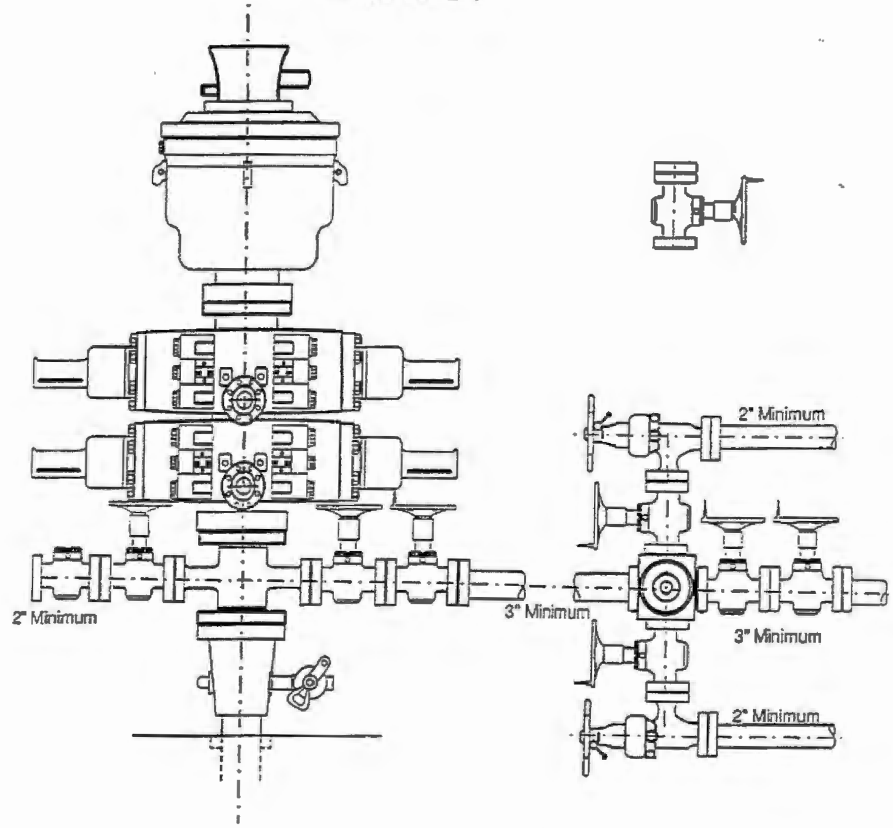
## TYPICAL PRESSURE CONTROL MECHANISMS

# 3-M SYSTEM

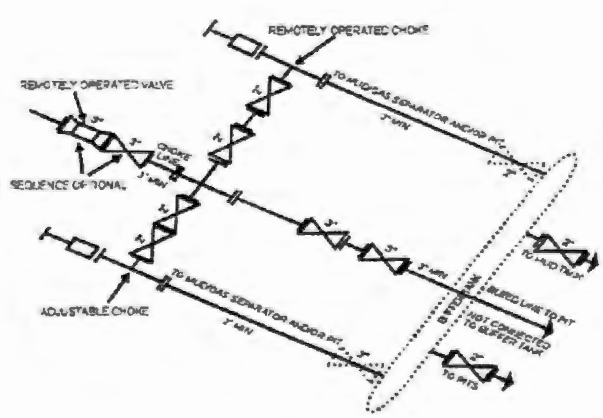


5-M Choke Manifold Diagram

# 5M BOP




5M BOP




5M CHOKE MANIFOLD EQUIPMENT - CONFIGURATION OF CHOKES MAY VARY

Although not required for any of the choke manifold systems, buffer tanks are sometimes installed downstream of the choke assemblies for the purpose of manifolding the bleed lines together. Where buffer tanks are employed, valves shall be installed upstream to isolate a failure or malfunction without interrupting flow control. Though not shown on 2M, 3M, 10M, OR 15M drawings, it would also be applicable to those situations.

[54 FR 39528, Sept. 27, 1989]

# ATTACHMENT 2:

## TYPICAL WELL BORE DIAGRAMS

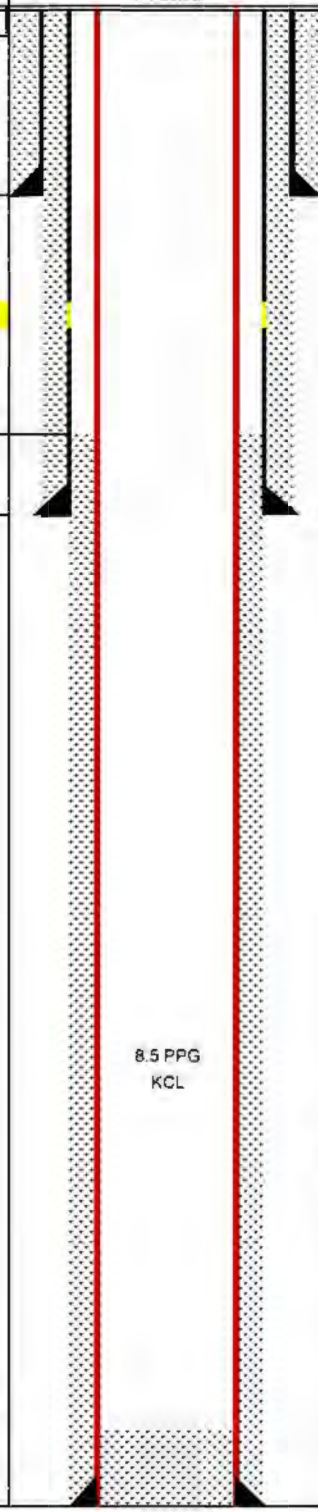
# SG INTERESTS

## TYPICAL AS DRILLED WBD VERTICAL MANCOS WELL

**Lease:** Typical Vertical Mancos Well
**Well :**
**Area:** Gunnison County, Colorado
**Field:** Bull Mountain

**Location :**
**BHL:**
**Survey:**
**API No:**

| ESTIMATED DAYS | |
|---|---|
| Est. Drill Case & Suspend Days: | 32 |
| Est. Completion Days: | 14 |
| Est. Total Days: | 46 |
| Date: | October 15, 2013 |




| Directional | | Markers | Depth TVD | Depth MD | Casing Profile | Hole Size | Casing Details | Mud Wt. & Type | MAX Dogleg |
|---|---|---|---|---|---|---|---|---|---|
| None | | | | +/- 80' | | Pre-Set | 20" Welded Conductor | N/A | |
| None | | | 400' | 400' | | 16" Hole | 13-3/8" 54.5# J-55 STC | Water Spud Mud MW=9.1 | <1°/100' |
| None | | 9-5/8"DV Tool | 3,550' | 3,550' | | 12-1/4" Hole | | 9.1 WBM | |
| | | TOC | 4,700' | 4,700' | | | | | |
| | | | 5,000' | 5,000' | | | 9-5/8" 40# J-55 LTC | MW=12.2 | <1°/100' |
| | | Float Collar | 8,160' | 8,160' | | 8-1/2" Hole | | | |
| TD | | Float Shoe | 8,200' | 8,200' | | | 5-1/2" 17# P-110 LTC | WBM MW 10.8 | <1°/100' |

Note: Not to Scale

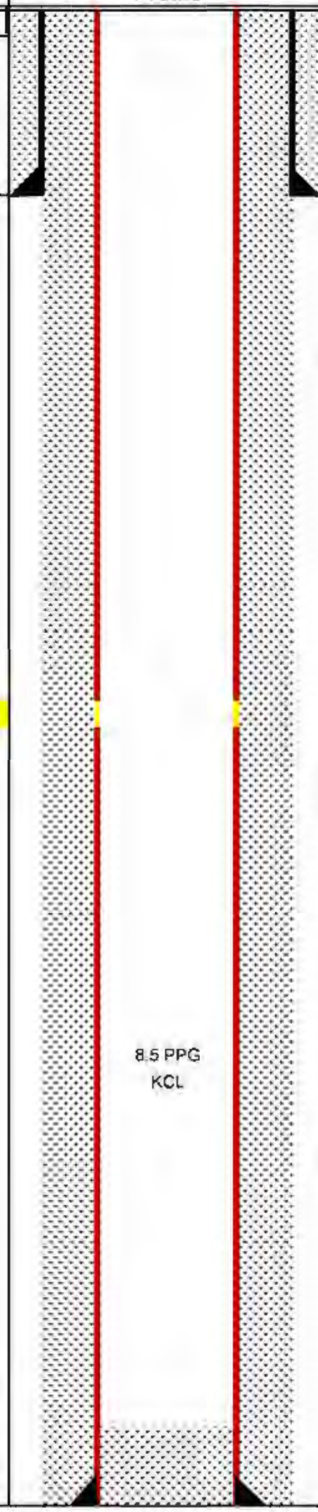
# SG INTERESTS

## TYPICAL AS DRILLED WBD VERTICAL COZ-COR WELL

**Lease:** Typical Vertical Coz-Cor Well **Location :**
**Well :** **BHL:**
**Area:** Gunnison County, Colorado **Survey:**
**Field:** Bull Mountain **API No:**

| ESTIMATED DAYS | |
|---|---|
| Est Drill Case & Suspend Days: | 18 |
| Est. Completion Days: | 7 |
| Est. Total Days: | 25 |
| Date: | October 15, 2013 |

| Directional | | Markers | Depth TVD | Depth MD | Casing Profile | Hole Size | Casing Details | Mud Wt. & Type | MAX Dogleg |
|---|---|---|---|---|---|---|---|---|---|
| None | | | | +/- 80' | | Pre-Set | 16" 75# J-55 Conductor | N/A | |
| None | | | 400' | 400' | | 12-1/4" Hole | 9-5/8" 40# J-55 LTC | Water Spud Mud MW=9.1 | <1°/100' |
| None | | | | | | 8-1/2" Hole | | 9.1 WBM | |
| | | 5-1/2" DV Tool | 3,600' | 3,600' | | | | | |
| | | | | | 8.5 PPG KCL | 8-1/2" Hole | | | |
| | | Float Collar | 5,610' | 5,610' | | | | | |
| TD | | Float Shoe | 5,650' | 5,650' | | | 5-1/2" 17# N-80 LTC | WBM MW 12.2 | <1°/100' |




**Note: Not to Scale**

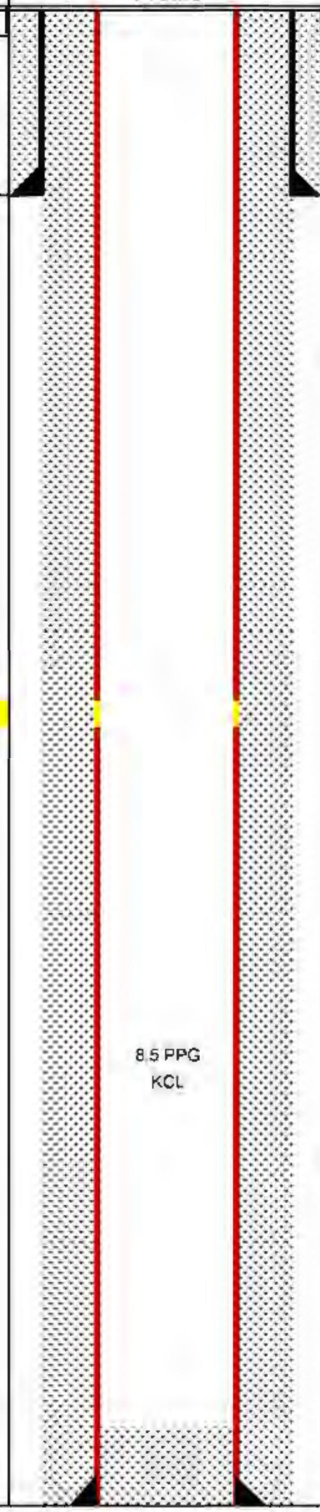
# SG INTERESTS

## TYPICAL AS DRILLED WBD VERTICAL COAL WELL

**Lease:** Typical Vertical Coal Well
**Well :**
**Area:** Gunnison County, Colorado
**Field:** Bull Mountain

**Location :**
**BHL:**
**Survey:**
**API No:**

| ESTIMATED DAYS | |
|---|---|
| Est. Drill Case & Suspend Days: | 13 |
| Est. Completion Days: | 7 |
| Est. Total Days: | 20 |
| Date: | October 15, 2013 |




| Directional | | Markers | Depth TVD | Depth MD | Casing Profile | Hole Size | Casing Details | Mud Wt. & Type | MAX Dogleg |
|---|---|---|---|---|---|---|---|---|---|
| None | | | | +/- 80' | | Pre-Set | 16" 75# J-55 Conductor | N/A | |
| | | | | | | 12-1/4" Hole | | Water Spud Mud | |
| None | | | 400' | 400' | | | 9-5/8" 40# J-55 LTC | MW=9.1 | <1°/100' |
| None | | | | | | 8-1/2" Hole | | 9.1 WBM | |
| | | 5-1/2" DV Tool | 3,031' | 3,031' | | | | | |
| | | | | | | 8-1/2" Hole | | | |
| | | Float Collar | 3,710' | 3,710' | | | | | |
| TD | | Float Shoe | 3,750' | 3,750' | | | 5-1/2" 17# N-80 LTC | WBM MW=9.6 | <1°/100' |

Note: Not to Scale

# SG INTERESTS

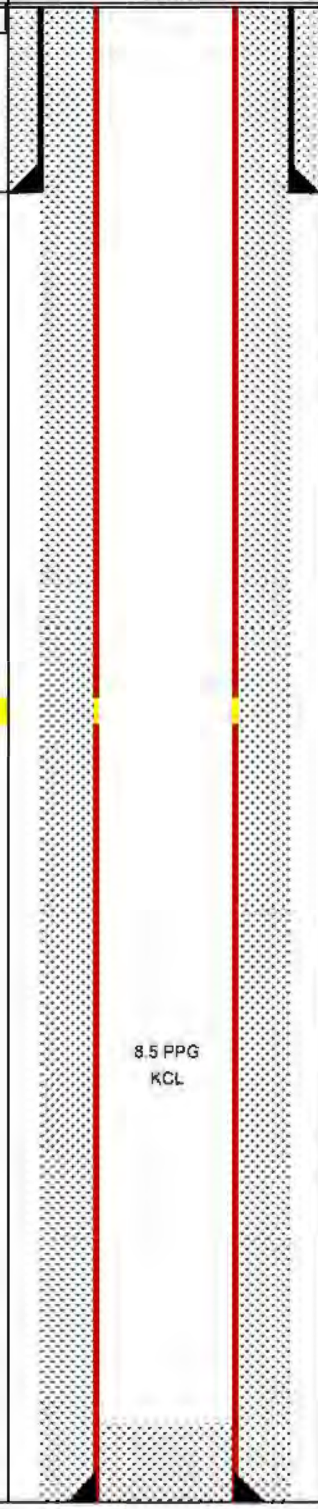
## TYPICAL AS DRILLED WBD S-CURVE COZ-COR WELL

**Lease:** Typical S-Curve Coz-Cor Well
**Well :**
**Area:** Gunnison County, Colorado
**Field:** Bull Mountain

**Location :**
**BHL:**
**Survey:**
**API No:**

| ESTIMATED DAYS | |
|---|---|
| Est. Drill Case & Suspend Days: | 21 |
| Est. Completion Days: | 7 |
| Est. Total Days: | 28 |
| Date: | October 15, 2013 |

| Directional | | Markers | Depth TVD | Depth MD | Casing Profile | Hole Size | Casing Details | Mud Wt. & Type | MAX Dogleg |
|---|---|---|---|---|---|---|---|---|---|
| None | | | | +/- 80' | | Pre-Set | 16" 75# J-55 Conductor | N/A | |
| | | | | | | 12-1/4" Hole | | Water Spud Mud | |
| None | | | 400' | 400' | | | 9-5/8" 40# J-55 LTC | MW=9.1 | <1°/100' |
| | | | | | | | | 9.1 WBM | |
| KOP 2.5°/100' | | KOP 2.5°/100' | 607' | 607' | | | | | 2°/100' |
| | | | | | | 8-1/2" Hole | | | |
| EOB (23.6°) Drop | | EOB (23.6°) Drop 1.555°/100' | 1,525' | 1,551' | | | | | 2°/100' |
| Vertical | | Vertical | 3,000' | 3,069' | | | | | |
| | | 5-1/2" DV Tool | 3,600' | 3,669' | | | | | |
| | | | | | | 8-1/2" Hole | | | |
| | | Float Collar | 5,612' | 5,679' | | | | | |
| TD | | Float Shoe | 5,650' | 5,719' | | | 5-1/2" 17# N-80 LTC | WBM MW 12.2 | <1°/100' |




Note: Not to Scale

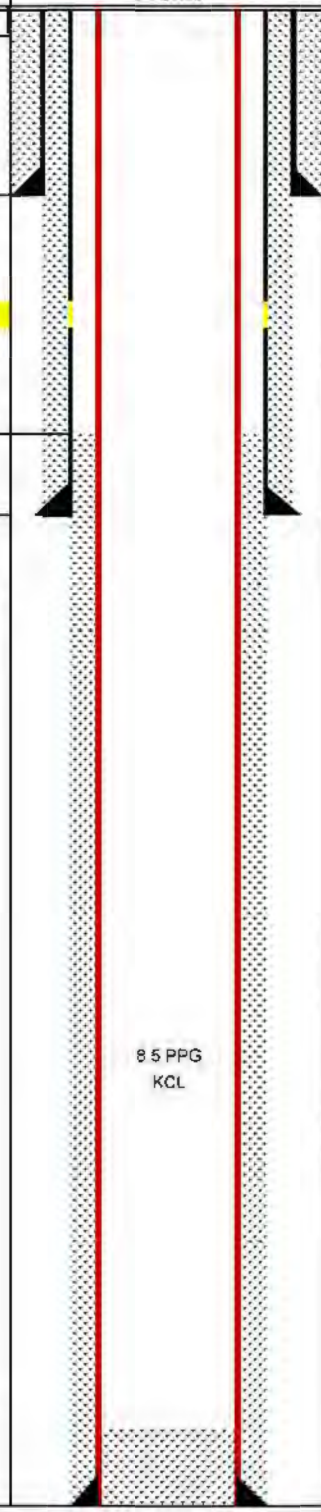
# SG INTERESTS

## TYPICAL AS DRILLED WBD S-CURVE MANCOS WELL

**Lease:** Typical S-Curve Mancos Well
**Well :**
**Area:** Gunnison County, Colorado
**Field:** Bull Mountain

**Location :**
**BHL:**
**Survey:**
**API No:**

| ESTIMATED DAYS | |
|---|---|
| Est. Drill Case & Suspend Days: | 35 |
| Est. Completion Days: | 14 |
| Est. Total Days: | 49 |
| Date: | October 15, 2013 |

| Directional | | Markers | Depth TVD | MD | Casing Profile | Hole Size | Casing Details | Mud Wt. & Type | MAX Dogleg |
|---|---|---|---|---|---|---|---|---|---|
| None | | | | +/- 80' |  | Pre-Set | 20" Welded Conductor | N/A | |
| | | | | | | 16" Hole | | Water Spud Mud | |
| None | | | 400' | 400' | | | 13-3/8" 54.5# J-55 STC | MW=9.1 | <1°/100' |
| | | | | | | | | 9.1 WBM | |
| KOP 2°/100' | | KOP 2°/100' | 3,163' | 3,163' | | | | | 2°/100' |
| | | 9-5/8"DV Tool | 3,550' | 3,551' | | | | | |
| EOB (20°) Drop | | EOB (20°) Drop 1.055°/100' | 4,163' | 4,163' | | 12-1/4" Hole | | | |
| | | TOC | 4,707' | 4,753' | | | | | |
| | | | 5,000' | 5,053' | | | 9-5/8" 40# J-55 LTC | MW=12.2 | 2°/100' |
| Vertical | | | 6,000' | 6,059' | | | | | |
| | | | | | | 8-1/2" Hole | | | |
| | | Float Collar | 9,060' | 9,118' | | | | | |
| | | | | | | | | WBM | |
| TD | | Float Shoe | 9,100' | 9,158' | | | 5-1/2" 17# P-110 LTC | MW 10.8 | <1°/100' |



Note: Not to Scale

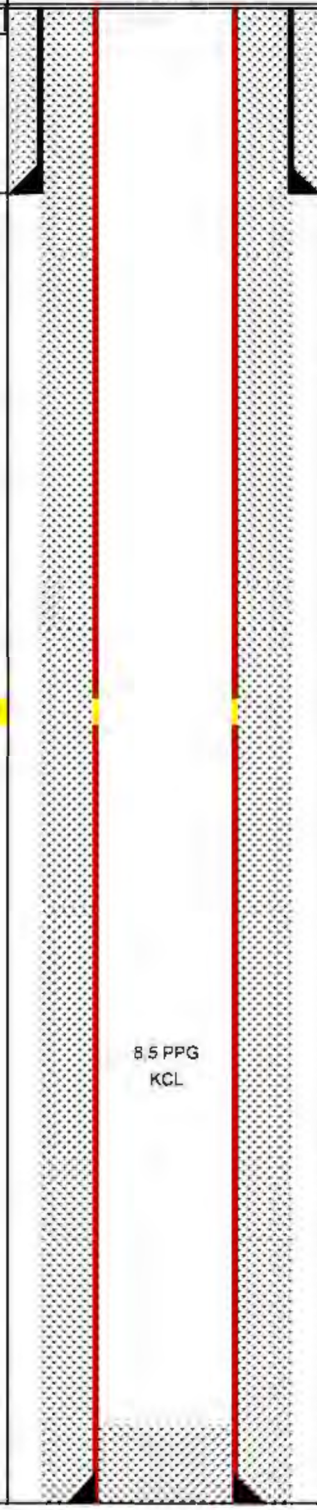
# SG INTERESTS

## TYPICAL AS DRILLED WBD S-CURVE COAL WELL

**Lease:** Typical S-Curve Coal Well **Location :**
**Well :** **BHL:**
**Area:** Gunnison County, Colorado **Survey:**
**Field:** Bull Mountain **API No:**

**ESTIMATED DAYS**
**Est. Drill Case & Suspend Days:** 16
**Est. Completion Days:** 7
**Est. Total Days:** 23
**Date:** October 15, 2013

| Directional | | Markers | Depth TVD | Depth MD | Casing Profile | Hole Size | Casing Details | Mud Wt. & Type | MAX Dogleg |
|---|---|---|---|---|---|---|---|---|---|
| None | | | | +/- 80' | | Pre-Set | 16" 75# J-55 Conductor | N/A | |
| | | | | | | 12-1/4" Hole | | Water Spud Mud | |
| | | | | 400' | | | 9-5/8" 40# J-55 LTC | MW=9.1 | <1°/100' |
| | | | | | | | | 9.1 WBM | |
| KOP 2.5°/100' | | KOP 2.5°/100' | 607' | 607' | | | | | 2°/100' |
| | | | | | | 8-1/2" Hole | | | |
| EOB (23.6°) Drop | | EOB (23.6°) Drop 1.555°/100' | 1,525' | 1,551' | | | | | 2°/100' |
| Vertical | | Vertical | 3,000' | 3,069' | | | | | |
| | | 5-1/2" DV Tool | 3,031' | 3,100' | | | | | |
| | | | | | | 8-1/2" Hole | | | |
| | | Float Collar | 3,710' | 3,779' | | | | | |
| TD | | Float Shoe | 3,750' | 3,819' | | | 5-1/2" 17# N-80 LTC | WBM MW=9.6 | <1°/100' |




**Note: Not to Scale**

| | OPERATOR: SG Interests | LEASE / WELL: Typical Horizontal Mancos w/ Protection Casing | SURVEY LOCATION: | DATE 10/15/2013 |
|---|---|---|---|---|
| | DRILLING RIG: COMPLETION RIG: 20/40 | COUNTY / STATE: Gunnison County, CO. | SURFACE LOCATION: | FIELD: Bull Mountain Unit |

| HORIZONTAL HOLE | | | | | |
|---|---|---|---|---|---|
| KOP | 7,679' | 11° /100' | | | |
| EOB | 8,497' | MD | 8,200' | TVD | |

## TUBULAR DATA

| Tubulars | Size | Weight | Grade | Thread | MD | TVD | TOL |
|---|---|---|---|---|---|---|---|
| DRIVE PIPE | | | | | | | |
| CONDUCTOR | 20" | 106.5# | X-42 / A-53 | Welded | 80' | 80' | |
| SURFACE | 13-3/8" | 54.5# | J-55 | ST&C | 400' | 400' | |
| INTERMEDIATE | 9-5/8" | 40# | J-55 | LT&C | 5,000' | 5,000' | |
| PROTECTION | 7" | 29# | P-110 | LT&C | 7,580' | 7,580' | |
| PROTECTION | 7" | 29# | P-110 | BUTT | 8,497' | 8,200' | |
| PROD LINER | 4-1/2" | 13.5# | P-110 | TKC 4040 RTC | 13,497' | 8,200' | 7,580' |
| PROD TIEBACK | | | | | | | |
| PROD LINER | | | | | | | |
| TUBING (Short String) | | | | | | | |
| TUBING (Long String) | | | | | | | |
| COILED TUBING | | | | | | | |

## ESTIMATED DAYS

Est. Drill Case & Suspend Days: 64

Est. Completion Days: 21

Est Total Days: 85

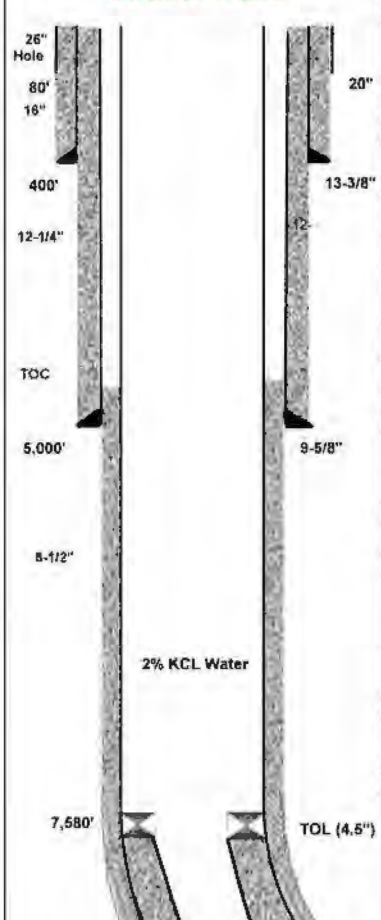
| ELEVATIONS: RKB: RKB-ELEV: | GROUND ELEVATION |
|---|---|

## DRILLING / COMPLETION FLUID

| | |
|---|---|
| DRILLING FLUID: | ppg - |
| DRILLING FLUID: | ppg - |
| DRILLING FLUID: | ppg - |
| COMPLETION FLUID: | ppg - |
| PACKER FLUID: | ppg - |

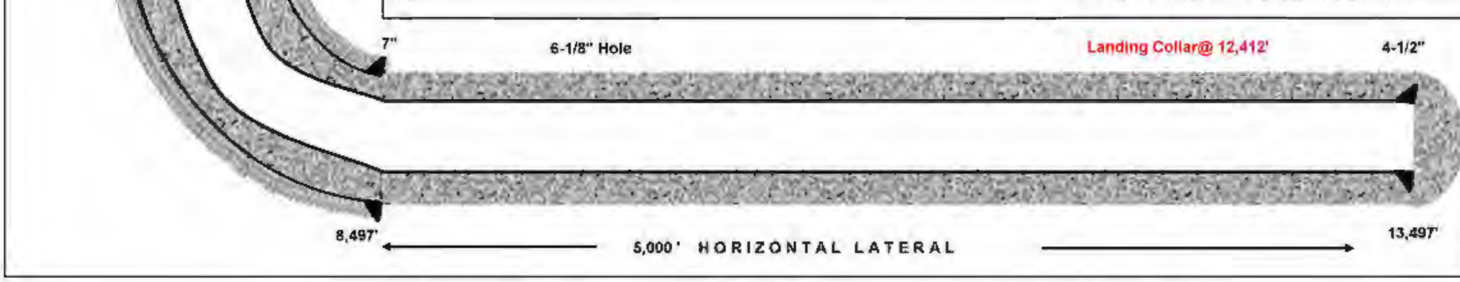
## WELLBORE SKETCH

DRAWING NOT TO SCALE




| Formation Tops (TVD) | | | | DEPTH MD | INCL DEG | DEPTH TVD |
|---|---|---|---|---|---|---|
| 9-5/8" DV Tool @ 3,550' | | | | | | |

| COMMENTS: | Working Interest: | PLUG BACK DEPTH: | | |
|---|---|---|---|---|
| API # | Net Revenue Interest | TOTAL WELL DEPTH: | | |
| Property# | | PREPARED OR REVISED BY: | DATE: | |
| Spud Date | | Dennis Romero | October 15, 2013 | |




# TYPICAL WBD MANCOS HORIZONTAL W/ PROTECTION CASING

| OPERATOR: | LEASE / WELL: | SURVEY LOCATION: | DATE |
|---|---|---|---|
| SG Interests | Typical Horizontal Mancos No Protection Casing | | 10/15/2013 |
| DRILLING RIG: | COUNTY / STATE: | SURFACE LOCATION: | FIELD: |
| COMPLETION RIG: | Gunnison County, CO. | | Bull Mountain Unit |

**HORIZONTAL HOLE**

| | | | | |
|---|---|---|---|---|
| KOP | 7,679' | 11° /100' | | |
| EOB | 8,497' MD | 8,200' | TVD | |

**DRILLING / COMPLETION FLUID**

| | |
|---|---|
| DRILLING FLUID: | ppg - |
| DRILLING FLUID: | ppg - |
| DRILLING FLUID: | ppg - |
| COMPLETION FLUID: | ppg - |
| PACKER FLUID: | ppg - |

**TUBULAR DATA**

| Tubulars | Size | Weight | Grade | Thread | MD | TVD | TOL |
|---|---|---|---|---|---|---|---|
| DRIVE PIPE | | | | | | | |
| CONDUCTOR | 20" | 106.5# | X-42 / A-53 | Welded | 80' | 80' | |
| SURFACE | 13-3/8" | 54.5# | J-55 | ST&C | 400' | 400' | |
| INTERMEDIATE | 9-5/8" | 40# | J-55 | LT&C | 5,000' | 5,000' | |
| PRODUCTION | 5-1/2" | 17# | P-110 | LT&C | 7,580' | 7,580' | |
| PRODUCTION | 5-1/2" | 17# | P-110 | BUTT | 13,497' | 8,200' | |
| PROD LINER | | | | | | | |
| PROD TIEBACK | | | | | | | |
| PROD LINER | | | | | | | |
| TUBING (Short String) | | | | | | | |
| TUBING (Long String) | | | | | | | |
| COILED TUBING | | | | | | | |

**ESTIMATED DAYS**

Est. Drill Case & Suspend Days: 57

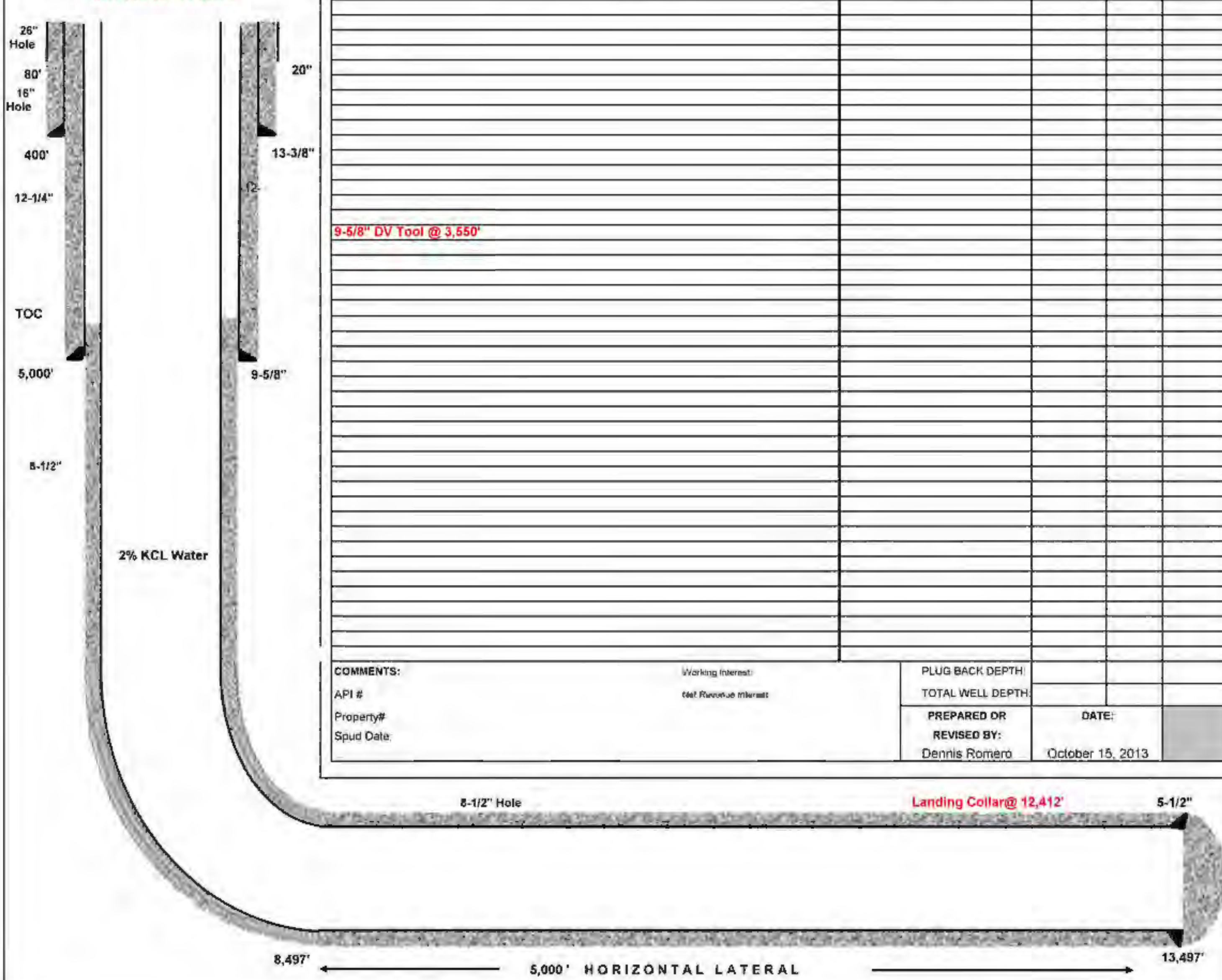
Est. Completion Days: 21

Est Total Days: 78

| ELEVATIONS: RKB: RKB-ELEV: | GROUND ELEVATION |
|---|---|

**WELLBORE SKETCH**

DRAWING NOT TO SCALE




| Formation Tops (TVD) | | | | DEPTH MD | INCL DEG | DEPTH TVD |
|---|---|---|---|---|---|---|
| 9-5/8" DV Tool @ 3,550' | | | | | | |

| COMMENTS: | Working Interest: | PLUG BACK DEPTH: | | |
|---|---|---|---|---|
| API # | Net Revenue Interest: | TOTAL WELL DEPTH: | | |
| Property# | | PREPARED OR REVISED BY: | DATE: | |
| Spud Date: | | Dennis Romero | October 15, 2013 | |

# TYPICAL WBD MANCOS HORIZONTAL NO PROTECTION CASING

| OPERATOR: | LEASE / WELL: | SURVEY LOCATION: | DATE: |
|---|---|---|---|
| **SG Interests** | **Typical Horizontal Coz-Cor Well** | | **10/15/2013** |
| DRILLING RIG: COMPLETION RIG: 20/40 | COUNTY / STATE: **Gunnison County, CO.** | SURFACE LOCATION: | FIELD: **Bull Mountain** |

**HORIZONTAL HOLE**

| | | | | |
|---|---|---|---|---|
| KOP | 4,279' | 11° /100' | | |
| EOB | 5,097' | MD | 4,800' | TVD |

**DRILLING / COMPLETION FLUID**

| | |
|---|---|
| DRILLING FLUID: | ppg - |
| DRILLING FLUID: | ppg - |
| DRILLING FLUID: | ppg - |
| COMPLETION FLUID: | ppg - |
| PACKER FLUID: | ppg - |

**TUBULAR DATA**

| Tubulars | Size | Weight | Grade | Thread | MD | TVD | TOL |
|---|---|---|---|---|---|---|---|
| DRIVE PIPE | | | | | | | |
| CONDUCTOR | 16" | 42# | A-52A | Welded | 80' | 80' | |
| SURFACE | 9-5/8" | 40# | J-55 | LTC | 400' | 400' | |
| INTERMEDIATE | | | | | | | |
| PROTECTION | | | | | | | |
| PROTECTION | | | | | | | |
| PRODUCTION | 5-1/2" | 17# | P-110 | LTC | 4,179' | 4,179' | |
| PRODUCTION | 5-1/2" | 17# | P-110 | BUTT | 10,097' | 4,800' | |
| PROD LINER | | | | | | | |
| TUBING (Short String) | | | | | | | |
| TUBING (Long String) | | | | | | | |
| COILED TUBING | | | | | | | |

