Final Environmental Impact Statement for the Bull Mountain Unit Master Development Plan

Volume II, Appendices

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BLM

United States Department of the Interior
Bureau of Land Management

Environmental Impact Statement

BLM/CO/PL-16/012

July 2016

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Location: *Gunnison County, Colorado*

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VOLUME II:
Appendices A through O

TABLE OF CONTENTS – VOLUME I

Chapter Page

ES. Executive Summary ES-1

ES.1 Overview ES-1
ES.1.1 Project Setting ES-1
ES.2 Purpose and Need ES-3
ES.3 Relationship to Laws, Regulations, and Policies ES-3
ES.4 Decisions to be Made ES-4
ES.5 Scope of Analysis ES-4
ES.5.1 Requirements for Future NEPA Analysis ES-5
ES.6 Summary of the Reasonably Foreseeable Development Scenario ES-5
ES.7 Alternatives ES-6
ES.7.1 Alternative A, No Action ES-6
ES.7.2 Alternative B, Proposed Action ES-10
ES.7.3 Alternative C, Modified Action ES-10
ES.7.4 Alternative D, the BLM's Preferred Alternative ES-11
ES.8 Summary of Environmental Consequences Analysis ES-11
ES.9 Public Involvement, Consultation, and Coordination ES-12
ES.9.1 Comments on the Draft EIS ES-12
ES.9.2 Cooperating Agencies ES-13

1. Introduction 1-1

1.1 Overview 1-1
1.1.1 Regional Setting 1-2
1.2 Purpose and Need 1-5
1.3 Decisions to be Made 1-5
1.4 Relationship to BLM Plans and Policies 1-6
1.4.1 BLM National and Statewide Regulations and Policies 1-6
1.4.2 Conformance with the Current Resource Management Plan 1-7
1.4.3 Uncompahgre Resource Management Plan Revision 1-7
1.5 Federal, State, and Local Permitting and Approvals 1-7
1.6 Scope of Analysis 1-9
1.6.1 Requirements for Future NEPA Analysis 1-10
1.7 Public Involvement 1-11
1.7.1 Cooperating Agencies 1-12
1.8 Key Issues Addressed in this EIS 1-13
1.8.1 Issues Identified at Environmental Assessment Scoping 1-13
1.8.2 Additional Issues Considered in this EIS 1-14
1.9 Changes between the Draft EIS and the Final EIS 1-15
1.9.1 Updates to Geographic Information Systems Information 1-16
1.9.2 Changes to the Alternatives (Chapter 2) 1-16
1.9.3 Changes to Other Chapters and Appendices 1-17

2. Alternatives 2-1

2.1 Introduction 2-1
2.2 Alternatives 2-1
2.2.1 Alternative Development 2-1
2.2.2 Alternatives Considered for Detailed Analysis 2-2
2.2.3 Identifying the Preferred Alternative (Alternative D) 2-3
2.2.4 Summary of the Alternatives 2-3
2.2.5 Elements Common to All Alternatives 2-8
2.2.6 Alternative A, No Action 2-13
2.2.7 Alternative B, Proposed Action 2-40
2.2.8 Alternative C, Modified Action 2-73
2.2.9 Alternative D, the BLM's Preferred Alternative 2-86
2.3 Alternatives Considered but Eliminated from Detailed Analysis 2-102
2.3.1 Alternatives Considered and Eliminated during EA Development 2-102
2.3.2 Alternatives Considered and Eliminated from EIS Development 2-103
2.4 Summary of Alternatives 2-105
2.5 Summary of Impacts 2-116

3. Affected Environment 3-1

3.1 Introduction 3-1
3.2 Resources 3-4
3.2.1 Air Resources 3-4
3.2.2 Noise 3-21
3.2.3 Soil Resources 3-23
3.2.4 Water Resources 3-30
3.2.5 Geology 3-48
3.2.6 Vegetation 3-57
3.2.7 Invasive, Nonnative Species 3-63
3.2.8 Fish and Wildlife 3-65
3.2.9 Migratory Birds 3-73
3.2.10 Special Status Species (Threatened, Endangered, Sensitive Species) 3-81
3.2.11 Wildland Fire Management 3-97
3.2.12 Cultural Resources 3-98
3.2.13 Paleontological Resources 3-101
3.2.14 Visual Resources 3-106
3.3 Resource Uses 3-109
3.3.1 Livestock Grazing 3-109
3.3.2 Minerals (Leasable, Locatable, Salable) 3-113
3.3.3 Recreation 3-119
3.3.4 Lands and Realty 3-120
3.3.5 Transportation and Access 3-122
3.4 Social and Economic Conditions 3-125
3.4.1 Hazardous Materials and Wastes 3-125
3.4.2 Socioeconomics 3-128
3.4.3 Environmental Justice 3-135

4. Environmental Consequences 4-1

4.1 Introduction 4-1
4.1.1 General Methodology for Analyzing Impacts 4-1
4.1.2 Analytical Assumptions 4-3
4.1.3 Cumulative Effects 4-4
4.1.4 Incomplete or Unavailable Information 4-21
4.2 Resources 4-22
4.2.1 Air Quality 4-22
4.2.2 Noise 4-72
4.2.3 Soil Resources 4-80
4.2.4 Water Resources 4-91
4.2.5 Geology 4-109
4.2.6 Vegetation and Invasive, Nonnative Species 4-118
4.2.7 Fish and Wildlife 4-128
4.2.8 Migratory Birds 4-152
4.2.9 Special Status Species 4-158
4.2.10 Wildland Fire Management 4-172
4.2.11 Cultural Resources 4-174
4.2.12 Paleontological Resources 4-179
4.2.13 Visual Resources 4-183
4.3 Resource Uses 4-191
4.3.1 Livestock Grazing 4-191
4.3.2 Minerals (Leasable, Locatable, Salable) 4-194
4.3.3 Recreation 4-199
4.3.4 Lands and Realty 4-202
4.3.5 Transportation and Access 4-207
4.4 Social and Economic Conditions 4-214
4.4.1 Hazardous Materials and Wastes 4-214
4.4.2 Socioeconomics 4-219
4.4.3 Environmental Justice 4-244
4.5 Irreversible and Irretrievable Commitment of Resources and Relationship of Short-term Uses of the Environment to Long-term Productivity 4-245
4.5.1 Irreversible and Irretrievable Commitment of Resources 4-245
4.5.2 Relationship of Short-term Uses of the Environment to Long-term Productivity 4-246

5. Consultation and Coordination 5-1

5.1 Introduction 5-1
5.2 Notice of Intent and Public Comments 5-1
5.3 Notice of Availability for the Draft EIS and Public Review 5-2
5.3.1 Public Meetings 5-2
5.4 Summary of Comments Received on the Draft EIS 5-3
5.4.1 Process and Methodology 5-3
5.4.2 Public Comments 5-5

5.5 Consultation and Coordination with Agencies and Tribal Governments 5-7
5.5.1 Government-to-Government Consultation with Native American Tribes..... 5-7
5.5.2 Colorado State Historic Preservation Officer Consultation..... 5-8
5.5.3 US Fish and Wildlife Service Consultation 5-8
5.5.4 US Environmental Protection Agency..... 5-9
5.6 Cooperating Agencies..... 5-9

6. List of Preparers 6-1

7. References..... 7-1

Glossary Glossary-1

TABLES

Page

ES-1 Summary of Actions by Alternative ES-7
ES-2 Summary of Design Features and Mitigation Measures per Alternative ES-9
1-1 Federal, State, and Local Permits and Approvals Applicable to the Bull Mountain Unit 1-7
2-1 Traffic Estimates for Construction, Drilling, Completion, and Production Activities per Well Pad 2-10
2-2 Project Feature Assumed Short- and Long-Term Disturbance Estimates 2-12
2-3 Existing Features within the Unit 2-12
2-4 McIntyre Flowback Pits 2-27
2-5 Bull Mountain Unit Annual Production Rates 2-30
2-6 Alternative A Traffic Estimates per Well Pad for Construction, Drilling, Completion, and Production Activities 2-37
2-7 Alternative B Traffic Estimates for Construction, Drilling, Completion, and Production Activities 2-71
2-8 Alternative C Traffic Estimates for Construction, Drilling, Completion, and Production Activities 2-82
2-9 Alternative D Traffic Estimates for Construction, Drilling, Completion, and Production Activities 2-98
2-10 Summary of Actions by Alternative 2-105
2-11 Stipulations, Design Features, and Mitigation Measures 2-107
2-12 Summary of Surface Disturbance Acres by Alternative 2-116
2-13 Estimated Total Traffic Round Trips for Drilling, Completion, and Production Activities by Alternative[1] 2-117
2-14 Summary of Environmental Consequences by Alternative 2-118
3-1 Approved Standards for Public Land Health 3-2
3-2 Ambient Air Standards and PSD Increments ($\mu g/m^3$) 3-6
3-3 Near-Field Analysis Background Ambient Air Quality Concentrations 3-8
3-4 Background Nitrogen and Sulfur Deposition Values (kg/ha-yr) 3-12
3-5 Background Acid Neutralizing Capacity Values for Acid-Sensitive Lakes 3-13
3-6 Mean Monthly Temperature Ranges and Total Precipitation Amounts 3-15
3-7 Wind Direction Frequency Distribution 3-17
3-8 Wind Speed Distribution 3-17
3-9 Common Sound Levels 3-21
3-10 Regulatory Limits for Noise Generated by Natural Gas Facilities 3-22
3-11 Noise Levels Associated with Typical Construction Equipment (dBA) 3-23
3-12 Classified Soil Types in the Bull Mountain Unit 3-25
3-13 Acres of Farmlands in the Bull Mountain Unit 3-26
3-14 Acres of Slopes in the Bull Mountain Unit 3-26
3-15 Soil Erosion Ratings for the Bull Mountain Unit 3-28
3-16 Erosion Potential of Roads and Trails for the Bull Mountain Unit 3-28
3-17 Land Health Assessment Results in the Bull Mountain Unit 3-29
3-18 Typical Monthly Flows for USGS near the Unit (cfs[1]) 3-33
3-19 General Water Quality of Springs within the Unit (one sample per station) 3-35
3-20 Stream Classifications and Water Quality Standards 3-36