**ESTIMATED DAYS**

Est. Drill Case & Suspend Days: 36

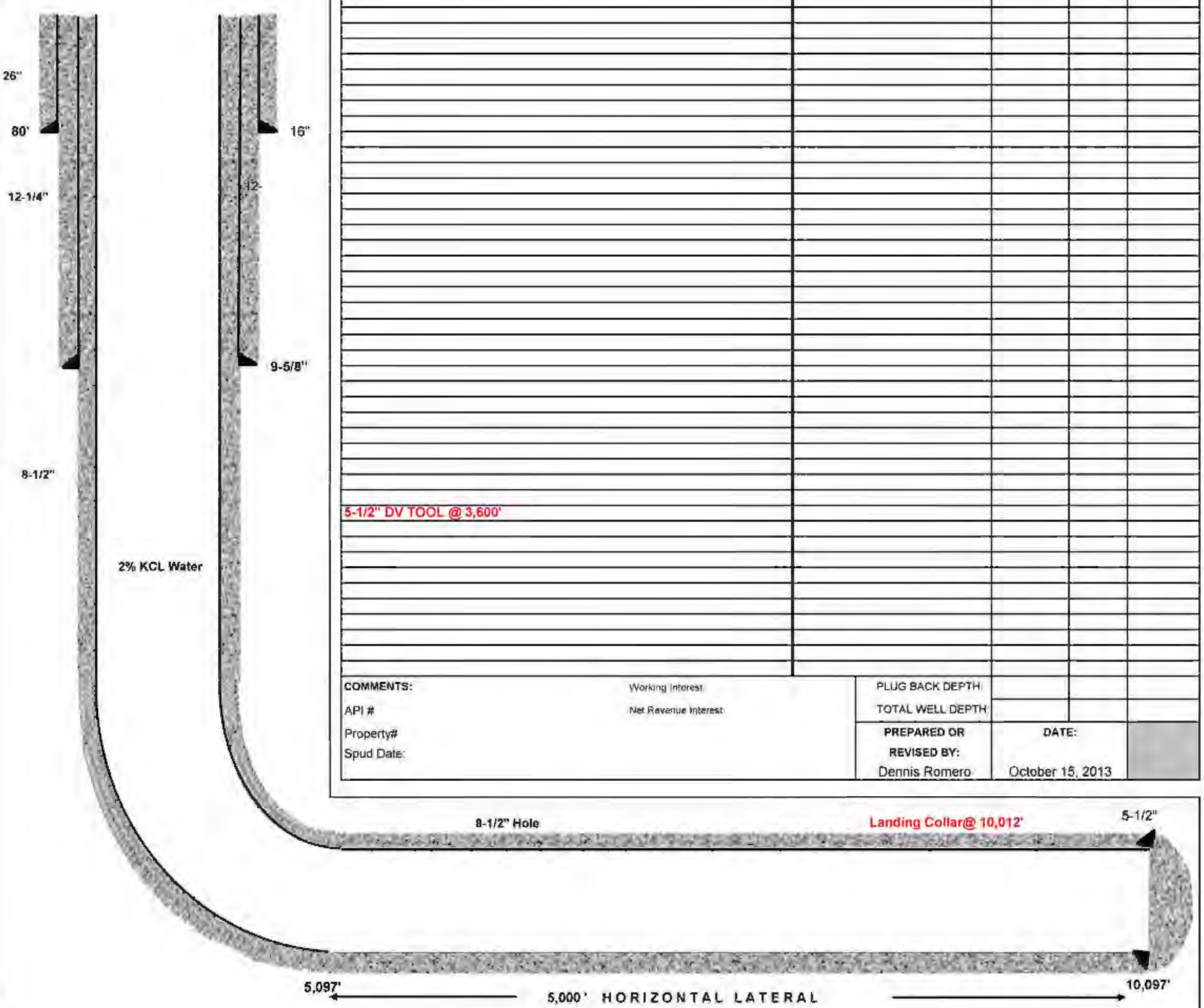
Est. Completion Days: 14

Est Total Days: 50

| ELEVATIONS: | GROUND ELEVATION |
|---|---|
| RKB: | |
| RKB-ELEV: | |

**WELLBORE SKETCH**

DRAWING NOT TO SCALE




| Formation Tops (TVD) | | | | DEPTH MD | INCL DEG | DEPTH TVD |
|---|---|---|---|---|---|---|
| 5-1/2" DV TOOL @ 3,600' | | | | | | |

| | | | |
|---|---|---|---|
| COMMENTS: | Working Interest: | PLUG BACK DEPTH: | |
| API # | Net Revenue Interest: | TOTAL WELL DEPTH: | |
| Property# | | PREPARED OR REVISED BY: | DATE: |
| Spud Date: | | Dennis Romero | October 15, 2013 |

## TYPICAL WBD COZ_COR HORIZONTAL

| | | | | |
|---|---|---|---|---|
| OPERATOR: **SG Interests** | LEASE / WELL: **Typical Horizontal Coal Well** | | SURVEY LOCATION: | DATE: **10/15/2013** |
| DRILLING RIG: | | COUNTY / STATE: **Gunnison County, CO.** | SURFACE LOCATION: | FIELD: **Bull Mountain** |
| COMPLETION RIG: 20/40 | | | | |

### HORIZONTAL HOLE

| | | | | |
|---|---|---|---|---|
| KOP | 2,979' | 11° /100' | | |
| EOB | 3,797' | MD | 3,500' | TVD |

### DRILLING / COMPLETION FLUID

| | |
|---|---|
| DRILLING FLUID: | ppg - |
| DRILLING FLUID: | ppg - |
| DRILLING FLUID: | ppg - |
| COMPLETION FLUID: | ppg - |
| PACKER FLUID: | ppg - |

### TUBULAR DATA

| Tubulars | Size | Weight | Grade | Thread | MD | TVD | TOL |
|---|---|---|---|---|---|---|---|
| DRIVE PIPE | | | | | | | |
| CONDUCTOR | 16" | 42# | A-52A | Welded | 80' | 80' | |
| SURFACE | 9-5/8" | 40# | J-55 | LTC | 400' | 400' | |
| INTERMEDIATE | | | | | | | |
| PROTECTION | | | | | | | |
| PROTECTION | | | | | | | |
| PRODUCTION | 5-1/2" | 17# | P-110 | LTC | 2,879' | 2,879' | |
| PRODUCTION | 5-1/2" | 17# | P-110 | BUTT | 8,797' | 3,500' | |
| PROD LINER | | | | | | | |
| TUBING (Short String) | | | | | | | |
| TUBING (Long String) | | | | | | | |
| COILED TUBING | | | | | | | |

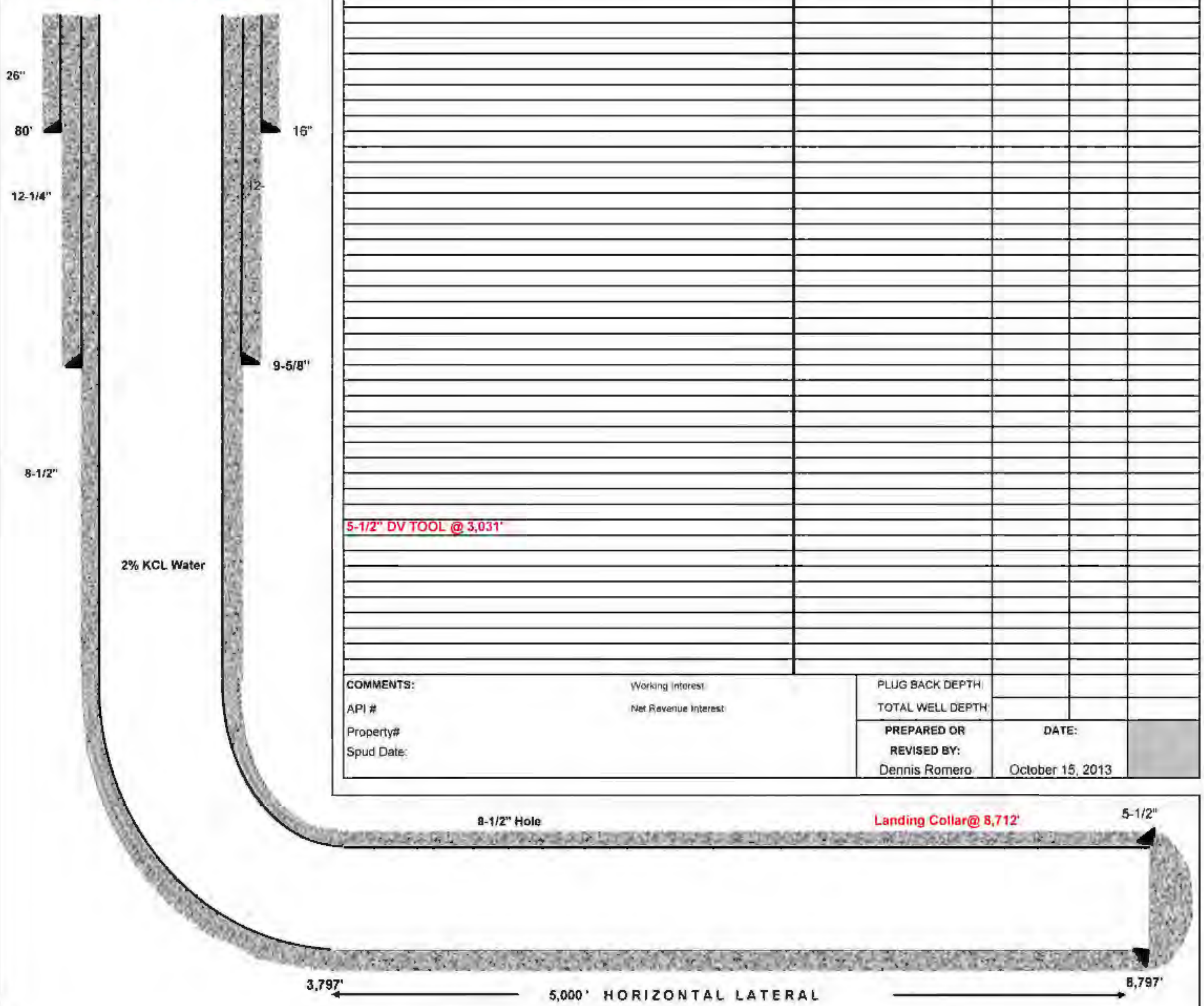
### ESTIMATED DAYS

| | |
|---|---|
| Est. Drill Case & Suspend Days: | 25 |
| Est. Completion Days: | 14 |
| Est Total Days: | 39 |

| | |
|---|---|
| ELEVATIONS: | GROUND ELEVATION |
| RKB: | |
| RKB-ELEV: | |

### WELLBORE SKETCH

DRAWING NOT TO SCALE




| Formation Tops (TVD) | | | | DEPTH MD | INCL DEG | DEPTH TVD |
|---|---|---|---|---|---|---|
| | | | | | | |

| | | | |
|---|---|---|---|
| COMMENTS: | | PLUG BACK DEPTH: | |
| API # | Working Interest: | TOTAL WELL DEPTH: | |
| Property# | Net Revenue Interest: | PREPARED OR REVISED BY: | DATE: |
| Spud Date: | | Dennis Romero | October 15, 2013 |

## TYPICAL WBD COAL HORIZONTAL

# Appendix F

## Summary of Lease Stipulations

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# APPENDIX F
# SUMMARY OF LEASE STIPULATIONS

The following federal leases are included in the area delineated by the boundary of the Bull Mountain Unit and are, at a minimum, subject to the terms and conditions provided for in the original lease authorization. All federal leases were also reviewed for consistency with the decisions outlined in the Uncompahgre Basin RMP (UBRMP) Record of Decision (ROD), specifically for resource values recognized in Management Unit 16. The UBRMP ROD states that federal oil and gas mineral estate is open to leasing. **Table F-1** provides a summary of lease stipulations that would apply to the Proposed Action and Alternative 1 and to existing federal authorizations on federal mineral leases.

Although these lease stipulations do not apply to every acre of the federal leases to be developed by the Proposed Action or Alternative 1, these and any other protective measures deemed appropriate by the Authorized Officer could be applied as Conditions of Approval (COAs) on individual applications for permit to drill (APDs).

**Table F-1**
**Summary of Lease Stipulations within BMMDP Area**

| Lease | Description of Lands | Federal Pad[1] | Lease Stipulations |
|---|---|---|---|
| COC-42314<br>Year: 1971 | T11S, R90W, 6th P.M., Gunnison County, Colorado<br>Section 14: Lot 3, SWNE, NWNW, SE | -- | The portion of parcel COC-42314 inside the Bull Mountain unitized area is subject only to the standard terms of the original lease authorization.<br>This lease parcel was authorized in 1971 as parcel COC-13484 and originally included US Forest Service lands. In 1984, parcel COC-42314 was created out of a segregation of parcel COC-13484. |
| COC-63486<br>Year: 2000 | T11S, R90W, 6th P.M., Gunnison County, Colorado<br>Section 11: Lots 3, 4, 8-10<br>Section 13: Lots 5, | -- | Standard stipulations of the original lease authorization shall apply. No additional stipulations from the 1989 UBRMP ROD are applicable to this lease parcel.<br>Lease parcel #110 authorized by NEPA action CO-150-00-15DNA. 2/10/2000 competitive oil and gas sale. |

**Table F-1**
**Summary of Lease Stipulations within BMMDP Area**

| Lease | Description of Lands | Federal Pad[1] | Lease Stipulations |
|---|---|---|---|
| | 12-14, S2SW | | |
| COC-64164<br><br>Year: 2000 | T11S, R89W, 6th P.M., Gunnison County, Colorado<br><br>Section 7: Lots 1, 2, E2NW<br><br>Section 8: N2, E2SW, SE<br><br>Section 17: NE, E2NW, N2SW, SESW, SE<br><br>Section 18: NESE | 11-89-17 #2 | Standard stipulations of the original lease authorization shall apply. No additional stipulations from the 1989 UBRMP ROD are applicable to this lease parcel.<br><br>Lease parcel #587 authorized by NEPA action CO-150-00-66DNA. 11/9/2000 competitive oil and gas sale. |
| COC-64165<br><br>Year: 2000 | T11S, R89W, 6th P.M., Gunnison County, Colorado<br><br>Section 19: Lots 3-11, SESW, SWSE<br><br>Section 20: ALL | -- | Standard stipulations of the original lease authorization shall apply. No additional stipulations from the 1989 UBRMP ROD are applicable to this lease parcel.<br><br>Lease parcel #588 authorized by NEPA action CO-150-00-66DNA. 11/9/2000 competitive oil and gas sale. |
| COC-64166<br><br>Year: 2000 | T11S, R89W, 6th P.M., Gunnison County, Colorado<br><br>Section 30: Lots 1-4, 7, W2NE, E2W2, SE<br><br>Section 31: Lots 1-4, E2, E2W2 | -- | In addition to application of standard stipulations of the original lease authorization, it was determined that all lands of the lease are also subject to UBRMP stipulation UB-04.<br><br>**TIMING LIMITATION STIPULATION**:<br><br>To protect crucial deer and elk winter ranges. No surface use is allowed during the following time period November 30 – May 1.<br><br>This stipulation does not apply to operation and maintenance of production facilities.<br><br>Lease parcel #589 authorized by NEPA action CO-150-00-66DNA. 11/9/2000 competitive oil and gas sale. |
| COC-64167<br><br>Year: 2000 | T11S, R89W, 6th P.M., Gunnison County, Colorado<br><br>Section 29: Lots 1-5, E2 | -- | Standard stipulations of the original lease authorization shall apply. No additional stipulations from the 1989 UBRMP ROD are applicable to this lease parcel.<br><br>Lease parcel #594 authorized by NEPA action CO-150-00-66DNA. 11/9/2000 competitive oil and gas sale. |
| COC-64170<br><br>Year: 2000 | T11S, R90W, 6th P.M., Gunnison County, Colorado<br><br>Section 22: Lots 1-3, NWSE<br><br>Section 23: Lots 1-7, | 11-90-24 #1 | Standard stipulations of the original lease authorization shall apply.<br><br>Lease parcel authorized by NEPA action CO-150-00-66DNA. 11/9/2000 competitive oil and gas sale: The entirety of parcel 590. |

**Table F-1**
**Summary of Lease Stipulations within BMMDP Area**

| Lease | Description of Lands | Federal Pad[1] | Lease Stipulations |
|---|---|---|---|
| | N2N2, S2NE, SENW, N2SE, SESE<br>Section 24: Lots 1-4, W2E2, W2 | | |
| COC-64170<br>Year: 2000 | T11S, R90W, 6th P.M., Gunnison County, Colorado<br>Section 23: Lots 1-7, N2NW, NWNE, S2NE, SENW, N2SE, SESE<br>Section 24: SW | 11-90-24 #2 WDW | In addition to application of standard stipulations of the original lease authorization, it was determined that portions of the lease area are also subject to UBRMP stipulation UB-04.<br>**TIMING LIMITATION STIPULATION**:<br>To protect crucial deer and elk winter ranges. No surface use is allowed during the following time period November 30 – May 1. This stipulation does not apply to operation and maintenance of production facilities.<br>Lease parcel authorized by NEPA action CO-150-00-66DNA. 11/9/2000 competitive oil and gas sale: The entirety of parcel 590. |
| COC-64171<br>Year: 2000 | T11S, R90W, 6th P.M., Gunnison County, Colorado<br>Section 27: Lots 1-2, W2NE<br>Section 34: E2<br>Section 35: ALL<br>Section 36: Lots 1-4, W2E2, W2 | 11-90-35 #1 | In addition to application of standard stipulations of the original lease authorization, it was determined that all lands of the lease are also subject to UBRMP stipulation UB-04.<br>**TIMING LIMITATION STIPULATION**:<br>To protect crucial deer and elk winter ranges. No surface use is allowed during the following time period November 30 – May 1. This stipulation does not apply to operation and maintenance of production facilities.<br>Lease parcel #591 authorized by NEPA action CO-150-00-66DNA. 11/9/2000 competitive oil and gas sale. |
| COC-64172<br>Year: 2000 | T11S, R90W, 6th P.M., Gunnison County, Colorado<br>Section 25: Lots 1-4, W2E2, W2<br>Section 26: Lots 1-5 | -- | In addition to application of standard stipulations of the original lease authorization, it was determined that all lands of the lease are also subject to UBRMP stipulation UB-04.<br>**TIMING LIMITATION STIPULATION**:<br>To protect crucial deer and elk winter ranges. No surface use is allowed during the following time period November 30 – May 1. This stipulation does not apply to operation and maintenance of production facilities.<br>Lease parcel #592 authorized by NEPA action CO-150-00-66DNA. 11/9/2000 competitive oil and gas sale. |

**Table F-1**
**Summary of Lease Stipulations within BMMDP Area**

| Lease | Description of Lands | Federal Pad[1] | Lease Stipulations |
|---|---|---|---|
| COC-66704<br>Year: 2003 | T12S, R89W, 6th P.M., Gunnison County, Colorado<br>Section 4: Lots 1-4, S2N2, S2<br>Section 5: Lot 4, SWNW, W2SW, SESW, S2SE<br>Section 6: Lots 1-7, S2NE, SENW, E2SW, SE<br>Section 7: Lots 1-4, E2, E2W2 | -- | In addition to application of standard stipulations of the original lease authorization, it was determined that all lands of the lease are also subject to CO lease notice exhibit CO-34.<br>**LEASE NOTICE:**<br>To alert lessee of potential habitat for threatened, endangered, candidate, or other special status plant or animal.<br>Lease parcel #1975 authorized by NEPA action CO-150-2003-0021DNA. 05/08/2003 competitive oil and gas sale. |
| COC-66704<br>Year: 2003 | T12S, R89W, 6th P.M., Gunnison County, Colorado<br>Section 6: Lots 1-7, S2NE, SENW, E2SW, SE<br>Section 7: Lots 1-4, E2, E2W2 | -- | In addition to application of standard stipulations of the original lease authorization, it was determined that portions of the lease are also subject to UBRMP stipulation UB-04.<br>**TIMING LIMITATION STIPULATION**:<br>To protect crucial deer and elk winter ranges. No surface use is allowed during the following time period December 1 - April 30. This stipulation does not apply to operation and maintenance of production facilities.<br>Lease parcel #1975 authorized by NEPA action CO-150-2003-0021DNA. 05/08/2003 competitive oil and gas sale. |
| COC-66705<br>Year: 2003 | T12S, R89W, 6th P.M., Gunnison County, Colorado<br>Section 8: N2, SW, N2SE, SWSE<br>Section 9: N2, NWSW, E2SE | -- | In addition to application of standard stipulations of the original lease authorization, it was determined that all lands of the lease are also subject to CO lease notice exhibit CO-34.<br>**LEASE NOTICE:**<br>To alert lessee of potential habitat for threatened, endangered, candidate, or other special status plant or animal.<br>Lease parcel #1976 authorized by NEPA action CO-150-2003-0021DNA. 05/08/2003 competitive oil and gas sale. |
| COC-66705<br>Year: 2003 | T12S, R89W, 6th P.M., Gunnison County, Colorado<br>Section 8: W2W2SW, W2SWNW | -- | In addition to application of standard stipulations of the original lease authorization, it was determined that portions of the lease are also subject to UBRMP stipulation UB-04.<br>**TIMING LIMITATION STIPULATION**:<br>To protect crucial deer and elk winter ranges. No surface use is allowed during the following time period |

**Table F-1**
**Summary of Lease Stipulations within BMMDP Area**

| Lease | Description of Lands | Federal Pad[1] | Lease Stipulations |
|---|---|---|---|
| | | | December 1 - April 30. This stipulation does not apply to operation and maintenance of production facilities.<br>Lease parcel #1976 authorized by NEPA action CO-150-2003-0021DNA. 05/08/2003 competitive oil and gas sale. |
| COC-66714<br>Year: 2003 | T11S, R90W, 6th P.M., Gunnison County, Colorado<br>Section 11: SWSW | -- | In addition to application of standard stipulations of the original lease authorization, it was determined that all lands of the lease are also subject to CO lease notice exhibit CO-34.<br>**LEASE NOTICE:**<br>To alert lessee of potential habitat for threatened, endangered, candidate, or other special status plant or animal.<br>Lease parcel #1917 authorized by NEPA action CO-150-2003-0021DNA. 05/08/2003 competitive oil and gas sale. |
| COC-66715<br>Year: 2003 | T12S, R90W, 6th P.M., Gunnison County, Colorado<br>Section 1: Lots 3-4, S2NW, SW<br>Section 2: Lots 1-9, SWNE, SENW, NESW, W2SE<br>Section 11: Lot 2, SENE, SWNW, SE<br>Section 12: ALL | -- | In addition to application of standard stipulations of the original lease authorization, it was determined that all lands of the lease are also subject to CO lease notice exhibit CO-34.<br>**LEASE NOTICE:**<br>To alert lessee of potential habitat for threatened, endangered, candidate, or other special status plant or animal.<br>Lease parcel #1984 authorized by NEPA action CO-150-2003-0021DNA. 05/08/2003 competitive oil and gas sale. |
| COC-66715<br>Year: 2003 | T12S, R90W, 6th P.M., Gunnison County, Colorado<br>Section 1: Lots 3-4, S2NW, SW<br>Section 2: Lots 1-5, Section 12: N2SE | -- | In addition to application of standard stipulations of the original lease authorization, it was determined that portions of the lease are also subject to UBRMP stipulation UB-04.<br>**TIMING LIMITATION STIPULATION**:<br>To protect crucial deer and elk winter ranges. No surface use is allowed during the following time period December 1 - April 30. This stipulation does not apply to operation and maintenance of production facilities.<br>Lease parcel #1984 authorized by NEPA action CO-150-2003-0021DNA. 05/08/2003 competitive oil and gas sale. |

**Table F-1**
**Summary of Lease Stipulations within BMMDP Area**

| Lease | Description of Lands | Federal Pad[1] | Lease Stipulations |
|---|---|---|---|
| COC-67145<br>Year: 2004 | T11S, R89W, 6th P.M., Gunnison County, Colorado<br>Section 19: Lot 12<br>Section 30: Lots 5-6 | -- | In addition to application of standard stipulations of the original lease authorization, it was determined that all lands of the lease are also subject to CO lease notice exhibit CO-34.<br>**LEASE NOTICE:**<br>To alert lessee of potential habitat for threatened, endangered, candidate, or other special status plant or animal.<br>Lease parcel #2098 authorized by NEPA action CO-150-2003-0045DNA. 11/13/2003 competitive oil and gas sale. |
| COC-67120X<br>Bull Mountain Unit Agreement<br>Year: 2003 | All Federal mineral estate mentioned above. | 11-89-17 #2<br>11-90-24 #1<br>11-90-24 #2 WDW<br>11-90-35 #1 | **Item 18. <u>Leases and Contracts Conformed and Extended</u>**<br>The terms, conditions, and provisions of all leases, subleases, and other contracts relating to exploration, drilling, development or operation for oil or gas on lands committed to this agreement are hereby expressly modified and amended to the extent necessary to make the same conform to the provisions hereof, but otherwise to remain in full force and effect… |

[1] Authorized development to date

# Appendix G

## Hazardous Materials Management Summary

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# APPENDIX G
# HAZARDOUS MATERIALS MANAGEMENT SUMMARY

The following types of hazardous and extremely hazardous materials may be expected to be used, stored, or transported within the project area. In accordance with 29 CFR 1910.1200 (g)(8) and/or (g)(9), Safety Data Sheets (SDS) for every chemical or hazardous material brought on-site will be kept on file at the operator's field office.

**Table G-1**
**Hazardous Materials that may be Used, Stored, and Transported within the Bull Mountain Unit**

| Material | Use |
|---|---|
| Calcium chloride | Drilling |
| Type III cement | Casing |
| Surfactant wash | Drilling |
| Mud Clean I | Drilling |
| Cement, Premium Lite HS | Casing |
| Cement, Premium Lite Plus | Casing |
| KCl water | Drilling |
| Poz (fly ash) | Drilling |
| CSE-2 | Drilling |
| Bentonite II | Drilling |
| Kol Seal | Drilling |
| Methanol | Operations |
| 1% KCl | Operations |
| CaCl | Workover |
| Packer fluid | Operations |
| Pegasus 805 | Operations |
| Rock Drill gear oil | Operations |
| EC106A biocide - Nalco | Operations |
| 04VD008 Scale corrosion inhibitor | Operations |
| 50/50 Antifreeze | Operations |

**Table G-1**
**Hazardous Materials that may be Used, Stored, and Transported within the Bull Mountain Unit**

| Material | Use |
|---|---|
| Diesel | Fuel for drilling rig and workover rig |
| Silica Flour | Drilling |
| Ultra Flush II | Drilling |
| NALCO Biocide ECT 35A corrosion inhibit | Operations |
| NALCO Biocide EC1071A corrosion inhibit | Operations |
| Gear oil | On rig during drilling/completion ops |
| Zetag Polymer | Drilling |
| DI-30 | Drilling |
| Fiber Plug | Drilling |
| Fiber Seal | Drilling |
| Walnut hulls, medium | Drilling |
| Walnut hulls, fine | Drilling |
| Sodium bicarbonate | Drilling |
| Soda Ash | Drilling |
| Sawdust | Drilling |
| SAPP | Drilling |
| Pronto Plug Fine | Drilling |
| NOV XAN D | Drilling |
| NOV Thin L | Drilling |
| NOV PLEX | Drilling |
| NOV PAC LV | Drilling |
| NOV Fiber Fine | Drilling |
| NOV Fiber Coarse | Drilling |
| NOV EFS #13 | Drilling |
| NOV Drill Liquid | Drilling |
| NOV Carb (M) | Drilling |
| NOV Biocide GA25-R | Drilling |
| Mica Fine | Drilling |
| Maxi-Thin | Drilling |
| Lime | Drilling |
| Lignite | Drilling |
| K+Formate | Drilling |
| Caustic soda | Drilling |
| Barite | Drilling |
| Aqua-Block | Drilling |
| LGC-36 Guar | Completion |
| 15% Hydrochloric Acid | Completion |
| HAI-81M, acid inhibitor (isopropanol, ethyl octynol, kerosene, propargyl alcohol, methanol) | Completion |
| LOSURF-300M, surfactant (ethanol, aromatic petroleum naphtha) | Completion |
| BC-140, crosslinker (borate, ethylene glycol) | Completion |
| BA-40L, buffer (sodium carbonate and potassium carbonate) | Completion |

**Table G-1**
**Hazardous Materials that may be Used, Stored, and Transported within the Bull Mountain Unit**

| Material | Use |
|---|---|
| SandWedge, conductivity enhancer (aromatic petroleum & isopropanol) | Completion |
| GBW-30, enzyme breaker (carbohydrates, hemicellulase enzyme) | Completion |
| BE-6 Biocide (2-bromo-2-nitro-1, 3-propanediol) | Completion |
| FR-66 friction reducer (hydrotreated light petroleum distillate) | Completion |
| Ferrotrol 300L, prevents precipitation of metal oxides (citric acid) | Completion |
| XLW-32, maintains fluid viscosity as temp increases (methanol) | Completion |
| GBW-15L, allows delayed breakdown of gel polymer chains (sodium chloride) | Completion |
| Alpha 125, eliminates bacteria (glutaraldehyde) | Completion |
| AI-2, acid corrosion inhibitor (ethylene glycol monobutylether, propargyl alcohol, isopropyl alcohol, proprietary component) | Completion |
| OB-Fe, gel breaker (propylene glycol, ferrous sulfate, heptahydrate) | Completion |
| Bioclear 200, biocide (2,2-dibromo-3-nitrilopropionamide, polyethylene glycol mixture) | Completion |
| SAS-2, gelling agent (hydrotreated light distallate, mineral spirits, propylene glycol, ethoxylated alcohols) | Completion |
| FE-1A, dissolves minerals, initiate fractures in rock (acetic acid, acetic anhydride) | Completion |
| FR-46, removes oxygen from the water to protect pipe from corrosion (ammonium bisulfate) | Completion |
| CL-31 crosslinker, (potassium metaborate and potassium hydroxide) | Completion |
| Vicon NF Breaker (chlorous acid, sodium salt and sodium chloride) | Completion |
| CL-37 crosslinker (triethanolamine zirconate, propanol, and glycerine) | Completion |
| BA-40L buffering agent (potassium carbonate) | Completion |
| Gel-Sta L stabilizer (sodium thiosulfate) | Completion |
| SP Breaker (sodium persulfate) | Completion |

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# Appendix H

## Water Quality Sampling Constituents for the Bull Mountain Unit

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# APPENDIX H
# WATER QUALITY SAMPLING CONSTITUENTS FOR THE BULL MOUNTAIN UNIT

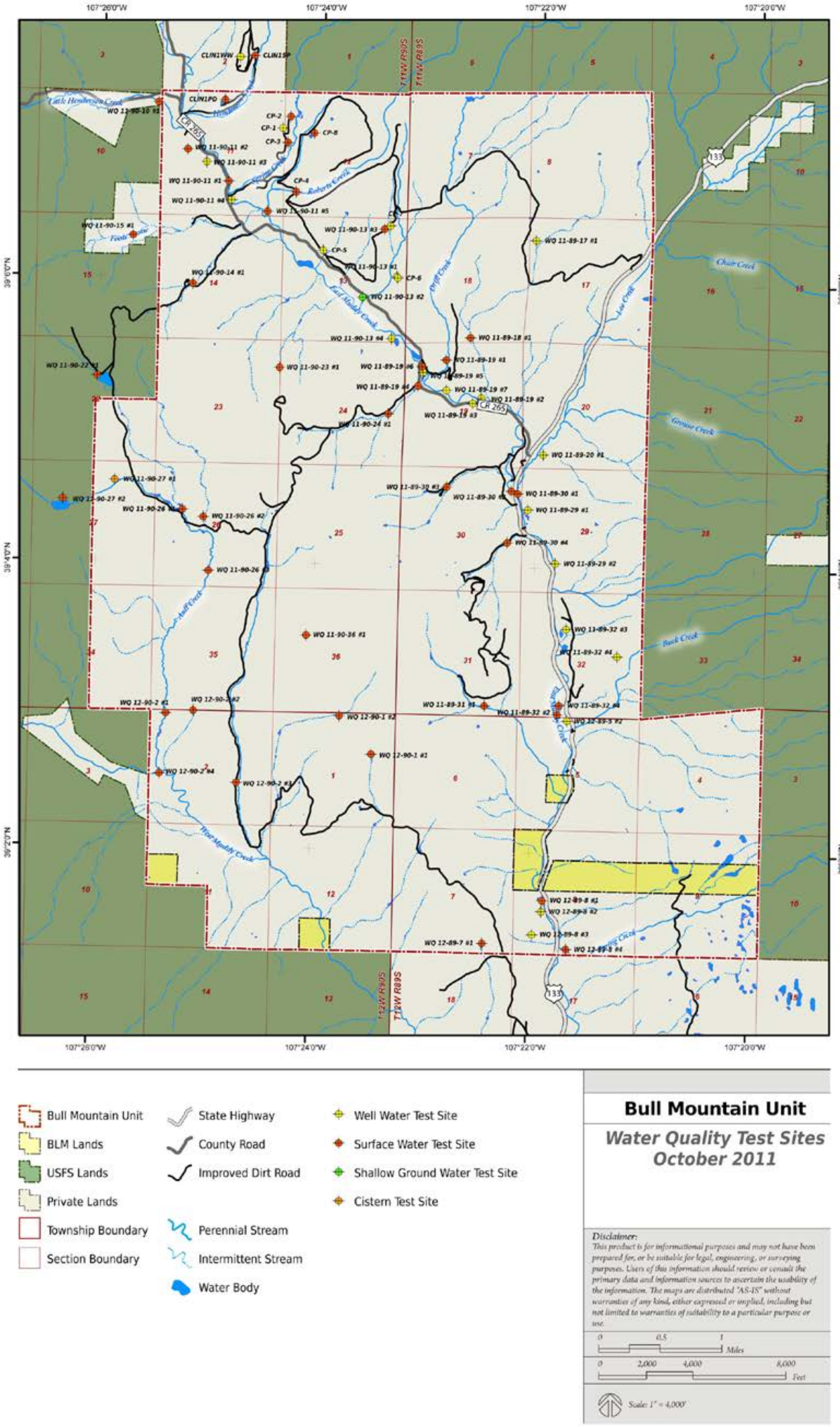
| **Constituents for Gunnison County Surface Water (Based on COGCC Rule 910 – Table 910-1)[1]** | |
|---|---|
| **Inorganic** | **Organic** |
| *Metals Analysis* | BTEX/Volatile Hydrocarbons |
| Arsenic | Benzene |
| Barium | Toluene |
| Calcium | Ethylbenzene |
| Chromium | m p Xylene |
| Iron | o Xylene |
| Magnesium | Total Xylenes |
| Selenium | TVH (Total Volatile Hydrocarbons) |
| Sodium | PAH-Polynuclear Aromatic Hydrocarbons |
| *Wet Chemistry* | 2-Methylnapthalene |
| Alkalinity as CaCO3 | Acenaphthene |
| Bicarbonate as CaCO3 | Acenaphthylene |
| Carbonate as CaCO3 | Anthracene |
| Hydroxide as CaCO3 | Benzo(a)anthracene |
| Total Alkalinity | Benzo(a)pyrene |
| Chloride | Benzo(b)fluoranthene |
| Conductivity @ 25C | Benzo(g,h,i)perylene |
| Fluoride | Benzo(k)fluoranthene |
| pH (Field) | Chrysene |
| Sulfate | Dibenzo(a,h)anthracene |
| | Fluoranthene |
| | Fluorene |
| | Indeno(1,2,3-cd)pyrene |
| | Naphthalene- |
| | Phenanthrene |
| | Pyrene |
| | TPH (Total Extractable Petroleum Hydrocarbons) |

| **Constituents for COGCC Rule 608.b.(2) Compliance Coalbed Methane Sampling for Water Wells** | |
|---|---|
| All major cations & anions | Specific conductance |
| Total Dissolved Solids | Field pH |
| Iron | Hydrogen sulfide (field test methodology) |
| Manganese | Presence of Bacteria (iron related, sulfate reducing, slime) |
| Selenium | Field observations (odor, water color, sediment, bubbles and effervescence) |
| Nitrates & Nitrites | Water well surveyed |
| Dissolved methane | Sodium adsorption ratio |
| Fecal coliform | |
| **Constituents for COGCC Rule 908.b.(9) Compliance for Flowback Pits** | |
| All major cations & anions | Nitrates & Nitrites |
| Total Dissolved Solids | BTEX |
| Iron | pH |
| Manganese | Specific conductance |
| Selenium | |

[1] Gunnison County does not provide the operator with what parameters of water quality needed to be reported.

The locations of the current (October 2011) water quality monitoring sites associated with the Bull Mountain Gap site are included on **Figure H-1**, Water Quality Test Sites.

## Figure H-1, Water Quality Test Sites



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# Appendix I

## Noxious Weed Management Plan

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# APPENDIX I
# NOXIOUS WEED MANAGEMENT PLAN

## I.1 INTRODUCTION

This Noxious Weed Management Plan (plan) identifies measures to be taken by SG Interests I, Ltd. (SGI) and its contractors (Contractor) to minimize the spread and establishment of noxious weeds and non-native invasive species.

Measures identified in this plan apply to work within the project area defined as well pads, pipeline rights-of-way, access roads, temporary use areas, and other areas used in association with the natural gas development within the Bull Mountain Unit and adjacent areas in Gunnison County.

### I.1.1 Purpose

SGI is committed to preventing the introduction of noxious weeds during construction and controlling the expansion of existing noxious weed populations over the life of the project. All noxious weeds as defined by Gunnison County and the state of Colorado (Colorado Weed Management Act CRS Title 35, Article 5.5 as amended) will be controlled. The purpose of this plan is to prescribe methods to treat existing weed infestations, prevent introduction and spread of infestations during construction, and monitor and treat infestations after construction is complete.

## I.2 NOXIOUS WEED MANAGEMENT

### I.2.1 Weed Identification

The following noxious weeds are listed noxious weeds in the state of Colorado or in the Gunnison Basin Weed District Management Plan. The goal for Colorado A Listed weeds is eradication. The goal for B Listed weeds is to stop their spread. C Listed weeds are those weeds that are managed by local jurisdictions within the state of Colorado.