3-21 List of Impaired Water Quality Segments 3-36
3-22 General Water Quality of East Muddy/Muddy Creeks on/near the Unit..... 3-37
3-23 Water Quality Lab Test Results from Produced Water from Existing Producing Natural Gas Wells within the Producing Formations in the Unit..... 3-41
3-24 Summary of Results for Selected Analytes in Samples from 23 Wells Collected between July 16, 2002 and June 12, 2013 3-45
3-25 Summary of Results for Selected Analytes in Samples from 51 Surface Water Locations Collected between July 16, 2002 and August 10, 2012 3-45
3-26 Existing Vegetation Communities in Bull Mountain Unit 3-58
3-27 Land Health Assessment Results in the Bull Mountain Unit 3-63
3-28 Colorado Noxious Weeds in Gunnison County and Noxious Weeds Observed in Bull Mountain Unit..... 3-64
3-29 Birds of Conservation Concern of the Uncompahgre Field Office 3-75
3-30 Threatened and Endangered Species of the Uncompahgre Field Office 3-82
3-31 Existing Habitats within the Ragged Mountain Lynx Analysis Unit 3-86
3-32 Existing Habitats within the Crystal West Lynx Analysis Units..... 3-86
3-33 BLM Sensitive Species of the Uncompahgre Field Office[1] 3-90
3-34 Sedimentary Rock Units, Their Fossil-bearing Potential, and Known Fossil Resources 3-103
3-35 Ranches and Allotments within the Bull Mountain Unit..... 3-110
3-36 Bull Mountain Unit Existing Facilities 3-114
3-37 Annual Wages by Industry, 2012..... 3-130
4-1 Summary of Cumulative Actions within the Unit by Alternative 4-5
4-2 Summary Cumulative Surface Disturbance Acres within the Unit by Alternative 4-8
4-3 Past, Present, and Reasonably Foreseeable Projects, Plans, or Actions that Comprise the Cumulative Impact Scenario 4-16
4-4 Acute Reference Exposure Levels (1-hour exposure) 4-31
4-5 Sensitive Lakes Analyzed in Far-Field Analysis..... 4-33
4-6 Alternative A Year 2 Emissions (TPY) 4-38
4-7 Alternative A Year 2 GHG Emissions (metric tons per year) 4-39
4-8 Alternative A - Maximum Modeled Pollutant Concentrations at Class I and Sensitive Class II Areas (µg/m^3)..... 4-40
4-9 Alternative A - Maximum Visibility Impacts at Class I and Sensitive Class II Areas 4-42
4-10 Alternative A - Maximum Nitrogen and Sulfur Deposition Impacts at Class I and Sensitive Class II Areas 4-43
4-11 Alternative A - Maximum Impacts on Lakes within the Class I and Sensitive Class II Areas..... 4-44
4-12 Alternative B Year 5 Emissions (TPY) 4-45
4-13 Alternative B Year 5 GHG Emissions (metric tons per year) 4-46
4-14 Alternative B - Criteria Pollutant Modeling Results for Field Development Activities..... 4-46
4-15 Alternative B - Criteria Pollutant Modeling Results for Field Production Activities..... 4-47
4-16 Alternative B - HAP Modeling Results for Field Production Sources 4-48
4-17 Alternative B - Unit Risk Analyses 4-49

4-18 Alternative B - Maximum Modeled Pollutant Concentrations at Class I and Sensitive Class II Areas (µg/m^3) 4-50
4-19 Alternative B - Maximum Visibility Impacts at Class I and Sensitive Class II Areas 4-52
4-20 Alternative B - Maximum Nitrogen and Sulfur Deposition Impacts at Class I and Sensitive Class II Areas 4-52
4-21 Alternative B - Maximum Impacts on Lakes within the Class I and Sensitive Class II Areas 4-53
4-22 Cumulative Pollutant Concentrations (CARMMS 2021 High Development Scenario) at Class I and Sensitive Class II Areas (µg/m^3) 4-67
4-23a Cumulative Visibility Results (Δdv) for Worst 20% Visibility Days at Class I Areas for Current Year (2008) and 2021 High Development Scenario all Emissions and Contributions from RFD Sources 4-70
4-23b 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 4-70
4-24 Cumulative RFD Nitrogen and Sulfur Deposition Impacts (CARMMS 2021 High Development Scenario) at Class I and Sensitive Class II Areas 4-71
4-25 Cumulative RFD Impacts on Lakes (CARMMS 2021 High Development Scenario) within the Class I and Sensitive Class II Areas 4-71
4-26 Average Noise Levels Produced during Construction and Operations 4-74
4-27 Acres of Soils on Steep Slopes Potentially Impacted (Alternative A) 4-83
4-28 Acres of Soils with Erosion Hazard Ratings Potentially Impacted (Alternative A) ... 4-83
4-29 Acres of Soils with Erosion Hazard Ratings for Roads (Alternative A) 4-84
4-30 Acres of Soils on Steep Slopes Potentially Impacted (Alternative B) 4-84
4-31 Acres of Farmlands Potentially Impacted (Alternative B) 4-85
4-32 Acres of Soils with Erosion Hazard Ratings Potentially Impacted (Alternative B) ... 4-85
4-33 Acres of Soils with Erosion Hazard Ratings for Roads (Alternative B) 4-86
4-34 Acres of Farmlands Potentially Impacted (Alternative C) 4-87
4-35 Acres of Soils on Steep Slopes Potentially Impacted (Alternative C) 4-87
4-36 Acres of Soils with Erosion Hazard Ratings Potentially Impacted (Alternative C) ... 4-87
4-37 Acres of Soils with Erosion Hazard Ratings for Roads Potentially Impacted (Alternative C) 4-88
4-38 Acres of Farmlands Potentially Impacted (Alternative D) 4-88
4-39 Acres of Soils on Steep Slopes Potentially Impacted (Alternative D) 4-89
4-40 Acres of Soils with Erosion Hazard Ratings Potentially Impacted (Alternative D) ... 4-89
4-41 Acres of Soils with Erosion Hazard Ratings for Roads Potentially Impacted (Alternative D) 4-90
4-42 Estimated Risk of a Reportable Spill from a Producing Gas Well in Colorado 2009 to 2013 4-96
4-43 Direct Impacts on Vegetation Communities in Bull Mountain Unit (Alternative A) 4-121
4-44 Direct Impacts on Vegetation Communities in Bull Mountain Unit (Alternative B) 4-122
4-45 Permanent Impacts on Vegetation Communities from Development of Well Pad 12-89-7-1 4-123

4-46 Direct Impacts on Vegetation Communities in Bull Mountain Unit (Alternative C) 4-124
4-47 Direct Impacts on Vegetation Communities in Bull Mountain Unit (Alternative D) 4-125
4-48 Cumulative Impacts on Vegetation Communities in Bull Mountain Unit (Alternatives A and B combined) 4-126
4-49 Cumulative Impacts on Vegetation Communities in Bull Mountain Unit (Alternatives A and C combined) 4-126
4-50 Cumulative Impacts on Vegetation Communities in Bull Mountain Unit (Alternatives A and D combined) 4-127
4-51 Habitat Quality Categories as a Function of Road Density 4-132
4-52 Habitat Categories by Alternative 4-133
4-53 Impacts on Mule Deer and Elk Habitat in Bull Mountain Unit under Alternative A 4-134
4-54 Impacts on Mule Deer and Elk Habitat in Bull Mountain Unit under Alternative B 4-142
4-55 Impacts on Mule Deer and Elk Habitat in Bull Mountain Unit under Alternative C 4-145
4-56 Impacts on Mule Deer and Elk Habitat in the Bull Mountain Unit under Alternative D 4-149
4-57 Cumulative Impacts on Mule Deer and Elk Habitat in Bull Mountain Unit (Alternatives A and B combined) 4-150
4-58 Impacts on Mule Deer and Elk Habitat in Bull Mountain Unit (Alternatives A and C combined) 4-151
4-59 Impacts on Mule Deer and Elk Habitat in the Bull Mountain Unit (Alternatives A and D Combined) 4-151
4-60 Visual Resources Inventory Scenic Quality Evaluation Ratings 4-184
4-61 Grazing Disturbance on BLM Allotments from Roads and Well Pads 4-192
4-62 Alternative A - Surface Disturbance[1] by Landownership 4-204
4-63 Alternative B - Surface Disturbance[1] by Landownership 4-205
4-64 Alternative C - Surface Disturbance[1] by Landownership 4-206
4-65 Alternative D - Surface Disturbance[1] by Landownership 4-206
4-66 Bull Mountain Unit Estimated Annual Direct Labor Requirements and Costs - Alternative A 4-227
4-67 Bull Mountain Unit Direct and Indirect Annual Contributions - Alternative A 4-228
4-68 Impacts on Local Fiscal Conditions—Alternative A 4-231
4-69 Bull Mountain Unit Direct Annual Employment and Labor Costs—Alternative B 4-234
4-70 Bull Mountain Unit Direct and Indirect Annual Contributions—Alternative B 4-235
4-71 Impacts on Local Fiscal Conditions - Alternative B 4-237
4-72 Irreversible and Irretrievable Commitment of Resources 4-246
4-73 Relationship of Short-term Uses of the Environment to Long-term Productivity 4-247
5-1 Number of Unique Submissions and Comments by Affiliation 5-5
5-2 Number of Comments on the Draft EIS by Category 5-6

FIGURES

Page

ES-1 Bull Mountain Unit ES-2
1-1 Regional Bull Mountain Unit 1-3
1-2 Bull Mountain Unit 1-4
2-1 Alternative A, No Action 2-14
2-2 Alternative B, Proposed Action 2-41
2-3 Alternative B, C, and D 12-89-7-1 APD 2-43
2-4 Alternative B, Proposed Action Wildlife Habitat Plan 2-44
2-5 Alternative C, Modified Action 2-75
2-6 Alternative C, Constraints 2-76
2-7 Alternative D, BLM's Preferred Alternative 2-89
2-8 Alternative D, BLM's Preferred Alternative Wildlife Habitat Plan 2-90
3-1 Air Quality Study Area 3-7
3-2 Soils 3-24
3-3 Farmlands 3-27
3-4 Watersheds 3-31
3-5 Streams and Springs 3-34
3-6 Water Quality Monitoring 3-44
3-7 Geology Cross Section 3-50
3-8 Geology 3-53
3-9 Landslides 3-55
3-10 Vegetation 3-59
3-11 Riparian and Wetland Vegetation 3-62
3-12 Fish and Aquatic Wildlife Habitat 3-66
3-13 Mule Deer Habitat 3-69
3-14 Elk Habitat 3-70
3-15 Purple Martin Habitat 3-79
3-16 Bald Eagle Habitat 3-80
3-17 Canada Lynx Habitat 3-87
3-18 North Fork Landscape Unit Prehistoric Site Sensitivity Model 3-100
3-19 Potential Fossil Yield Classification 3-105
3-20 Grazing Allotments 3-111
3-21 Existing Infrastructure 3-123
4-1 Alternatives A and B Cumulative 4-12
4-2 Alternatives A and C Cumulative 4-13
4-3 Alternatives A and D Cumulative 4-14
4-4 Cumulative Effects Study Area 4-15
4-5 Near-Field Analysis, Well Pad and Access Road Construction Modeling Scenario 4-25
4-6 Near-Field Analysis, Well Production Modeling Scenario 4-26
4-7 Near-Field Analysis, Well Development Modeling Scenario 4-27
4-8 Well Production Receptor Grid 4-28
4-9 Near-Field Analysis, Well Development Receptor Grid 4-29
4-10 Far-field Analysis Modeling Scenario 4-34
4-11 Far-field Analysis, Source Layout 4-35

4-12 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. 4-63
4-13 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). 4-65
4-14 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. 4-66
4-15 Habitat Categories by Alternative 4-135

APPENDICES – VOLUME II

A Well Pad Site Suitability Models and Methodology
B Construction, Drilling, Completion, and Reclamation
C Design Features, Mitigation Measures, and Conditions of Approval
D Master Surface Use Plan of Operations
E Master Drilling Plan
F Summary of Lease Stipulations
G Hazardous Materials Management Summary
H Water Quality Sampling Constituents for the Bull Mountain Unit
I Noxious Weed Management Plan
J Air Quality Technical Support Document for the Bull Mountain Unit MDP EIS
K Economic Impact Analysis Methodology – Technical Report
L Bainard Augmentation Plan
M Poly Pipeline Operation Plan
N Response to Comments on the Draft EIS
O 12-89-7-1 APD Package

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ACRONYMS AND ABBREVIATIONS

	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
WHP	Wildlife Habitat Plan

Appendix A

Well Pad Site Suitability Models and Methodology

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 were 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	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

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.

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.

Photo 2: The same wetland area after two growing seasons.

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

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.

Photo 4: Reclaimed pipeline corridor adjacent to road

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 every two years per well is anticipated for purposes of this EIS 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

Design Features, Mitigation Measures, and Conditions of Approval

APPENDIX C
DESIGN FEATURES, MITIGATION MEASURES, AND CONDITIONS OF APPROVAL

All federal actions undertaken as a result of the No Action, Proposed Action, Modified Action, and Preferred 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).

DESIGN FEATURES, MITIGATION MEASURES, AND CONDITIONS OF APPROVAL

The Proposed Action and alternatives are made up of design features, or those specific means, measures, or practices that include all phases of the natural gas development process such as construction activities and operating procedures, as well as additional requirements such as lease stipulations and measures that reduce or avoid adverse environmental impacts (BLM NEPA Handbook, H-1790-1, pages 44-45 and 61).

The detailed analyses presented in Chapter 4, Environmental Consequences, are based on a thorough review of the design features presented in the alternatives. When the analysis identified the need for additional measures to reduce or avoid impacts, then authors included them as

mitigation measures. The BLM NEPA Handbook (H-1790-1) defines "mitigation measures" as "specific means, measures, or practices that would reduce or eliminate the effects of the Proposed Action or alternatives. They may be used to reduce or avoid adverse impacts, whether or not impacts are significant. A measure or practice is termed 'mitigation measure' only if it has not been incorporated into the Proposed Action or alternatives" (page 44-45 and 61, emphasis added).

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), or developed through the NEPA analysis process. 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.

The following table of measures is a modified version of those presented in the Draft Environmental Impact Statement (EIS) and identifies measures that are design features, mitigation measures, and Conditions of Approval. Based on public comments and internal review of the measures, the BLM found that several were redundant and restated legal, regulatory, or policy requirements, and did not need to be repeated here. The table below identifies the measures that will be used by the Uncompahgre Field Office (UFO) when considering APDs under the MDP.

Phase or Resource Program		Measure	Alternative B			Alternative C			Alternative D		
			COA	Mitigation Measure	Design Feature	COA	Mitigation Measure	Design Feature	COA	Mitigation Measure	Design Feature
Surface Disturbing Activities	1	Prior to approval of any Federal APDs which initiate construction of a well pad analyzed in this EIS, alternate siting within a 40-acre area of the Federal well pad may be required by the Authorized officer as a result of reviewing the proposed surface location identified in the operator's corresponding NOS/APD. The 40-acre area is identified by drawing a circle with a radius of 745-feet around the proposed location. Alternate siting may be required by the authorized officer to minimize adverse impacts to other resource values, land uses or users not addressed in the lease stipulations, other specific nondiscretionary statutes, and EIS conditions of approval at the time operations are proposed. Alternate siting of a Federal well pad beyond the 40-acre limitation may result in additional environmental analysis being required to obtain approval.	X	X		X		X	X		X
	2	The operator shall notify the BLM Authorized Officer (AO) at least 48 hours prior to initiation of construction.	X	X		X		X	X		X
	3	Site-specific slope-stability studies will be conducted in areas of potential geologic hazard as identified in the MDP analysis 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.	X	X		X		X	X		X
	4	Any loose rock occurring in the vicinity will be scaled prior to construction if it presents a safety hazard.	X	X		X		X	X		X
	5	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.	X	X		X		X	X		X
	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.	X	X		X		X	X		X
	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.	X	X		X		X	X		X
	8	The operator shall use only certified weed-free seed and erosion-control materials.	X	X		X		X	X		X
	9	Use of erosion-control blankets with plastic netting shall not be permitted.	X	X		X		X	X		X
	10	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.	X	X		X		X	X		X
	11	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.	X	X		X		X	X		X
	12	Dust abatement measures will be applied to unpaved roads and well pads to achieve at least 50% control during all construction and development phases. Dust abatement measures will also be applied (greater than or equal to 50%) to unpaved roads and well pads during the production phase when expected traffic rates exceed 2 trips to each well pad within the Unit per day. 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.	X	X		X		X	X		X
	13	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. Existing ROWs would be managed to protect valid existing rights.	X	X		X		X	X		X