**Table I-1**
**Listed Noxious Weeds**

| Weed Name | Scientific Name | Gunnison Co. Listed | Colorado List (A, B, or C) |
|---|---|---|---|
| Absinth wormwood | *Artemisia absinthium* | √ | B |
| African rue | *Peganum harmala* | | A |
| Black henbane | *Hyoscyamus niger* | √ | B |
| Bull thistle | *Cirsium vulgare* | | B |
| Burdock | *Arctium minus* | | C |
| Camelthorn | *Alhagi pseudalhagi* | | A |
| Canada thistle | *Cirsium arvense* | | B |
| Chicory | *Chichorium intybus* | | C |
| Common crupina | *Crupina vulgaris* | | A |
| Common St. Johnswort | *Hypericum perforatum* | | C |
| Cypress spurge | *Euphorbia cyparissias* | | A |
| Dalmation toadflax | *Linaria dalmatica* | √ | B |
| Dame's rocket | *Hesperis matronalis* | √ | B |
| Diffuse knapweed | *Centaurea diffusa* | √ | B |
| Dyer's Woad | *Isatis tinctoria* | | A |
| Field bindweed | *Convolvulus arvensis* | √ | C |
| Giant salvinia | *Salvinia molesta* | | C |
| Halogeton | *Halogeton glomeratus* | | C |
| Hoary cress | *Cardaria draba* | √ | B |
| Houndstongue | *Cynoglossum officinale* | | B |
| Hydrilla | *Hydrilla verticillata* | | A |
| Jointed goatgrass | *Aegilops cylindrica* | | B |
| Leafy spurge | *Euphorbia esula* | √ | B |
| Meadow knapweed | *Centaurea pratensis* | | A |
| Mediterranean sage | *Salvia aethopis* | | A |
| Medusahead | *Taeniatherum caputmedusae* | | A |
| Myrtle spurge | *Euphorbia myrsinites* | | A |
| Musk thistle | *Carduus nutans* | √ | B |
| Orange hawkweed | *Hieracium aurantiacum* | √ | |
| Oxeye Daisy | *Chrysanthemum leucanthemum* | √ | B |
| Plumeless thistle | *Carduus acanthoides* | √ | B |
| Poison hemlock | *Conium maculatum* | | C |
| Puncturevine | *Tribulus terrestris* | | C |
| Purple loosestrife | *Lythrum salicaria* | √ | A |
| Rush skeletonweed | *Chondrilla juncea* | | A |
| Russian knapweed | *Centaurea repens* | √ | B |
| Russian olive | *Elaeagnus angustifolia* | | B |
| Sericea lespedeza | *Lespedeza cuneata* | | A |
| Scotch thistle | *Onopordum acanthium* | √ | B |
| Spotted knapweed | *Centaurea maculosa* | √ | B |
| Squarrose knapweed | *Centaurea virgata* | | B |

**Table I-1**
**Listed Noxious Weeds**

| Weed Name | Scientific Name | Gunnison Co. Listed | Colorado List (A, B, or C) |
|---|---|---|---|
| Tamarisk | *Tamarix parviflora, T.ramosissima* | √ | B |
| Tansy ragwort | *Senecio jacobaea* | | A |
| Yellow starthistle | *Centaurea solstitialis* | | A |
| Yellow toadflax | *Linaria vulgaris* | √ | B |

### I.2.2 Preventative Measures

The following preventative measures will be implemented to prevent the spread of noxious weeds:

- If soil stockpiles are created in infested areas, these stockpiles will be kept as close as possible to the infested areas. No soil from infested areas will be moved until they are leveled and used. Soil from an infested area will not be used in any other area beside where it was collected.
- Vehicles and equipment will be required to arrive at the work site clean, power-washed, and free of soil and vegetative debris capable of transporting weed seeds or other propagules.
- Materials used for erosion control and reclamation (i.e. straw bales and seed mixes) will be obtained from sources that are weed-free. Seed mixes will also be weed free.
- Disturbed areas will be reseeded in accordance with the Surface Use Agreement and any applicable permit stipulations as soon as possible after construction activities have been completed.

### I.2.3 Weed Treatment Measures

Depending upon the species of weed and the time planned for construction, methods of weed pre-treatment may include:

- Mechanical—mowing, pulling by hand, or tillage could be used.
- Chemical—application of an approved herbicide by a licensed applicator. Herbicides will be selected based on recommendations by local weed control district or BLM/Forest Service and subject to fee-landowner approval. All herbicides will be applied in accordance with all applicable laws and regulations on BLM/Forest Service and fee-lands.
- Cultural – employing practices such as reseeding with non-invasive species that can outcompete noxious species. This type of treatment will be conducted in some fashion on all disturbed areas associated with the project.

Effective control measures vary for different weed species. For many species, a combination of measures should be employed to be most effective. The following table lists the known and potential weeds within the Bull Mountain Unit as well as the best control measures for each.

**Table I-2**
**Noxious Weeds and Appropriate Controls**

| Weed Name | Herbicide Used? | Herbicide Details | Mechanical Measures Used? | Type of Mechanical Control | Cultural Control Used? | Type of Cultural Control |
|---|---|---|---|---|---|---|
| Bull thistle | Yes (ex. Tordon) | Spray rosettes in early spring | Yes | Removal of rosettes and mowing of bolting plants | Yes | Seeding w/desirable species |
| Burdock | No | NA | Yes | Sever tap root | Yes | Seeding w/desirable species |
| Canada thistle | Yes | Mow then spray in late summer or fall | Yes | Mowing prior to spraying | Yes | Seeding w/desirable species |
| Chicory | Possibly | Contact county specialist | No | NA | Yes | Seeding w/desirable species |
| Common St. Johnswort | Yes(ex. Roundup Ultra) | Spray green plants, preflowering | No | NA | Yes | Seeding w/ desirable species |
| Dalmatian toadflax | Yes (ex. Tordon K) | Herbicide w/surfactant in early stages | Yes | Hand grubbing during summer | Yes | Seeding w/ desirable species |
| Diffuse knapweed | Yes | Spray at rosette stage | Yes | Hand pulling of rosettes and plants early in bolting stage | Yes | Seeding w/desirable species |
| Dyer's Woad | Yes | Spray rosettes in spring or fall | Yes | Hand pull bolting plants, bag any heads | Yes | Seeding w/desirable species |
| Field bindweed | Yes (ex. Roundup Ultra) | Spray green plants, early flowering stage | No | NA | Yes | Seeding w/desirable species |
| Halogeton | No | NA | No | NA | Yes | Seeding w/desirable species |
| Hoary cress | Yes | Spray pre or early bloom stage | No | NA | Yes | Seeding w/desirable species |
| Houndstongue | Yes | Spray prebud or rosette state | Yes | Hand pull after bolting stage, if flowers bag heads | Yes | Seeding w/desirable species |
| Jointed goatgrass | No | NA | Yes | Mow just after seed heads form | Yes | Seeding w/desirable species |
| Leafy spurge | Yes (ex. Tordon 22K) | Spray in spring pre flowering and in fall | No | NA | Yes | Seeding w/desirable species |
| Mediterranean sage | No | NA | Yes | Cut flowering plants and bag heads | Yes | Seeding w/desirable species |

**Table I-2**
**Noxious Weeds and Appropriate Controls**

| Weed Name | Herbicide Used? | Herbicide Details | Mechanical Measures Used? | Type of Mechanical Control | Cultural Control Used? | Type of Cultural Control |
|---|---|---|---|---|---|---|
| Musk thistle | Yes (ex. Tordon 22K) | Spray rosettes and early bolting stages | Yes | Hand pull, sever tap root, bag heads, mow large infestations at bolting or early flowering | Yes | Seeding w/ desirable species |
| Oxeye Daisy | Yes | Spray preflowering stage | No | NA | Yes | Seeding w/desirable species |
| Plumeless thistle | Yes (ex. Tordon 22K) | Spray rosette to early bolting stage | Yes | Sever tap root, bag heads, mow large infestations bolting to early flower stage | Yes | Seeding w/desirable species |
| Poison hemlock | Yes (ex. phenoxy herbicides or glyphosate) | Spray young plants | No | NA | Yes | Seeding w/desirable species |
| Puncturevine | Yes (ex. chlorsulfuron and 2, 4-D) | Chlorsulfuron preemergence and 2, 4-D , soon after emergence | Yes | Cut or hoe plants prior to seeding, bag any heads | Yes | Seeding w/desirable species |
| Purple loosestrife | Yes (2,4-D and glyphosate) | Spray in spring preflowering fall spraying w/removal of flower heads | Yes | Hand pull small plants, mow larger infestations | Yes | Seeding w/desirable species |
| Russian knapweed | Yes (ex. Curtail) | Spray in bud to bloom stage in summer and fall | No | NA | Yes | Seeding w/desirable species |
| Russian olive | Yes (ex. Garlon) | Spray cut stump or apply to basal bark | Yes | Cut trees down or cut basal bark (follow up with chemical treatment) | Yes | Seeding w/desirable species and plant willow cuttings, Carex plugs |
| Scotch thistle | Yes (ex. Milestone) | Spray rosettes using surfactant added spray | Yes | Dig rosettes, sever root | Yes | Seeding w/desirable species |
| Spotted knapweed | Yes (ex. Tordon 22K) | Spray rosettes | No | NA | Yes | Seeding w/desirable species |
| Tamarisk | Yes (ex. Garlon 4) | Paint stump w/herbicide, spray sprouts, use basal bark treatment for small diameter trees | Yes | Cut tree (follow up with chemical treatment) | Yes | Seeding w/desirable species, plant willow cuttings, Carex plugs |

**Table I-2**
**Noxious Weeds and Appropriate Controls**

| Weed Name | Herbicide Used? | Herbicide Details | Mechanical Measures Used? | Type of Mechanical Control | Cultural Control Used? | Type of Cultural Control |
|---|---|---|---|---|---|---|
| Yellow starthistle | Yes (ex. Tordon 22K) | Spray rosettes & early bolting stages | Yes | Hand pull small infestations | Yes | Seeding w/desirable species |
| Yellow toadflax | Possibly | Consult specialists | Possibly | Consult specialists | Yes | Seeding w/desirable species |

Best Management Practices for the Noxious Weeds of Mesa County recommendations with some herbicide recommendations from 2006 North Dakota Weed Control Guide (http://www.ag.ndsu.edu/weeds/w253/w253w.htm) and additional information from Weed Control Methods Handbook: Tools and Techniques for Use in Natural Areas, The Nature Conservancy.

If any soil stockpiles are maintained for longer than 90 days, these stockpiles will be treated for weeds.

## I.3 RESEEDING

### I.3.1 Seed Mix

The seed mix will be chosen by the landowner, stipulated in permit conditions of approval, or dictated by the surface management agency. Some possible seed sources are:

- Arkansas Valley Seed Solutions 877-957-3337; 4625 Colorado Blvd, Denver, CO 80216
- Pawnee Butte Seed Co. 970-356-7002; P.O. Box 1604, Greeley, CO 80632
- Sharp Bros, Seed Co. 800-421-4234 104 East 4th Street Road Greeley, Colorado 80631
- Southwest Seed, 13260 County Road 29, Dolores, CO 81323

### I.3.2 Planting Schedule

Areas slated for reclamation will be returned to near pre-construction grades and contours. Topsoil will then be replaced over the disturbed area from which it was stripped.

Final cleanup after work in waterbodies and wetlands (primarily associated with pipeline installation) will be concluded, seeding accomplished, and mulching or erosion control mats installed, prior to the end of the following time frames:

- Waterbodies—24 hours after initial in-stream disturbance
- Wetlands—within 10 days of backfilling in that wetland

There are exceptions to these time frames, as noted below:

- Seeding and installation of erosion control matting may be deferred until final cleanup (i.e., temporary bridge is removed and waterbody banks across the travel lane are restored to pre-construction conditions) if the streambanks and all disturbed slopes above the waterbody are stabilized with an application of mulch extending 25 feet up the slope.

- If reclamation and seeding is deferred more than 10 days after final grade restoration near waterbodies and wetlands, all disturbed slopes above waterbodies and wetlands will be temporarily stabilized by applying straw mulch for a minimum distance of 200 feet above the edge of the waterbody or wetland. Wetlands will not be seeded unless noxious weeds are present. Successful recolonization by wetland species is generally related to effective topsoil salvage methods and sources of seed and rhizomes in adjacent areas. Streambanks will be seeded immediately upon completion of final cleanup.

- Specific permit conditions may alter the wetland and waterbody timelines.

- Weather constraints may alter the time frames.

### I.3.3 Seeding Methods and Procedures

SGI's contractor will employ broadcast or drill seeding as site conditions allow. Seeding activities will be contingent upon weather and soil conditions. Seeding will not be permitted if there is more than 2 inches of snow on the ground unless approved by the surface landowner or surface management agency. On BLM/Forest Service lands and where approved by the fee-landowner, the contractor will randomly distribute any windrowed trees and shrubs or other remaining vegetation debris over the right-of-way (after seeding) by hand or appropriate equipment so as not to disturb the seedbed.

Drill seeding is the preferred seeding method and will be employed wherever soil characteristics and slope allow effective operation of a rangeland seed drill. Drill seeding will be performed perpendicular to the slope. Seed will be placed in direct contact with the soil at an average depth of 0.5-inches, covered with soil, and firmed to eliminate air pockets around the seeds. Seed will be applied using a rangeland seed drill with a seed release and agitation mechanism sufficient to allow seeds of various sizes and densities to be planted at the proper seeding depth.

Broadcast seeding will be employed only in areas where drill seeding is unsafe or physically impossible. Seed will be applied using manually operated cyclone-bucket spreaders, mechanical spreaders, or blowers. Seed will be uniformly broadcast over disturbed areas. Broadcast application rates will be twice that of drill rates. Seed will be applied so that uniform coverage of 20 seeds per square foot is obtained. Immediately after broadcasting, the seed will be uniformly raked, chained, dragged, or cultipacked to incorporate seed to a sufficient seeding depth. If the area is seeded prior to a soil crust forming, harrowing or raking may not be necessary.

### I.3.4 Evaluating Reclamation Success

SGI will conduct intensive monitoring after the first growing season in accordance with Colorado Discharge Permit System (CDPS) requirements. Monitoring will occur routinely thereafter to assess soil stability and revegetation success (as required by CDPS permit).

## I.4 MONITORING

SGI will continue to monitor the distribution and density of noxious weeds for the life of the project. Surveys will be conducted concurrently with reclamation monitoring and will occur as early in the year as feasible to identify and control noxious weeds before they produce seed. Monitoring data collected will include the noxious weed species, location, and extent of infestation. At locations where new populations have been identified or pre-existing populations have expanded, SGI will take action to eradicate the population or control their spread. The selection of control methods will be based on the available technology and information of the weed species.

# Appendix J

## Draft Air Quality Technical Support Document for the Bull Mountain Unit MDP EIS

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# AIR QUALITY TECHNICAL SUPPORT DOCUMENT FOR THE BULL MOUNTAIN UNIT MASTER DEVELOPMENT PLAN ENVIRONMENTAL IMPACT STATEMENT

Prepared for

**U.S. Department of the Interior**
**Bureau of Land Management**
**Uncompahgre Field Office**
**Montrose, Colorado**

By

**Carter Lake Consulting**
**Laramie, Wyoming**

**January 2015**

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# CHAPTER 1
# INTRODUCTION

This air quality analysis addresses the impacts on ambient air quality and Air Quality Related Values (AQRVs) from the Bull Mountain Unit Master Development Plan (MDP) Project potential air emissions due to development and production activities within the Bull Mountain Unit (the Unit; **Figure 1-1**). Potential ambient air quality impacts are quantified and compared to applicable state and Federal standards, and AQRV impacts (impacts on visibility, atmospheric deposition, and potential increases in acidification to acid-sensitive lakes) are quantified and compared to applicable thresholds as defined in the Federal Land Managers' (FLMs') Air Quality Related Values Work Group (FLAG) guidance document (FLAG 2010), and other state and Federal agency guidance.

The methods used in the Bull Mountain air impact analysis were documented in an initial Air Quality Impact Assessment Modeling Protocol (Appendix A) that was developed prior to performing the air impact assessment. The Protocol was provided to the Bureau of Land Management (BLM), and members of the air quality interagency review team (IART) including the Environmental Protection Agency (EPA), U.S. Forest Service, Colorado Department of Public Health and Environment – Air Pollution Control Division (CDPHE-APCD) for review and comment prior to performing the analysis. Comments were received from the IART on the initial protocol and the BLM provided comment responses to the IART. The air quality modeling analysis summarized herein considers the comments provided by the IART and details the BLM's approach, computational methods, and input data that were used for analyzing air quality and AQRV impacts from project sources.

The analysis utilized the U.S. Environmental Protection Agency's (EPA's) Guideline model AERMOD to estimate potential pollutant impacts from proposed project sources within and nearby the Unit. The EPA Guideline model CALPUFF was used to estimate potential air quality and AQRV impacts (impacts on visibility [regional haze], atmospheric deposition, and potential increases in acidification to acid sensitive lakes) at Prevention of Significant Deterioration (PSD) Class I and sensitive Class II areas of concern that are within 200 kilometers of the Unit.

The analysis procedures for assessing project impacts to potential ozone formation and cumulative (project source emissions and regional source emissions) air quality and AQRV impacts are not described in this technical support document. As part of the adaptive management strategy for managing air resources within the BLM Grand Junction Field Office (GJFO) and Uncompahgre Field Office (UFO) planning areas, the BLM is conducting a regional air modeling study to evaluate potential impacts on air quality from future mineral development in Colorado. The modeling study, entitled the Colorado Air Resources Management Modeling Study (CARMMS), will assess predicted impacts on air quality from projected increases in oil and gas development for each BLM Colorado Field Office. The CARMMS will include potential impacts using projections of oil and gas development up to a maximum of ten years in the future to reflect realistic estimations of development projections and technology improvements. The CARMMS results will include the predicted impacts from projected BLM oil and gas authorizations within the Grand Junction and Uncompahgre Field Offices as well as cumulative impacts from all projected oil and gas development within the region. Emissions from the Bull Mountain Unit project sources are included in this study. The future CARRMS oil and gas development scenario for the UFO planning area accounts for 232 additional federal oil and gas wells that represent the Bull Mountain Unit and the nearby U.S. Department of Agriculture Forest Service (Forest Service) Petrox project. The CARMMS study will analyze criteria pollutant impacts including ozone and AQRV impacts, and the results will be used for addressing ozone and cumulative air quality and AQRV impacts for this project.

## 1.1 PROJECT DESCRIPTION

SG Interests (SGI) is proposing a Master Development Plan (MDP) for natural gas exploration and development of up to 146 natural gas wells (approximately 50 percent shale gas and 50 percent coalbed methane natural gas), up to 4 water disposal wells, and associated infrastructure on federal and private mineral leases within a federally unitized area known as the Bull Mountain Unit. The Bull Mountain Unit includes approximately 19,670 acres of federal and private subsurface mineral estate located about 30 miles northeast of the Town of Paonia and bisected by State Highway 133 (see **Figure 1-1**). The land in the planning area consists of rolling topography in a mountainous region with an approximate elevation of 7,400 feet.

The Bull Mountain Unit is located in Gunnison County, Colorado and encompasses approximately 19,670 acres of both federal and private subsurface mineral estate. The Unit consists of:

- 440 surface acres of federal surface underlain by federal mineral estate and administered by BLM;
- 12,900 acres of split-estate lands consisting of private surface and federal minerals also administered by BLM; and
- 6,330 acres of private surface and private minerals regulated by the Colorado Oil and Gas Conservation Commission.

### 1.1.1 Existing Development

There are currently 18 well pads with 17 producing gas wells, 1 water disposal well, 4 flowback pits, and 1 storage area in the Bull Mountain Unit. The Unit also has 16 miles of access roads, 11 miles of pipelines (2 miles co-located with roads) and overhead power lines (to the water disposal well). Four of the existing well pads, five gas wells and the water well are on federal mineral estate lands and the rest of the well pads and gas wells are on fee lands.

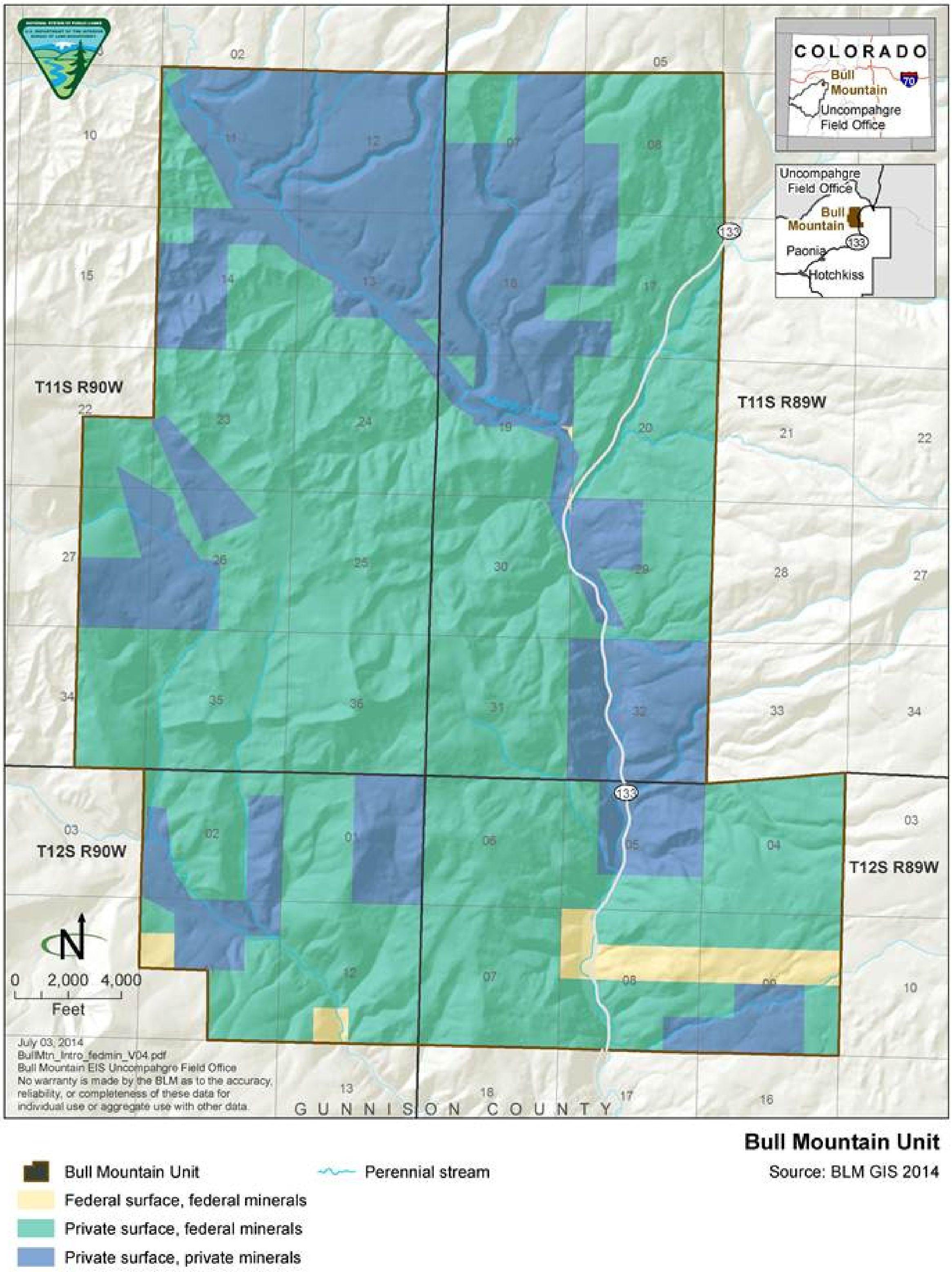


**Figure 1-1: Bull Mountain Unit**

### 1.1.2 Alternative A (No Action)

The No Action Alternative assumes that previously authorized activities and activities on state lands/state mineral estate or fee lands/fee mineral estate would continue, but that no new development on federal lands would occur under the Master Development Plan. Previously authorized activities include continuation of existing federal authorizations on 18 existing well pads, continued operation of existing fee wells targeting fee minerals, and development of 12 new well pads and 55 new wells on fee surface targeting fee minerals lines. In addition, 12 new wells would be drilled on existing well pads. There would be no new water disposal wells drilled and no need for additional electrical line construction. It is assumed that drilling activities would occur for approximately 3 years. The quantity and combination of CBNG and shale gas wells on each pad is not known at this time.

An estimated 3 miles of new access roads, 2 miles of upgrades to existing access roads, and 11 miles of pipelines could potentially be constructed. Additional compression needed for the 55 wells would be approximately 637 hp at 1 compression station.

### 1.1.3 Alternative B (Proposed Action)

The Proposed Action Alternative entails constructing, drilling, completing, and producing up to 146 new natural gas wells and 4 new water disposal wells in the Unit, along with the construction of access roads, pipelines, compressor stations, and power lines. The Proposed Action includes both the previously authorized activities and activities on state lands/state mineral estate or fee lands/fee mineral estate described above in the No Action Alternative and the proposed new development on federal lands.

Under the Proposed Action Alternative it is assumed that drilling activities would occur for approximately 6 years. The quantity and combination of CBNG and shale gas wells on each pad is not known at this time. The number of wells per well pad would vary depending on the required downhole well density and how many directional wells can be drilled from the location, whether or not both shallow and deep horizons are being developed, and topographic considerations. Some well pad locations would therefore host as few as 1 well whereas others may have up to 12 wells drilled from a single well pad.

Compression in the field may be necessary as wells come online. It is estimated that up to 4 new compressor stations, 637 horsepower (hp) each, may be required (2,548 hp total). SGI is proposing to use natural gas-fired internal combustion engines to power the compressors.

The Proposed Action would result in SGI constructing up to 36 new well pads, and require the construction and improvement of up to 25 miles of access road on federal, state, and private surface. Initial surface disturbance resulting from the construction or improvement of access roads would be up to 97 acres, which includes 20 acres for co-located access roads and proposed pipelines, and 77 acres for proposed access roads alone. Under the Proposed Action 11 miles of new cross-country pipelines would be constructed with an initial disturbance of approximately 62 acres. All of the pipeline construction corridors would be fully reclaimed resulting in zero acres of long-term surface disturbance. SGI also proposes to construct four new overhead electrical lines to supply power to the water disposal wellheads.

## 1.2 Outline of the Air Quality Technical Support Document

The air quality analysis assesses potential impacts on ambient air quality and AQRVs from air pollutant emissions that could result from construction, drilling, and production operations of the Bull Mountain project alternatives. The Bull Mountain Unit Alternative A (No Action) and Alternative B (Proposed Action) alternatives were analyzed. These alternatives represent the proposed minimum and maximum levels of development that could occur within the Bull Mountain Unit. Analyses were also performed that included emissions from the existing sources in the Bull Mountain Unit.

In Section 2 of this document, the emission inventories used in the Bull Mountain Project impact analysis are described. An overview of the methods and data used in developing the emissions inventories is provided. A detailed description of the emissions calculation for each emissions source category is given in Appendix B.

Section 3 of this document describes the AERMOD near-field modeling, including the project sources, meteorological and other data used as inputs in the modeling. Impacts on near-field levels of criteria pollutants and hazardous air pollutants are described, and cancer risks are assessed.

Section 4 describes the methods and the results of the CALPUFF far-field modeling. Methods and results are shown for impacts on criteria pollutants, visibility, atmospheric deposition and effects of deposition on sensitive lakes.

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# CHAPTER 2
# PROJECT EMISSIONS

Project emissions inventories have been compiled for well development activities, production activities, and ancillary facilities planned as part of the No Action and Proposed Action Alternatives and for the existing production activities in the Bull Mountain Unit. Pollutants inventoried include total nitrogen oxides ($NO_x$), sulfur dioxide ($SO_2$), carbon monoxide (CO), carbon dioxide ($CO_2$), particulate matter less than or equal to 10 microns in size ($PM_{10}$), particulate matter less than or equal to 2.5 microns in size ($PM_{2.5}$), volatile organic compounds (VOC), methane ($CH_4$), and hazardous air pollutants (HAPs), including benzene, toluene, ethyl benzene, xylene, n-hexane and formaldehyde. Lead emissions are negligible and have not been calculated in the inventory. Methane ($CH_4$), nitrous oxide ($N_2O$) and carbon dioxide ($CO_2$) emissions are also included in the project inventory for the purposes of quantifying greenhouse gas (GHG) emissions. $CO_2$ equivalents for all three GHGs were reported over the life of the project. The emissions inventory was developed using field-specific equipment specifications and data, field natural gas composition data, AP-42 (EPA 1995), EPA emissions standards, and other accepted engineering methods.

There are two separate activities (field development and production) associated with the Project Alternatives for which emission inventories were compiled. The specific components of field development and production emissions and total field-wide emissions are discussed in the following subsections.

## 2.1 FIELD DEVELOPMENT EMISSIONS

Emissions-generating activities during field development include: well pad and access road construction; drilling; completion; fracturing; gathering and sales pipeline construction, and vehicle travel during all of these activities. Emission calculations for these and other potential emission generating activities used operator-supplied actual data whenever possible, depending upon availability.

## 2.2 PRODUCTION EMISSIONS

Combustion equipment associated with production includes tank heaters, separator heater-treaters, well-site pumping units, water transfer pumps, all natural-gas fired, vehicle travel, and diesel engines used in periodic well workovers. Four new central production facilities will include natural gas-fired compressor engines and separators equipped with natural gas-fired heaters. Combustion emissions of $NO_x$, CO, $PM_{10}$/$PM_{2.5,}$ VOC and HAPs will result these sources. In addition, fugitive VOC emissions will result from process leaks.

## 2.3 MAXIMUM PROJECT EMISSIONS

Field-wide project emissions inventories were for the existing project sources and for the No Action and Proposed Action alternatives. For the No Action Alternative, ten project years were examined representing three years of field development and phased-in production followed by seven years of full-field production. For the Proposed Action Alternative, ten project years were examined which reflected six years of development and phased-in production followed by four years of full-field production. The maximum potential field-wide emissions are expected to occur in project year 2 for the No Action Alternative and in project year 5 for the Proposed Action Alternative, years which include both project development and production activities. In addition, maximum field-wide emissions from existing Bull Mountain Unit production activities were developed. Maximum annual field-wide project emissions of $NO_x$, CO, $SO_2$, $PM_{10}$, $PM_{2.5}$, VOC and HAPs for the existing production activities, the No Action Alternative, and the Proposed Action Project Alternative are shown in **Tables 2-1**, **2-2**, and **2-3**, respectively. The VOC and HAP emissions shown in **Table 2-3** for the Proposed Action Alternative represent year 5 emissions levels; however Project year 6 is expected to have slightly higher VOC and HAP emissions of 82.95 tons per year (tpy) and 20.59 tpy, respectively. Detailed emissions inventories are provided in Appendix B.

For the far-field modeling analysis these maximum year, field-wide project emissions of $NO_x$, $SO_2$, $PM_{10}$, and $PM_{2.5}$ were modeled to assess impacts to air quality and AQRVs (atmospheric deposition and visibility) at Class I and sensitive Class II areas that are within 200 kilometers of the Unit. As part of the far-field assessment, emissions from existing production sources are included in analyses for both the No Action and Proposed Action Alternatives.

Maximum potential $NO_2$, CO, $SO_2$, $PM_{10}$, $PM_{2.5}$ and HAP impacts that could occur within and near the Unit were assessed in the near-field analysis and are described below in Section 3.0.

**Table 2-1**
**Existing Emissions by Activity (tons per year)**

| Activity | $NO_x$ | CO | $SO_2$ | VOC | HAPs | $PM_{10}$ | $PM_{2.5}$ |
|---|---|---|---|---|---|---|---|
| **BLM Lands and Mineral Estate** | | | | | | | |
| Workover Rigs | 0.63 | 0.36 | 0.002 | 0.04 | 0.001 | 0.02 | 0.02 |
| Production Traffic | 0.09 | 0.53 | 0.0005 | 0.04 | -- | 3.05 | 0.31 |
| Separator Heaters | 0.46 | 0.23 | -- | 0.14 | 0.02 | 0.03 | 0.03 |
| Tank Heaters | 0.64 | 0.32 | -- | 0.20 | 0.03 | 0.05 | 0.05 |
| Fugitives | -- | -- | -- | 5.34 | 1.27 | -- | -- |
| Water Transfer Pumps | 27.00 | 5.57 | -- | 1.89 | 0.20 | 0.76 | 0.76 |
| Pumping Units | 13.50 | 2.78 | -- | 0.95 | 0.10 | 0.38 | 0.38 |
| **Total Emissions** | **42.32** | **9.79** | **0.002** | **8.61** | **1.63** | **4.30** | **1.55** |

**Table 2-2**
**No Action Year 2 Emissions by Activity (tons per year)**

| Activity | $NO_x$ | CO | $SO_2$ | VOC | HAPs | $PM_{10}$ | $PM_{2.5}$ |
|---|---|---|---|---|---|---|---|
| **Construction Emissions** | | | | | | | |
| Well Pad and Road Construction - Fugitive | -- | -- | -- | -- | -- | 1.67 | 0.17 |
| Well Pad and Road Construction – Traffic | 0.47 | 0.45 | 0.002 | 0.05 | -- | 2.78 | 0.30 |
| Well Pad and Road Construction – Heavy | 2.37 | 2.20 | 0.11 | 0.17 | -- | 0.13 | 0.13 |
| Pipeline Construction - Fugitive Dust | -- | -- | -- | -- | -- | 0.94 | 0.09 |
| Pipeline Construction – Traffic | 0.09 | 0.15 | 0.0004 | 0.01 | -- | 0.85 | 0.09 |
| Pipeline Construction – Heavy Equipment | 1.79 | 1.03 | 0.05 | 0.16 | -- | 0.06 | 0.06 |
| Drill Rig Engines | 34.71 | 20.06 | 0.11 | 2.31 | 0.03 | 1.16 | 1.16 |
| Drilling Traffic | 2.62 | 2.59 | 0.02 | 0.53 | -- | 15.25 | 15.25 |
| Completion Engines – Fracturing | 9.43 | 5.45 | 0.11 | 0.63 | 0.01 | 0.31 | 0.31 |
| Completion Engines – Mobile Rigs | 2.68 | 1.55 | 0.003 | 0.18 | 0.003 | 0.09 | 0.09 |
| Completion Traffic | 0.13 | 0.10 | 0.001 | 0.01 | -- | 0.62 | 0.07 |
| Completion Flaring | 0.91 | 4.97 | -- | 0.37 | 0.09 | 0.10 | 0.10 |
| **Total Construction Emissions** | **55.19** | **38.55** | **0.40** | **4.43** | **0.14** | **23.96** | **17.82** |
| **Production Emissions** | | | | | | | |
| Workover Rigs | 1.72 | 0.99 | 0.002 | 0.11 | 0.002 | 0.06 | 0.06 |
| Production Traffic | 0.09 | 0.17 | 0.0004 | 0.02 | -- | 1.36 | 0.14 |
| Separator Heaters | 1.45 | 0.72 | -- | 0.46 | 0.06 | 0.11 | 0.11 |
| Tank Heaters | 1.93 | 0.97 | -- | 0.61 | 0.09 | 0.15 | 0.15 |
| Fugitives | -- | -- | -- | 20.58 | 4.87 | -- | -- |
| Compressors | 6.15 | 13.16 | -- | 2.52 | 1.44 | 0.26 | 0.26 |
| Compressor Station Separator Heaters | 0.05 | 0.03 | -- | 0.02 | 0.002 | 0.004 | 0.004 |
| Water Transfer Pumps | 18.00 | 3.71 | -- | 1.26 | 0.13 | 0.51 | 0.51 |
| Pumping Units | 41.24 | 8.50 | -- | 2.89 | 0.31 | 1.16 | 1.16 |
| **Total Production Emissions** | **70.64** | **28.26** | **0.002** | **29.47** | **6.91** | **3.61** | **2.39** |
| **Total Emissions** | **125.83** | **66.80** | **0.40** | **32.90** | **7.05** | **27.57** | **20.21** |

**Table 2-3**
**Proposed Action Year 5 Emissions by Activity (tons per year)**

| Activity | $NO_x$ | CO | $SO_2$ | VOC | HAPs | $PM_{10}$ | $PM_{2.5}$ |
|---|---|---|---|---|---|---|---|
| **Construction Emissions** | | | | | | | |
| Well Pad and Road Construction - Fugitive | -- | -- | -- | -- | -- | 1.67 | 0.17 |
| Well Pad and Road Construction – Traffic | 0.47 | 0.45 | 0.002 | 0.05 | -- | 2.78 | 0.30 |
| Well Pad and Road Construction – Heavy | 2.37 | 2.20 | 0.11 | 0.17 | -- | 0.13 | 0.13 |
| Pipeline Construction - Fugitive Dust | -- | -- | -- | -- | -- | 0.94 | 0.09 |
| Pipeline Construction – Traffic | 0.09 | 0.15 | 0.0004 | 0.01 | -- | 0.85 | 0.09 |
| Pipeline Construction – Heavy Equipment | 1.79 | 1.03 | 0.05 | 0.16 | -- | 0.06 | 0.06 |
| Drill Rig Engines | 34.71 | 20.06 | 0.11 | 2.31 | 0.03 | 1.16 | 1.16 |
| Drilling Traffic | 2.62 | 2.59 | 0.02 | 0.53 | -- | 15.25 | 15.25 |
| Completion Engines – Fracturing | 9.43 | 5.45 | 0.11 | 0.63 | 0.01 | 0.31 | 0.31 |
| Completion Engines – Mobile Rigs | 2.68 | 1.55 | 0.003 | 0.18 | 0.003 | 0.09 | 0.09 |
| Completion Traffic | 0.13 | 0.10 | 0.001 | 0.01 | -- | 0.62 | 0.07 |
| Completion Flaring | 0.91 | 4.97 | -- | 0.37 | 0.09 | 0.10 | 0.10 |
| **Total Construction Emissions** | **55.19** | **38.55** | **0.40** | **4.43** | **0.14** | **23.96** | **17.82** |
| **Production Emissions** | | | | | | | |
| Workover Rigs | 4.33 | 2.50 | 0.005 | 0.29 | 0.004 | 0.14 | 0.14 |
| Production Traffic | 0.23 | 0.46 | 0.001 | 0.04 | -- | 3.65 | 0.37 |
| Separator Heaters | 3.64 | 1.82 | -- | 1.15 | 0.16 | 0.28 | 0.28 |
| Tank Heaters | 4.86 | 2.43 | -- | 1.54 | 0.22 | 0.37 | 0.37 |
| Fugitives | -- | -- | -- | 51.73 | 12.25 | -- | -- |
| Compressors | 24.60 | 52.65 | -- | 10.09 | 5.77 | 0.98 | 0.98 |
| Compressor Station Separator Heaters | 0.21 | 0.11 | -- | 0.07 | 0.01 | 0.02 | 0.02 |
| Water Transfer Pumps | 50.22 | 10.35 | -- | 3.52 | 0.38 | 1.42 | 1.42 |
| Pumping Units | 101.84 | 20.99 | -- | 7.14 | 0.76 | 2.87 | 2.87 |
| **Total Production Emissions** | **189.94** | **91.32** | **0.01** | **75.57** | **19.65** | **9.72** | **6.44** |
| **Total Emissions** | **245.13** | **129.87** | **0.40** | **79.99** | **19.69** | **33.68** | **24.26** |

# CHAPTER 3
# NEAR-FIELD ANALYSIS

## 3.1 MODELING METHODOLOGY

A near-field ambient air quality impact assessment was performed to quantify maximum pollutant impacts within and nearby the Unit resulting from project-related development and production emissions. Air quality impacts due to criteria pollutant emissions of $PM_{10}$, $PM_{2.5}$, $NO_x$, $SO_2$, and CO, and emissions of hazardous air pollutants (HAPs) (benzene, toluene, ethyl benzene, xylene, n-hexane, and formaldehyde) were evaluated as part of the near-field study. These impacts would result from emissions associated with Project development and production activities, and are compared to applicable ambient air quality standards and significance thresholds. All modeling analyses were performed in general accordance with the Bull Mountain Air Quality Impact Assessment Modeling Protocol (Appendix A) with input from the BLM and members of the air quality interagency review team (IART), including the EPA, U.S. Forest Service, and CDPHE-APCD.