Phase or Resource Program		Measure	Alternative B			Alternative C			Alternative D		
			COA	Mitigation Measure	Design Feature	COA	Mitigation Measure	Design Feature	COA	Mitigation Measure	Design Feature
Road Construction and Maintenance	14	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.	X	X		X		X	X		X
	15	The operator shall provide timely year-round road maintenance and cleanup on the access roads.	X	X		X		X	X		X
	16	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.	X	X		X		X	X		X
	17	Unless otherwise approved by BLM, avoid headwalls, midslope locations on steep, unstable slopes, seeps, old landslides, slopes in excess of 40%, and areas where the geologic bedding planes or weathering surfaces are inclined with the slope.	X	X		X		X	X		X
	18	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% of vegetation has been destroyed due to side casting.	X	X		X		X	X		X
	19	During wet weather conditions, no mud blading will be allowed. When road conditions are such that vehicles create ruts deeper than 4 inches, travel activities will be temporarily suspended.	X	X		X		X	X		X
Tanks and Pits	20	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 and/or tanks on the pad of the well being drilled, or hauled to an approved disposal site	X	X		X		X	X		X
	21	The operator shall install netting over the pits 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.	X	X		X		X	X		X
	22	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 2-foot freeboard (below the top of the liner) minimum at any time.	X	X		X		X	X		X
	23	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.	X	X		X		X	X		X
Pipeline and Power Line Construction	24	Hydrostatic Pipeline testing. Prior to water discharge, the operator will submit to BLM a copy of the approved conditions and stipulations from CDPHE's Colorado Discharge Permit System for Hydrostatic Testing of Pipelines, Tanks and Similar Vessels and identify on a map the location of the water discharge point.	X	X		X		X	X		X
	25	Power line and ancillary structure design shall adhere to guidance provided in "Suggested Practices for Avian Protection on Power lines: State of the Art."	X	X		X		X	X		X
	26	Poles and transmission line locations will be selected to achieve the minimum practicable adverse impact on visual quality.	X	X		X		X	X		X
	27	Pipeline corridors will be recontoured to pre-construction contours as soon as construction activities cease unless otherwise approved by BLM.	X	X		X		X	X		X
Gas Well Drilling	28	For dry holes, the abandonment marker will be capped with a 2-foot by 2-foot steel plate, at least 1/4 inch thick. The plate must be permanently inscribed with the identity requirements of 43 CFR 3162.6d) and buried a minimum of 2 feet below the final reclaimed ground level.	X	X		X		X	X		X

Phase or Resource Program		Measure	Alternative B			Alternative C			Alternative D		
			COA	Mitigation Measure	Design Feature	COA	Mitigation Measure	Design Feature	COA	Mitigation Measure	Design Feature
Air Quality and AQRVs	29	The BLM will place a COA on each permit, requiring the operator to emit 5 tons per year (tpy) 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 NO2 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 NOx 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.	X	X		X		X	X		X
	30	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 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 (drill / completion / fracturing) related 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 NO2 1-hour NAAQS.	X	X		X		X	X		X
	31	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).	X	X		X		X	X		X
	32	The BLM would require SGI to apply continuous watering to keep the surface moist during access road and well-pad construction, and during heavy traffic periods, including drilling and completion phases of well development. SGI would be required to limit off-site transport by maintaining no visible dust plume operations.	X	X		X		X	X		X
	33	SGI would be required to utilize and operate pneumatic devices, tanks and dehydrators in accordance with CDPHE and EPA Oil and Gas Regulations.	X		X	X		X	X		X
Noise	34	This project will be compliant with COGCC and CDPHE standards for noise abatement.	X	X		X		X	X		X
Cultural Resources	35	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.	X	X		X		X	X		X
Visual Resources	36	Downlighting will be used for all operating and production facilities.	X	X		X		X	X		X

Phase or Resource Program		Measure	Alternative B			Alternative C			Alternative D		
			COA	Mitigation Measure	Design Feature	COA	Mitigation Measure	Design Feature	COA	Mitigation Measure	Design Feature
Rangeland Management	37	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.	X	X		X		X	X		X
Hazardous Substances	38	Signs will be posted on-site that identify potential hazards associated with site operation, including chemical hazards.	X	X		X		X	X		X
Wildlife and Wildlife Habitat	39	No surface-disturbing activities shall occur from December 1 through April 30 in those portions of the Unit mapped as winter concentration and severe 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:" • Heavy construction requiring the use of cranes, backhoes, bulldozers or other heavy equipment • Drilling and completion operations • Workover rigs • 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 and may be granted by the 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."	X	X		X		X			
	40	From May 15 - 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.		X		X		X			
	41	Bear-resistant dumpsters and trash receptacles shall be installed at all facilities.	X	X		X		X	X		X
	42	The operator shall install screens on all heater-treaters and other exhaust systems to prevent nesting bird activity and bird mortality.	X	X		X		X	X		X
	43	All lethal and non-lethal injury events that involve migratory birds will be reported to a BLM official immediately.	X	X		X		X	X		X
	44	Screened water-suction hoses shall be utilized to exclude fish when drawing water from streams, ponds, and lakes.	X	X		X		X	X		X
	45	Wildlife crossovers (trench plugs) with ramps shall be installed on each side of trenches at maximum ¼ 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.	X	X		X		X	X		X

Phase or Resource Program		Measure	Alternative B			Alternative C			Alternative D		
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Invasive, Non-native Species	46	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.	X	X		X		X	X		X
	47	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 hot water and high-pressure sprayers to remove dirt, mud and foreign debris before equipment is brought on-site.	X	X		X		X	X		X
	48	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.	X	X		X		X	X		X
	49	Monitoring and control of noxious or invasive weeds attempting to establish within the project boundaries throughout the construction and production phases should be performed in coordination with routine maintenance activities and in accordance with state law and BLM regulations.	X	X		X		X	X		X
Reclamation	50	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.	X	X		X		X	X		X
	51	Exposed slopes shall be revegetated as soon as possible, 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.	X	X		X		X	X		X
	52	A Reclamation Status Report will be submitted to the UFO annually for all actions that require disturbance of surface 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.	X	X		X		X	X		X
Geologic Hazards	53	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.		X		X	X		X		X
	54	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.		X		X	X		X		X
	55	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.		X		X	X		X		X

Phase or Resource Program		Measure	Alternative B			Alternative C			Alternative D		
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Geologic Hazards (*continued*)	56	The following measures fall under the state regulations for injection wells and are within their jurisdiction. They are included with the preferred alternative for measures to apply to BLM authorized wells: • 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. • 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.		X		X	X		X		X
Water Baseline Monitoring	57	In addition to the State of Colorado baseline water monitoring requirements, the following will be added to the existing baseline monitoring program conducted by the operator. • Sampling will be conducted prior to drilling and at intervals of 1 year, 3 years, and 6 years following completion. • Sampling radius will include water wells 1 mile from well pad location. • Include all surface water sources and spring sources within 1 mile from well pad location. Surface water and springs will be sampled two times a year, at high flow and at low flow to meet the baseline monitoring requirements. Water will be analyzed for major ions, trace metals, dissolved gases (including methane), BTEX, TPH, dissolved organic carbon (DOC), nutrients, and field properties including temperature, pH, specific conductance, dissolved oxygen, turbidity, and alkalinity. Quality assurance sampling will include one replicate and one blank during each sampling trip. The replicate and blank will be analyzed for the same constituents as the environmental sample. • Surface water and groundwater baseline samples should include stable isotopes of methane (carbon and deuterium) to determine the origin of the methane (biogenic and/or thermogenic.) . Noble gases should also be sampled to age date groundwater and in combination with methane data can help distinguish between natural sources of methane or those induced from drilling activities. • Sample collection for surface water and groundwater should follow the National field manual for the collection of water-quality data[1]. Instrument logs, well characteristics, and other QA/QA collection methods should be submitted to the BLM. • Data should be summarized and provided to the BLM annually for review. BLM will determine if further analysis of data may be required by a third party such as the U.S. Geological Survey. Any additional expenses incurred for third party reviews as required by BLM, will be the responsibility of the operator. [1]U.S. Geological Survey, variously dated, National field manual for the collection of water-quality data: U.S. Geological Survey Techniques of Water-Resources Investigations, book 9, chaps. A1-A9, available online at http://pubs.water.usgs.gov/twri9A.					X		X		X