The EPA's Guideline (EPA 2005) model, AERMOD (version 13350), was used to assess near-field impacts of criteria pollutants $PM_{10}$, $PM_{2.5}$, $SO_2$, $NO_2$ and CO, and to estimate short-term and long-term HAP impacts. Regulatory model settings were used with the exception of the non-regulatory Ozone Limiting Method (OLM) model option, which was used for modeling $NO_2$ concentration estimates. Modeling analyses for $NO_2$ concentration estimates also utilized seasonal diurnal ozone concentration profiles developed using the years 2011-2013 data collected at the Clean Air Status and Trends Network (CASTNET) Gothic ozone site located in Gunnison County, Colorado. Two meteorology data sets, for year 2008, at two locations within the Unit were used with the AERMOD dispersion model to estimate these pollutant impacts. Impacts reported herein represent the maximum modeled impacts from either of the two meteorological data sets.

Modeling analyses were performed to quantify near-field pollutant concentrations within and nearby the Unit from project-related emissions sources for a various scenarios to assure that the maximum near-field impacts were estimated. Impacts from scenarios including the construction of a well pad, well drilling activities, well production facilities and proposed compression were modeled. For sources where buildings and structures could potentially influence dispersion, the

Building Profile Input Program (BPIP) (version 04112) was used to determine appropriate direction-specific building dimension downwash parameters for each affected source.

A discussion of the meteorological data used for the near-field analysis and the ambient background data which was combined with modeled concentrations impacts is provided in the following sections. The criteria pollutant impact assessment is provided in Section 3.4 and the HAPs analysis is presented in Section 3.5.

## 3.2 METEOROLOGICAL DATA

Due to the absence of any available representative monitored meteorology data for the Unit, the 2008 Weather Research and Forecasting (WRF) meteorological model output produced as part of the Western Regional Air Partnership's (WRAP) West-wide Jump Start Air Quality Modeling Study (WestJumpAQMS) (ENVIRON et al. 2012) was used to generate meteorological datasets (surface and profile files) for the AERMOD modeling.

The WRF model was run by WRAP for an extensive 4-kilometer domain that focuses on the Intermountain West including the Project location and surrounding areas. As part of the WestJumpAQMS study, a model performance evaluation (MPE) was performed for all meteorological parameters important to air quality simulations including winds, temperature and atmospheric mixing. It was shown in the MPE report that all parameters fell within or close to the standard performance benchmarks and all parameters fell within the complex terrain performance benchmarks that are more appropriate for the Western U.S.

In Appendix C the WRF MPE plots (for wind direction, wind speed, and temperature) are provided for three meteorological data sites included in the WestJumpAQMS study that are closest to the Unit; Grand Junction airport, Montrose airport, and Rifle airport. As expected, when the evaluation considers individual sites rather than the average of multiple sites over a larger area, the model performance tends to degrade. It is also important to note that MPEs are not intended as a pass/fail test; rather they are used to inform and qualify the results air quality impacts. It is likely that the difference between WRF and the observed data is due to several factors including the resolution of land cover and terrain in WRF as well as WRF configurations that were not tailored for this specific area. In addition, the airport meteorology data are collected using Automated Surface Observing Systems (ASOS), which use equipment and techniques to monitor meteorology data that limit the overall quality of the data for use in modeling analyses. For example the anemometer threshold for ASOS equipment is 2 knots (2.3 miles per hour) meaning that low wind speed conditions are not captured in these data, which could explain the WRF model low wind speed bias in the MPEs for the 3 airport sites shown in Appendix C.

In addition, as part of the meteorology data selection process for the Bull Mountain analysis, meteorology data collected at other sites, Parachute and Greasewood sites which are located approximately 70 kilometers and 105 kilometers northwest of the Unit, were reviewed for site representativeness. This review was documented in a Memorandum "Bull Mountain Project – Comparison of 2008 WRF Model Meteorological Data at Sites within the Unit and Nearby Meteorological Station Data" (Carter Lake Consulting 2014), which is provided in Appendix C.

Overall, after full consideration of the options available for representative meteorological data for the Unit, the WRF data were selected for use.

**Figure 3-1** shows the area surrounding the Unit and the center points to each WRF model 4-kilometer grid cell are indicated.

To generate appropriate meteorology for input into AERMOD, the Mesoscale Model Interface Program (MMIF) was used in conjunction with 2008 WRF model output. MMIF converts WRF model meteorological output fields to the parameters and formats required for direct input into dispersion models (ENVIRON 2013) such as AERMOD. MMIF Version 3.0 was used to produce AERMOD ready meteorology files (surface and profile files) by extracting appropriate information from the 2008 WestJumpAQMS WRF dataset. The grid cells used as the extraction point for the Bull Mountain Project meteorology data are indicated in **Figure 3-1**. There are 2 WRF model (4-kilometer) grid cells within the Unit, a north site and a south site. Wind roses for the 2008 data for the north and south locations are provided in **Figures 3-2** and **3-3**. The predominant wind directions for both sites seem to be consistent with the local terrain in the area and are expected to provide a representative assessment of source impacts.

MMIF was used to extract the WRF meteorology data for these two sites and both these meteorological data sets were used to assess impacts from project alternative emissions.

### 3.3 BACKGROUND DATA

Background pollutant concentrations are used as an indicator of existing conditions in the region, and are assumed to include emissions from industrial emission sources in operation and from mobile, urban, biogenic, other non-industrial emission sources, and transport into the region. These background concentrations are added to modeled near-field Project impacts to calculate total ambient air quality impacts. **Table 3-1** presents the background values used in this analysis. These data were collected at monitoring sites in western Colorado, and are considered appropriate background sites for the Bull Mountain Unit Project as determined by the Colorado Department of Public Health and Environment – Air Pollution Control Division (CDPHE-APCD) (CDPHE 2013). Since the background concentrations provided by CDPHE were measured at sites that are not affected by the same air mass impacting the Unit, the background concentrations provided by CDPHE are intended to represent that expected conditions of a rural area in western Colorado that is impacted by distant man-made sources.

**Table 3-1**
**Near-Field Analysis Background Ambient Air Quality Concentrations**

| Pollutant | Averaging Period | Measured Background Concentration (µg/m3) |
|---|---|---|
| Carbon monoxide (CO)[1] | 1-hour | 1150 |
| | 8-hour | 1150 |
| Nitrogen dioxide ($NO_2$)[1] | 1-hour | 21 |
| | Annual | 1.9 |
| $PM_{10}$[2] | 24-hour | 36 |
| | Annual | 15 |
| $PM_{2.5}$[1] | 24-hour | 14 |
| | Annual | 3 |
| Sulfur dioxide ($SO_2$)[1] | 1-hour | 3 |
| | 3-hour | 3 |
| | 24-hour | 3 |
| | Annual | 3 |

[1] Data collected at Williams Willow Creek during 2012.
[2] Data from S. Ute, collected 1 mile NE of Ignacio during 2003-2005..

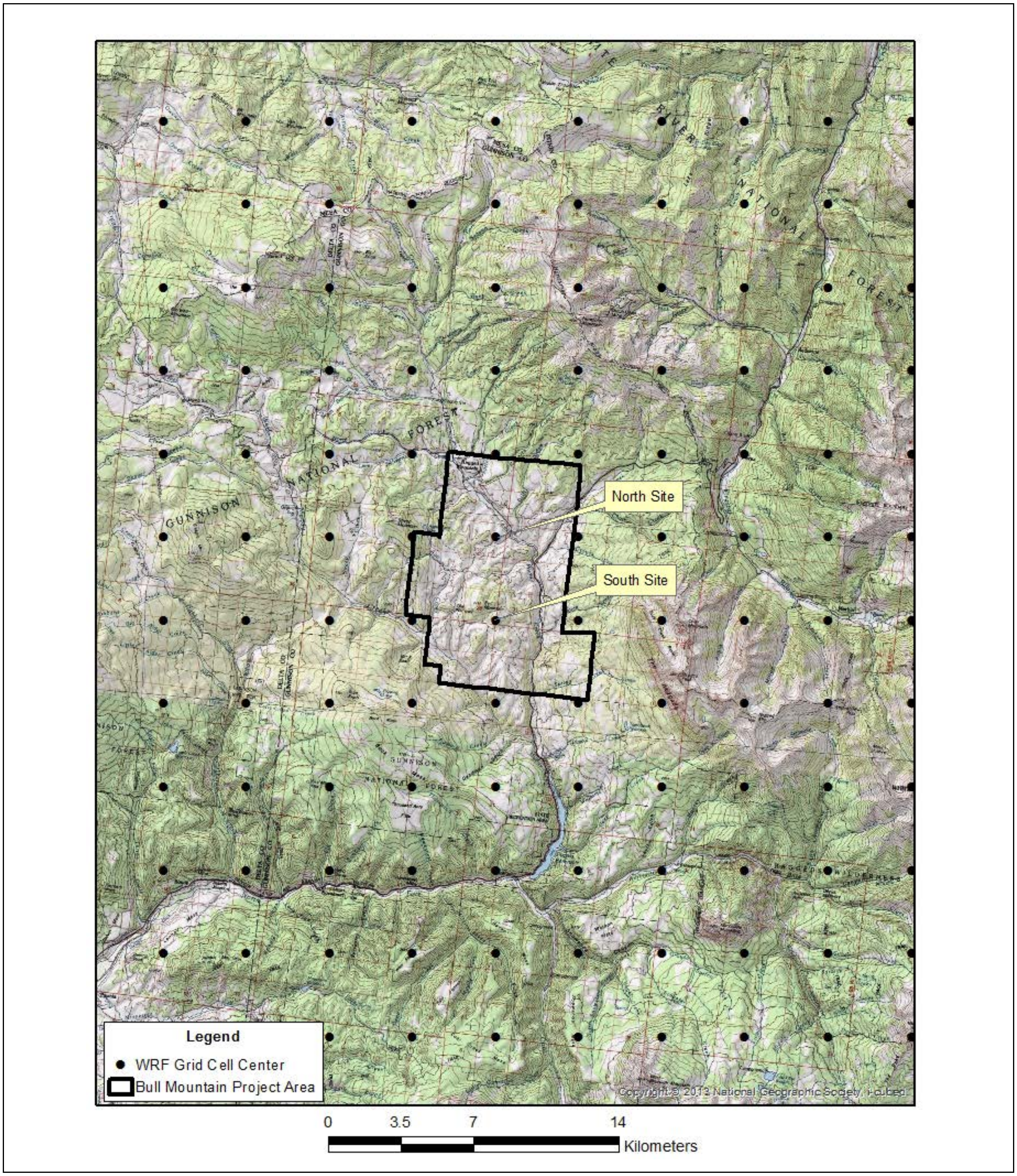


**Figure 3-1: Site Locations for Bull Mountain Unit Meteorology Data**

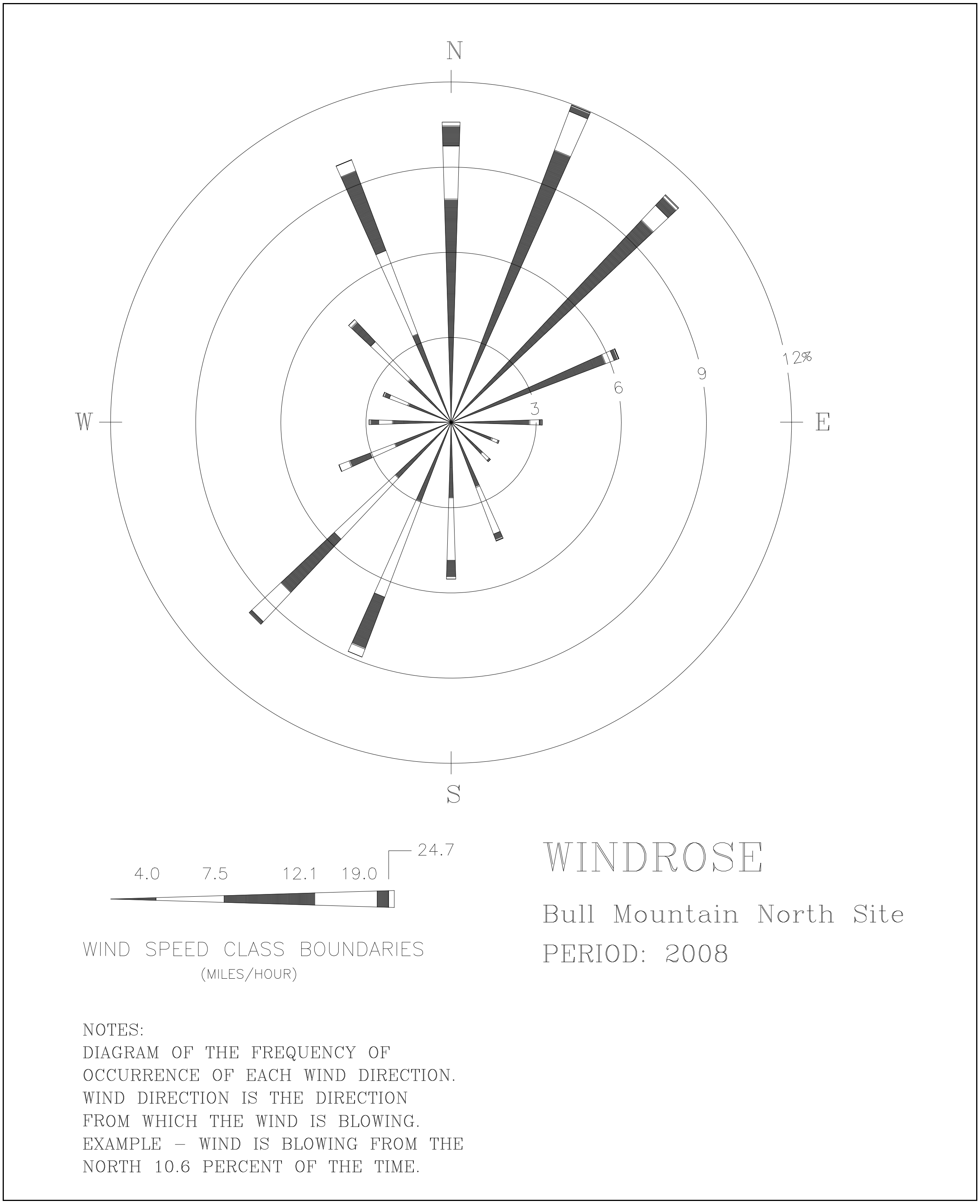


**Figure 3-2: Bull Mountain Unit Windrose – North Site**

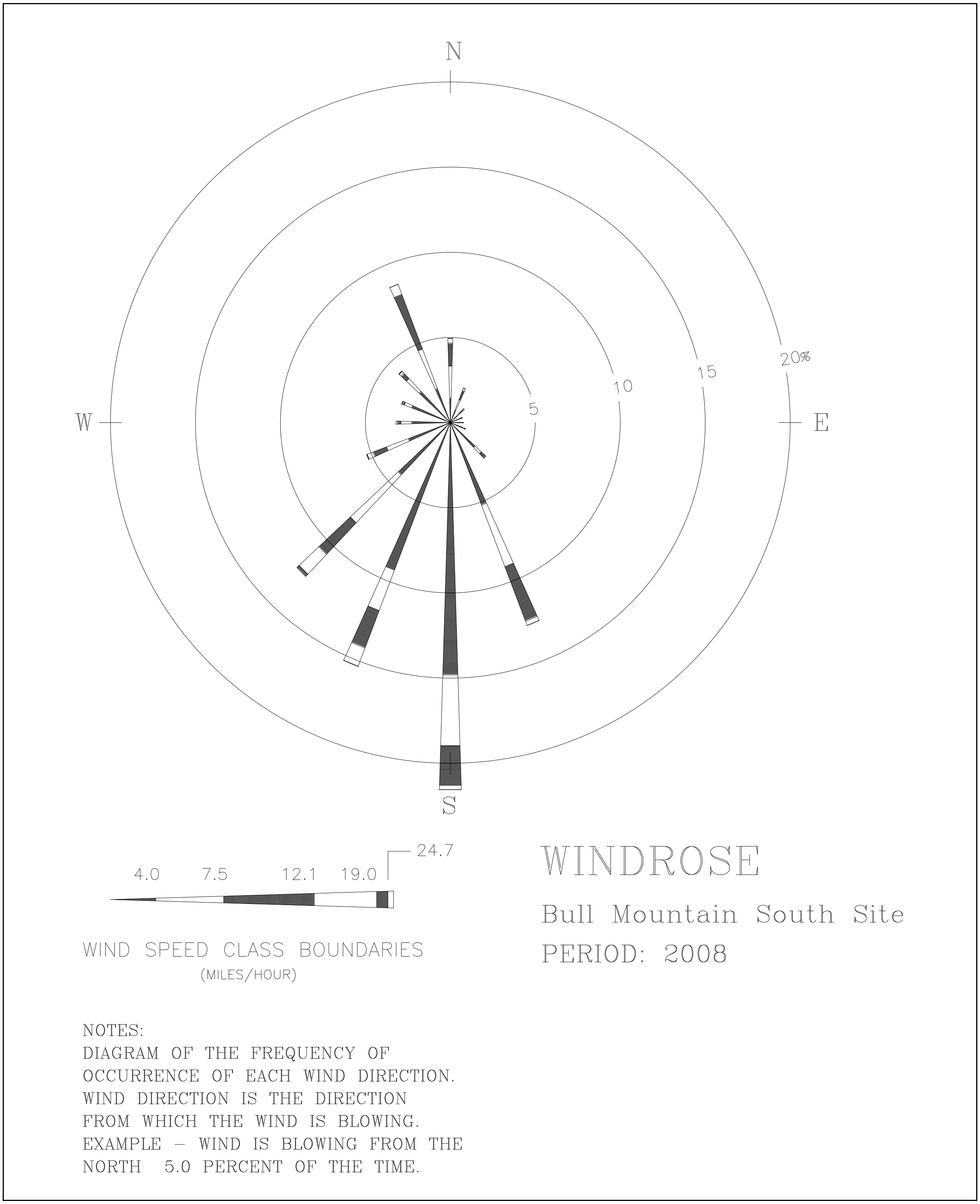


**Figure 3-3: Bull Mountain Unit Windrose – South Site**

### 3.4 CRITERIA POLLUTANT IMPACT ASSESSMENT

A near-field ambient air quality impact assessment was performed to evaluate maximum pollutant impacts of $PM_{10}$, $PM_{2.5}$, $SO_2$, $NO_2$, and CO within and near the Unit resulting from project alternative field development and operation activities. EPA's Guideline (EPA 2005) model, AERMOD (version 13350), was used to assess these near-field impacts. Maximum predicted concentrations in the vicinity of project emissions sources were compared with the National Ambient Air Quality Standards (NAAQS), Colorado Ambient Air Quality Standards (CAAQS) and applicable Prevention of Significant Deterioration (PSD) Class II increments shown in **Table 3-2**. This NEPA analysis compared potential air quality impacts from project alternatives not only to applicable ambient air quality standards but also to PSD increments. The comparisons to the PSD Class II increments are intended to evaluate a threshold of concern for potential impacts, and do not represent a regulatory PSD increment comparison. Such a regulatory analysis is the responsibility of the state air quality agency (under EPA oversight).

**Table 3-2**
**NAAQS, CAAQS, and PSD Class II Increments for Comparison to Near-Field Analysis Results (μg/m³)**

| Pollutant/Averaging Time | NAAQS | CAAQS | PSD Class II Increment[1] |
|---|---|---|---|
| CO | | | |
| 1-hour[2] | 40,000 | -- | --[3] |
| 8-hour[2] | 10,000 | -- | --[3] |
| $NO_2$ | | | |
| 1-hour[4] | 188 | -- | --[3] |
| Annual[5] | 100 | -- | 25 |
| $PM_{10}$ | | | |
| 24-hour[2] | 150 | -- | 30 |
| Annual[5] | --[6] | -- | 17 |
| $PM_{2.5}$ | | | |
| 24-hour[7] | 35 | -- | 9 |
| Annual[5] | 12 | -- | 4 |
| $SO_2$ | | | |
| 1-hour[8] | 196 | -- | --[3] |
| 3-hour[2] | 1,300 | 700 | 512 |
| 24-hour[2] | 365[9,10] | -- | 91 |
| Annual[5] | 80[9,10] | -- | 20 |

1 The PSD demonstrations serve information purposes only and do not constitute a regulatory PSD increment consumption analysis.
2 No more than one (1) exceedance per year.
3 No PSD increments have been established for this pollutant–averaging time.
4 An area is in compliance with the standard if the 98th percentile of daily maximum 1-hour $NO_2$ concentrations in a year, averaged over 3 years, is less than or equal to the level of the standard.
5 Annual arithmetic mean.
6 No standards are established for this pollutant-averaging time.
7 An area is in compliance with the standard if the maximum 24-hour $PM_{2.5}$ concentrations in a year, averaged over 3 years, is less than or equal to the level of the standard.
8 An area is in compliance with the standard if the 99th percentile of daily maximum 1-hour $SO_2$ concentrations in a year, averaged over 3 years, is less than or equal to the level of the standard.
9 The NAAQS for this averaging time for this pollutant has been revoked by EPA.
10 The 24 and annual NAAQS remain in effect in Colorado until 1 year after the area is designated for the 2010 (1-hour) standard. Designations for the 1-hour $SO_2$ NAAQS in CO have not occurred.

For well pad and access road construction during field development, near-field modeling assessed $PM_{10}$ and $PM_{2.5}$ impacts. Particulate emissions from one representative well pad and road segment under construction were analyzed, and included fugitive dust from construction activities and wind erosion, and particulate from vehicle travel and mobile source fuel combustion. Road and pad vehicle activities were idealized as volume sources and wind erosion emissions were idealized as area sources. Hourly emission rate adjustment factors were applied to well pad and access road construction sources since these activities occur only during daytime hours. Model receptors were placed at 25-meter increments along a boundary 100 meters from the well pad and access road, and then defined on 100-meter intervals extending outward approximately 1.5 kilometers. Flat terrain receptors were used. The source and receptor layout for this modeling scenario is shown in **Figure 3-4**.

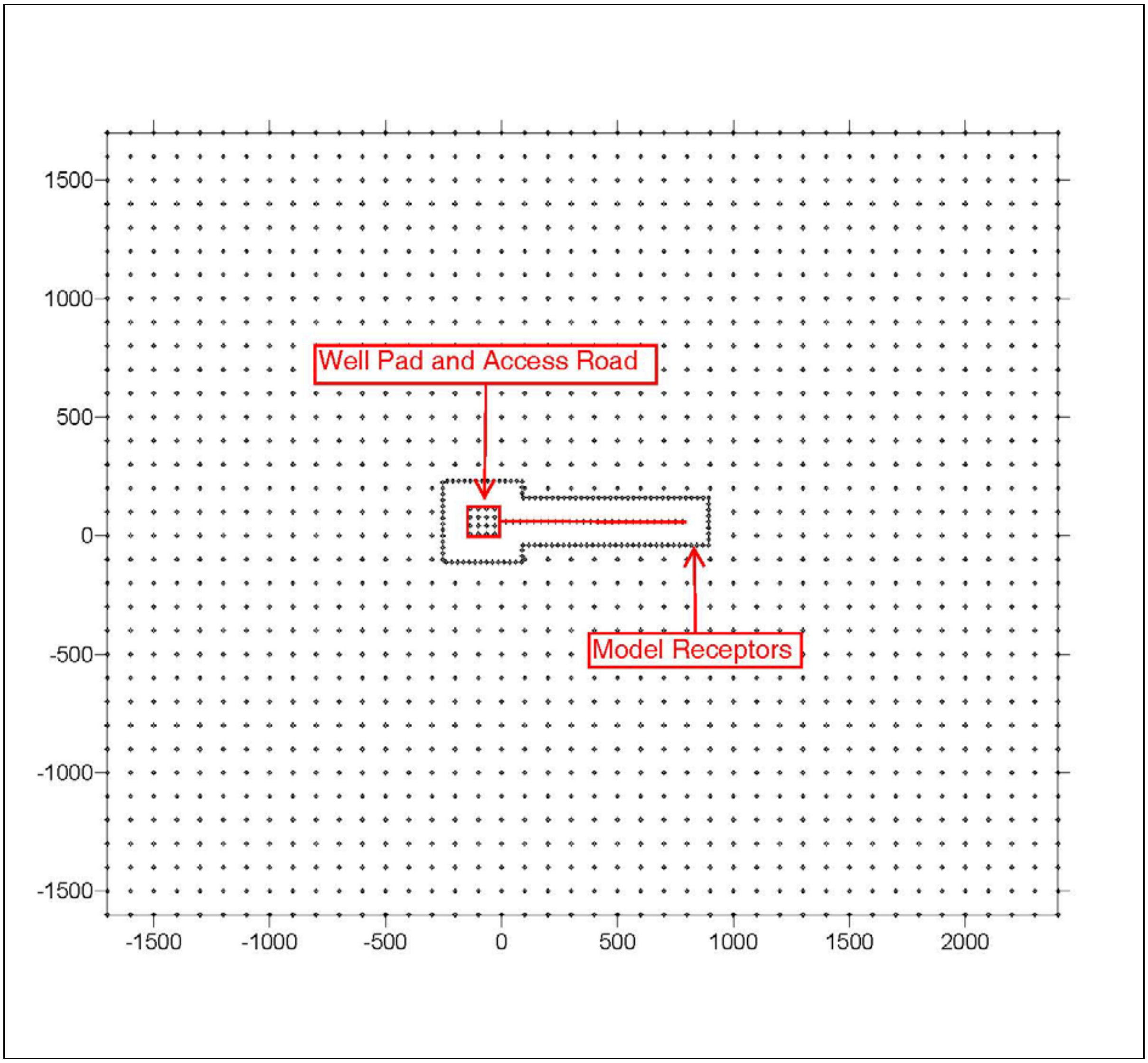


**Figure 3-4: Near-Field Analysis, Well Pad and Access Road Construction Modeling Scenario**

**Table 3-3** presents maximum modeled $PM_{10}$ and $PM_{2.5}$ impacts that could occur from well pad and access road development activities. When maximum modeled concentrations from the modeled scenarios are added to representative background concentrations, it is demonstrated that the total ambient air concentrations are less than the applicable NAAQS and CAAQS. Note that the emissions from field development activities would be temporary and would not consume PSD increment, and as a result are excluded from increment comparisons.

**Table 3-3**
**$PM_{10}$/$PM_{2.5}$ Modeling Results for Well Pad and Access Road Construction**

| Pollutant | Averaging Time | Maximum Concentration (μg/m$^3$) | Background Concentration (μg/m$^3$) | Total Concentration (μg/m$^3$) | NAAQS/ CAAQS (μg/m$^3$) |
|---|---|---|---|---|---|
| $PM_{10}$ | 24-Hour | 84.7 | 36 | 120.7 | 150 |
| $PM_{2.5}$ | 24-Hour | 12.6 | 14 | 26.6 | 35 |
| | Annual | 1.2 | 3 | 4.2 | 12 |

Notes:
Modeled highest second-high value shown for $PM_{10}$, 24-hour value
Modeled 8$^{th}$ highest value shown for $PM_{2.5}$, 24-hour values

Two modeling scenarios were developed for the Proposed Action Alternative to represent a concentrated area of development proposed in the Unit. Modeling scenarios for well production and field development (drilling) were based on the projected locations of well pads and compressor stations and the locations existing of existing well pads in the Unit, and are shown in **Figures 3-5** (production) and **3-6** (field development).

The modeling scenario for well production (**Figure 3-5**) included 10 new well pads, 4 existing well pads, and 3 proposed compressor stations. New well pads included three pumping units, and associated activities (well site heaters, traffic, and fugitive emissions) for four wells in production. Existing well pads included two pumping units and related activities for two wells in production. A 100-meter pad size (approximately 2 acres) was used for well production and compressor station pads.

The modeling scenario for field development (drilling) (**Figure 3-6**) included seven new well pads and four existing well pads under production, three compressor stations, and three Tier-2 drilling rigs operating (one year-round and two operating from April through November). Drill rig emissions were based on a maximum hourly load conditions. New well pads included three pumping units, and associated activities (i.e., tank and separator heaters, fugitives, and traffic) for four wells in production. Existing well pads included two pumping units and related activities for two wells in production. Tank heaters were assumed to operate only during winter months (October through March). A 100-meter pad size was used for well and compressor station pads. For the 3 well pads with drilling, a 150-meter (approximately 5 acres) pad size was used.

Both analyses utilized receptor grids that extended outward approximately 1.5 kilometers from the edge of any well pad. Discrete modeling receptors were defined on a 25-meter interval along boundaries, and then defined on 100-meter intervals throughout the modeling domain. **Figures 3-7** and **3-8** illustrate the receptor grids used for analyzing well production and well construction, respectively. Terrain elevations for each receptor were developed using the AERMAP (Version 11103) processor along with available digital elevation model data.

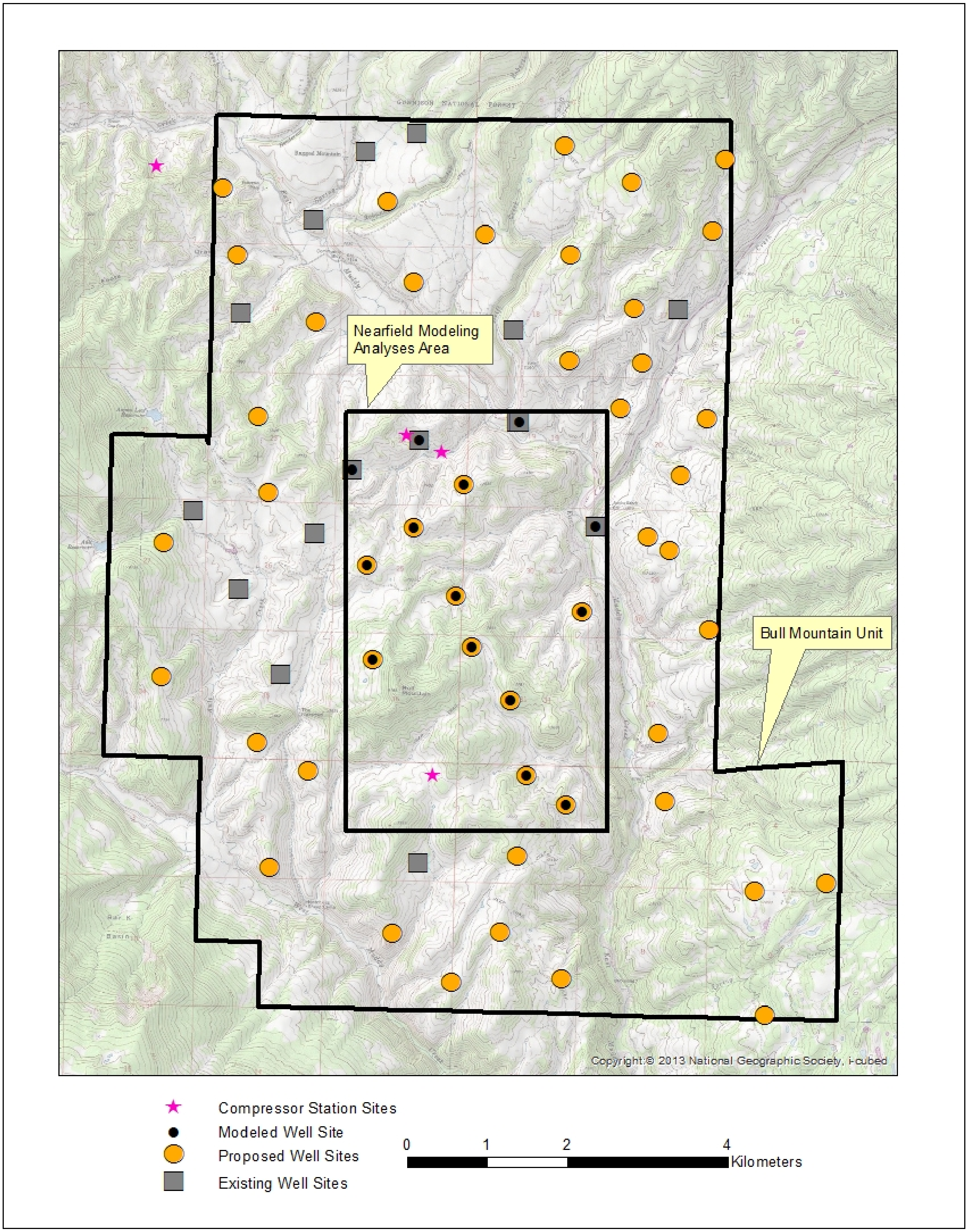


**Figure 3-5: Near-Field Analysis, Well Production Modeling Scenario**

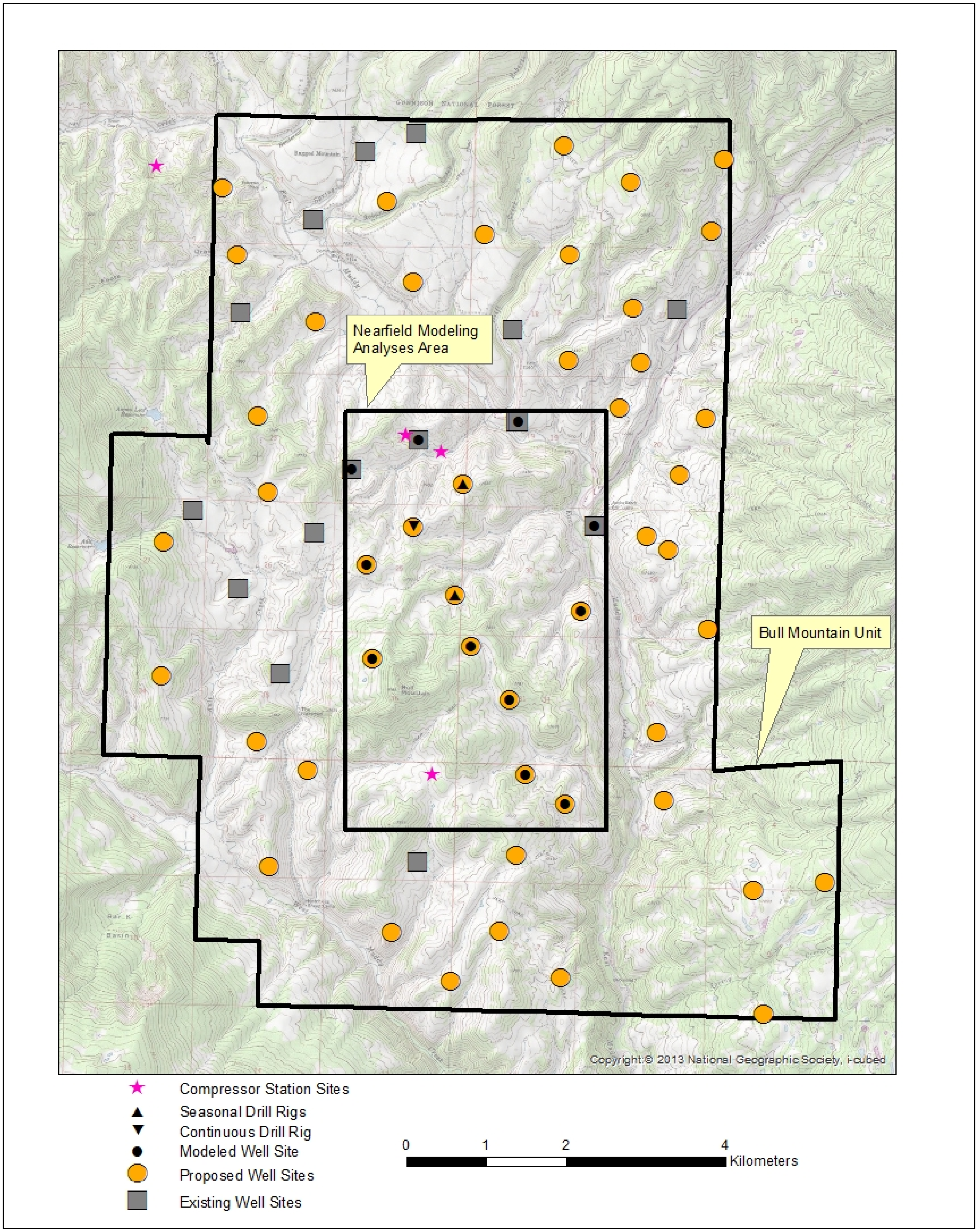


**Figure 3-6: Near-Field Analysis, Well Development Modeling Scenario**

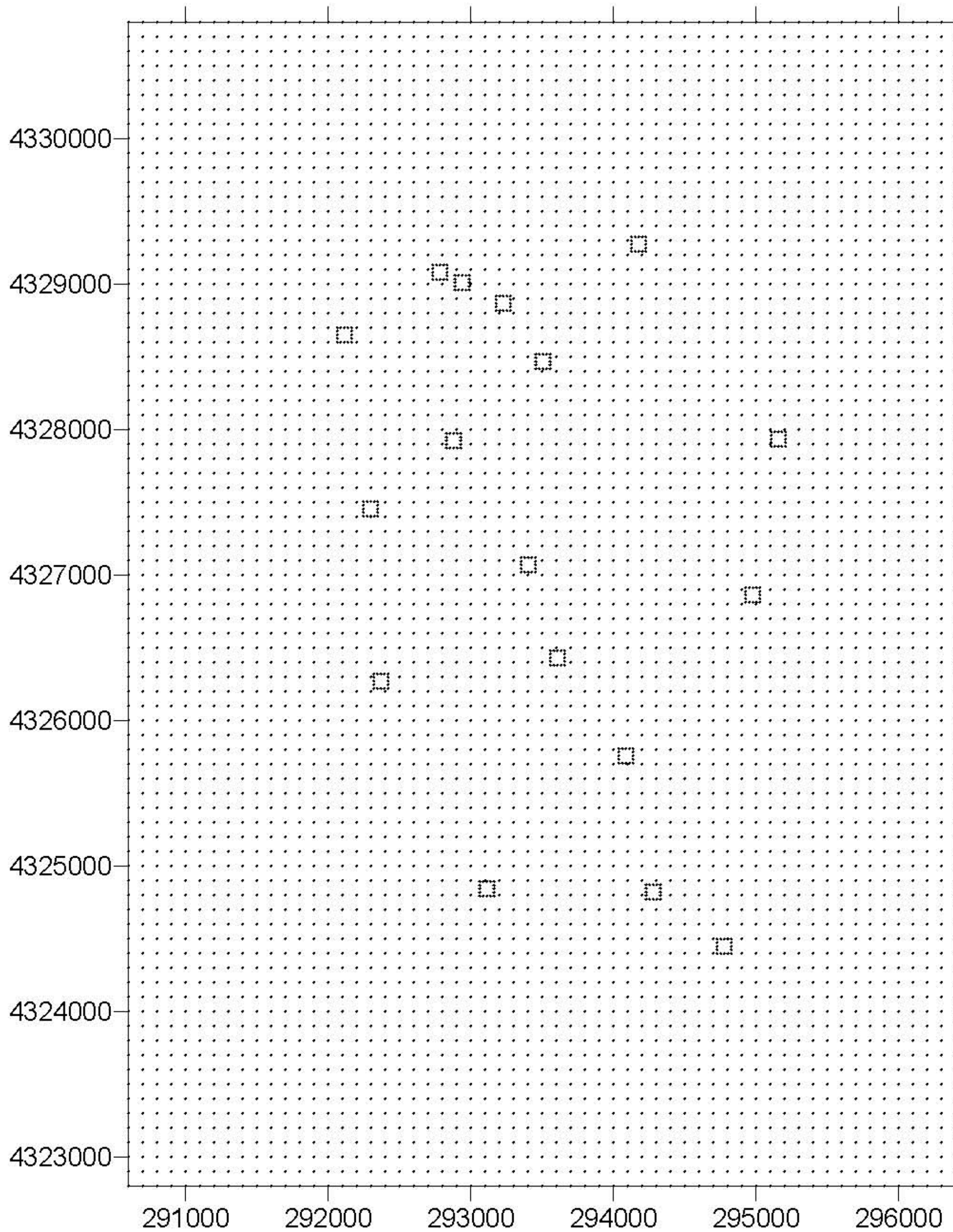


**Figure 3-7: Near-Field Analysis, Well Production Receptor Grid**

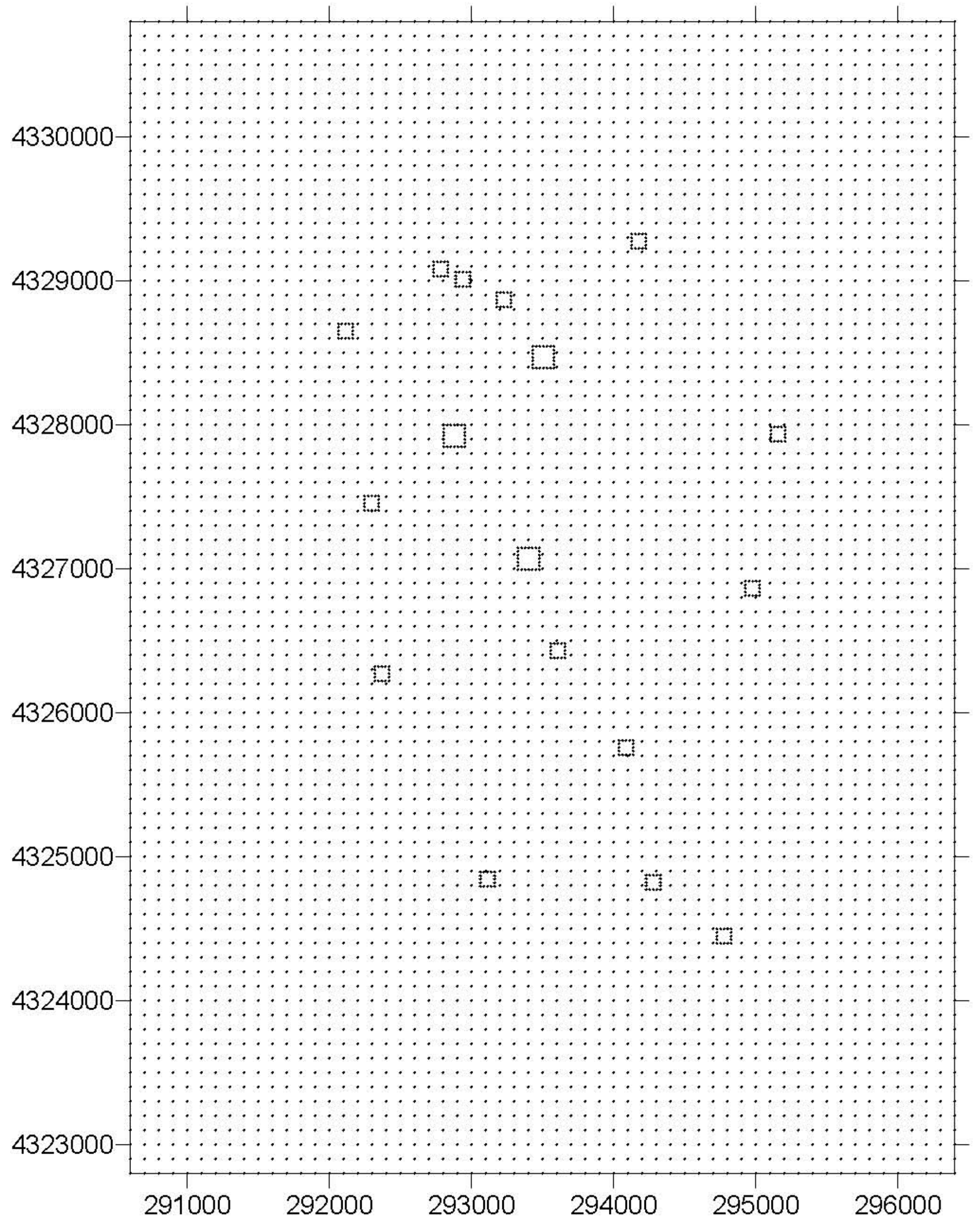


**Figure 3-8: Near-Field Analysis, Well Development Receptor Grid**

Point sources were used for modeling emissions from compressors, heaters, pumping units, and drilling rigs, using representative release parameters for these source types that have been compiled for other NEPA oil and gas development projects throughout Wyoming and Colorado. Building downwash parameters were developed and used for modeling the compressor engines and heaters. Volume sources were used for modeling well-site fugitive emissions and road travel. Volume source parameters were also used for modeling one pumping unit at each well given that these units could have a horizontal stack release. A sample AERMOD model input control file is provided in Appendix D that contains detailed source parameter information used in the modeling analysis. In addition, all modeling input and output files are contain on model archive for the Project.