Phase or Resource Program		Measure	Alternative B			Alternative C			Alternative D		
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Wildlife and Wildlife Habitat	58	WHP: SGI will conduct raptor and migratory bird nest surveys at areas proposed for new surface disturbance and heavy construction and drilling activities. SG will conduct these surveys between May 15 and July 15 of each year, prior to submitting a COGCC Form 2 or BLM Notice of Staking. The intent of the surveys is to implement avoidance strategies where possible and minimize potential impacts to nesting raptors and migratory birds. These surveys may result in modifications to facility design, minor site location adjustments, and operational awareness that reduce direct and indirect impacts when a habitat of concern is identified. Where active raptor nests are identified, SGI will apply CPWs raptor nest buffer guidelines (Recommended Buffer Zones and Seasonal Restrictions for Colorado Raptors, 2008). When other migratory bird nests are located, SGI will avoid disturbance of nests, nestling birds are flagged when located and avoided during the nesting season.	X		X				X		X
Drilling	59	BLM's standard would be for closed loop systems to be used to eliminate pits on location and the release of VOCs, unless impacts could be demonstrated to be less when a reserve pit system is used. (There would be no net benefit to using a closed loop system.) The type of drilling system would be determined when the drilling application is submitted.							X		X
Construction	60	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.			X			X			X
	61	WHP: SGI will use multiple-well pad sites. The use of multiple-well pad sites reduces surface disturbance and overall habitat fragmentation and may result in a reduction of heavy equipment on road traffic due to fewer rig mobilizations and de-mobilizations.			X						X
	62	WHP: Where applicable, each new facility will be tied into a field-wide produced water gathering system for water disposal. This water gathering system, when used in conjunction with temporary surface poly lines, results in a significant reduction in truck traffic and consolidation of water handling facilities.			X						X
	63	WHP: In addition to installing standard stormwater erosion controls to protect water quality as required by the Colorado Department of Health and Environment (CDPHE), SGI will make efforts to comply with CPW and COGCC recommended buffers for aquatic habitats in the BMU (see LIDAR discussion below). SGI will implement the following BMPs within the BMU: • Except as outlined on Figure 2 of the Wildlife Habitat Plan (see Appendix O) and other excepting activities outlined in Appendix O, no surface disturbance within 300 feet of a designated cutthroat trout stream. • In other watersheds, well pads and facilities will not be sited, to the extent practicable, within 150 feet of any natural lake, wetland, or perennial or seasonally flowing stream or river. • Roads crossing CPW mapped cutthroat trout streams will be bridged or use appropriately sized culverts to prevent stream bed damage and the transfer of disease organisms. Pipelines that cross cutthroat trout streams should be bored if practicable. • Stream disturbances in or upstream of CPW -mapped cutthroat trout habitat will be avoided between June 1 and August 31 to avoid impacts to spawning cutthroat trout. • All stream crossing and culverts on perennial and intermittent streams shall be designed to allow aquatic species passage. • Minimum right-of-way widths will be used where pipelines cross riparian areas and streams and crossing will be constructed at right angles to the stream channel. • Native riparian canopy cover and stream bank vegetation will be left intact to the extent practicable.			X						X

Phase or Resource Program		Measure	Alternative B			Alternative C			Alternative D		
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Construction (*continued*)		• Chemical dust suppression activities will be avoided within 300 feet of the ordinary high water mark of any reservoir, lake, wetland, or natural perennial or seasonally flowing stream or river, unless required by surface owner, county or state requirements. • Screen water suction hoses to exclude fish and amphibians. Disinfect heavy equipment, hand tools, boots and any other equipment that was previously used in a river, stream, lake, pond, or wetland in a different watershed prior to moving the equipment to another water body. The disinfection practice applies fieldwide and follows the procedure outlined in COGCC Rule 1204.a.2.									
	64	WHP: SGI will meet annually with BLM by December 31 each year to summarize its development and mitigation activities for the previous 12-months and to forecast with best available information the next year's development and mitigation activities as they relate to the Wildlife Habitat Plan.			X						X
	65	SGI would have a yearly meeting with the BLM to present an annual construction and operational activities plan prior to the construction season.			X			X			
	66	With an annual agreement by SGI as part of the annual Operations Plan, SGI would present the order for development phasing around the Unit to avoid widespread impacts on wintering big game species during a winter period.			X			X			
	67	WHP: SGI will observe the Restricted Surface Occupancy (RSO) buffer restrictions contained in COGCC Rules. If SGI cannot comply with the RSO buffer restrictions for a particular facility, SGI agrees to enter into an individual consultation with CPW on that facility under Rule 306.c. to evaluate options for avoidance, minimization, and mitigation.			X						X
	68	WHP: SGI will avoid the verified Elk Winter Concentration areas where practicable in re-siting the well pad. The primary constraint in avoiding these areas will be the 40-acre analysis area within which the well pad can be relocated under the MDP EIS analysis. Other resources such as slope, soil, and wetlands will also factor into any re-siting analysis. Where this conflict occurs and cannot be resolved, site-specific mitigations will be addressed during any future required site specific NEPA analysis.			X						X
	69	SGI 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.						X			
	70	Active streams would be crossed outside the spawning season identified by CPW for applicable aquatic species.						X			X
Access Road Construction	71	New road construction and improvements would only occur on an as-needed basis to facilitate access to well pads and other facilities.			X			X			X
	72	Access roads would be constructed using standard crown-and-ditch specifications.			X			X			X
	73	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).			X			X			X
	74	Spur roads to individual well pads would be constructed immediately prior to well pad construction.			X			X			X
Well Pad Construction (Gas & Water Disposal Wells)	75	WHP: SGI will use multiple-well pad sites. The use of multiple-well pad sites reduces surface disturbance and overall habitat fragmentation and may result in a reduction of heavy equipment on road traffic due to fewer rig mobilizations and de-mobilizations			X						X
	76	All available topsoil to a depth of 8 to 12 inches would be stockpiled and segregated from subsoils over the entire disturbed surface			X			X			X
	77	SGI would ensure that water accumulation on pads is not allowed to drain into wetlands or riparian areas down-gradient from the Unit.			X			X			X

Phase or Resource Program		Measure	Alternative B			Alternative C			Alternative D		
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Pipeline Construction	78	WHP: SGI will co-locate of pipelines and other utilities adjacent to road rights-of-way where practicable			X						X
	79	The entire pipeline network would be required to be collocated with current and proposed road network development consistent with Gold Book recommendations unless deemed a detriment to resources.						X			
	80	Highway crossing methods and construction requirements would be according to the Colorado Department of Transportation (CDOT) permit stipulations and general conditions as necessary.			X			X			X
	81	SG will ensure that access is provided for property owners, tenants, or ROW holders to move vehicles, equipment, and livestock across the trench where necessary.			X			X			X
	82	If crossing a road or wetland, SGI could utilize a pipeline bore for the crossing.			X			X			X
	83	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 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 entire construction zone would be seeded in the first appropriate season after disturbance.			X			X			X
	84	The entire pipeline would be tested in compliance with USDOT regulations (49 CFR Part 192). 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.			X			X			X
	85	Carsonite pipeline markers would be installed on the surface and tracer wire would be installed for all buried pipelines.			X			X			X
	86	Pipelines and roads would be sited to avoid identified elk winter concentration areas, unless avoiding such habitats would result in greater net surface disturbance or if it were determined to be a detriment to other resource values. Where feasible, trunk lines would be buried in the roadbed or in the borrow ditch to further reduce surface disturbance. No more than a 30-foot-wide disturbance route in addition to the average 16-foot-wide road would be approved for collocated pipelines.									X
Overhead Electrical Line Construction	87	WHP: SGI will co-locate of pipelines and other utilities adjacent to road rights-of-way where practicable			X						X
	88	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			X						X
	89	New electrical lines would be buried adjacent to the roads to minimize overhead disturbance to wildlife resources.						X			
Drilling	90	WHP: SGI will limit the number of drilling rigs operating in the BMU during those times when wintering big game could be most impacted. Under SGI's Proposed Action, SGI will operate up to three (3) drilling rigs between April 15 and December 1 of each year. Only one drilling rig would operate from December 1 through April 15 each year. WHP: To address potential direct and indirect impacts to wintering big game, SGI will voluntarily limit winter activities in portions of the BMU that have been identified by CPW as the most critical to wintering big game. See Figure 1, Winter Closure Areas, in the WHP. SGI agrees that the activities listed below will not be allowed within the voluntary big game "Winter Closure Areas" between December 1 and April 15 each year:			X						X