The AERMOD near-field modeling utilized default regulatory model switch settings, with the exception of the non-default Ozone Limiting Method (OLM) option, which was used for modeling $NO_2$ concentration estimates. Modeling analyses for $NO_2$ concentration estimates utilized seasonal diurnal ozone concentration profiles developed using the years 2011-2013 data collected at the Clean Air Status and Trends Network (CASTNET) Gothic ozone site located in Gunnison County, Colorado. A value of 20 percent was used for all source in-stack $NO_2$ concentration estimates. This value is a conservative estimate supported by data from EPA's $NO_2/NO_x$ In-Stack Ratio (ISR) Database (EPA 2013) and from data provided from oil and gas operators.

For 1-hour $NO_2$ NAAQS compliance demonstrations, where the 1-hour NAAQS is defined as the 3-year average of the 98th percentile of the yearly distribution of 1-hour daily maximum concentrations, all modeled impacts presented represent the 3-year average of the eighth-highest daily maximum 1-hour concentrations. For scenarios where drilling operations were modeled, drilling operations were assumed to occur for a maximum of 1 year during the 3-year averaging period. Since drill rigs move to different locations during field development, it is unlikely that drilling would occur for 3 consecutive years in the same location.

**Table 3-4** presents the maximum predicted modeled air pollutant concentrations from well production activities and **Table 3-5** presents the maximum predicted concentrations from well development activities. When maximum modeled concentrations from the modeled scenarios are added to representative background concentrations, it is demonstrated that the total ambient air concentrations are less than the applicable NAAQS and CAAQS. In addition, direct modeled concentrations are below the applicable PSD Class II increments. As noted earlier in this section, the emissions from field development activities would be temporary and would not consume PSD increment, and as a result are excluded from increment comparisons.

**Table 3-6** presents the yearly eighth-highest daily maximum 1-hour $NO_2$ concentrations used in calculating the 3-year average concentration for NAAQS/CAAQS comparison for the field development modeling scenario where drilling activities are included. Table 3-6 also includes the 8-highest daily maximum 1-hour $NO_2$ concentrations (unpaired in space) that could occur in any year from drilling and production activities. These values can be compared with the NAAQS to identify whether yearly 1-hour $NO_2$ impacts resulting from drilling and production activities are above the level of the NAAQS.

**Table 3-4**
**Criteria Pollutant Modeling Results for Field Production Activities**

| Pollutant | Averaging Time | Maximum Concentration (μg/m$^3$) | Background Concentration (μg/m$^3$) | Total Concentration (μg/m$^3$) | NAAQS/ CAAQS (μg/m$^3$) | PSD Class II Increment (μg/m$^3$) |
|---|---|---|---|---|---|---|
| CO | 1-Hour | 775.4 | 1150 | 1,925.1 | 40,000 | -- |
| | 8-Hour | 481.1 | 1150 | 1,630.9 | 10,000 | -- |
| $NO_2$ | 1-Hour | 159.1 | 21 | 180.4 | 188 | -- |
| | Annual | 38.6 | 1.9 | 39.2 | 100 | 25 |
| $SO_2$ | 1-Hour | 0.002 | 3 | 3.0 | 196 | -- |
| | 3-Hour | 0.001 | 3 | 3.0 | 1,300/700 | 512 |
| | 24-Hour | 0.001 | 3 | 3.0 | 365/-- | 91 |
| | Annual | 0.0003 | 3 | 3.0 | 80/-- | 20 |
| $PM_{10}$ | 24-Hour | 0.007 | 36 | 36.0 | 150 | 30 |
| | Annual | 0.002 | -- | -- | -- | 17 |
| $PM_{2.5}$ | 24-Hour | 0.007 | 14 | 14.0 | 35 | 9 |
| | Annual | 0.002 | 3 | 3.0 | 12 | 4 |

Notes:
Modeled highest second-high value shown for all short-term averaging periods
$NO_2$ 1-hour value is calculated as the 3-year average of the 8$^{th}$ highest daily maximum 1-hour concentrations
$SO_2$ 1-hour value is the maximum 1-hour concentration

**Table 3-5**
**Criteria Pollutant Modeling Results for Field Development Activities**

| Pollutant | Averaging Time | Maximum Concentration (μg/m$^3$) | Background Concentration (μg/m$^3$) | Total Concentration (μg/m$^3$) | NAAQS/CAAQS (μg/m$^3$) |
|---|---|---|---|---|---|
| CO | 1-Hour | 775.1 | 1150 | 1,925.1 | 40,000 |
| | 8-Hour | 480.9 | 1150 | 1,630.9 | 10,000 |
| $NO_2$ | 1-Hour | 159.4 | 21 | 180.4 | 188 |
| | Annual | 37.3 | 1.9 | 39.2 | 100 |
| $SO_2$ | 1-Hour | 4.0 | 3 | 7.0 | 196 |
| | 3-Hour | 3.0 | 3 | 6.0 | 1,300/700 |
| | 24-Hour | 0.8 | 3 | 3.8 | 365/-- |
| | Annual | 0.09 | 3 | 3.1 | 80/-- |
| $PM_{10}$ | 24-Hour | 7.8 | 36 | 43.8 | 150 |
| $PM_{2.5}$ | 24-Hour | 7.8 | 14 | 21.8 | 35 |
| | Annual | 0.9 | 3 | 3.9 | 12 |

Notes:
Modeled highest second-high value shown for all short-term averaging periods
$NO_2$ 1-hour value is calculated as the 3-year average of the 8$^{th}$ highest daily maximum 1-hour concentrations
$SO_2$ 1-hour value is the maximum 1-hour concentration

**Table 3-6**
**1-Hour $NO_2$ Modeling Summary for Field Development Activities**

| 3-year average 1-hour $NO_2$ concentration (μg/m$^3$) | Maximum 8$^{th}$ high daily 1-hour $NO_2$ concentrations (μg/m3) used for computing 3-year average 1-hour $NO_2$ concentration (paired in space) | | | Maximum 8th high daily 1-hour $NO_2$ concentrations (μg/m3) for each modeling scenario (not paired in space) | | |
|---|---|---|---|---|---|---|
| | Year 1 Scenario 1 Drilling | Year 2 Scenario 2 Production | Year 3 Scenario 3 Production | Year 1 Scenario 1 Drilling | Year 2 Scenario 2 Production | Year 3 Scenario 3 Production |
| 159.4 | 160.0 | 159.1 | 159.1 | 281.9 | 159.1 | 159.1 |

Note:
Maximum 3-year average 1-hour $NO_2$ concentrations are calculated as the 3-year average of the 8th highest daily maximum 1- hour concentrations
Where drilling rigs are modeled, the maximum 1-year of concentrations are combined with the 2 years of field production concentrations

The air quality impacts presented above are based on maximum emissions scenarios developed for the Proposed Action alternative. Air quality impacts for all other development alternatives would be similar to or less than impacts from the Proposed Action because those alternatives have smaller field development plans or exhibit lower proposed emissions.

## 3.5 HAPS MODELING

AERMOD modeling was performed to estimate near-field HAPs concentrations for assessing impacts both in the immediate vicinity of the Unit emission sources for short-term (acute) exposure assessment and for calculation of long-term risk. Maximum HAPs emissions would occur from well-site fugitive emissions and natural gas fired compressor engines and pumping unit engines. Because HAPs would be emitted predominantly during the production phase, only emissions from production activities were analyzed. The modeling scenario used for analyzing field production for the Proposed Action in Section 3.4 was used for estimating maximum HAP impacts.

Short-term (1-hour) HAPs concentrations were compared to acute Reference Exposure Levels (RELs), shown in **Table 3-7**. RELs are defined as concentrations at or below which no adverse health effects are expected. No RELs are available for ethylbenzene and n-hexane; instead, the available Immediately Dangerous to Life or Health divided by 10 (IDLH/10) values are used. These IDLH values are determined by the National Institute for Occupational Safety and Health (NIOSH) and were obtained from EPA's Air Toxics Database (EPA 2011). These values are approximately comparable to mild effects levels for 1-hour exposures.

Long-term exposure to HAPs emitted by Proposed Action sources were compared to Reference Concentrations for Chronic Inhalation (RfCs). An RfC is defined by EPA as the daily inhalation concentration at which no long-term adverse health effects are expected. RfCs exist for both non-carcinogenic and carcinogenic effects on human health (EPA 2012). Annual modeled concentrations for all HAPs emitted were compared directly to the non-carcinogenic RfCs shown in **Table 3-8**.

**Table 3-7**
**Acute RELs (1-Hour Exposure)**

| HAP | REL (μg/m$^3$) |
|---|---|
| Benzene | 1,300[1] |
| Toluene | 37,000[1] |
| Ethyl Benzene | 350,000[2] |
| Xylene | 22,000[1] |
| n-Hexane | 390,000[2] |
| Formaldehyde | 55[1] |

[1] EPA Air Toxics Database, Table 2 (EPA 2011).
[2] No REL available for these HAPs. Values shown are from Immediately Dangerous to Life or Health (IDLH/10), EPA Air Toxics Database, Table 2 (EPA 2011).

**Table 3-8**
**Non-Carcinogenic HAPs RfCs (Annual Average) [1]**

| HAP | Non-Carcinogenic RfC[1] (μg/m$^3$) |
|---|---|
| Benzene | 30 |
| Toluene | 5000 |
| Ethyl Benzene | 1,000 |
| Xylenes | 100 |
| n-Hexane | 700 |
| Formaldehyde | 9.8 |

[1] EPA Air Toxics Database, Table 1 (EPA 2012).

**Table 3-9** present the short-term and long-term HAP modeling results for the Proposed Action modeling scenario. As shown in **Table 3-9** all HAP impacts are below the applicable short-term RELs, and the long-term non-carcinogenic RfCs, with the exception of the modeled formaldehyde concentration, which is slightly above the short-term REL threshold. The maximum formaldehyde impact occurs near 1 of the 3 modeled compressor stations (approximately 150 meters from the compressor station). Formaldehyde impacts are below the applicable REL at a 200 meter distance from any compressor station.

**Table 3-9**
**HAPs Modeling Results for Field Production Activities**

| HAP | Maximum 1-hour concentration (μg/m$^3$) | REL (μg/m$^3$) | Annual Concentration (μg/m$^3$) | RFC(μg/m$^3$) |
|---|---|---|---|---|
| Formaldehyde | 81.6 | 55 | 3.89 | 9.8 |
| n-Hexane | 8.0 | 390,000 | 1.33 | 700 |
| Benzene | 14.8 | 1,300 | 2.47 | 30 |
| Toluene | 23.6 | 37,000 | 3.92 | 5,000 |
| Ethyl Benzene | 1.3 | 350,000 | 0.21 | 1,000 |
| Xylene | 10.4 | 22,000 | 1.74 | 100 |

Long-term exposures to emissions of suspected carcinogens (benzene, ethyl benzene and formaldehyde) were evaluated based on estimates of the increased latent cancer risk over a 70-year lifetime. This analysis presents the potential incremental risk from these pollutants, and does not represent a total risk analysis. The cancer risks were calculated using the maximum predicted annual concentrations and EPA's chronic inhalation unit risk factors (URF) for carcinogenic constituents (EPA 2012). Estimated cancer risks were evaluated based on the EPA's Acceptable Exposure Level (AEL) concentration levels where a lifetime cancer risk range of 1 to 100 x $10^{-6}$ is generally acceptable (EPA 2014).

Two estimates of cancer risk are presented: 1) a most likely exposure (MLE) scenario; and 2) a maximum exposed individual (MEI) scenario. The estimated cancer risks are adjusted to account for duration of exposure and time spent at home. The adjustment for the MLE scenario is assumed to be 9 years, which corresponds to the mean duration that a family remains at a residence (EPA 1993). This duration corresponds to an adjustment factor of 9/70 = 0.13. The duration of exposure for the MEI scenario is assumed to be 50 years (i.e., the LOP), corresponding to an adjustment factor of 50/70 = 0.71. A second adjustment is made for time spent at home versus time spent elsewhere. For the MLE scenario, the at-home time fraction is 0.64 (EPA 1993), and it is assumed that during the rest of the day the individual would remain in an area where annual HAP concentrations would be one quarter as large as the maximum annual average concentration. Therefore, the final MLE adjustment factor is (0.13) x [(0.64 x 1.0) + (0.36 x 0.25)] = 0.0949. The MEI scenario assumes that the individual is at home 100 percent of the time, for a final MEI adjustment factor of (0.71 x 1.0) = 0.71. **Table 3-10** provides RfCs for suspected carcinogens benzene, ethyl benzene, and formaldehyde, expressed as unit risk factors, and the exposure adjustment factors used to evaluate the potential incremental risk from these pollutants.

For each constituent, the cancer risk is computed by multiplying the maximum predicted annual concentration by the URF and by the overall exposure adjustment factor. The cancer risks for both constituents are then summed to provide an estimate of the total inhalation cancer risk.

**Table 3-10**
**Carcinogenic HAPs RfCs and Exposure Adjustment Factors**

| Analysis[1] | HAPs Constituent | Carcinogenic RfC (Risk Factor)[2] 1/(μg/m$^3$)[3] | Exposure Adjustment Factor |
|---|---|---|---|
| MLE | Benzene | 7.8 x $10^{-6}$ | 0.0949 |
| MLE | Ethyl Benzene | 2.5 x $10^{-6}$ | 0.0949 |
| MLE | Formaldehyde | 1.3 x $10^{-5}$ | 0.0949 |
| MEI | Benzene | 7.8 x $10^{-6}$ | 0.71 |
| MEI | Ethyl Benzene | 2.5 x $10^{-6}$ | 0.71 |
| MEI | Formaldehyde | 1.3 x $10^{-5}$ | 0.71 |

[1] MLE = most likely exposure; MEI = maximally exposed individual.
[2] EPA Air Toxics Database, Table 1 (EPA 2012).
[3] Annual Average Concentration.

The maximum modeled long-term risk from project emissions is shown in **Table 3-11**. Under both the MLE and MEI scenarios, the estimated cancer risk associated with long-term exposure to benzene and formaldehyde is greater than one-in-one-million risk level, but within the AEL lifetime cancer risk to an individual of between range of (1 in 10,000) and (1 in 1,000,000). These maximum impacts occur within 150 meters of production activities (compressor station). The approximate distance to be below a one-in-one-million cancer risk level for either the MLE or MEI analysis is 3 kilometers.

**Table 3-11**
**Unit Risk Analysis for Field Production Activities**

| | Analysis | HAP | Modeled Concentration (ug/m3) | Unit Risk Factor 1/(ug/m3) | Exposure Adjustment Factor | Cancer Risk |
|---|---|---|---|---|---|---|
| Field Production | MLE | Benzene | 2.47 | 7.8E-06 | 0.095 | 1.8E-06 |
| | | Ethylbenzene | 0.21 | 2.5E-06 | 0.095 | 5.0E-08 |
| | | Formaldehyde | 3.89 | 1.3E-05 | 0.095 | 4.8E-06 |
| Total Combined | | | | | | 6.7E-06 |
| Field Production | MEI | Benzene | 0.20 | 7.8E-06 | 0.71 | 1.4E-05 |
| | | Ethylbenzene | 0.01 | 2.5E-06 | 0.71 | 3.7E-07 |
| | | Formaldehyde | 3.89 | 1.3E-05 | 0.71 | 3.6E-05 |
| Total Combined | | | | | | 5.0E-05 |

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# CHAPTER 4
# FAR-FIELD ANALYSIS

The purpose of the far-field analysis was to quantify potential air quality impacts to both ambient air concentrations and AQRVs (visibility and atmospheric deposition) from air pollutant emissions of $NO_x$, $SO_2$, $PM_{10}$ and $PM_{2.5}$ expected to result from construction and operation of the Proposed Action and No Action alternatives and from existing sources in the Bull Mountain Unit. The CALPUFF model was used to analyze ambient air quality impacts of $NO_2$, $SO_2$, $PM_{10}$, and $PM_{2.5}$, and AQRVs at far-field Class I and sensitive Class II areas that are within 200 kilometers of the Unit. The Class I and sensitive Class II areas located within 200 kilometers of the Unit are shown on **Figure 4-1**. The CALPUFF domain is also indicated in **Figure 4-1**.

Air quality and AQRV impacts were assessed at the following Class I and sensitive Class II areas within 200 kilometers of the Unit (exceptions noted):

- Arches National Park, Utah (Class I);
- Black Canyon of the Gunnison National Park, Colorado (Class I);
- Colorado National Monument, Colorado, (Class II);
- Dinosaur National Monument, Colorado-Utah (Federal Class II, Colorado Class I ($SO_2$ only);
- Eagles Nest Wilderness Area, Colorado (Class I);
- Flat Tops Wilderness Area, Colorado (Class I);
- La Garita Wilderness Area, Colorado (Class I);
- Maroon Bells – Snowmass Wilderness Area, Colorado (Class I);
- Mount Zirkel Wilderness Area, Colorado (Class I);
- Ragged Wilderness Area, Colorado (Class II) (deposition analysis only);
- Rocky Mountain National Park, Colorado (Class I);

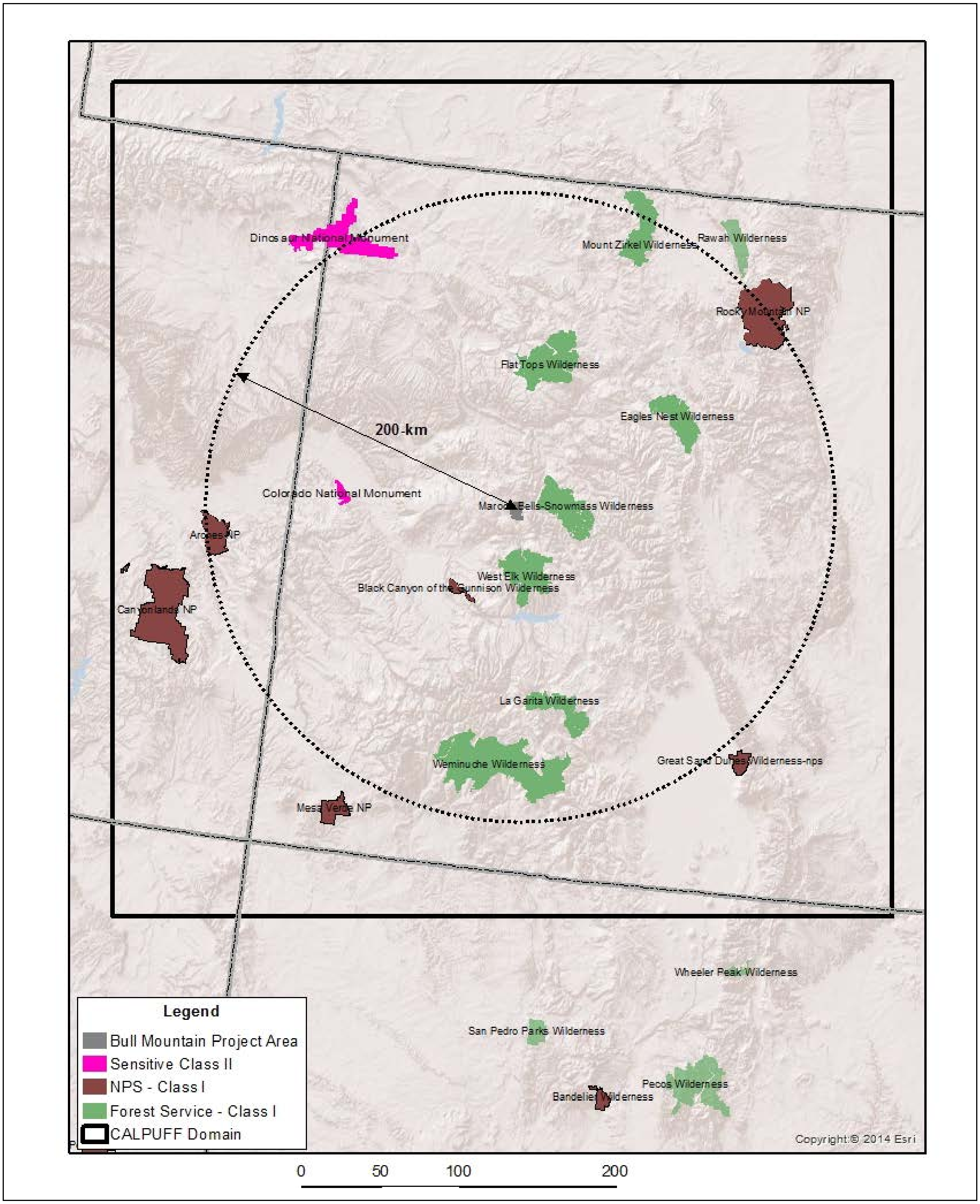


**Figure 4-1: Class I and Sensitive Class II Areas located within 200 kilometers of the Bull Mountain Unit**

- Weminuche Wilderness Area , Colorado (Class I); and
- West Elk Wilderness Area, Colorado (Class I).

Twenty-eight lakes within the Class I and sensitive Class II areas identified as being sensitive to atmospheric deposition were assessed for potential increases in lake acidification from atmospheric deposition impacts. These lakes are listed below in **Table 4-1**:

**Table 4-1**
**Sensitive Lakes Analyzed in Far-Field Analysis**

| Wilderness Area | Lake |
|---|---|
| Eagles Nest Wilderness Area | Booth Lake |
| Eagles Nest Wilderness Area | Upper Willow Lake |
| Flat Tops Wilderness Area | Ned Wilson Lake |
| Flat Tops Wilderness Area | Upper Ned Wilson Lake |
| Flat Tops Wilderness Area | Lower Packtrail Pothole |
| Flat Tops Wilderness Area | Upper Packtrail Pothole |
| La Garita Wilderness Area | Small Lake Above U-Shaped Lake |
| La Garita Wilderness Area | U-Shaped Lake |
| Maroon Bells Wilderness Area | Avalanche Lake |
| Maroon Bells Wilderness Area | Capitol Lake |
| Maroon Bells Wilderness Area | Moon Lake |
| Mount Zirkel Wilderness Area | Lake Elbert |
| Mount Zirkel Wilderness Area | Seven Lakes (LG East) |
| Mount Zirkel Wilderness Area | Summit Lake |
| Raggeds Wilderness Area | Deep Creek Lake |
| Weminuche Wilderness Area | Big Eldorado Lake |
| Weminuche Wilderness Area | Four Mile Pothole |
| Weminuche Wilderness Area | Lake Due South of Ute Lake |
| Weminuche Wilderness Area | Little Eldorado Lake |
| Weminuche Wilderness Area | Little Granite Lake |
| Weminuche Wilderness Area | Lower Sunlight Lake |
| Weminuche Wilderness Area | Middle Ute Lake |
| Weminuche Wilderness Area | Small Pond Above Trout Lake |
| Weminuche Wilderness Area | Upper Grizzly Lake |
| Weminuche Wilderness Area | Upper Sunlight Lake |
| Weminuche Wilderness Area | West Snowdon Lake |
| Weminuche Wilderness Area | White Dome Lake |
| West Elk Wilderness Area | South Golden Lake |

## 4.1 MODELING METHODOLOGY

The analyses was performed using the EPA-approved version of the CALPUFF modeling system (Version 5.8.4) with the exception of the use of Mesoscale Model Interface Program (MMIF) Version 3.0 (ENVIRON 2013) to develop a meteorological windfield rather than CALMET. All CALPUFF model options conform to the 2009 EPA guidance except for the vertical layering, which utilized a top layer of 5,000 meters increased per CDPHE protocol comments (EPA 2009). All CALPOST model options and inputs conform to FLAG 2010 guidance (FLAG 2010).

CALPUFF model receptors for these areas are shown in **Figure 4-2**. The receptors for the Class I areas were obtained the FLM receptor database. The receptors for sensitive Class II areas were obtained from prior NEPA CALPUFF air quality analyses, i.e. the Greater Natural Buttes EIS.

Ambient air impacts of $NO_2$, $SO_2$, $PM_{10}$, $PM_{2.5}$ and AQRVs (visibility and acid deposition) were analyzed at the each of the Class I and sensitive Class II areas. In addition, 28 lakes that are designated as acid sensitive (**Table 4-1**) were assessed for potential lake acidification from atmospheric deposition impacts. The lake locations are indicated on **Figure 4-2**.

The far-field assessment assumed maximum field-wide emissions scenarios with well development and production activities occurring simultaneously throughout the Unit (Section 2.0). Maximum field-wide emissions for the No Action Alternative were represented by Project year 2, and maximum field-wide emissions for the Proposed Action were represented by Project year 5.

Emissions from existing sources in the Bull Mountain Unit were also considered in the far-far analysis. Scenarios for both the No Action and Proposed Action alternatives were analyzed that included these existing project emissions.

Three drilling rigs operating continuously (one year-round and two operating from April through November), and one completion rig operating year-round were included in the modeling analysis for each project alternative. Compression and well site production emissions (including heaters, pumping units, and traffic emissions) were included in the modeling analysis. Drilling rigs, completion rigs, and compressor stations were idealized as point sources, and well site activities were idealized as volume sources. The source layout analyzed for the far-field analysis is shown in **Figure 4-3**. A sample CALPUFF model input control file is provided in Appendix D that contains detailed source parameter information used in the modeling analysis.

CALPUFF-predicted pollutant concentration impacts at Class I and sensitive Class II areas were compared with the applicable PSD increments[1]. In addition CALPUFF model results were processed with the CALPOST processor to estimate visibility and deposition impacts at the Class I and sensitive Class II areas. The visibility and deposition impacts were compared with applicable thresholds for these areas of concern. CALPUFF deposition impacts at the sensitive lakes were used to estimate potential lake acidification.

A discussion of the meteorological data used for the far-field analysis and the ozone and ammonia data used in the CALPUFF modeling is provided in the following sections. The air quality impact assessment is provided in Section 4.4, the visibility assessment in Section 4.5, the atmospheric deposition assessment in Section 4.6 and the assessment for potential lake acidification in Section 4.7.

[1] PSD Increments are used as the comparison thresholds for far-field air quality analyses given that predicted impacts are generally far below ambient air quality standards.

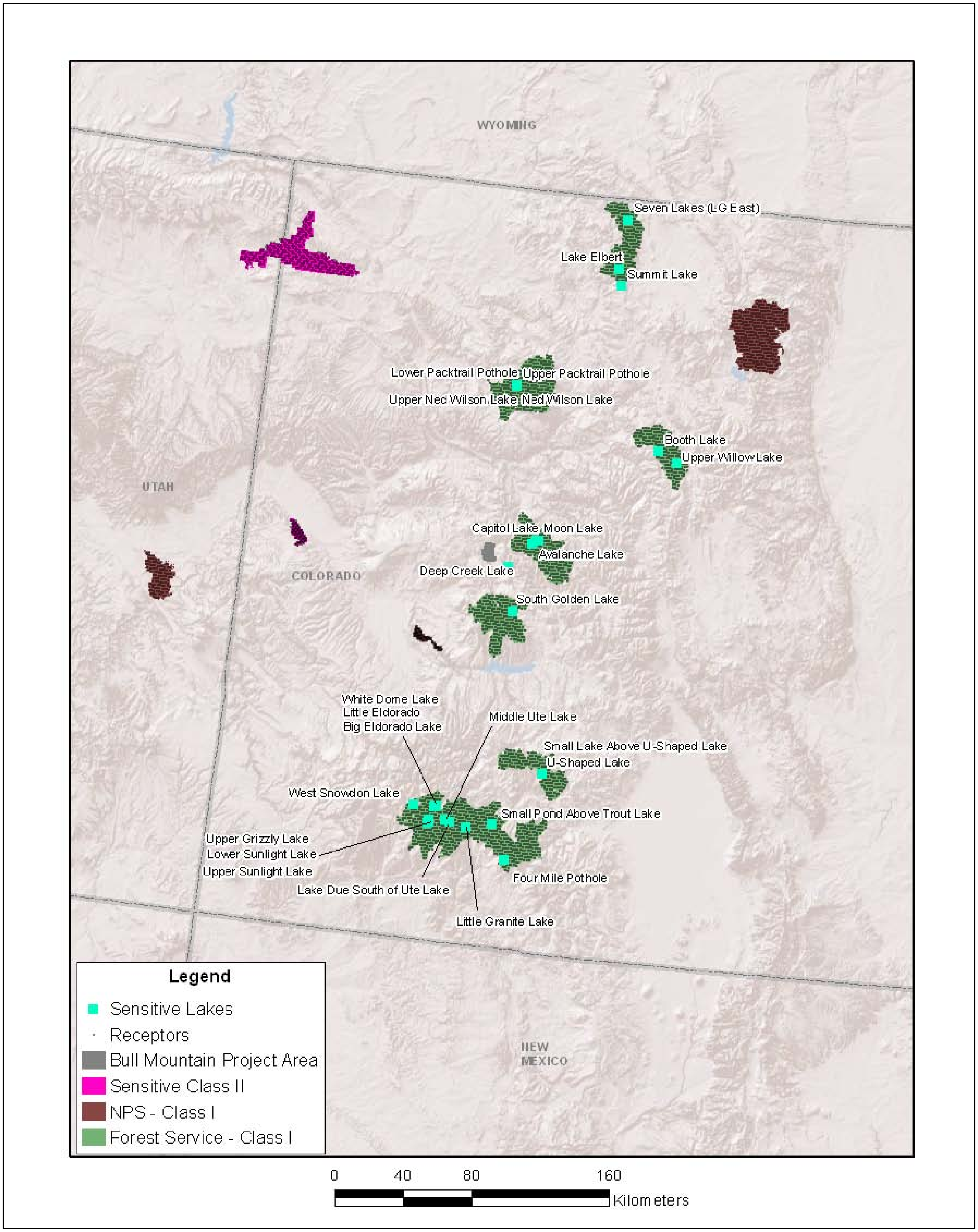


**Figure 4-2: Class I and Sensitive Class II Area Receptors Analyzed in the Far-Field Modeling Analysis**

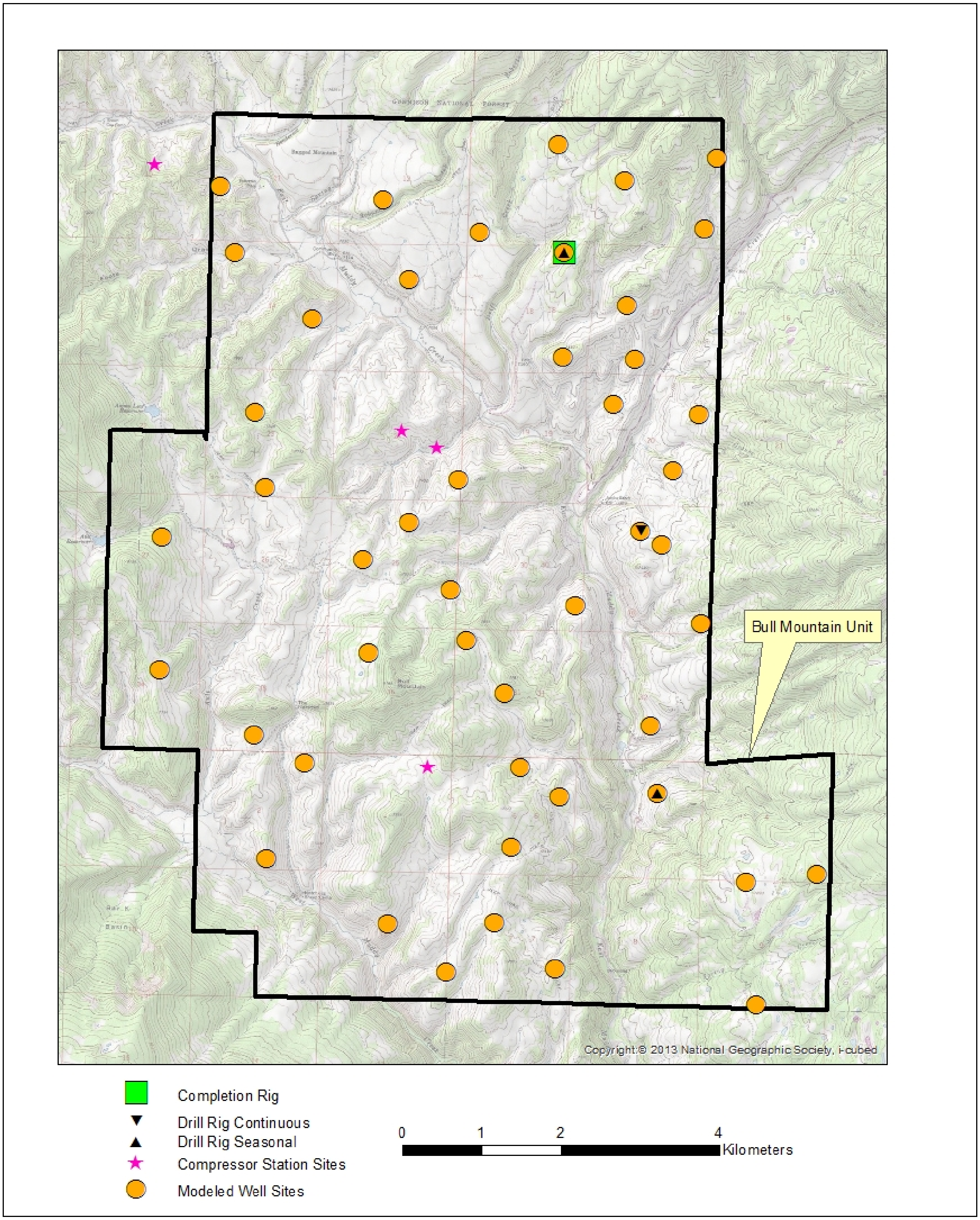


**Figure 4-3: Far-Field Analysis, Source Locations**

### 4.2 Meteorological Data

The 2008 WRF meteorological model output produced as part of the WRAP WestJumpAQMS (ENVIRON et al. 2012) was used as the meteorological dataset for input into the CALPUFF modeling. A subset of the WestJumpAQMS modeling output was extracted for the air quality modeling domain and processed into CALPUFF-ready format using the MMIF (Version 3.0) meteorological preprocessor.