Phase or Resource Program		Measure	Alternative B			Alternative C			Alternative D		
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Drilling *(continued)*	91	• Drilling of new wells. • Well work-over and completion activity intended to increase the production of a well. • Reclamation activities and existing road maintenance activities that can be delayed until after April 15 each year. • New surface-disturbing activities, including pipeline construction and installation, road and pad construction, and other general construction and facility installation. Where activities prohibited within the Winter Closure Areas between December 1 and April 15 of each year are initiated in a timely fashion and where it is anticipated that the date of completion will be prior to December 1, but where operational or regulatory restraints require continuing operations after December 1, BLM shall not unreasonably withhold individual waivers allowing for such continuing activity. SGI will limit activities to the following between December 1 and April 15 each year: • Well production and routine maintenance activities. In this context, well production and routine maintenance activities include: o Emergency work-overs or other emergency actions necessary to remedy equipment failures or unanticipated declines in production, or as required by local, state, or federal regulatory agencies. o Non-routine pipeline facility maintenance necessary to remedy unanticipated production problems, to address safety issues, or as required by local, state, and federal regulatory agenc1es. o Normal daily production activities including "pumping" of wells, generally requiring up to two (2) vehicle trips per day or less to a well pad. Normal daily production activities require snow plowing and the minimum amount of road maintenance necessary to access the well. Daily access to each well pad is necessary for safe and environmentally responsible operations. For example, formation water produced from wells in the BMU and stored temporarily in tanks on each location, require daily site visits to ensure prudent and environmentally responsible operations. The combination of large volumes of stored water and extreme low temperatures can potentially result in mechanical failures that can only be effectively monitored by daily site visits. Roads to each location must be plowed to ensure minimal response times for necessary equipment to address any issue which could result in damage to environmental resources. Remote telemetry monitoring cannot provide the same level of assurance and environmental protection that human daily site visits ensure. • SGI will install gates and signage to limit access to the extent permitted by the landowners at all entry points to the Voluntary Big Game Closure Areas shown on Figure 1.			X						X
	92	Drilling methods would either utilize a reserve pit on the well pad or a pit-less "closed-loop system." 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.			X						
	93	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.				X		X			

Phase or Resource Program		Measure	Alternative B			Alternative C			Alternative D		
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Drilling *(continued)*	94	When using a closed-loop system, the following will apply: • The reserve pit would be replaced with a series of storage tanks that separate liquids and solids. • Equipment to separate solids (e.g., screen shakers, hydrocyclones, or centrifuges) and collection equipment (e.g., vacuum trucks) would minimize the volume of drilling waste muds and cuttings that require disposal and would maximize the volume of drilling fluid recycled and reused in the drilling process. • The recovered drilling fluid would be stored in 500-barrel tanks and reused in active mud systems. • Drilling fluid would be moved from well-to-well and reconditioned by the dewatering equipment and mud products. • Solid wastes would be transferred off-site for disposal at oilfield waste disposal facilities.						X			X

	95	When using a reserve pit system, the following will apply:
		• The reserve pit would not be used to store flowback water during the completion phase nor used to store produced water during the production phase.
		• 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.
		• Reserve pit fences would be constructed and maintained according to the permitting agency's 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 or federal regulations.
		• The pit would be lined with an impermeable minimum 24-mil plastic liner so as not to leak, break, or allow discharge.
		• Reserve pit sizes vary with well type and site conditions but would typically be approximately 50 feet by 150 feet and lined.
		• Fencing:
		  o Reserve pits would be fenced on three sides during drilling and on the fourth side immediately after the drilling rig is removed in order to keep big game and wildlife out of the pits.
		  o Silt fencing would be installed around the base of the fences.
		• Bird netting would be installed over the pit within 24 hours after drilling has begun.
		• Two feet of freeboard would be required at all times.
		• Pits would have a two-foot unlined berm in addition to the minimum two feet of freeboard around them to prevent snowmelt on the pad from flowing into the pits.
		• Fill from the pit would be stockpiled along the edge of the pit and the adjacent edge of the well pad.
		• Erosion control measures would be used, including proper grading to minimize slopes, diversion ditches, mulching, riprap, fiber matting, temporary sediment traps, and broad-based drainage dips, as necessary and appropriate to minimize erosion and surface runoff during well pad construction and operation.
					X						X

Phase or Resource Program		Measure	Alternative B			Alternative C			Alternative D		
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Drilling *(continued)*	96	WHP: SGI will manage pits necessary for production activities to minimize the likelihood of wildlife mortalities. SGI will install wildlife fencing around pits and netting over open pits to exclude birds, bats, and terrestrial wildlife. For reserve pits, 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 reserve pit, but may be removed once the pits are dried. For dry pits, SGI will provide escape ramps or other means to allow terrestrial wildlife opportunity to escape from open pits. SGI may implement closed loop pitless drilling systems at its own discretion to avoid the need to fence and net reserve pits.			X						X
	97	Solid wastes would be transferred off-site for disposal at oilfield waste disposal facilities.			X			X			X
	98	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.			X			X			X
	99	Tier-2 or better drilling and/or completion rigs will be used.						X			X
	100	Tier-2 or -3 drilling and/or completion rigs will be used.			X						
	101	Freshwater-based drilling would be used; oil-based drilling fluids may also be used in production formations where borehole stability requires it or for directionally drilled wells.						X			X
	102	Both water-based and oil-based drilling fluids would be used, depending on the target formations. Specifics on which type of drilling fluid used would be included on the individual APD.			X						
	103	Casing and cementing plans are designed by engineers and included in an APD and associated Drilling Plan. Casing programs are dependent on the target depth and individual well casing plan.			X			X			X
	104	Blowout preventer controls must be installed prior to drilling out the surface shoe and prior to starting workover or completion operations.			X			X			X
Water Disposal Well Drilling	105	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.			X			X			X
	106	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.						X			X
	107	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.			X			X			X
Gas Well Completions	108	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.			X			X			X
	109	Test gas could be flared (released to the atmosphere) or environmentally friendly green completion technology may be used. See also COGCC regulation 2 CCR 805.b(3) for further details on green completion technologies			X						X
	110	Operators would be required to employ green completion technologies following EPA NSPS OOOO Regulations.						X			
	111	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.			X						X
Water Disposal Well Completion	112	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.			X			X			X

Phase or Resource Program		Measure	Alternative B			Alternative C			Alternative D		
			COA	Mitigation Measure	Design Feature	COA	Mitigation Measure	Design Feature	COA	Mitigation Measure	Design Feature
Interim Reclamation	113	The operator will 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.						X			X
	114	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.			X						
	115	WHP: SGI will use a CPW-recommended wildlife friendly seed mix for interim and final reclamation where approved by the surface owner. The CPW-recommended wildlife friendly seed mixes for the BMU are found in Appendix A of the Wildlife Habitat Plan.			X						X
	116	Surfaces not needed for long-term operations would be recontoured and seeded as per the requirements set by the landowner agreement, COGCC, and/or BLM.			X			X			X
	117	If availability were a concern, the operator would request the use of BLM's or COGCC's approved alternate seed mixture.			X						
	118	Reclamation efforts would continue until all related requirements were met.			X			X			X
	119	Removal or burial of any surfacing material used to complete the well pad would be according to the authorizing agency's standards.			X			X			X
	120	Return 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.			X			X			X
	121	SGI would minimize dust and erosion during the interim reclamation process.			X			X			X
	122	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.			X						
	123	Areas needed for production and subsequent drilling operations (those planned within 12 months) would be stabilized to minimize fugitive dust and erosion.			X			X			X
	124	Stockpiled topsoil, as well as remnant vegetation (e.g., uprooted sagebrush and oak brush) would be spread over interim reclamation areas.			X			X			X
	125	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.			X			X			X
Production	126	WHP: In addition to the daily site inspections at each well pad location, SGI will remotely monitor specific aspects of well production. This remote monitoring is proposed as a way to provide monitoring between the daily site inspections by SGI personnel. Additionally, this proposed remote monitoring will be conducted at all fee and federal well pad locations as proposed in SGI's Proposed Action under Alternative A and Alternative B. SGI will monitor the following aspects of well production using remote telemetry: • Tubing pressure, • Casing pressure, • Gathering system line pressure, • Wellhead differential pressure, • Wellhead gas temperature • Wellhead gas rate, and • Production tank level alarms			X						X

Phase or Resource Program		Measure	Alternative B			Alternative C			Alternative D		
			COA	Mitigation Measure	Design Feature	COA	Mitigation Measure	Design Feature	COA	Mitigation Measure	Design Feature
Production *(continued)*	127	WHP: SGI will implement this proposed remote monitoring under the following time limits: • Wells existing in the BMU on the effective date of this WMP shall be retrofitted and become compliant with the seven (7) monitored aspects of well production listed above within twenty-four (24) months of the effective date of this WMP. • Wells not yet existing in the BMU on the effective date of this WMP shall be compliant with the seven (7) monitored aspects of the well production listed above within six (6) months of such a well being placed on production.			X						X
	128	SGI 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.						X			
	129	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.			X			X			X
	130	Protective barriers would be installed around the production facilities, including tanks.			X			X			X
	131	All site security guidelines would be followed as identified in the authorizing agency's statutes, regulations, and policy			X			X			X
	132	Centralized production facilities may be used should it be determined that doing so would provide a net benefit to the impacted resources. Whether centralized production facilities are required or developed as part of a project's design features would be determined at the permitting stage.						X			X
	133	SGI would conduct the minimal amount of seasonal road maintenance required to pump the well or conduct emergency activities.						X			X
Produced Water Management	134	WHP: Where applicable, each new facility will be tied into a field-wide produced water gathering system for water disposal. This water gathering system, when used in conjunction with temporary surface poly lines, results in a significant reduction in truck traffic and consolidation of water handling facilities.			X						X
	135	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 and/or in accordance with a plan approved by the COGCC rules and regulations.			X			X			X
Workovers	136	Workover activities would typically be implemented during daylight hours only.			X						X
	137	For those locations that are in critical winter ranges, all maintenance would occur between 9 a.m. and 3 p.m. from December 1 to April 30, except during emergencies						X			
Maintenance	138	SGI would be required to prepare and implement a road maintenance plan for all roads used for project-related purposes.			X			X			X
	139	SG is committed to adherence with county road maintenance and encroachment ordinance requirements.			X			X			X
Final Reclamation & Abandon-ment	140	Development of a site-specific reclamation plan, based on information provided in **Appendix D** would include consultation between the BLM, the surface owner, and SGI. 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.			X			X			X
	141	Plugging and abandonment of wells will use industry BMPs and comply with all applicable rules and regulations set forth by the BLM, and/or the COGCC for plugging. Depending upon surface estate, abandonment would comply with the appropriate surface management agency (SMA).			X			X			X
Reclamation Monitoring	142	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.			X			X			X

Phase or Resource Program		Measure	Alternative B			Alternative C			Alternative D		
			COA	Mitigation Measure	Design Feature	COA	Mitigation Measure	Design Feature	COA	Mitigation Measure	Design Feature
Reclamation Monitoring *(continued)*	143	SGI would monitor interim and final reclamation progress at 1-, 3-, and 5-year intervals.			X			X			X
	144	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.			X			X			X
Water Use & Water Sources	145	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).			X			X			X
	146	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.			X			X			
	147	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.			X			X			
Hazardous Materials & Solid Waste	148	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 Prevention, Countermeasure and Control (SPCC) Plan.			X			X			X
	149	Spills will be reported according to the regulations in place for the specific land ownership, type of spill and volume of spill.			X			X			X
	150	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.			X			X			X
	151	Bear-resistant trash containers would be located on active construction sites.			X						
	152	Portable toilets 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 accordance with applicable rules and regulations regarding sewage treatment and disposal.			X			X			X

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WILDLIFE HABITAT PLAN

New developments under the Proposed Action (Alternative B) and the Preferred Alternative (Alternative D) would be subject to the Bull Mountain Unit Wildlife Habitat Plan (WHP) submitted by SGI. The WHP would apply throughout development phase activities (construction, drilling, and completion); it would not apply to production or maintenance phase activities.

“Wildlife Mitigation Plan (WMP)” is a term of art that has specific regulatory meaning per COGCC Rule 1202.d(2). Per this definition, the plan submitted by SGI is not a WMP as it has not been agreed to or approved by CPW. In response to CPW’s comment and to avoid confusion, BLM refers to the plan as a “Wildlife Habitat Plan” or “WHP” throughout the EIS. As the original copy of the plan was a PDF submitted by SGI and signed by the company president, BLM has included this version here although it still uses the inaccurate terminology.

SG Interests I, Ltd. **100 Waugh Drive, Suite 400** **Houston, Texas 77007**

June 16, 2015

Transmitted via email to vaarmstrong@blm.gov
and Federal Express

Lori Armstrong
Southwest District Manager
Bureau of Land Management
2465 S. Townsend Ave
Montrose, CO 81401

Re: Bull Mountain Unit EIS
BLM Preferred Alternative

Dear Ms. Armstrong:

Thank you for meeting with us this past Friday, June 12, 2015, regarding the BLM Preferred Alternative under SG Interests I, Ltd.'s Master Development Plan Environmental Impact Statement.

You informed us during the meeting that the BLM has developed a Preferred Alternative that can be summarized as follows:

- 26 well pad locations from Alternative B will be carried forward in the BLM Preferred Alternative.
- 5 well pad locations from Alternative B will not be included in the Preferred Alternative but will remain as part of Alternative B
- 2 well pad locations will be included in the BLM Preferred Alternative from Alternative C.
- 5 well pad locations from Alternative B were identified by the BLM to have resource impacts that require additional mitigation measures from SG in order for BLM to carry them forward in the BLM Preferred Alternative.

It is also our understanding that the well pad locations that are carried forward in the BLM Preferred Alternative will be approved following issuance of a Record of Decision in the EIS through a Categorical Exclusion. Well pad locations that are not brought forward in the Preferred Alternative will require additional site specific NEPA such as an EA to resolve any outstanding issues or resource conflicts.

SG understands the BLM rational for moving forward with the EIS in this manner. In order to address the resource impacts on the 5 well pad locations that require additional mitigations, SG is enclosing and offers a revised Wildlife Mitigation Plan to address impacts that all locations may have on big game. In addition, the attached Table 1 lists SG's specific mitigation measures offered for the 5 locations requiring additional mitigations so that they can be included in the BLM Preferred Alternative.

Thank you for your consideration of this submittal. Should you have any questions, please do not hesitate to contact me, Catherine Dickert or Eric Sanford.

Sincerely,

SG Interests I, Ltd.

Robert H. Guinn, II
Vice President – Land

Rg
Attachments

Table 1

This Table 1 addresses the five (5) well pads identified by the BLM in a meeting on 6/12/15 as requiring additional mitigations measures from SG in order for the BLM to bring these well pads forward in the BMU EIS Preferred Alternative. This Table 1 outlines specific mitigation measures offered by SG in order to include these locations in the BLM Preferred Alternative.

Well	Mitigation Measures
Federal 12-90-2 #1	SG agrees to construct the access road to this well pad location according to plans developed and approved by a Professional Engineer in order to avoid potential geo-hazards and/or other resource impacts such as erosion.
Federal 11-89-30 #1	SG agrees to route the pipeline to this well pad location adjacent to existing roads where practicable. SG also agrees to implement visual mitigation strategies to reduce visibility from Colorado State Highway 133. These site specific measures could include adjustment of well pad layout, adjustment of well pad elevation, construction of visual mitigation berms, and low profile tanks.
Federal 12-89-4 #1	SG agrees to work with the surface owner of this well pad location to reduce impacts and conflicts which may arise from the unique operations and activities conducted by this surface owner.
Federal 11-89-29 #2	SG's revised voluntary Wildlife Mitigation Plan is offered for the Preferred Alternative locations as direct mitigation for impacts to elk from the operation of the well pad, road, and pipeline associated with this well pad location.
Federal 11-89-8 #1	SG's revised voluntary Wildlife Mitigation Plan is offered for the Preferred Alternative locations as direct mitigation for impacts to elk from the operation of the road and pipeline associated with this well pad location.

SG Interests I, Ltd. **100 Waugh Drive, Suite 400** **Houston, TX 77007**

June 16, 2015

Bureau of Land Management
Uncompaghre Field Office
Attn: Barb Sharrow
2465 South Townsend Avenue
Montrose, Colorado 81401

Re: **SG INTERESTS I, LTD.**
BULL MOUNTAIN FEDERAL UNIT AREA
VOLUNTARY WILDLIFE MITIGATION PLAN
GUNNISON COUNTY, COLORADO

Dear Ms. Sharrow;

Please consider the design criteria in this Wildlife Mitigation Plan as amendments to SGI's original Proposed Action for development of the Bull Mountain Unit. This letter dated June 16, 2015 supersedes and replaces the Voluntary Wildlife Mitigation Plan dated May 29, 2015, previously sent to the BLM.

Introduction and Background

This voluntary, operator proposed Wildlife Mitigation Plan (WMP) addresses potential impacts to wildlife from SG Interests I, Ltd.'s (SGI) proposed natural gas development of mineral leasehold interests in the Bull Mountain Federal Unit Area (BMU) in Gunnison County, Colorado encompassing approximately 19,645 acres (**Figure 1**). The BMU area surface ownership is approximately 98% private and 2% public (**Figure 2**). The BMU area land use is comprised primarily of historic homestead settlements and agricultural operations. The BMU provides a variety of private recreational hunting and fishing opportunities, as well as other private outdoor recreational activities. Public access for recreational purposes is limited to approximately 400 acres of BLM surface inside the BMU (**Figure 2**).