The WRF model output was processed with MMIF with the following options selected:

- Output for CALPUFF version 5.8.4;
- The WRF vertical layers were interpolated to the CDPHE-recommended vertical layers using the TOP option;
- The PG stability classes were calculated with the Golder option; and
- Planetary boundary layer heights were recalculated.

This CALPUFF-ready meteorological file specifications are:

- Projection of LCC with RLAT0 = 40N, RLON0 = 97W, XLAT1 = 33N and XLAT2 = 45N;
- Datum = NWS-84;
- NX =124;
- NY =133;
- NZ =11;
- DGRIDKM = 4;
- ZFACE = 0., 20., 40., 80., 160., 320., 640., 1200., 2000., 3000., 4000., 5000; and
- ZMAX = 4500.

### 4.3 Ozone and Ammonia Data

Representative ozone and ammonia data is required for use in the chemical transformation of primary pollutant emissions. Hourly ozone is used by CALPUFF to oxidize $NO_X$ and sulfur dioxide ($SO_2$) emissions within the modeling domain to nitric acid and sulfuric acid, respectively. The predicted nitric acid and sulfuric acid are then partitioned in CALPUFF between the gaseous and particulate nitrate and sulfate phases based on the available ammonia, and ambient temperature and relative humidity.

Hourly ozone data from USEPA Air Quality System (AQS) and CASTNET ozone sites within the modeling domain were used in the analysis. The sites with ozone data available for 2008 and used in the analysis are illustrated in **Figure 4-4**.

The background ammonia value used in the CALPUFF modeling was 1.0 parts per billion (ppb) for each month of the year following FLAG 2010 guidance for arid lands.

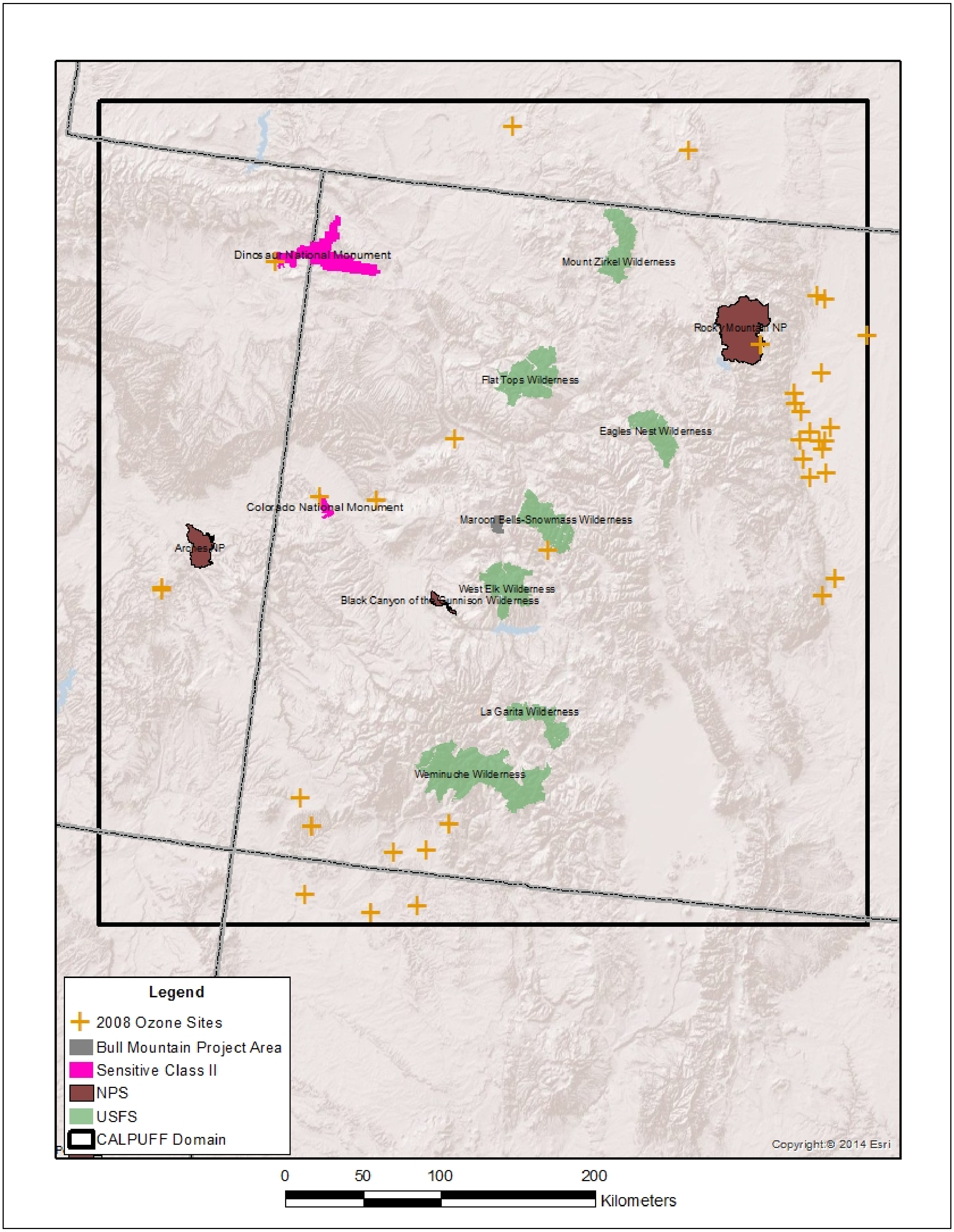


**Figure 4-4: Ozone Monitoring Sites Located within the CALPUFF Modeling Domain**

## 4.4 CRITERIA POLLUTANT IMPACT ASSESSMENT

CALPUFF modeled concentrations at the Class I and sensitive Class II areas are compared to applicable PSD increments, shown in **Table 4-2**. The PSD demonstrations are for information only and are not regulatory PSD Increment consumption analyses. Such a regulatory analysis is the responsibility of the state air quality agency (under EPA oversight).

**Table 4-2**
**PSD Class I and Class II Increments for Comparison to Far-Field Analysis Results (μg/m³)**

| Pollutant/Averaging Time | PSD Class I Increment[1] | PSD Class II Increment[1] |
|---|---|---|
| $NO_2$ | | |
| Annual[2] | 2.5 | 25 |
| $PM_{10}$ | | |
| 24-hour[3] | 8 | 30 |
| Annual[2] | 4 | 17 |
| $PM_{2.5}$ | | |
| 24-hour[3] | 2 | 9 |
| Annual[2] | 1 | 4 |
| $SO_2$ | | |
| 3-hour[3] | 25 | 512 |
| 24-hour[3] | 5 | 91 |
| Annual[2] | 2 | 20 |

[1] The PSD demonstrations serve information purposes only and do not constitute a regulatory PSD increment consumption analysis.
[2] Annual arithmetic mean.
[3] No more than one (1) exceedance per year.

The direct modeled concentrations of $NO_2$, $SO_2$, $PM_{10}$, and $PM_{2.5}$ at Class I and sensitive Class II areas for both the No Action and Proposed Action alternatives are provided in **Table 4-3** for comparison to applicable PSD Class I and Class II increments. As shown in **Table 4-3**, these values are well below the PSD Class I and Class II increments for both alternatives. In addition, the combined modeled concentrations resulting from existing Bull Mountain sources and from project alternative sources (**Table 4-4**) are well below the applicable increments.

**Table 4-3**
**Project Alternatives - Maximum Modeled Pollutant Concentrations at Class I and Sensitive Class II Areas**

| Location | Pollutant | Averaging Time | No Action Direct Modeled Concentration (μg/m³) | Proposed Action Direct Modeled Concentration (μg/m³) | PSD Increment (μg/m³) |
|---|---|---|---|---|---|
| Arches National Park | $NO_2$ | Annual | 5.9E-06 | 1.3E-05 | 2.5 |
| | $SO_2$ | 3-hour | 4.5E-04 | 5.2E-04 | 25 |
| | | 24-hour | 1.4E-04 | 1.6E-04 | 5 |
| | | Annual | 1.5E-06 | 1.9E-06 | 2 |
| | $PM_{10}$ | 24-hour | 7.1E-04 | 1.8E-03 | 8 |
| | | Annual | 1.0E-05 | 2.7E-05 | 4 |
| | $PM_{2.5}$ | 24-hour | 7.0E-04 | 1.8E-03 | 2 |
| | | Annual | 8.3E-06 | 2.0E-05 | 1 |

**Table 4-3**
**Project Alternatives - Maximum Modeled Pollutant Concentrations at Class I and Sensitive Class II Areas**

| Location | Pollutant | Averaging Time | No Action Direct Modeled Concentration (μg/m$^3$) | Proposed Action Direct Modeled Concentration (μg/m$^3$) | PSD Increment (μg/m$^3$) |
|---|---|---|---|---|---|
| Black Canyon of the Gunnison National Park | $NO_2$ | Annual | 3.6E-04 | 8.7E-04 | 2.5 |
| | $SO_2$ | 3-hour | 3.2E-03 | 4.3E-03 | 25 |
| | | 24-hour | 1.0E-03 | 1.2E-03 | 5 |
| | | Annual | 3.2E-05 | 4.0E-05 | 2 |
| | $PM_{10}$ | 24-hour | 8.3E-03 | 2.4E-02 | 8 |
| | | Annual | 2.2E-04 | 5.9E-04 | 4 |
| | $PM_{2.5}$ | 24-hour | 7.2E-03 | 2.0E-02 | 2 |
| | | Annual | 1.9E-04 | 4.8E-04 | 1 |
| Colorado National Monument | $NO_2$ | Annual | 4.6E-05 | 1.0E-04 | 2.5 |
| | $SO_2$ | 3-hour | 5.7E-04 | 6.7E-04 | 25 |
| | | 24-hour | 1.4E-04 | 1.5E-04 | 5 |
| | | Annual | 6.7E-06 | 7.9E-06 | 2 |
| | $PM_{10}$ | 24-hour | 1.4E-03 | 3.3E-03 | 8 |
| | | Annual | 4.0E-05 | 1.0E-04 | 4 |
| | $PM_{2.5}$ | 24-hour | 1.1E-03 | 2.5E-03 | 2 |
| | | Annual | 3.3E-05 | 7.6E-05 | 1 |
| Dinosaur National Monument | $NO_2$ | Annual | 6.4E-06 | 1.4E-05 | 25 |
| | $SO_2$ | 3-hour | 2.7E-04 | 3.1E-04 | 512 |
| | | 24-hour | 4.8E-05 | 5.5E-05 | 91 |
| | | Annual | 1.3E-06 | 1.6E-06 | 20 |
| | $PM_{10}$ | 24-hour | 5.1E-04 | 1.4E-03 | 30 |
| | | Annual | 1.2E-05 | 3.0E-05 | 17 |
| | $PM_{2.5}$ | 24-hour | 5.0E-04 | 1.4E-03 | 9 |
| | | Annual | 9.4E-06 | 2.3E-05 | 4 |
| Eagles Nest Wilderness Area | $NO_2$ | Annual | 3.6E-04 | 8.7E-04 | 2.5 |
| | $SO_2$ | 3-hour | 1.8E-03 | 3.0E-03 | 25 |
| | | 24-hour | 3.4E-04 | 5.2E-04 | 5 |
| | | Annual | 4.2E-05 | 5.3E-05 | 2 |
| | $PM_{10}$ | 24-hour | 7.7E-03 | 2.4E-02 | 8 |
| | | Annual | 3.7E-04 | 9.7E-04 | 4 |
| | $PM_{2.5}$ | 24-hour | 7.2E-03 | 2.2E-02 | 2 |
| | | Annual | 2.9E-04 | 7.0E-04 | 1 |
| Flat Tops Wilderness Area | $NO_2$ | Annual | 2.0E-04 | 4.9E-04 | 2.5 |
| | $SO_2$ | 3-hour | 1.7E-03 | 3.0E-03 | 25 |
| | | 24-hour | 4.0E-04 | 5.9E-04 | 5 |
| | | Annual | 2.1E-05 | 2.8E-05 | 2 |
| | $PM_{10}$ | 24-hour | 8.2E-03 | 2.5E-02 | 8 |
| | | Annual | 2.2E-04 | 5.7E-04 | 4 |
| | $PM_{2.5}$ | 24-hour | 8.0E-03 | 2.5E-02 | 2 |
| | | Annual | 1.8E-04 | 4.5E-04 | 1 |

**Table 4-3**
**Project Alternatives - Maximum Modeled Pollutant Concentrations at Class I and Sensitive Class II Areas**

| Location | Pollutant | Averaging Time | No Action Direct Modeled Concentration (μg/m$^3$) | Proposed Action Direct Modeled Concentration (μg/m$^3$) | PSD Increment (μg/m$^3$) |
|---|---|---|---|---|---|
| La Garita Wilderness Area | $NO_2$ | Annual | 1.1E-04 | 2.8E-04 | 2.5 |
| | $SO_2$ | 3-hour | 2.9E-03 | 7.0E-03 | 25 |
| | | 24-hour | 5.3E-04 | 1.2E-03 | 5 |
| | | Annual | 1.5E-05 | 2.0E-05 | 2 |
| | $PM_{10}$ | 24-hour | 1.0E-02 | 3.3E-02 | 8 |
| | | Annual | 1.5E-04 | 3.9E-04 | 4 |
| | $PM_{2.5}$ | 24-hour | 1.1E-02 | 3.5E-02 | 2 |
| | | Annual | 1.2E-04 | 3.0E-04 | 1 |
| Maroon Bells - Snowmass Wilderness Area | $NO_2$ | Annual | 7.8E-03 | 1.8E-02 | 2.5 |
| | $SO_2$ | 3-hour | 2.8E-02 | 3.3E-02 | 25 |
| | | 24-hour | 6.9E-03 | 8.3E-03 | 5 |
| | | Annual | 6.7E-04 | 8.4E-04 | 2 |
| | $PM_{10}$ | 24-hour | 5.5E-02 | 1.6E-01 | 8 |
| | | Annual | 3.0E-03 | 8.1E-03 | 4 |
| | $PM_{2.5}$ | 24-hour | 3.9E-02 | 1.0E-01 | 2 |
| | | Annual | 1.9E-03 | 4.7E-03 | 1 |
| Mount Zirkel Wilderness Area | $NO_2$ | Annual | 4.9E-05 | 1.1E-04 | 2.5 |
| | $SO_2$ | 3-hour | 5.4E-04 | 7.7E-04 | 25 |
| | | 24-hour | 2.1E-04 | 2.6E-04 | 5 |
| | | Annual | 7.4E-06 | 9.2E-06 | 2 |
| | $PM_{10}$ | 24-hour | 3.0E-03 | 7.1E-03 | 8 |
| | | Annual | 7.0E-05 | 1.8E-04 | 4 |
| | $PM_{2.5}$ | 24-hour | 2.5E-03 | 5.5E-03 | 2 |
| | | Annual | 5.8E-05 | 1.4E-04 | 1 |
| Rocky Mountain National Park | $NO_2$ | Annual | 1.4E-04 | 3.3E-04 | 25 |
| | $SO_2$ | 3-hour | 1.1E-03 | 1.9E-03 | 25 |
| | | 24-hour | 3.5E-04 | 4.4E-04 | 5 |
| | | Annual | 2.0E-05 | 2.5E-05 | 2 |
| | $PM_{10}$ | 24-hour | 3.0E-03 | 8.5E-03 | 8 |
| | | Annual | 2.0E-04 | 5.1E-04 | 4 |
| | $PM_{2.5}$ | 24-hour | 2.3E-03 | 6.4E-03 | 2 |
| | | Annual | 1.6E-04 | 3.8E-04 | 1 |
| Weminuche Wilderness Area | $NO_2$ | Annual | 6.0E-05 | 1.5E-04 | 2.5 |
| | $SO_2$ | 3-hour | 1.2E-03 | 3.6E-03 | 25 |
| | | 24-hour | 2.6E-04 | 6.8E-04 | 5 |
| | | Annual | 9.8E-06 | 1.3E-05 | 2 |
| | $PM_{10}$ | 24-hour | 6.8E-03 | 2.2E-02 | 8 |
| | | Annual | 9.3E-05 | 2.4E-04 | 4 |
| | $PM_{2.5}$ | 24-hour | 6.9E-03 | 2.2E-02 | 2 |
| | | Annual | 7.9E-05 | 1.9E-04 | 1 |

**Table 4-3**
**Project Alternatives - Maximum Modeled Pollutant Concentrations at Class I and Sensitive Class II Areas**

| Location | Pollutant | Averaging Time | No Action Direct Modeled Concentration (µg/m$^3$) | Proposed Action Direct Modeled Concentration (µg/m$^3$) | PSD Increment (µg/m$^3$) |
|---|---|---|---|---|---|
| West Elk Wilderness Area | $NO_2$ | Annual | 2.7E-03 | 6.7E-03 | 2.5 |
| | $SO_2$ | 3-hour | 7.4E-03 | 1.2E-02 | 25 |
| | | 24-hour | 2.8E-03 | 3.3E-03 | 5 |
| | | Annual | 2.1E-04 | 2.6E-04 | 2 |
| | $PM_{10}$ | 24-hour | 2.3E-02 | 6.7E-02 | 8 |
| | | Annual | 1.2E-03 | 3.3E-03 | 4 |
| | $PM_{2.5}$ | 24-hour | 2.1E-02 | 6.3E-02 | 2 |
| | | Annual | 8.8E-04 | 2.2E-03 | 1 |

**Table 4-4**
**Project Alternatives and Existing Sources - Maximum Modeled Pollutant Concentrations at Class I and Sensitive Class II Areas**

| Location | Pollutant | Averaging Time | No Action Direct Modeled Concentration (µg/m$^3$) | Proposed Action Direct Modeled Concentration (µg/m$^3$) | PSD Increment (µg/m$^3$) |
|---|---|---|---|---|---|
| Arches National Park | $NO_2$ | Annual | 7.5E-06 | 1.5E-05 | 2.5 |
| | $SO_2$ | 3-hour | 4.7E-04 | 5.3E-04 | 25 |
| | | 24-hour | 1.4E-04 | 1.6E-04 | 5 |
| | | Annual | 1.6E-06 | 1.9E-06 | 2 |
| | $PM_{10}$ | 24-hour | 9.6E-04 | 2.1E-03 | 8 |
| | | Annual | 1.3E-05 | 2.9E-05 | 4 |
| | $PM_{2.5}$ | 24-hour | 9.6E-04 | 2.1E-03 | 2 |
| | | Annual | 1.1E-05 | 2.2E-05 | 1 |
| Black Canyon of the Gunnison National Park | $NO_2$ | Annual | 5.0E-04 | 1.0E-03 | 2.5 |
| | $SO_2$ | 3-hour | 3.4E-03 | 4.6E-03 | 25 |
| | | 24-hour | 1.1E-03 | 1.2E-03 | 5 |
| | | Annual | 3.3E-05 | 4.2E-05 | 2 |
| | $PM_{10}$ | 24-hour | 1.1E-02 | 2.7E-02 | 8 |
| | | Annual | 2.8E-04 | 6.5E-04 | 4 |
| | $PM_{2.5}$ | 24-hour | 1.0E-02 | 2.3E-02 | 2 |
| | | Annual | 2.5E-04 | 5.3E-04 | 1 |
| Colorado National Monument | $NO_2$ | Annual | 5.8E-05 | 1.1E-04 | 2.5 |
| | $SO_2$ | 3-hour | 5.9E-04 | 6.9E-04 | 25 |
| | | 24-hour | 1.4E-04 | 1.5E-04 | 5 |
| | | Annual | 7.0E-06 | 8.2E-06 | 2 |
| | $PM_{10}$ | 24-hour | 1.7E-03 | 3.7E-03 | 8 |
| | | Annual | 4.9E-05 | 1.1E-04 | 4 |
| | $PM_{2.5}$ | 24-hour | 1.4E-03 | 2.9E-03 | 2 |
| | | Annual | 4.2E-05 | 8.5E-05 | 1 |

**Table 4-4**
**Project Alternatives and Existing Sources - Maximum Modeled Pollutant Concentrations at Class I and Sensitive Class II Areas**

| Location | Pollutant | Averaging Time | No Action Direct Modeled Concentration (µg/m³) | Proposed Action Direct Modeled Concentration (µg/m³) | PSD Increment (µg/m³) |
|---|---|---|---|---|---|
| Dinosaur National Monument | $NO_2$ | Annual | 8.2E-06 | 1.6E-05 | 25 |
| | $SO_2$ | 3-hour | 2.8E-04 | 3.2E-04 | 512 |
| | | 24-hour | 4.9E-05 | 5.7E-05 | 91 |
| | | Annual | 1.4E-06 | 1.7E-06 | 20 |
| | $PM_{10}$ | 24-hour | 7.1E-04 | 1.6E-03 | 30 |
| | | Annual | 1.4E-05 | 3.3E-05 | 17 |
| | $PM_{2.5}$ | 24-hour | 6.9E-04 | 1.5E-03 | 9 |
| | | Annual | 1.2E-05 | 2.5E-05 | 4 |
| Eagles Nest Wilderness Area | $NO_2$ | Annual | 4.7E-04 | 9.8E-04 | 2.5 |
| | $SO_2$ | 3-hour | 1.9E-03 | 3.3E-03 | 25 |
| | | 24-hour | 3.5E-04 | 5.4E-04 | 5 |
| | | Annual | 4.4E-05 | 5.5E-05 | 2 |
| | $PM_{10}$ | 24-hour | 1.0E-02 | 2.6E-02 | 8 |
| | | Annual | 4.5E-04 | 1.0E-03 | 4 |
| | $PM_{2.5}$ | 24-hour | 9.5E-03 | 2.5E-02 | 2 |
| | | Annual | 3.7E-04 | 7.7E-04 | 1 |
| Flat Tops Wilderness Area | $NO_2$ | Annual | 2.8E-04 | 5.7E-04 | 2.5 |
| | $SO_2$ | 3-hour | 1.7E-03 | 3.3E-03 | 25 |
| | | 24-hour | 4.4E-04 | 6.2E-04 | 5 |
| | | Annual | 2.3E-05 | 2.9E-05 | 2 |
| | $PM_{10}$ | 24-hour | 1.1E-02 | 2.8E-02 | 8 |
| | | Annual | 2.7E-04 | 6.3E-04 | 4 |
| | $PM_{2.5}$ | 24-hour | 1.1E-02 | 2.8E-02 | 2 |
| | | Annual | 2.4E-04 | 5.0E-04 | 1 |
| La Garita Wilderness Area | $NO_2$ | Annual | 1.4E-04 | 3.1E-04 | 2.5 |
| | $SO_2$ | 3-hour | 3.5E-03 | 7.5E-03 | 25 |
| | | 24-hour | 6.1E-04 | 1.3E-03 | 5 |
| | | Annual | 1.6E-05 | 2.1E-05 | 2 |
| | $PM_{10}$ | 24-hour | 1.4E-02 | 3.6E-02 | 8 |
| | | Annual | 1.8E-04 | 4.2E-04 | 4 |
| | $PM_{2.5}$ | 24-hour | 1.5E-02 | 3.8E-02 | 2 |
| | | Annual | 1.6E-04 | 3.4E-04 | 1 |
| Maroon Bells - Snowmass Wilderness Area | $NO_2$ | Annual | 9.5E-03 | 1.9E-02 | 2.5 |
| | $SO_2$ | 3-hour | 2.9E-02 | 3.4E-02 | 25 |
| | | 24-hour | 7.1E-03 | 8.4E-03 | 5 |
| | | Annual | 6.9E-04 | 8.6E-04 | 2 |
| | $PM_{10}$ | 24-hour | 6.5E-02 | 1.7E-01 | 8 |
| | | Annual | 3.4E-03 | 8.5E-03 | 4 |
| | $PM_{2.5}$ | 24-hour | 4.9E-02 | 1.1E-01 | 2 |
| | | Annual | 2.4E-03 | 5.1E-03 | 1 |

**Table 4-4**
**Project Alternatives and Existing Sources - Maximum Modeled Pollutant Concentrations at Class I and Sensitive Class II Areas**

| Location | Pollutant | Averaging Time | No Action Direct Modeled Concentration (μg/m$^3$) | Proposed Action Direct Modeled Concentration (μg/m$^3$) | PSD Increment (μg/m$^3$) |
|---|---|---|---|---|---|
| Mount Zirkel Wilderness Area | $NO_2$ | Annual | 6.4E-05 | 1.3E-04 | 2.5 |
| | $SO_2$ | 3-hour | 5.6E-04 | 8.2E-04 | 25 |
| | | 24-hour | 2.2E-04 | 2.7E-04 | 5 |
| | | Annual | 7.8E-06 | 9.5E-06 | 2 |
| | $PM_{10}$ | 24-hour | 3.5E-03 | 7.6E-03 | 8 |
| | | Annual | 8.6E-05 | 1.9E-04 | 4 |
| | $PM_{2.5}$ | 24-hour | 3.0E-03 | 6.1E-03 | 2 |
| | | Annual | 7.4E-05 | 1.5E-04 | 1 |
| Rocky Mountain National Park | $NO_2$ | Annual | 1.8E-04 | 3.7E-04 | 25 |
| | $SO_2$ | 3-hour | 1.1E-03 | 1.9E-03 | 25 |
| | | 24-hour | 3.6E-04 | 4.5E-04 | 5 |
| | | Annual | 2.1E-05 | 2.6E-05 | 2 |
| | $PM_{10}$ | 24-hour | 3.8E-03 | 9.3E-03 | 8 |
| | | Annual | 2.4E-04 | 5.5E-04 | 4 |
| | $PM_{2.5}$ | 24-hour | 3.3E-03 | 7.3E-03 | 2 |
| | | Annual | 2.0E-04 | 4.3E-04 | 1 |
| Weminuche Wilderness Area | $NO_2$ | Annual | 8.4E-05 | 1.8E-04 | 2.5 |
| | $SO_2$ | 3-hour | 1.4E-03 | 3.8E-03 | 25 |
| | | 24-hour | 2.9E-04 | 7.2E-04 | 5 |
| | | Annual | 1.0E-05 | 1.3E-05 | 2 |
| | $PM_{10}$ | 24-hour | 9.0E-03 | 2.4E-02 | 8 |
| | | Annual | 1.2E-04 | 2.6E-04 | 4 |
| | $PM_{2.5}$ | 24-hour | 9.0E-03 | 2.4E-02 | 2 |
| | | Annual | 1.0E-04 | 2.2E-04 | 1 |
| West Elk Wilderness Area | $NO_2$ | Annual | 3.6E-03 | 7.6E-03 | 2.5 |
| | $SO_2$ | 3-hour | 7.7E-03 | 1.3E-02 | 25 |
| | | 24-hour | 2.9E-03 | 3.3E-03 | 5 |
| | | Annual | 2.2E-04 | 2.7E-04 | 2 |
| | $PM_{10}$ | 24-hour | 2.9E-02 | 7.2E-02 | 8 |
| | | Annual | 1.5E-03 | 3.6E-03 | 4 |
| | $PM_{2.5}$ | 24-hour | 2.9E-02 | 7.2E-02 | 2 |
| | | Annual | 1.1E-03 | 2.4E-03 | 1 |

## 4.5 VISIBILITY

CALPUFF predicted 24-hour concentrations of nitrate, sulfate, $PM_{10}$ and $PM_{2.5}$ at each of the analyzed Class I and sensitive Class II areas were processed using CALPOST following the procedures described in the FLAG 2010 document to estimate potential change in light extinction. A first level screening analysis was conducted using the methodology recommended in the FLAG 2010 report. The FLAG method uses seasonal natural background visibility conditions and monthly relative humidity factors from the FLAG report. For the sensitive Class II areas the data for the closest Class I area was used. For the Class II Colorado National Monument, background data for Black Canyon of the Gunnison National Park were used. Data from the Flat Tops Wilderness Area were used for the Class II Dinosaur National Monument.

Change in atmospheric light extinction relative to background conditions is used to measure regional haze. Analysis thresholds for atmospheric light extinction are set forth in FLAG (2010), with the results reported in percent change in light extinction and change in deciview (Δdv). A 5 percent change in light extinction (approximately equal to a 0.5 Δdv) is the threshold recommended in FLAG (2010) and is considered to contribute to regional haze visibility impairment.

**Table 4-5** provides the CALPUFF visibility modeling results for both the No Action and Proposed Action alternatives. The maximum Δdv is reported for each Class I and sensitive Class II area. As is indicated in **Table 4-5** the maximum visibility impacts are below the 0.5 Δdv threshold at all the Class I and sensitive Class II areas for both project alternatives. In addition the modeled visibility impacts resulting from existing Bull Mountain sources and from project alternative sources (**Table 4-6**) are below the 0.5 Δdv threshold at all the Class I and sensitive Class II areas.

**Table 4-5**
**Project Alternatives - Maximum Visibility Impacts at Class I and Sensitive Class II Areas**

| | **No Action Alternative** | **Proposed Action Alternative** |
|---|---|---|
| **Area of Concern** | **Maximum Δdv** | **Maximum Δdv** |
| Arches National Park | 0.003 | 0.008 |
| Black Canyon of the Gunnison National Park | 0.028 | 0.078 |
| Colorado National Monument | 0.004 | 0.009 |
| Dinosaur National Monument | 0.002 | 0.006 |
| Eagles Nest Wilderness Area | 0.033 | 0.102 |
| Flat Tops Wilderness Area | 0.037 | 0.115 |
| La Garita Wilderness Area | 0.045 | 0.142 |
| Maroon Bells Wilderness Area | 0.170 | 0.449 |
| Mount Zirkel Wilderness Area | 0.011 | 0.024 |
| Rocky Mountain National Park | 0.009 | 0.026 |
| Weminuche Wilderness Area | 0.031 | 0.098 |
| West Elk Wilderness Area | 0.086 | 0.260 |

**Table 4-6**
**Project Alternatives and Existing Sources - Maximum Visibility Impacts at Class I and Sensitive Class II Areas**

| | **No Action Alternative** | **Proposed Action Alternative** |
|---|---|---|
| **Area of Concern** | **Maximum Δ dv** | **Maximum Δ dv** |
| Arches National Park | 0.004 | 0.009 |
| Black Canyon of the Gunnison National Park | 0.039 | 0.090 |
| Colorado National Monument | 0.005 | 0.010 |
| Dinosaur National Monument | 0.003 | 0.007 |
| Eagles Nest Wilderness Area | 0.043 | 0.112 |
| Flat Tops Wilderness Area | 0.052 | 0.129 |
| La Garita Wilderness Area | 0.060 | 0.156 |
| Maroon Bells Wilderness Area | 0.216 | 0.494 |
| Mount Zirkel Wilderness Area | 0.013 | 0.026 |
| Rocky Mountain National Park | 0.012 | 0.027 |
| Weminuche Wilderness Area | 0.041 | 0.108 |
| West Elk Wilderness Area | 0.123 | 0.296 |

## 4.6 DEPOSITION

The POSTUTIL and CALPOST processors were used to determine the maximum total (wet and dry) annual atmospheric deposition of sulfur (S) and nitrogen (N) from CALPUFF modeled deposition results at each Class I and sensitive Class II area. The results are expressed in kilograms per hectare per year (kg/ha-yr).

FLAG (2010) recommends that applicable sources assess impacts of nitrogen and sulfur deposition at Class I areas. This guidance recognizes the importance of establishing critical deposition loading values ("critical loads") for each specific Class I area, as these critical loads are completely dependent on local atmospheric, aquatic and terrestrial conditions, and chemistry. Critical load thresholds are essentially a level of atmospheric pollutant deposition below which negative ecosystem effects are not likely to occur. FLAG (2010) does not include any critical load levels for specific Class I areas and refers to site-specific critical load information on FLM websites for each area of concern. This guidance does, however, recommend the use of deposition analysis thresholds (DATs) developed by the National Park Service and the U.S. Fish and Wildlife Service. The DATs represent screening level values for nitrogen and sulfur deposition from project alone emission sources below which estimated impacts are considered negligible. The DAT established for both nitrogen and sulfur in western Class I areas is 0.005 kilograms per hectare per year (kg/ha/yr). Results for project alone sources are compared to these thresholds.

Potential atmospheric deposition impacts within the Class I and sensitive Class II areas were calculated for No Action sources and are shown in **Table 4-7**. The maximum N and S deposition impacts are predicted to be below the DAT of 0.005 kg/ha-yr at all Class I and sensitive Class II areas

**Table 4-7**
**No Action – Maximum Nitrogen and Sulfur Deposition Impacts at Class I and Sensitive Class II Areas**

| Location | Maximum N Deposition (kg/ha/yr) | Maximum S Deposition (kg/ha/yr) |
|---|---|---|
| Arches National Park | 0.00001 | 0.000001 |
| Black Canyon of the Gunnison National Park | 0.00030 | 0.000044 |
| Colorado National Monument | 0.00003 | 0.000005 |
| Dinosaur National Monument | 0.00001 | 0.000002 |
| Eagles Nest Wilderness Area | 0.00047 | 0.000061 |
| Flat Tops Wilderness Area | 0.00030 | 0.000038 |
| La Garita Wilderness Area | 0.00025 | 0.000036 |
| Maroon Bells-Snowmass Wilderness Area | 0.00427 | 0.000705 |
| Mount Zirkel Wilderness Area | 0.00011 | 0.000014 |
| Ragged Wilderness Area (Deep Creek Lake) | 0.00273 | 0.000416 |
| Rocky Mountain National Park | 0.00026 | 0.000032 |
| Weminuche Wilderness Area | 0.00015 | 0.000022 |
| West Elk Wilderness Area | 0.00134 | 0.000177 |

**Table 4-8** provides the estimated atmospheric deposition impacts for the Proposed Action sources. The maximum N and S deposition are predicted to be well below the DAT of 0.005 kg/ha-yr at all Class I and sensitive Class II areas with the exception of the Maroon Bells-Snowmass Wilderness Area and at the Raggeds Wilderness Area (Deep Creek Lake). At the Maroon Bells-Snowmass Wilderness Area the maximum predicted N deposition impact is 0.0095 kg/ha-yr, and at the Ragged Wilderness Area (Deep Creek Lake) the maximum N deposition impact is 0.0062 kg/ha-yr.

**Table 4-8**
**Proposed Action – Maximum Nitrogen and Sulfur Deposition Impacts at Class I and Sensitive Class II Areas**

| Location | Maximum N Deposition (kg/ha/yr) | Maximum S Deposition (kg/ha/yr) |
|---|---|---|
| Arches National Park | 0.00002 | 0.000001 |
| Black Canyon of the Gunnison National Park | 0.00070 | 0.000054 |
| Colorado National Monument | 0.00008 | 0.000006 |
| Dinosaur National Monument | 0.00002 | 0.000002 |
| Eagles Nest Wilderness Area | 0.00110 | 0.000075 |
| Flat Tops Wilderness Area | 0.00069 | 0.000045 |
| La Garita Wilderness Area | 0.00057 | 0.000043 |
| Maroon Bells-Snowmass Wilderness Area | 0.00953 | 0.000874 |
| Mount Zirkel Wilderness Area | 0.00025 | 0.000017 |
| Ragged Wilderness Area (Deep Creek Lake) | 0.00623 | 0.000521 |
| Rocky Mountain National Park | 0.00061 | 0.000039 |
| Weminuche Wilderness Area | 0.00034 | 0.000026 |
| West Elk Wilderness Area | 0.00319 | 0.000221 |

**Table 4-9** provides the estimated atmospheric deposition impacts for the No Action and existing sources modeling scenario. The maximum N and S deposition impacts are predicted to be below the DAT of 0.005 kg/ha-yr at all Class I and sensitive Class II areas with the exception of the Maroon Bells-Snowmass Wilderness Area. At the Maroon Bells-Snowmass Wilderness Area the maximum predicted N deposition impact is 0.0052 kg/ha-yr.

**Table 4-9**
**No Action and Existing Sources – Maximum Nitrogen and Sulfur Deposition Impacts at Class I and Sensitive Class II Areas**

| Location | Maximum N Deposition (kg/ha/yr) | Maximum S Deposition (kg/ha/yr) |
|---|---|---|
| Arches National Park | 0.00001 | 0.000001 |
| Black Canyon of the Gunnison National Park | 0.00039 | 0.000046 |
| Colorado National Monument | 0.00004 | 0.000006 |
| Dinosaur National Monument | 0.00001 | 0.000002 |
| Eagles Nest Wilderness Area | 0.00061 | 0.000063 |
| Flat Tops Wilderness Area | 0.00039 | 0.000039 |
| La Garita Wilderness Area | 0.00032 | 0.000037 |
| Maroon Bells-Snowmass Wilderness Area | 0.00520 | 0.000725 |
| Mount Zirkel Wilderness Area | 0.00014 | 0.000015 |
| Ragged Wilderness Area (Deep Creek Lake) | 0.00341 | 0.000429 |
| Rocky Mountain National Park | 0.00034 | 0.000033 |
| Weminuche Wilderness Area | 0.00019 | 0.000023 |
| West Elk Wilderness Area | 0.00174 | 0.000185 |

The maximum N and S deposition impacts for the Proposed Action and existing sources modeling scenario are shown in **Table 4-10**. The N and S deposition impacts are predicted to be well below the DAT of 0.005 kg/ha-yr at all Class I and sensitive Class II areas with the exception of the Maroon Bells-Snowmass Wilderness Area and at the Raggeds Wilderness Area (Deep Creek Lake). At the Maroon Bells-Snowmass Wilderness Area the maximum predicted N deposition impact is 0.0105 kg/ha-yr, and at the Ragged Wilderness Area (Deep Creek Lake) the maximum N deposition impact is 0.0069 kg/ha-yr.

**Table 4-10**
**Proposed Action and Existing Sources – Maximum Nitrogen and Sulfur Deposition Impacts at Class I and Sensitive Class II Areas**

| Location | Maximum N Deposition (kg/ha/yr) | Maximum S Deposition (kg/ha/yr) |
|---|---|---|
| Arches National Park | 0.00002 | 0.000002 |
| Black Canyon of the Gunnison National Park | 0.00079 | 0.000056 |
| Colorado National Monument | 0.00008 | 0.000006 |
| Dinosaur National Monument | 0.00003 | 0.000002 |
| Eagles Nest Wilderness Area | 0.00123 | 0.000078 |
| Flat Tops Wilderness Area | 0.00079 | 0.000047 |
| La Garita Wilderness Area | 0.00064 | 0.000045 |
| Maroon Bells-Snowmass Wilderness Area | 0.01045 | 0.000894 |
| Mount Zirkel Wilderness Area | 0.00028 | 0.000018 |
| Ragged Wilderness Area (Deep Creek Lake) | 0.00690 | 0.000534 |
| Rocky Mountain National Park | 0.00069 | 0.000041 |
| Weminuche Wilderness Area | 0.00039 | 0.000027 |
| West Elk Wilderness Area | 0.00360 | 0.000229 |

## 4.7 LAKE CHEMISTRY

CALPUFF modeled annual N and S deposition impacts at sensitive lake locations were used to estimate changes in ANC. The changes in ANC were calculated following the January 2000, USFS Rocky Mountain Region's *Screening Methodology for Calculating ANC Change to High Elevation Lakes, User's Guide* (USDA Forest Service 2000). The most recent lake chemistry background ANC data available from the Forest Service for the 28 sensitive lakes was obtained from the Visibility Information Exchange Web System (VIEWS 2014). The 10th percentile lowest ANC values were calculated for each lake following procedures provided by the Forest Service and these values are provided in **Table 4-11**. Of the 28 lakes listed in **Table 4-11**, 6 lakes are considered by the Forest Service as extremely sensitive to atmospheric deposition because the background ANC values are less than 25 microequivalents per liter (μeq/l). Annual precipitation data for each lake were obtained from the Parameter-elevation Regressions on Independent Slopes Model (PRISM) (PRISM 2014) climate mapping system data base, and these precipitation values were used in the calculation of ANC changes.

The CALPUFF-predicted annual deposition fluxes of S and N at sensitive lake receptors were used to estimate the change in ANC. The predicted changes in ANC are compared with the Forest Service's Level of Acceptable Change (LAC) thresholds of 10 percent for lakes with ANC values greater than 25 microequivalents per liter (μeq/l) and 1 μeq/l for lakes with background ANC values of 25 μeq/l and less.

**Table 4-11**
**Background ANC Values for Acid Sensitive Lakes[1]**

| Wilderness Area | Lake | Latitude (Degs) | Longitude (Degs) | Annual Precipitation (m)[3] | 10th Percentile Lowest ANC Value (μeq/l)[2] | Number of Samples | Monitoring Period |
|---|---|---|---|---|---|---|---|
| Eagles Nest | Booth Lake | 39.698 | 106.304 | 1.10 | 86.8 | 49 | 1993-2010 |
| Eagles Nest | Upper Willow Lake | 39.647 | 106.174 | 0.90 | 134.1 | 52 | 1990-2011 |
| Flat Tops | Ned Wilson Lake | 39.961 | 107.324 | 1.14 | 39.0 | 191 | 1981-2007 |
| Flat Tops | Upper Ned Wilson Lake | 39.963 | 107.324 | 1.14 | 12.9 | 143 | 1983-2007 |
| Flat Tops | Lower NWL Packtrail Pothole | 39.968 | 107.324 | 1.14 | 29.7 | 96 | 1987-2007 |
| Flat Tops | Upper NWL Packtrail Pothole | 39.966 | 107.324 | 1.14 | 48.7 | 96 | 1987-2007 |
| La Garita | Small Lake Above U-Shaped Lake | 37.944 | 106.865 | 0.80 | 59.9 | 24 | 1992-2009 |
| La Garita | U-Shaped Lake | 37.943 | 106.862 | 0.80 | 81.4 | 23 | 1992-2009 |
| Maroon Bells | Avalanche Lake | 39.144 | 107.100 | 1.60 | 158.8 | 55 | 1991-2010 |
| Maroon Bells | Capitol Lake | 39.163 | 107.082 | 1.44 | 154.4 | 57 | 1991-2010 |
| Maroon Bells | Moon Lake | 39.164 | 107.059 | 1.21 | 53.0 | 54 | 1991-2010 |
| Mount Zirkel | Lake Elbert | 40.634 | 106.707 | 1.70 | 56.6 | 67 | 1985-2007 |
| Mount Zirkel | Seven Lakes | 40.896 | 106.682 | 1.30 | 36.2 | 67 | 1985-2007 |
| Mount Zirkel | Summit Lake | 40.545 | 106.682 | 1.40 | 48.0 | 107 | 1985-2007 |
| Raggeds | Deep Creek Lake | 39.009 | 107.240 | 1.03 | 20.6 | 24 | 1995-2009 |
| Weminuche | Big Eldorado | 37.713 | 107.543 | 1.10 | 19.6 | 55 | 1985-2007 |
| Weminuche | Four Mile Pothole | 37.468 | 107.052 | 1.40 | 123.4 | 19 | 2000-2009 |
| Weminuche | Lake Due South of Ute Lake | 37.636 | 107.443 | 1.10 | 13.2 | 24 | 1992-2009 |
| Weminuche | Little Eldorado Lake | 37.713 | 107.546 | 1.10 | -3.3 | 54 | 1985-2007 |
| Weminuche | Little Granite Lake | 37.621 | 107.332 | 0.60 | 80.7 | 20 | 2000-2009 |
| Weminuche | Lower Sunlight | 37.633 | 107.583 | 1.20 | 80.9 | 52 | 1985-2007 |
| Weminuche | Middle Ute Lake | 37.648 | 107.475 | 1.00 | 42.8 | 29 | 1985-2009 |
| Weminuche | Small Pond Above Trout Lake | 37.652 | 107.156 | 0.90 | 25.5 | 27 | 1992-2009 |
| Weminuche | Upper Grizzly | 37.620 | 107.584 | 1.20 | 29.9 | 45 | 1985-2007 |
| Weminuche | Upper Sunlight | 37.628 | 107.580 | 1.20 | 28.0 | 51 | 1985-2007 |
| Weminuche | West Snowdon Lake | 37.710 | 107.694 | 1.20 | 39.4 | 26 | 2000-2009 |
| Weminuche | White Dome Lake | 37.709 | 107.553 | 1.10 | 2.1 | 52 | 1985-2007 |
| West Elk | South Golden Lake | 38.778 | 107.183 | 1.14 | 111.4 | 25 | 1995-2008 |

[1] From VIEWS (2014)
[2] 10th Percentile Lowest ANC Values reported
[3] Annual precipitation for 2008 from PRISM (2014)

**Tables 4-12** and **4-13** provided the estimated changes in ANC for the No Action and Proposed Action alternatives, and **Tables 4-14** and **4-15** provide the estimated changes in ANC for the combined existing Bull Mountain sources and project alternative sources modeling scenarios.

For all modeling scenarios, the estimated changes in ANC are all predicted to be less than the significance thresholds of less than a 10 percent change in ANC for lakes with ANC values greater than 25 μeq/l, and a 1.0 μeq/l change in ANC for lakes with background ANC values equal to or less than 25 μeq/l.

**Table 4-12**
**No Action – Maximum Impacts to Lakes within the Class I and Sensitive Class II Areas**

| Wilderness Area | Sensitive Lake | 10th Percentile Lowest ANC Value (μeq/L) | N Deposition (kg/ha/yr) | S Deposition (kg/ha/yr) | ANC Relative Change (%) | ANC Absolute Change (μeq/L) |
|---|---|---|---|---|---|---|
| Eagles Nest | Booth Lake | 86.8 | 0.00040 | 0.00005 | 0.005 | n/a |
| Eagles Nest | Upper Willow Lake | 134.1 | 0.00042 | 0.00005 | 0.004 | n/a |
| Flat Tops | Ned Wilson Lake | 39.0 | 0.00019 | 0.00002 | 0.005 | n/a |
| Flat Tops | Upper Ned Wilson Lake | 12.9 | 0.00019 | 0.00002 | 0.015 | 0.002 |
| Flat Tops | Lower Packtrail Pothole | 29.7 | 0.00019 | 0.00002 | 0.007 | n/a |
| Flat Tops | Upper Packtrail Pothole | 48.7 | 0.00019 | 0.00002 | 0.004 | n/a |
| La Garita | Small Lake Above U-Shaped Lake | 59.9 | 0.00021 | 0.00003 | 0.005 | n/a |
| La Garita | U-Shaped Lake | 81.4 | 0.00021 | 0.00003 | 0.004 | n/a |
| Maroon Bells | Avalanche Lake | 158.8 | 0.00209 | 0.00031 | 0.010 | n/a |
| Maroon Bells | Capitol Lake | 154.4 | 0.00208 | 0.00031 | 0.011 | n/a |
| Maroon Bells | Moon Lake | 53.0 | 0.00207 | 0.00031 | 0.039 | n/a |
| Mount Zirkel | Lake Elbert | 56.6 | 0.00010 | 0.00001 | 0.001 | n/a |
| Mount Zirkel | Seven Lakes (LG East) | 36.2 | 0.00008 | 0.00001 | 0.002 | n/a |
| Mount Zirkel | Summit Lake | 48.0 | 0.00011 | 0.00001 | 0.002 | n/a |
| Raggeds | Deep Creek Lake | 20.6 | 0.00273 | 0.00042 | 0.156 | 0.032 |
| Weminuche | Big Eldorado Lake | 19.6 | 0.00008 | 0.00001 | 0.004 | 0.001 |
| Weminuche | Four Mile Pothole | 123.4 | 0.00009 | 0.00001 | 0.001 | n/a |
| Weminuche | Lake Due South of Ute Lake | 13.2 | 0.00008 | 0.00001 | 0.006 | 0.001 |
| Weminuche | Little Eldorado | -3.3 | 0.00008 | 0.00001 | 0.027 | 0.001 |
| Weminuche | Little Granite Lake | 80.7 | 0.00008 | 0.00001 | 0.002 | n/a |
| Weminuche | Lower Sunlight Lake | 80.9 | 0.00007 | 0.00001 | 0.001 | n/a |
| Weminuche | Middle Ute Lake | 42.8 | 0.00008 | 0.00001 | 0.002 | n/a |
| Weminuche | Small Pond Above Trout Lake | 25.5 | 0.00009 | 0.00001 | 0.005 | n/a |
| Weminuche | Upper Grizzly Lake | 29.9 | 0.00007 | 0.00001 | 0.002 | n/a |
| Weminuche | Upper Sunlight Lake | 28.0 | 0.00007 | 0.00001 | 0.003 | n/a |
| Weminuche | West Snowdon Lake | 39.4 | 0.00008 | 0.00001 | 0.002 | n/a |
| Weminuche | White Dome Lake | 2.1 | 0.00008 | 0.00001 | 0.042 | 0.09 |
| West Elk | South Golden Lake | 111.4 | 0.00091 | 0.00012 | 0.009 | n/a |

**Table 4-13**
**Proposed Action – Maximum Impacts to Lakes within the Class I and Sensitive Class II Areas**

| Wilderness Area | Sensitive Lake | 10th Percentile Lowest ANC Value (μeq/L) | N Deposition (kg/ha/yr) | S Deposition (kg/ha/yr) | ANC Relative Change (%) | ANC Absolute Change (μeq/L) |
|---|---|---|---|---|---|---|
| Eagles Nest | Booth Lake | 86.8 | 0.00093 | 0.00006 | 0.011 | n/a |
| Eagles Nest | Upper Willow Lake | 134.1 | 0.00098 | 0.00007 | 0.009 | n/a |
| Flat Tops | Ned Wilson Lake | 39.0 | 0.00042 | 0.00003 | 0.011 | n/a |
| Flat Tops | Upper Ned Wilson Lake | 12.9 | 0.00042 | 0.00003 | 0.032 | 0.004 |
| Flat Tops | Lower Packtrail Pothole | 29.7 | 0.00042 | 0.00003 | 0.014 | n/a |
| Flat Tops | Upper Packtrail Pothole | 48.7 | 0.00042 | 0.00003 | 0.009 | n/a |
| La Garita | Small Lake Above U-Shaped Lake | 59.9 | 0.00049 | 0.00004 | 0.012 | n/a |
| La Garita | U-Shaped Lake | 81.4 | 0.00049 | 0.00004 | 0.009 | n/a |
| Maroon Bells | Avalanche Lake | 158.8 | 0.00471 | 0.00038 | 0.021 | n/a |
| Maroon Bells | Capitol Lake | 154.4 | 0.00467 | 0.00038 | 0.024 | n/a |
| Maroon Bells | Moon Lake | 53.0 | 0.00465 | 0.00039 | 0.083 | n/a |
| Mount Zirkel | Lake Elbert | 56.6 | 0.00022 | 0.00002 | 0.003 | n/a |
| Mount Zirkel | Seven Lakes (LG East) | 36.2 | 0.00018 | 0.00001 | 0.004 | n/a |
| Mount Zirkel | Summit Lake | 48.0 | 0.00025 | 0.00002 | 0.004 | n/a |
| Raggeds | Deep Creek Lake | 20.6 | 0.00623 | 0.00052 | 0.335 | 0.069 |
| Weminuche | Big Eldorado Lake | 19.6 | 0.00018 | 0.00002 | 0.010 | 0.002 |
| Weminuche | Four Mile Pothole | 123.4 | 0.00021 | 0.00002 | 0.001 | n/a |
| Weminuche | Lake Due South of Ute Lake | 13.2 | 0.00018 | 0.00001 | 0.014 | 0.002 |
| Weminuche | Little Eldorado | -3.3 | 0.00018 | 0.00002 | 0.057 | 0.002 |
| Weminuche | Little Granite Lake | 80.7 | 0.00019 | 0.00002 | 0.004 | n/a |
| Weminuche | Lower Sunlight Lake | 80.9 | 0.00017 | 0.00001 | 0.002 | n/a |
| Weminuche | Middle Ute Lake | 42.8 | 0.00018 | 0.00001 | 0.005 | n/a |
| Weminuche | Small Pond Above Trout Lake | 25.5 | 0.00022 | 0.00002 | 0.011 | n/a |
| Weminuche | Upper Grizzly Lake | 29.9 | 0.00016 | 0.00001 | 0.005 | n/a |
| Weminuche | Upper Sunlight Lake | 28.0 | 0.00017 | 0.00001 | 0.006 | n/a |
| Weminuche | West Snowdon Lake | 39.4 | 0.00017 | 0.00002 | 0.004 | n/a |
| Weminuche | White Dome Lake | 2.1 | 0.00018 | 0.00002 | 0.089 | 0.19 |
| West Elk | South Golden Lake | 111.4 | 0.00215 | 0.00015 | 0.019 | n/a |

**Table 4-14**
**No Action and Existing Sources – Maximum Impacts to Lakes within the Class I and Sensitive Class II Areas**

| Wilderness Area | Sensitive Lake | 10th Percentile Lowest ANC Value (μeq/L) | N Deposition (kg/ha/yr) | S Deposition (kg/ha/yr) | ANC Relative Change (%) | ANC Absolute Change (μeq/L) |
|---|---|---|---|---|---|---|
| Eagles Nest | Booth Lake | 86.8 | 0.00051 | 0.00005 | 0.006 | n/a |
| Eagles Nest | Upper Willow Lake | 134.1 | 0.00054 | 0.00006 | 0.005 | n/a |
| Flat Tops | Ned Wilson Lake | 39.0 | 0.00024 | 0.00003 | 0.006 | n/a |
| Flat Tops | Upper Ned Wilson Lake | 12.9 | 0.00024 | 0.00003 | 0.019 | 0.002 |
| Flat Tops | Lower Packtrail Pothole | 29.7 | 0.00024 | 0.00003 | 0.008 | n/a |
| Flat Tops | Upper Packtrail Pothole | 48.7 | 0.00024 | 0.00003 | 0.005 | n/a |
| La Garita | Small Lake Above U-Shaped Lake | 59.9 | 0.00027 | 0.00003 | 0.007 | n/a |
| La Garita | U-Shaped Lake | 81.4 | 0.00027 | 0.00003 | 0.005 | n/a |
| Maroon Bells | Avalanche Lake | 158.8 | 0.00263 | 0.00032 | 0.012 | n/a |
| Maroon Bells | Capitol Lake | 154.4 | 0.00261 | 0.00032 | 0.014 | n/a |
| Maroon Bells | Moon Lake | 53.0 | 0.00260 | 0.00032 | 0.048 | n/a |
| Mount Zirkel | Lake Elbert | 56.6 | 0.00013 | 0.00001 | 0.002 | n/a |
| Mount Zirkel | Seven Lakes (LG East) | 36.2 | 0.00010 | 0.00001 | 0.002 | n/a |
| Mount Zirkel | Summit Lake | 48.0 | 0.00014 | 0.00002 | 0.002 | n/a |
| Raggeds | Deep Creek Lake | 20.6 | 0.00341 | 0.00043 | 0.190 | 0.039 |
| Weminuche | Big Eldorado Lake | 19.6 | 0.00010 | 0.00001 | 0.006 | 0.001 |
| Weminuche | Four Mile Pothole | 123.4 | 0.00012 | 0.00001 | 0.001 | n/a |
| Weminuche | Lake Due South of Ute Lake | 13.2 | 0.00010 | 0.00001 | 0.008 | 0.001 |
| Weminuche | Little Eldorado | -3.3 | 0.00010 | 0.00001 | 0.033 | 0.001 |
| Weminuche | Little Granite Lake | 80.7 | 0.00011 | 0.00001 | 0.003 | n/a |
| Weminuche | Lower Sunlight Lake | 80.9 | 0.00009 | 0.00001 | 0.001 | n/a |
| Weminuche | Middle Ute Lake | 42.8 | 0.00010 | 0.00001 | 0.003 | n/a |
| Weminuche | Small Pond Above Trout Lake | 25.5 | 0.00012 | 0.00001 | 0.006 | n/a |
| Weminuche | Upper Grizzly Lake | 29.9 | 0.00009 | 0.00001 | 0.003 | n/a |
| Weminuche | Upper Sunlight Lake | 28.0 | 0.00009 | 0.00001 | 0.003 | n/a |
| Weminuche | West Snowdon Lake | 39.4 | 0.00010 | 0.00001 | 0.002 | n/a |
| Weminuche | White Dome Lake | 2.1 | 0.00010 | 0.00001 | 0.052 | 0.001 |
| West Elk | South Golden Lake | 111.4 | 0.00119 | 0.00013 | 0.011 | n/a |

**Table 4-15**
**Proposed Action and Existing Sources – Maximum Impacts to Lakes within the Class I and Sensitive Class II Areas**

| Wilderness Area | Sensitive Lake | 10th Percentile Lowest ANC Value (µeq/L) | N Deposition (kg/ha/yr) | S Deposition (kg/ha/yr) | ANC Relative Change (%) | ANC Absolute Change (µeq/L) |
|---|---|---|---|---|---|---|
| Eagles Nest | Booth Lake | 86.8 | 0.00105 | 0.00006 | 0.011 | n/a |
| Eagles Nest | Upper Willow Lake | 134.1 | 0.00110 | 0.00007 | 0.009 | n/a |
| Flat Tops | Ned Wilson Lake | 39.0 | 0.00048 | 0.00003 | 0.011 | n/a |
| Flat Tops | Upper Ned Wilson Lake | 12.9 | 0.00048 | 0.00003 | 0.032 | 0.004 |
| Flat Tops | Lower Packtrail Pothole | 29.7 | 0.00048 | 0.00003 | 0.014 | n/a |
| Flat Tops | Upper Packtrail Pothole | 48.7 | 0.00048 | 0.00003 | 0.009 | n/a |
| La Garita | Small Lake Above U-Shaped Lake | 59.9 | 0.00055 | 0.00004 | 0.012 | n/a |
| La Garita | U-Shaped Lake | 81.4 | 0.00055 | 0.00004 | 0.009 | n/a |
| Maroon Bells | Avalanche Lake | 158.8 | 0.00525 | 0.00039 | 0.021 | n/a |
| Maroon Bells | Capitol Lake | 154.4 | 0.00520 | 0.00040 | 0.024 | n/a |
| Maroon Bells | Moon Lake | 53.0 | 0.00518 | 0.00040 | 0.083 | n/a |
| Mount Zirkel | Lake Elbert | 56.6 | 0.00025 | 0.00002 | 0.003 | n/a |
| Mount Zirkel | Seven Lakes (LG East) | 36.2 | 0.00020 | 0.00001 | 0.004 | n/a |
| Mount Zirkel | Summit Lake | 48.0 | 0.00028 | 0.00002 | 0.004 | n/a |
| Raggeds | Deep Creek Lake | 20.6 | 0.00690 | 0.00053 | 0.335 | 0.069 |
| Weminuche | Big Eldorado Lake | 19.6 | 0.00020 | 0.00002 | 0.010 | 0.002 |
| Weminuche | Four Mile Pothole | 123.4 | 0.00023 | 0.00002 | 0.001 | n/a |
| Weminuche | Lake Due South of Ute Lake | 13.2 | 0.00020 | 0.00002 | 0.014 | 0.002 |
| Weminuche | Little Eldorado | -3.3 | 0.00020 | 0.00002 | 0.057 | 0.002 |
| Weminuche | Little Granite Lake | 80.7 | 0.00021 | 0.00002 | 0.004 | n/a |
| Weminuche | Lower Sunlight Lake | 80.9 | 0.00019 | 0.00002 | 0.002 | n/a |
| Weminuche | Middle Ute Lake | 42.8 | 0.00020 | 0.00002 | 0.005 | n/a |
| Weminuche | Small Pond Above Trout Lake | 25.5 | 0.00024 | 0.00002 | 0.011 | n/a |
| Weminuche | Upper Grizzly Lake | 29.9 | 0.00018 | 0.00001 | 0.005 | n/a |
| Weminuche | Upper Sunlight Lake | 28.0 | 0.00019 | 0.00001 | 0.006 | n/a |
| Weminuche | West Snowdon Lake | 39.4 | 0.00020 | 0.00002 | 0.004 | n/a |
| Weminuche | White Dome Lake | 2.1 | 0.00020 | 0.00002 | 0.089 | 0.19 |
| West Elk | South Golden Lake | 111.4 | 0.00242 | 0.00016 | 0.019 | n/a |

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# CHAPTER 5
# REFERENCES


Baron, Jill S. 2006. Hindcasting Nitrogen Deposition to Determine and Ecological Critical Load. Ecological Applications, 16(2), 2006, pp 433-439.

Carter Lake Consulting. 2014. Memorandum to Chad Meister and Forrest Cook, BLM from Jim Zapert, Carter Lake Consulting regarding the Bull Mountain Project – Comparison of 2008 WRF Model Meteorological Data at Sites within the Bull Mountain Project Area and Nearby Meteorological Station Data. January 15, 2014.

CDPHE. 2013. Colorado Department of Public Health and Environment, Air Pollution Control Division, Letter from Nancy Chick to Susan Connell, Carter Lake Consulting, Summary of background concentration estimates for the Bull Mountain Unit area, June 12 2013.

ENVIRON, Alpine Geophysics and University of North Carolina. 2012. Western Regional Air Partnership (WRAP) West-wide Jump Start Air Quality Modeling Study (WestJumpAQMS) WRF Application/Evaluation. Prepared for Tom Moore WRAP. February 29, 2012.

ENVIRON. 2013. The Mesoscale Model Interface Program (MMIF) Version 3.0, Draft Users Manual. Prepared for Environmental Protection Agency Office of Air Quality Planning and Standards, Air Quality Assessment Division, Air Quality Modeling Group, Research Triangle Park, North Carolina. September 30, 2013.

Environmental Protection Agency. 1993. Superfund's Standard Default Exposure Factors for the Central Tendency and Reasonable Maximum Exposure. Preliminary Review Draft.

Environmental Protection Agency. 1995. AP-42 Fifth Edition. Compilation of Air Pollutant Emission Factors, Volume I: Stationary Point and Area Sources. EPA Office of Air Quality Planning and Standards, Research Triangle Park, NC. With updates through 2009.

Environmental Protection Agency. 2009. Clarification on EPA-FLM Recommended Settings for CALMET. Environmental Protection Agency Office of Air Quality Planning and Standards, Research Triangle Park, North Carolina. August 31, 2009.

Environmental Protection Agency. 2005. Guideline on Air Quality Models. Updated 2005. Environmental Protection Agency Office of Air Quality Planning and Standards, Research Triangle Park, North Carolina. Published in Federal Register, Vol. 70, No. 216, November 9, 2005.

Environmental Protection Agency. 2011. Air Toxics Database, Table 2, Acute Dose-Response Values for Screening Risk Assessments (12/19/2011). Office of Air Quality Planning and Standards (OAQPS). Technology Transfer Network Air Toxics Website. (http://www.epa.gov/ttn/atw/ toxsource/Table2.pdf).

Environmental Protection Agency. 2012. Air Toxics Database, Table 1, Prioritized Chronic Dose-Response Values (5/7/2012). Office of Air Quality Planning and Standards (OAQPS). Technology Transfer Network Air Toxics Website. (http://www.epa.gov/ttn/atw/toxsource/ Table1.pdf).

Environmental Protection Agency. 2013. NO2/NOx In-Stack Ratio (ISR) Database (8/26/2013). Office of Air Quality Planning and Standards (OAQPS). Technology Transfer Network, Support Center for Regulatory Atmospheric Modeling Website. (http://www.epa.gov/ttn/scram).

Environmental Protection Agency. 2014. Superfund Network. Accessed online: http://www.epa.gov/superfund/community/pdfs/toolkit/risk_communication-attachment6.pdf. Accessed March 2014.

Federal Land Managers' Air Quality Related Values Workgroup. 2010. Federal Land Managers' Air Quality Related Values Workgroup (FLAG) Phase I Report – Revised (2010). U.S. Forest Service-Air Quality Program, National Park Service-Air Resources Division, U.S. Fish and Wildlife Service-Air Quality Branch. October 2010.

U.S.D.A. Forest Service, Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colorado. 36 pp.

PRISM 2014. Parameter-elevation Regressions on Independent Slopes Model (PRISM), PRISM Climate Group, Oregon State University. Online at http://prism.oregonstate.edu/.

U.S.D.A. Forest Service. 2000. Screening Methodology for Calculating ANC Change to High Elevation Lakes, User's Guide. U.S. Department of Agriculture (USDA) Forest Service, Rocky Mountain Region. January 2000.

Visibility Information Exchange Web System (VIEWS). 2014. Lake Summary Datasets: R2 Long-Term Lake Monitoring, R2 Synoptic Lake Monitoring, and R2 U.S. Geological Survey Colorado Wilderness Long-Term Lake Survey. Accessed online: http://views.cira.colostate.edu/web/. Accessed January.

# Appendix K

## Economic Impact Analysis Methodology – Technical Report

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# APPENDIX K
# ECONOMIC IMPACT ANALYSIS METHODOLOGY – TECHNICAL REPORT

This report describes the methods and data that underlie the economic impact analysis including assumptions for direct employment and costs for the proposed action and alternatives as well as details of economic impact modeling and non-market analysis. Input-output models such as the Impact Analysis for Planning (IMPLAN) model, an economic impact analysis model, provide a quantitative representation of the production relationships between individual economic sectors. Thus, the economic modeling analysis uses information about physical production quantities and the prices and costs for goods and services. The inputs required to run the IMPLAN model are described in the following narrative. The resulting estimates from the IMPLAN model, by alternative, are in the Bull Mountain Master Development Plan Environmental Impact Statement (EIS), Chapter 4, Environmental Consequences, Section 4.4.2, Socioeconomics. The first portion of the following information describes the methods and assumptions used in the impact analysis. The next portion discusses the general aspects of the IMPLAN model and how it was used to estimate economic impacts.

## K.1 ECONOMIC IMPACT ANALYSIS METHODS AND ASSUMPTIONS

Economic analysis takes one of two forms, depending on the available data. For those activities that generate measurable spending (market values), the analysis estimates economic impact in terms of output (total spending), value added (income), and employment in the regional economy. For example, spending to produce coal, to raise cattle, and to recreate on BLM-administered land fits this type of analysis. Through the use of a regional input-output multiplier (IMPLAN), an assessment of impacts on from proposed project spending and employment. 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 a particular 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 EIS. The results measure the change in the level of output, employment, and income for those industrial sectors impacted by each action.

Economic impacts are described in terms of direct, indirect, and induced impacts. Direct impacts, such as income and employment, are directly affected by activity on BLM-administered land or federal mineral estate, such as SG Interest's (SGI's) employment of workers at drilling site to extract federal minerals overseen by the BLM Uncompahgre Field Office (UFO). Indirect impacts occur when related industries gain from purchases by the directly impacted businesses, such as the SGI buying construction equipment from local firms. Induced impacts are the results of spending by employees hired due to the business activity just described. Together, these are reported as the total impact of the different management alternatives. The economic analysis provides quantitative estimates of employment and economic contributions in the planning area from proposed drilling and production activity in the Bull Mountain Unit.

For all economic modeling presented here, data presented are estimates based on best available data. However, under all alternatives, the pace of development could differ from the rate assumed in the analysis. Actual impacts would also vary based on site-specific differences and changes in market demand for mineral resources, population change in the planning area, or various other factors that could alter the economic impact of BLM-administered land use. The BLM has limited control over the pace of development because it authorizes only economic activities but does not perform these activities. An abrupt shift in the pace of development could result in short-term impacts on the demand for housing and community services. It also could have short-term impacts on the supply of tax revenues from residences or businesses to support community services due to short-term changes in job opportunities and the resulting change in in-migration or out-migration trends. Any such impacts would likely be more severe for smaller communities, which are less likely to be able to absorb a sudden influx of new residents, or to continue to support existing infrastructure if out-migration were to suddenly increase.

In the absence of quantitative data, impacts are described using ranges of potential impacts, or a qualitative analysis was performed based on the best available data, as appropriate.

In addition, not all economic values can be measured by market transactions. Open space, access to recreation, and other factors enhance quality of life for residents and could attract individuals or business to an area. This analysis examines nonmarket factors on a qualitative basis using previous research.

Results of the quantitative and qualitative economic analysis also are applied in measuring the social impacts. A narrative discussion of the impacts on communities on social conditions that result from proposed project activities is included in Chapter 4.

The following key assumptions are applied for socioeconomic impact analysis:

- Wells completed during the planning period will produce throughout the planning period.
- Average well head price for natural gas in 2012 was is $2.66/MCF (thousand cubic feet; EIA 2013). Estimates from SGI predict natural gas prices of $4.50/MCF until 2017 and $5.50/MCF thereafter. Natural gas prices are volatile and actual average price is likely to change. Data are provided for comparative purposes only.

- Production estimates for drilled holes are based on SGI model numbers for composite coalbed methane and sandstone wells and Mancos wells models from 2015 to 2036.
- All data are displayed in 2014 dollar values. Data converted to 2010 model year dollars for input into IMPLAN model using standard deflator values.
- Percent of spending in the local economy dictated by IMPLAN- model regional percentage of local spending by sector.
- Assumes current rate of severance taxes, ad-valorem taxes, and federal mineral royalty rates and distribution.
- Unless otherwise stated it is assumed that the distribution of well type for a typically well pad with five wells is one sandstone, one coal, and three Mancos shale.

## K.2 THE IMPACT ANALYSIS FOR PLANNING (IMPLAN) MODEL

IMPLAN is a regional economic model that provides a mathematical accounting of the flow of money, goods, and services through a region's economy. The model provides estimates of how a specific economic activity translates into jobs and income for the region. It includes the ripple effect (also called the multiplier effect) of changes in economic sectors that may not be directly impacted by management actions, but are linked to industries that are directly impacted. In IMPLAN, these ripple effects are termed indirect impacts (for changes in industries that sell inputs to the industries that are directly impacted) and induced impacts (for changes in household spending as household income increases or decreases due to the changes in production).

This analysis used IMPLAN 2010. Prior to running the model, cost and price data were converted to the model dollar year (2010) using sector-specific adjustment factors from the IMPLAN model. The values in this report are expressed in year 2014 dollars.

The current IMPLAN model has 440 economic sectors, of which 221 are represented in the Socioeconomic Study Area counties. This analysis involved direct changes in economic activity for IMPLAN economic sectors, as well as changes in all other related sectors due to the ripple effect. The IMPLAN production coefficients were modified to reflect the interaction of producing sectors in the Socioeconomic Study Area. As a result, the calibrated model does a better job of generating multipliers and the subsequent impacts that reflect the interaction between and among the sectors in the Socioeconomic Study Area compared to a model using unadjusted national coefficients. Key variables used in the IMPLAN model were filled in using data specific to the Socioeconomic Study Area, including employment estimates, labor earnings, and total industry output.

The relationships between economic sectors can be manipulated based on knowledge of the local economy to more closely represent the study area. If these parameters are not known (as is often the case), the relationships can either be set to 100 percent of purchases staying within the study area (default), or to values provided by IMPLAN in its Social Accounting Matrix (SAM). These SAM values are an approximation of relationships based on economic data from previous years; it can predict the percentage of an economic input that stays within the local economy (producing direct, indirect, and induced impacts within the study area) and the percentage that leaves the study area as imports (having no further effect on the economy of the study area) for each sector. Because relationships between sectors within the study area were not known, the SAM values were used for all models.

The economic input for the model was a monetary value for a specific economic sector, and inputs for multiple sectors can be applied to each scenario. These scenarios are run against the model parameters to provide economic predictions of direct, indirect, and induced effects on employment, labor income, value added, and output, as well as breakdown of these effects on each sector.

The analysis for the Bull Mountain Master Development Plan EIS focused on impacts of the proposed oil and gas development based on estimates provided by SG Interest. The assumptions made to provide these inputs are discussed in detail below.

### K.2.1 Employment and Income

Estimates for direct employment by SGI and SGI contract employers were provided by SGI based on industry standards and company experience. See **Table K-1**, Labor Estimates- Drilling and **Table K-2**, Labor Estimates- Production. In addition to these employees, additional companies would be utilized to perform some specialized work required during drilling and construction activities (e.g. pipeline and well pad construction) as well as during production (e.g., workovers). The workers at these companies (vendors) would not be directly employed by SGI but the cost to hire these companies represents direct costs of the drilling phase. Estimated vendor costs provided by SGI were input into IMPLAN to determine approximant vendor employment numbers as well as total indirect and induced employment estimates for the drilling and production phase. Vendor costs broken down by components for each phase are provided in **Table K-3**, Vendor Costs, below.

**Table K-1**
**Labor Estimates- Drilling**

| Project Phase | Direct Employees | Labor Costs | Contract Employees | Labor Costs |
|---|---|---|---|---|
| Drilling 2015-2019 | 15 | $1,996,800.00 | 6 | $399,360.00 |

Source: SGI 2014

**Table K-2**
**Labor Estimates-Production**

| Project Phase | Direct Employees | Labor Costs | Contract Employees | Labor Costs |
|---|---|---|---|---|
| Production 2020-2040 | 22 | $2,496,000.00 | 10 | $665,600.00 |

Source: SGI 2014

**Table K-3**
**Vendor Costs**

| Component | Cost | Notes |
|---|---|---|
| *Drilling Phase* | | |
| Resource reports | $15,000.00 per well | |

**Table K-3**
**Vendor Costs**

| Component | Cost | Notes |
|---|---|---|
| Engineering permit/planning | $5,000 per well | |
| Water permitting/planning | $3,000 per well | |
| Well pad construction | $275,000.00 per well | |
| Drilling (including completions) | $7.0 million per horizontal shale well<br>$1.5 million per coal well<br>$2.0 million per sandstone well | Per well pad with 5 wells, one is coal, one is sandstone, and the remainder are Mancos |
| Pipeline | $350,000.00 per 1 mile | 1 mile 12" pipe<br>contract labor and supplies (not including pipe)0.7 miles pipe/well |
| Compression- vendor installation only (not including compressor equipment) | $130,000 per well | Additional $1.3 million per station cost for equipment |
| Roads | $30,000 per mile of artery road | 0.6 miles road/well<br>Road material costs are an additional $75,250.00 total material cost |
| Powerline (Rough estimates from DMEA representative) | $150,000-200,000 per mile | Cost depending on the size of the line needed. Additional costs if timber removal or excavation are needed |
| water quality | $5,400 | Cost is per location for 3 sampling events |
| air quality | $5,000 | Estimated average for one permit on a well |
| Unforeseen compliance work | $5,000 per well | |
| Annual cost per well | $ 5,596,600.00 | |
| Cost for 27 wells | $ 151,108,200.00 | |
| *Production Phase* | | |
| Work overs | $1,000,000.00 for entire unit | Estimated 67 work overs per year once all 146 wells have been drilled |
| Regular maintenance | $38,000 per well | |
| Well head maintenance | $44,000 per well | |
| Pipeline maintenance | $65,000 per well | |
| Meter techs | $4,600 per well | |
| Chart integration | $8,800 per well | |
| Road work | $150,000 per well | |
| Annual Cost Per Well | $325,800.00 | |
| Cost for 146 Wells | $47,566,800.00 | |

Source: SGI 2014
Assumes drilling is complete

Based on labor estimates above, the output from IMPLAN was obtained for direct, indirect and induced economic output, see **Table K-4**, IMPLAN Results. Drilling is assumed to occur at the same rate (27 wells per year) for all Alternatives, therefore while length of drilling period differs, annual employment and economic contributions are the same for the drilling phase for all Alternatives. For the Production phase, maximum build-out is assumed, with 55 wells in Alternative A and 146 wells in Alternatives B and C. Production phase estimates assume that drilling is complete.

**Table K-4**
**IMPLAN Results**

| | Employment | | | Labor Income | | | Total Value Added | | |
|---|---|---|---|---|---|---|---|---|---|
| | **Drilling Alts A-C** | **Productio n Alt A** | **Production Alts B-C** | **Drilling Alts A-C** | **Production Alt A** | **Production Alts B-C** | **Drilling Alts A-C** | **Production Alt A** | **Production Alts B-C** |
| Direct Effect | 284.8 | 34 | 93.6 | 21,601,664.1 | 1,114,712.0 | 3,151,584.0 | 89,775,487.6 | 3,687,102.3 | 10,024,831.1 |
| Indirect Effect | 66.7 | 8 | 21.7 | 2,217,235.0 | 334,690.0 | 894,294.0 | 4,781,740.5 | 956,283.3 | 2,555,175.3 |
| Induced Effect | 119.7 | 7 | 20.2 | 2,918,979.7 | 176,677.1 | 493,402.3 | 7,240,672.0 | 438,618.0 | 1,224,832.8 |
| Total Effect | 471.1 | 49 | 135.6 | 26,737,878.8 | 1,626,079.1 | 4,539,280.3 | 101,797,900.1 | 5,082,003.5 | 13,804,839.2 |

Source: SGI 2014, IMPLAN 2014

## K.3 Tax Revenue Estimates

General economic assumptions were supplied related to production and Colorado tax rates. These assumptions are supplied in **Table K-5**, General Economic Assumptions for Bull Mountain Unit.

**Table K-5**
**General Economic Assumptions - Bull Mountain Unit**

| | |
|---|---|
| Case: $4.50/mcf 1st 3 years, $5.50/mcf thereafter (as of 9/1/2014) | |
| Expenses: | |
| Op Costs: $7,000/month | |
| Water Disposal: $1.00/bbl | |
| **Colorado State Taxes** | **Multiplier of Net Revenue** |
| Estimated Ad Valorem Tax | 0.03 |
| Gas Severance Tax | 0.05 |
| Oil & Gas Conservation Fund Levy | 0.0012 |
| Oil & Gas Environmental Response Fund | 0.0002 |
| Federal Mineral Royalties | 0.125 |
| **Ownership** | |
| Working Interests | 100% |
| Revenue Interests | 86.5% |

SGI 2014

Production estimates were provided by SGI based on models for the two well type that may be utilized in the project area. In all cases, production by alternatives assumes 60 percent Mancos wells, and 40 percent composite sandstone/coalbed methane. Detailed estimates for production are considered proprietary and are not included in this public document, but are part of the project record.

Estimates were also supplied for net sales, tax and royalty payments for maximum build-out, based on rates as supplied in **Table K-5**, General Economic Assumptions - Bull Mountain Unit and SGI's production and revenue estimates. Detailed estimates for production are considered proprietary and are not included in this public document, but are part of the project record.

## K.4 Ranching and Agriculture

Potential impacts on agriculture and agricultural tourism consist of two main components, 1) impacts due to changes to water quality or quantity, soil quality or other factors that resulting in a decrease in quantity or quality of the product produced and, 2) impacts due to a perceived degradation of the area's quality of product that resulted in decreased sales and/or visitation.

Rumbach (2010) analyzed the potential impact of shale gas drilling on the New York tourism industry. He questioned whether drilling would permanently damage the "brand" of a region as a pristine and picturesque destination as well as the brand image for agricultural products from a shale drilling area. While quantitative analysis is lacking in Rumbach's paper and other literature, there is some indication that increased truck traffic and visual impacts of drilling rigs may impact visitor experience. Local organic farmers and wineries express similar concerns as noted in recent new articles (for example, Taylor 2013; Jaffee 2012). In a letter submit to the BLM related to leasing of North Fork parcels for oil and gas development, the Paonia Chamber of commerce stated, "Many of our farmers are very concerned that the mere perception of polluted air, soil, and water will drive away agricultural customers in search of other quality vendors…Our hospitality industry and community at large is concerned about the potential impacts on our growing agro-tourism economy and the West Elk Scenic and Historic Byway Tourism Loop, of which we have just received recognition and funds to promote as a 'healthy community travel destination."

Agriculture and agricultural tourism may be impacted by changes to water quality. Due to minimal change to water quantity and quality anticipated, direct impacts on agricultural operations are likely to be limited. Increased drilling may relate to a change to visitors experience of the area as well as the perceived quality of agricultural products from the area, but literature and data are lacking to verify this impact or quantitatively analyze potential impacts. It should be recognized that even if project activities do not directly result in significant changes in air or water quality, residents and visitors perception of the air and water quality may be influenced by the presence of development activities. In comments received during on the draft EA, commenters expressed ongoing concerns about risks to irrigation water due to accidental contamination, particularly for irrigation water in the Muddy River; such concerns are likely to be present with any level of development.

## K.5 TOURISM AND RECREATION

Economic impacts from recreation are a function of visits to recreation areas and expenditures per visit. Most public land use and activity participation estimates depend on a mix of computerized trail counter data, field observations, and professional judgment of the recreation staff and hence are not scientifically based. Recreation data are recorded in the BLM's Recreation Management Information System, which is a web-based application used to track, store, and retrieve data. The system enables the BLM to estimate recreation participation based on visitor registrations, permit records, observations, and professional judgment. A visitor day is a recreation unit of measure commonly used by federal agencies, and represents an aggregate of twelve visitor hours at a site or area. Current average annual recreation visits for the UFO are estimated at 297,700 general visits and approximately 320,866 visitor days. Approximately 18 percent (54,486 visitor days) were related to hunting (BLM 2011).

Estimates in 2007 dollars indicate that big game hunting in Colorado resulted in expenditures of $106 per day for in-state hunters and $216 per day for out-of-state hunters (BBC Research & Consulting 2008). Expenditures primarily included food, lodging and transportation. In addition, the area's hunting and fishing opportunities supported approximately 912 jobs in Delta and Gunnison counties and16 million and 31 million in direct expenditures in Delta and Gunnison Counties respectively (see **Table K-6**, Hunting and Fishing Economic Importance).

Visitation to the socioeconomic study area is anticipated to continue to increase, following trends in population change in the region. Socioeconomic analysis conducted for the UFO RMP estimated an increase between 2.5 and 4.5 percent per year. This analysis utilized the Colorado State Demography Office population projects as the independent variable, and the total visitors and activity type information from 2007 to 2011 as the dependent variables; linear regressions were performed to predict visitor growth for recreational use over the next 20 years. Information from the UFO field office is only partially reflective of the activity in the Bull Mountain Unit, as the majority of this area is on private surface and does not represent the full spectrum of

**Table K-6**
**Hunting and Fishing Economic Importance**

| County | Direct Expenditures (resident and non-resident) | Total impact (resident and non-resident) | Jobs (resident and non-resident spending) | Hunting (non-resident) | Hunting (resident) | Fishing (non-resident) | Fishing (resident) |
|---|---|---|---|---|---|---|---|
| Delta | 16,310,000 | $27,840,000 | 297 | $7,990,000 | $3,360,000 | $1,220,000 | $14,980,000 |
| Gunnison | 31,180,000 | $53,140,000 | 615 | $12,270,000 | $7,230,000 | $7,200,000 | $25,550,000 |

CDOW 2008
Note that nonresident numbers in this report do not include visitors from outside of the region but within Colorado, so estimates of economic contribution are undervalued. However, not all of these impacts are related to use of BLM-administered lands and include hunting and fishing on other federal and state lands.

recreational opportunities. However, general trends in recreation increases in the area are likely consistent.

Opportunities for recreation provided to residents are important, but their recreation expenditures are generally assumed to not represent new money introduced into the economy. This is because if opportunities on project area lands were not present, it is likely that residents would participate in other locally based recreation, so this money would still be retained in the local economy. Changes in nonresident recreation patterns, however, would alter the amount of money entering the socioeconomic study area. Additionally, it should be noted that jobs and income associated with recreation management do not capture the entire value of the experience held by recreation users.

Recreation visitation for the planning area has not been recorded; therefore quantitative estimates for current economic impacts or change to economic impacts from changes in visitation patterns based on project activity are not available.

Impacts are also possible from changes in visitation to the West Elk Loop Scenic. Economic impacts from scenic byway travel are difficult to determine, but one 2001 Colorado study estimated an approximant $50 - $188 Visitor group spending per day and $32,500 annual visitor spending per mile (Petraglia and Weisbrod 2001).

## K.6 Residential Property Value

Two common methods used to estimate economic values for ecosystem or environmental services that directly affect real estate prices include hedonic pricing studies and contingent valuation studies. Hedonic pricing recognizes that the price of a home is impacted by both by internal characteristics of the good being sold and external factors affecting it (e.g., surrounding location, local air and water quality). Continent valuation studies examine how much money people would be willing to pay (or willing to accept) to maintain the existence of (or be compensated for the loss of) an environmental feature.

Relevant studies examining the impacts of oil and gas development on residential property values are summarized in **Table K-7**, Hydraulic Fracturing/Energy Development-Real Estate Impacts. This information is utilized in the qualitative discussion of impacts by Alternative in Chapter 4.

**Table K-7**
**Hydraulic Fracturing/Energy Development-Real Estate Impacts**

| Paper | Method | Findings |
|---|---|---|
| Bennett, A. The Impact Of Hydraulic Fracturing On Housing Values In Weld County, Colorado: A Hedonic Analysis. Master Thesis. Department Of Agricultural And Resource Economics Colorado State University. Sumer 2013. | Hedonic Property Method Of 4035 Housing Transactions Between 2009 And 2012 In Weld County, Colorado. | Within .5 miles, negative impacts on property values.<br>Rural Households Are Statistically Unaffected By The Density Of Hydraulic Fracturing In Their Immediate Area.<br>Full County housing prices are positively and significantly impacted by development. |
| Boxall, P., Chan, W.H., And M. McMillan, 2005. "The Impact Of Oil And Natural Gas Facilities On Rural Residential Property Values: A Spatial Hedonic Analysis". Resources & Energy Economics, 27, 248-269. | Hazard Effects And Amenity Effects. | Property Values Are Negatively Correlated With The Number Of Sour Gas Wells And Flaring Oil Batteries Within 4km Of The Property. |
| Integra Realty Resources. 2010. Flower Mount Well Site Impact Study. Prepared For Kent Collins, P.E.. Assistant Town Manager, Town Of Flower Mound, Tx. Summary Consultation Report. File Number 116-2010-0511 | Sales Comparison Method. | Residential Properties With Price Points Over 250,000 And Immediately Adjacent To Well Sites had a 3% To 14% decrease In Property Value Impact dissipated Around 1,000 Ft From The Wellhead. |
| Leistritz, F.L., G.D. Wiedrich and H.G. Vreugdenhil. 1985. Effects of Energy Development on Agricultural Land Values. Western Journal of Agricultural Economics, 10(2): 204-215. | Multiple regression analysis on sale prices of agricultural land in western North Dakota. | The findings suggest that energy resources development has exerted only modest upward pressure on agricultural land values |
| Muehlenbachs, L., E. Spiller and C. Timmins. 2012. Shale Gas Development And Property Values: Differences Across Drinking Water Sources. National Bureau Of Economic Research. Working Paper 18390 http://www.nber.org/papers/w18390. September 2012. | Hedonic Method to identify the housing capitalization of groundwater risk, differentiating it from other externalities, lease payments to homeowners, and local economic development. | Proximity to wells increases housing values, though risks to groundwater fully offset those gains. By itself, groundwater risk reduces property values by up to 24 percent |
| Throupe, R., R.A. Simons, X. Mao. 2013. A review of Hydro "Fracking" and Potential effects on Real Estate. Journal Of Real Estate Literature. Volume 21, Number 2, 2013 | contingent valuation surveys | 5%–15% reduction in bid value for homes located proximate to fracking scenarios, depending on the petroleum-friendliness of the venue and proximity to the drilling site. |

## K.7 INFRASTRUCTURE

Impacts on roads may also occur due to increased traffic that occurs as a result of drilling, particularly that involving large trucks. In a 2014 study, the estimated road-reconstruction costs associated with a single horizontal well range from $13,000 to $23,000, or $5,000-$10,000 per well if state roads with the lowest traffic volumes are excluded (Abramzon et al 2014).

## K.8 Non-Market Analysis Overview

Non-market values are the benefits derived by society from the uses or experiences that are not dispensed through markets and do not require payment. Non-market values can be broken down into two categories, use and non-use values. The use-value of a non-market good is the value to society from the direct use of the asset; through recreational activities such as hiking, bird watching and OHV use. The use of non-market goods often requires consumption of associated market goods, such as lodging and gas. Non-use, or passive use, values of a non-market good reflect the value of an asset beyond its current use, due to willingness to preserve a resource for potential future use and for the benefit of preserving an asset for future generations to enjoy. This can include values such as scenic views and preservation of plant and animal habitat that are not currently providing economic benefits. Non-use values are typically measures in surveys of individual’s willingness to pay for preservation of a resource.

Some of the value of undeveloped areas can also be determined by examining ecosystem services, including clean air and water. BLM Instruction Memorandum (IM 2013-131) explains that “Ecosystem goods and services include a range of human benefits resulting from appropriate ecosystem structure and function, such as flood control from intact wetlands and carbon sequestration from healthy forests. Some involve commodities sold in markets, for example, natural gas. Others, such as wetlands protection and carbon sequestration, do not commonly involve markets, and thus reflect nonmarket values” (BLM 2013).

Conducting project specific surveys to determine project specific non-market impacts was out of the scope of this project. Therefore, Chapter 4 includes qualitative discussion of impacts described above.

## K.9 References

Abramzon, S., Samaras, C., Curtright, A., Litovitz, A., Burger, N. 2014. Estimating the Consumptive Use Costs of Shale Natural Gas Extraction on Pennsylvania Roadways. Journal of Infrastructure Systems, 10.1061/(ASCE)IS.1943-555X.0000203. 06014001.

Bennet. 2013. The Impact of Hydraulic Fracturing On Housing Values In Weld County, Colorado: A Hedonic Analysis. Thesis in Fulfilment of Degree of Master of Science Colorado State University Fort Collins, Colorado. Summer 2013

Boxall, P., Chan, W.H., And M. McMillan, 2005. The Impact Of Oil And Natural Gas Facilities On Rural Residential Property Values: A Spatial Hedonic Analysis. Resources & Energy Economics, 27, 248-269.

Colorado Division of Wildlife (CDOW), now Colorado Parks and Wildlife. 2008. The Economic Impacts of Hunting, Fishing and Wildlife Watching in Colorado. Prepared for CDOW by BBC Research Consulting, Denver, CO. September 26, 2008.

Department of Interior, Bureau of Land Management (BLM). 2013. Instruction Memorandum No. 2013-131. Guidance on Estimating Nonmarket Environmental Values. September 12, 2013.

_____.2011. BLM Recreation Management Information System for fiscal years 2007-2011 Uncompahgre Field Office.

Energy Information Administration (EIA). 2013. U.S. Natural Gas Wellhead Price (Dollars per Thousand Cubic Feet). Internet Web Site: http://www.eia.gov/dnav/ng/hist/n9190us3A.htm. Accessed December 30, 2013.

IMPLAN 2014. MIG, Inc., IMPLAN System (data and software 2010), 502 2nd Street, Suite 301, Hudson, WI 54016 provided on January 24, 2014. Updated information provided May 23, 2014.

Integra Realty Resources. 2010. Flower Mount Well Site Impact Study. Prepared For Kent Collins, P.E.. Assistant Town Manager, Town Of Flower Mound, Tx. Summary Consultation Report. File Number 116-2010-0511

Jaffee, Mark. 2012. Denver Post. Colorado North Fork Valley residents, businesses fighting prospect of fuel leases. Posted March 18, 2012.

Leistritz, F.L., G.D. Wiedrich and H.G. Vreugdenhil. 1985. Effects of Energy Development on Agricultural Land Values. Western Journal of Agricultural Economics, 10(2): 204-215.

Muehlenbachs, L., E. Spiller and C. Timmins. 2012. Shale Gas Development And Property Values: Differences Across Drinking Water Sources. National Bureau Of Economic Research. Working Paper 18390 http://www.nber.org/papers/w18390. September 2012.

Rumbach, A. 2010. “Natural Gas Drilling in the Marcellus Shale: Potential Impacts on the Tourism Economy of the Southern Tier.” Prepared for the Southern Tier Central Planning Board (Corning, New York).

Taylor, Phil. 2013. Rising wineries, organic farms clash with BLM over leasing in energy-rich western Colorado. EE News. January 28, 2013.

Throupe, R., R.A. Simons, X. Mao. 2013. A review of Hydro “Fracking” and Potential effects on Real Estate. Journal Of Real Estate Literature. Volume 21, Number 2, 2013.

# Appendix L

## Bainard Augmentation Plan

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Filed in the [illegible] Court
Water Division 4

JUL 0 6 2009

| | |
|---|---|
| **DISTRICT COURT, WATER DIVISION NO. 4**<br>**STATE OF COLORADO**<br>1200 North Grand Ave., Bin A<br>Montrose, CO 81401-3146 | Filed in the District Court<br>Water Division 4<br>JUN 1 1 2009 |
| **CONCERNING THE APPLICATION FOR WATER RIGHTS OF:**<br><br>**SG INTERESTS I, Ltd,**<br><br>**In the Gunnison River in Delta County** | ▲ COURT USE ONLY ▲ |
| | **Case No. 09CW16** |

**FINDINGS OF FACT, CONCLUSIONS OF LAW, RULING OF REFEREE, JUDGMENT AND DECREE**

The Applicant filed an Application entitled Case No. 09CW16 on February 18, 2009. The case was referred to the Water Referee for Water Division No. 4, State of Colorado, by the Water Judge of said Court in accordance with Article 92, Chapter 37, C.R.S., known as the Water Rights Determination and Administration Act of 1969, as amended. At the Division Engineer's recommendation, and the Applicant's consent and motion does hereby make the following Findings of Fact, Conclusions of Law, Ruling of the Referee and Judgment and Decree in this matter:

## FINDINGS OF FACT

1. *Name, address and telephone number of Applicant*:
   SG Interests I, Ltd.
   100 Waugh Suite 400
   Houston, TX 77007
   970-252-0696

2. Timely and adequate notice of the filing of the Application was given as required by law.

3. No statements of opposition were filed herein, and the time for filing statements of opposition has passed.

4. Applicant filed an application seeking a conditional storage water right and an approval of plan for augmentation.

   *Name of structure*: **Bainard Reservoir #1.**

A. *Legal description:*

*1. Location of Reservoir*: The Bainard Reservoir #1 will be located in the NW1/4NW1/4NE1/4 of Section 1, Township 11 South, Range 91 West, 6th P.M., Delta County, Colorado, with distances of 1647 feet from the North Section line, and 2542 feet from the East Section Line.

B. *Source*: The Bainard Reservoir #1 will be filled in priority by South Bainard Creek, tributary to the North Fork of the Gunnison River and the Gunnison River.

C. *Amount:* The **Bainard Reservoir #1** is an on-channel, non-jurisdictional reservoir with a proposed surface area of 18.5 acres, a dam height not to exceed ten feet, and an average depth of five feet, with a total storage capacity of 92.5 acre-feet.

D. *Date of initiation of appropriation*: January 24, 2009.

E. *Uses*: Applicant seeks a conditional decree for storage rights in the Bainard Reservoir #1 for augmentation of up to 50.64 acre feet, fish habitat, irrigation of 10 acres, stock, commercial, industrial, and fire protection with an appropriation date of January 24, 2009.

F. *Name and address of owner of land upon which the Bainard Reservoir #1 is located*: Rock Creek Ranch I, Ltd., same entity that owns SG Interests I, Ltd. *100 Waugh Suite 400, Houston, TX. 77007*

## SG INTERESTS I, LTD AUGMENTATION PLAN

5. The Bainard Reservoir #1 is an on-channel reservoir and is the sole augmentation source. Therefore, once a call is placed on the stream system, the level of the reservoir must be dropped via an agri-drain type outlet structure to ensure that out-of-priority evaporation depletions (based on the evaporation calculations included within the application) will not accrue to the stream. This reduction in reservoir level should not be considered as augmentation releases, but is necessary to size the reservoir accordingly to ensure enough augmentation water is available to

replace the out of priority depletions. In reference to Paragraph 5.5 and the Summary of Augmentation Plan table, the replacement water requiring a transit loss calculation should only be 42.68 acre-feet (versus the listed 75.75 acre-feet). This reduces the necessary transit loss to 7.96 acre-feet (versus the listed 14.13 acre-feet). In summation, augmentation releases will total 50.64 acre-feet and the reservoir will require an additional 33.07 acre-feet of additional storage to cover annual evaporation depletions. Therefore, the claimed live reservoir storage of 92.50 acre-feet covers the necessary replacements/depletions of 83.71 acre-feet.

6. This plan of augmentation will augment for all otherwise out-of-priority depletions from the evaporative loss from the **Bainard Reservoir #1, surface pumping for the uses of pad** site construction, drilling, dust suppression, and transit losses. Applicant has made the following assumptions in the development of his plan for augmentation. All following uses are considered to be 100% consumptive.

A. Applicant proposes to construct up to 8 gas wells per year during the months of April through November due to inaccessibility in the winter months. The demand for water during the drilling process is calculated to be 550,000 gal. (1.69 acre-feet per well, or 13.52 acre-feet for 8 wells).

B. The water demands for the pad site construction is estimated to be 250,000 gallons (0.77 acre- feet per site or 6.16 acre-feet for 8 sites)

C. Total water depletions from evaporative loss from the Bainard Reservoir #1 is determined to be 33.066 acre-feet based on an 18.5 surface area at an elevation of 8240 feet.

D. Applicant will be maintaining approximately 15 miles of road. Gunnison County applies Mag Chloride on portions of the public roads where SG Interests I, Ltd. share in the costs. Applicant, on occasion, will apply water for dust suppression for up to 15 miles of roads. The water needs per mile of road are 500,000 gallons of water that calculates to 23 acre-feet for the 15 miles of roads.

E. The distance calculated from the outlet of Bainard Reservoir #1 to the point at which depletions will be replaced is 18.66 miles at the confluence of Muddy Creek and West Muddy Creek. Based on a 1% per mile depletion factor the total depletions for the above uses of 42.68 acre-feet, and the transit loss are calculated to be 7.96 acre-feet. These uses result in a total annual depletion of 50.64 acre-feet.

7. Applicant realizes that calls upon Applicant's diversions might arise on any stream reaches downstream of Applicant's diversions.

8. Augmentation for the **Bainard Reservoir #1,** uses necessary for drilling purposes and dust abatement will be provided for by releases from Bainard Reservoir #1, an on-channel reservoir, available on a year round basis as needed for any senior calls downstream. The Bainard Reservoir #1 will be filled in priority by South Bainard Creek. All of the above uses are considered to be 100% consumptive, therefore, the total consumptive use for the reservoir evaporation, dust abatement, drilling and pad site construction, and transit loss has been calculated to be 83.71 acre-feet for their total annual depletions. The Applicant acknowledges that the augmentation water will be used solely for Applicants' use.

9. Applicant seeks non-decreed points of diversion for uses defined in paragraph 6 as follows pumped at the following locations:

A) All tributaries to the East Muddy Creek below **Ditch #3 Ditch. (E.** 290478 **N.** 4333558**)**

B) Lee Creek below the **Grouse Creek Extension Ditch.** (E. 295928 N. 4329718),

C) The Muddy Creek from its confluence with Lee Creek down to the confluence of the West Muddy.

D) The West Muddy and any tributaries below the **Snooks #2 Ditch. (E.** 288517 **N.** 4324870)

E) Drift Creek below the **Drift Creek Ditch. (E.** 294202 **N.** 4332271.)

10. The stretches of streams and tributaries for proposed pumping sites referenced in paragraph 9, allow for the pumping of water where there is no injury. The Bainard #1 Reservoir will protect the pumping requirements of SG Interests I, Ltd. from senior down stream calls.

## CONCLUSIONS OF LAW

11. The statements in the Application are true.

12. The Application was timely filed and is complete, covering all applicable matters required under COLO. REV. STAT. § 37-92-302.

13. The Applicant's request for adjudication of the storage water right and approval of plan for augmentation is contemplated and authorized by law, and this Court and the Water Referee have exclusive jurisdiction over these proceedings. C.R.S. §37-92-302(1)(a).

## RULING OF THE REFEREE

14. The Application for Storage Water Rights, and Approval of Plan for Augmentation requested by the Applicant is granted and approved, subject to the terms and conditions of this decree.

15. The applicant shall install an agri-drain and gauge rod on the Bainard Reservoir No. 1 and a Parshall flume (recommended size – six inches) downstream of the reservoir, provide accounting, and supply calculations regarding the timing of depletions as required by the Division Engineer for the operation of this plan. The applicants shall also file an annual report with the Division Engineer by November 15th of each year summarizing diversions and replacements made under this plan.

16. Once a call is placed on the stream system, the level of the reservoir must be dropped via an agri-drain type outlet structure to ensure that out-of-priority evaporation depletions (based on the evaporation calculations included within the application) will not accrue to the stream. This reduction in reservoir level should not be considered as augmentation releases, but is necessary to size the reservoir accordingly to ensure enough augmentation water is available to replace the out of priority depletions. In reference to Paragraph 5.5 of the application and the Summary of Augmentation Plan table, the replacement water requiring a transit loss calculation should only be 42.68 acre-feet (versus the listed 75.75 acre-feet). This reduces the necessary transit loss to 7.96 acre-feet (versus the listed 14.13 acre-feet). In summation, augmentation releases will total 50.64 acre-feet and the reservoir will require an additional 33.07 acre-feet of additional storage to cover annual evaporation depletions. Therefore, the claimed live reservoir storage of 92.50 acre-feet covers the necessary replacements/depletions of 83.71 acre-feet.

| | Jan. | Feb. | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Gas Well Drilling | 0.00 | 0.00 | 0.00 | 1.69 | 1.69 | 1.69 | 1.69 | 1.69 | 1.69 | 1.69 | 1.69 | 0.00 | 13.52 |
| Pad site Development | 0.00 | 0.00 | 0.00 | 0.77 | 0.77 | 0.77 | 0.77 | 0.77 | 0.77 | 0.77 | 0.77 | 0.00 | 6.16 |
| Dust Suppression | 0.00 | 0.00 | 0.00 | 2.88 | 2.88 | 2.88 | 2.88 | 2.88 | 2.88 | 2.88 | 2.88 | 0.00 | 23.00 |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Transit Losses | 0.00 | 0.00 | 0.00 | 0.995 | 0.995 | 0.995 | 0.995 | 0.995 | 0.995 | 0.995 | 0.995 | 0.00 | 7.96 |
| Reservoir Evap. | 0.00 | 0.00 | 0.691 | 2.892 | 4.986 | 7.101 | 6.583 | 4.856 | 3.809 | 2.148 | 0.00 | 0.0 | 33.066 |
| Total Depletions | 0.00 | 0.00 | 0.691 | 9.227 | 11.321 | 13.436 | 12.918 | 11.191 | 10.134 | 8.473 | 6.325 | 0.00 | 83.71 |

17. Prior to the augmentation plan becoming operational, the applicants must supply the Division Engineer's office with an as-built stage capacity table.

18. At least 24-hours in advance of pumping, the applicants must contact and receive approval from the local water commissioner relating to the time, location, and amount of water to be pumped.

19. Prior to the augmentation plan becoming operational, the applicants must produce accounting spreadsheets to be approved by the Division Engineer. These sheets must be supplied as frequently (i.e., daily, weekly, monthly) as directed by the local water commissioner.
The Division Engineer may modify the transit loss requirement as necessary per statutory authority.

20. Pursuant to C.R.S. 37-92-305(8), the State Engineer shall curtail all out-of-priority diversions, the depletions from which are not so replaced as to prevent injury to vested water rights.

21. To assure that adequate protection is provided to other vested water rights, the court should retain jurisdiction for a period of five years after the augmentation plan becomes operational.

22. The State Engineer, the Division Engineer, and/or the Water Commissioner shall not, at the request of other appropriators, or on their own initiative, curtail the diversions and use of water covered by this plan for augmentation so long as the out-of-priority depletions associated with such diversions are replaced to the stream system pursuant to the conditions contained herein. To the extent that Applicant or one of its successors or assigns is ever unable to provide the replacement water required, then Applicant's diversions shall not be entitled to

operate under the protection of this plan, and shall be subject to administration and curtailment in accordance with the laws, rules, and regulations of the State of Colorado.

23. Applicant shall make available for release to East Muddy Creek a sufficient quantity of water to replace out-of-priority diversions and the resultant depletions caused by the evaporation from the storage structure referenced herein, and from the pumping of surface water for the operations of said Applicant, subject to the pumping restrictions referenced in paragraph 9. The volume of augmentation water required to be released each year shall be limited to the out-of-priority depletions to the stream system directly attributable to the storage and pumping rights described herein at such times as a valid senior call is in place. The Division Engineer shall direct releases under this augmentation plan in a manner, which will help assure that the senior calling rights of other water users receive the benefit of the released augmentation water.

24. The priorities awarded herein for the decree for the storage right, are for a filing made in the Water Court in the year of 2009 which shall be administered, unless augmented hereunder, as filed in that year and shall be junior to all priorities awarded by this Court in previous years.

25. Prior to or during the month of July, 2015, and every six years thereafter until the conditional right is decreed absolutely, the owner or user thereof, if it is desired to maintain the same, shall file an application for finding of reasonable diligence with this Court. Applicant shall notify this Court of any change in mailing address. Upon the sale or other transfer of this conditional right, the transferee shall file with this Court a notice of transfer which shall state:

(1) The title and case number of this case;
(2) The description of the water right transferred;
(3) The name of the transferor;
(4) The name and mailing address of the transferee.

Applicant shall notify any transferee of the requirements of this paragraph.

Dated this 11th day of June, 2009.

S. Gregg Stanway
Water Referee, Division 4

No protest was filed in this matter. The foregoing ruling is confirmed and approved, and is made the judgment and decree of this Court.

DONE this 8th day of July, 2009.

J. Steven Patrick
Water Judge

# Appendix M

## Poly Pipeline Operation Plan

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# APPENDIX M
# POLY PIPELINE OPERATION PLAN

SG Interests designed and constructed the McIntyre Flowback Pits 3 and 4 in order to store water for use and reuse for drilling and completion activities associated with wells in the Bull Mountain area. Water stored in these pits is a mixture of fresh water, produced water, and flowback water from previous well completions. McIntyre Flowback Pits 1 and 2 were also designed and permitted, but have not been constructed as of August 2012. The basic plan for use of the facilities is to transport water to be stored in the pits via high density polyethylene (HDPE, referred to here as "poly") pipelines on the ground surface. The diameter and wall thickness required for each project are determined on site specific conditions, but if feasible, we will use the poly pipeline that SG Interests has purchased for this project. This pipe is 1 inch thick and 12 inches in diameter (DR-9). These pipelines can be laid on the ground without creating significant ground disturbance (see example photo below from http://www.wpandd.com/photoGallery.html, Figure 1). Wherever possible, these pipelines will be laid alongside or over existing disturbance such as along an existing access road.

Before the pipelines are cut and moved to a new location, they will be dried internally using a foam pig pushed by compressed air. The pig will be pushed back toward the pits allowing the fluid to drain into the pits. The pipeline can then either be dragged with a tracked or rubber tired vehicle whole or in sections to the new location or cut into pieces for storage. Poly pipelines for a well will be moved into place prior to completing the well. Following well completion, the well will flowback at a high rate and the poly pipelines will be used to transport this water back to the pits for recycling. The poly pipelines are expected to be kept in this location for approximately one to three months.

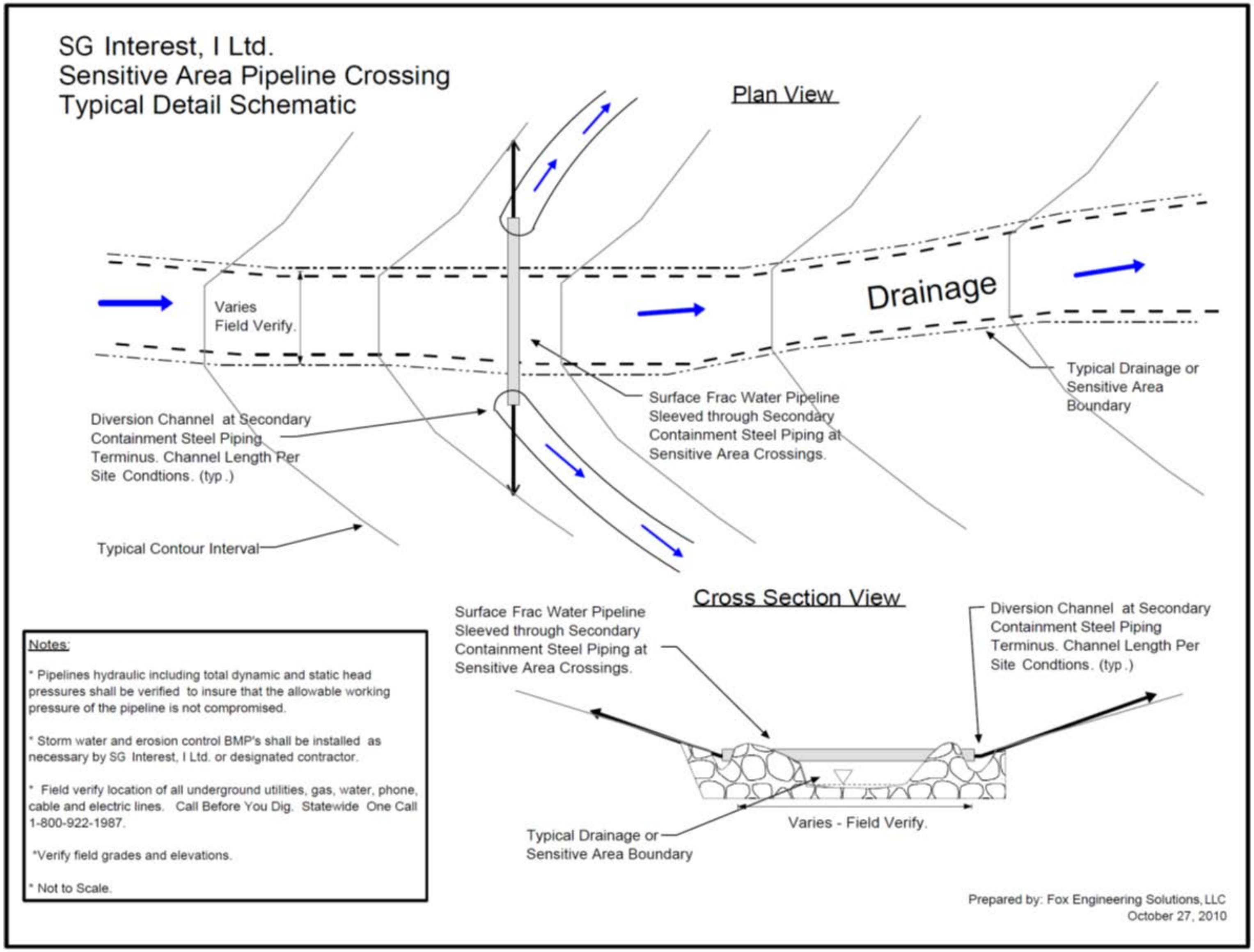
Poly pipelines are constructed between the pits and the well location generally by fusing the first several joints of pipe together end to end. The fuses are created by heating facing ends of pipe until they have melted and can then be cooled and fused together. The resulting fuse is as strong as the poly pipe itself. Where the poly pipe must connect to a metal pipe, it can be connected by a mechanical joining system such as a flange. Once several joints of pipe have been fused together, the pipeline is attached to a tracked or rubber tired vehicle and pulled along the pipeline route. Joints of poly pipe are then added to the end of the string of fused pipeline until the

Figure 1. Example of poly pipeline laid on surface (from WPD website).

vehicle can no longer pull the weight of the fused pipe or it has run out of space to pull the pipe. The fusing operation is then moved to the front of the poly pipeline and used to build another pipeline segment.

If the pipeline route passes through an environmentally sensitive area (as defined by Colorado Oil and Gas Conservation Commission, Rules and Regulations 100 Series) the pipe will be dragged into place from a working space to minimize environmental impact. In this scenario, a cable winch would be positioned at the end of the environmentally sensitive area on a work space such as an existing well pad. The cable is then taken back to the pipeline route starting point. The fusing crew would prepare a length of pipe (typically 400-500 feet in length depending on the weight of the pipe). The cable would then be attached to the end of the length of pipe. The cable would be used to drag the length of pipe into place. Additional lengths of pipe may be fused to the original length if needed and if the weight allows the longer pipe to be dragged into place. Personnel, communicating with hand-held radios, would monitor the operation to ensure that only minimal damage occurs to the outside of the pipe as it is dragged. Some cosmetic damage is expected, but if a gouge exceeds 10% of the wall thickness, that section of pipe must be cut out and replaced. A new section of pipe may be fused into its place. Surface poly pipelines that cross sensitive areas will have secondary containment to prevent a leak in a poly line from contaminating surface waters (see Figure 2 below). This containment

**Figure 2. Sensitive area poly pipeline crossing typical schematic.**



consists of sleeving the pipe within a steel pipe of greater diameter than the poly pipe. The sleeved ends of the steel containment pipe rest in an area in which an appropriately sized diversion channel has been constructed to direct any water leaking from the poly pipe away from the sensitive area. Sensitive areas are generally waterways and wetlands. Once the pipeline has been installed, field personnel perform a pressure test using either air or water. The COGCC Series 1100 regulations have been applied to our approved Form 15 applications as COAs as follows: “Operator shall pressure test surface poly-pipelines in accordance with Rule 1101.e.(1) prior to putting into initial service and following any reconfiguration of the pipeline network. Operator shall notify the COGCC 48 hours prior to testing surface poly pipeline”. The pressure test will be conducted with fresh water and not recycled or produced water.

In cases where the poly pipeline must cross a road, the pipeline may be placed in a culvert under the road surface. Alternatively, the poly pipe may be attached to a temporary pipe road crossing device. These devices connect between two pieces of poly pipe and provide a drivable steel surface for the crossing (see Figure 3 below).

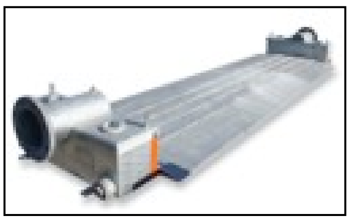


Figure 3. Example road crossing feature from Rain for Rent website: www.temporarypipe.com/products/spillguards/road_crossings.aspx

It is possible that due to topography between the pits and the project, booster pumps may need to be installed along the pipeline route. Booster pumps keep the water pressure in the pipeline more consistent and help prevent large pressure changes following elevation loss. Any booster pumps used in this project will have appropriately sized secondary containment to prevent fuel or pump fluids from reaching the ground surface.

The poly pipeline will be monitored and inspected as follows: “Operator shall conduct daily inspections of surface poly pipeline routes for leaks during active transfer of fluids. Inspections shall be conducted by viewing the length of the pipeline; operator will endeavor to minimize surface disturbance during pipeline monitoring. The operator shall maintain records of inspections, findings and repairs, if necessary, for the life of the pits.” This is required by the COGCC according to our Form 15 COAs. When booster pumps are used along the route, a sudden loss of pressure as measured by the pump’s pressure gauge will alert the pump operator that there is a leak in the pipe. The pump can immediately be shut down and the location of the leak discovered and cleaned up. Pumps are manned during use.