This voluntary WMP is the culmination of a multi-year collaborative effort between SGI and Colorado Parks and Wildlife (CPW) to develop a plan to mitigate anticipated potential wildlife impacts from development of SGI's Master Development Plan within the guidelines provided by the Colorado Oil and Gas Conservation Commission (COGCC) Rules of Practice and Procedure (Rules) governing oil and gas development activities in Colorado. While SGI and CPW have been able to reach agreement on most aspects of a negotiated WMP, we have been unable to reach agreement on one outstanding issue; compensation for CPW's calculated potential residual impacts to elk.

Therefore, SGI is voluntarily proposing this WMP as mitigation for potential impacts to wildlife under development of SGI's BMU Proposed Action. Based on recent discussions with the BLM, SG has voluntarily agreed to amend this WMP based on specific resource concerns raised by the BLM. Further, SG has also changed several road and pipeline alignments based on these same specific resource concerns. These changes are reflected in Figures 1 and 3 attached to this WMP. This WMP is relevant and effective only if the BLM selects the well pad locations identified in the attached Figure 1 and Figure 3, as all of the analysis including acreage calculations has been done in consideration of the development shown in these Figures. COGCC Rules identify Sensitive Wildlife Habitats (SWH's) and Restricted Surface Occupancy (RSO) areas for wildlife, and provide for consultation with CPW for facilities

proposed within these areas. The COGCC Rules also allow companies like SGI to prepare a WMP to address the potential impacts associated with one or more planned facilities. Once approved by CPW, a WMP satisfies any consultation requirement with CPW that may otherwise be required for each facility within SWH's [Rule 1202.d.(2)], resulting in a streamlined permitting process for individual facilities addressed in the WMP. It remains SG's hope that CPW will approve this voluntary plan as executed by SGI.

SGI and CPW began discussing options for a WMP for SGI's planned development activities in the BMU as early as May of 2011. In March of 2012, the Bureau of Land Management (BLM) released a Preliminary Environmental Assessment covering SGI's Master Development Plan (MDP) for the Bull Mountain Unit. BLM contacted CPW at that time regarding wildlife concerns associated with the Bull Mountain Unit MDP. Prior to release of the Final EA, BLM decided to complete an Environmental Impact Statement (EIS) for the Bull Mountain Unit MDP.

Since March of 2012, CPW and BLM staff have met numerous times to discuss impact analysis methodologies and mitigation opportunities for the Bull Mountain Unit MDP. This WMP is based on well site locations, proposed access roads, and proposed pipeline routes covered in the BLM's Preferred Alternative as discussed with SGI during a meeting on June 12, 2015. The well site locations, proposed access roads, and proposed pipeline routes in the BLM's Preferred Alternative are from SGI's Proposed Action (DEIS Alternative B)and from the BLM's Alternative C. Since the BMU EIS is intended to be a programmatic analysis and disclosure of impacts, the precise locations of the components of the MDP are not specifically known until each component is examined on a site-specific basis and each is approved by COGCC and BLM during the APD process. The well pad locations, proposed oil and gas roads, and pipelines shown in **Figure 1** include elements proposed by SGI in the BMU EIS Alternative A and Alternative B, and as proposed by the BLM in Alternative C.

It is the intent of this WMP to include or exclude each well pad location from the Winter Closure Areas as shown in **Figure 1**, even if individual well pad locations are later adjusted based on future site-specific analysis, as contemplated under the BLM's DEIS programmatic analysis. This approach is valid under a programmatic analysis because exact locations can change within a 40 acre area as analyzed by BLM. More significant changes to the locations would require additional analysis by the BLM, which would include all relevant resources including wildlife. The mitigation strategies contained in this voluntary WMP have been discussed with BLM during the development of the EA and EIS proposed actions with the hope of providing BLM an impact mitigation strategy that may be incorporated into the Bull Mountain Unit MDP DEIS where appropriate.

Scope of Wildlife Mitigation Plan

1) Geographic Scope and Jurisdiction

This WMP applies only to SGI's proposed oil and gas activities and facilities regulated by COGCC and BLM, proposed on private and federal lands and mineral estates located within the Bull Mountain Unit, as it exists on May 12, 2015. Unless explicitly stated in the WMP, the commitments made in this WMP by SGI in no way alter previous commitments made to county, state, or federal regulatory agencies. This WMP was prepared specifically to satisfy COGCC Rule 1202.d. (2) in making mitigation recommendations for this development to federal, state, and local agencies.

2) Number of Facilities, Activities Addressed, and Duration of WMP

This WMP addresses the potential impacts to wildlife resources from developing and operating the wells, pipelines, roads and other facilities and infrastructure for development of the BMU under SGI's Proposed Action, as amended herein. **(Figure 1)**. SGI will have up to six years to develop these facilities under this WMP and the future BLM EIS Record of Decision (ROD). This WMP will become effective on the date the BLM signs the BMU EIS ROD selecting SGI's Proposed Action. If full development of the facilities contemplated under this WMP is not completed within six years, SG may agree to extend the WMP for an additional six year period to allow the contemplated development to be completed.

3) Species addressed in the WMP

As part of the negotiations for development of a WMP between SGI and CPW, CPW evaluated potential target species and habitats for this WMP based on CPW data and biologist recommendations, as well as biological information compiled by SGI's contract wildlife biologist and BLM. CPW reviewed the baseline biological information provided in BLM's preliminary draft Environment Assessment for the BMU (for a complete list of species present see DOI-CO-150-2009-0005 EA, Bull Mountain Unit Master Development Plan Preliminary Environmental Assessment, March 2012 – [BLM BMU MDPEA]). CPW also solicited input from BLM on the species and habitats most likely to be impacted.

Due to CPW's identification of the importance of specific areas within the BMU to wintering big game in the region, impacts to critical big game winter range and wintering big game populations were identified as a primary concern for CPW and the focus of many of the mitigation efforts in this WMP. Although impacts to a number of the species and habitats of concern identified by BLM in the BMU MDP are not specifically regulated by COGCC (cavity nesting birds as an example), SGI is voluntarily addressing these species and habitats in this WMP. The Best Management Practices (BMPs) outlined below are designed to avoid and minimize impacts to many of these species. In addition, CPW has asserted that the avoidance and mitigation actions selected primarily for big game are likely to benefit these other species and their habitats due to habitat overlap with the targeted species.

Measures to Avoid and Minimize Impacts

1) Best Management Practices

CPW conducted an evaluation of habitats that would be potentially impacted by SGI's proposed development activities utilizing a GIS methodology. Based on the lack of comprehensive reliable site-specific data regarding known locations of northern goshawk and other raptor nest sites, nesting areas for cavity nesting birds, and occupied habitat for northern leopard frogs, impacts to these species of concern were addressed primarily through impact avoidance and minimization measures, including pre-construction survey requirements, incorporated into SGI's development practices. SGI agrees to implement voluntary Best Management Practices (BMPs) as standard operating practices that minimize direct and indirect impacts to these species. These BMPs reduce, but do not eliminate the direct and indirect impacts associated with each new facility and associated activity. The site-specific operational BMPs implemented by SGI at each new facility include:

a) Pre-construction raptor and migratory bird nest surveys and avoidance. SGI agrees to conduct raptor and migratory bird nest surveys at areas proposed for new surface disturbance and heavy construction and drilling activities. SG agrees to conduct these surveys between May 15 and July 15 of each year, prior to submitting a COGCC Form 2 or BLM Notice of Staking. The intent of the surveys is to implement avoidance strategies where possible and minimize potential impact to nesting raptors and migratory birds. These surveys may result in modifications to facility design, minor site location adjustments, and operational awareness that reduce direct and indirect impacts when a habitat of concern is identified. SGI previously conducted these surveys, pre-HB 1298 and outside of the context of a WMP to support compliance with the Bald and Golden Eagle Protection Act, the MBTA and ESA concerns. Where active raptor nests are identified, SGI will apply CPW's raptor nest buffer guidelines (Recommended Buffer Zones and Seasonal Restrictions for Colorado Raptors, 2008). When other migratory bird nests are located, SGI will avoid disturbance of nests, nestling, and fledglings during the breeding season. Note that nest trees being used by cavity nesting birds are flagged when located and avoided during the nesting season.

b) Pit management to exclude birds, bats, and other wildlife. SGI agrees to manage pits necessary for production activities to minimize the likelihood of wildlife mortalities. SGI agrees to install wildlife fencing around pits and netting over open pits to exclude birds, bats, and terrestrial wildlife. For reserve pits, 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 reserve pit, but may be removed once the pits are dried. For dry pits, SGI agrees to provide escape ramps or other means to allow terrestrial wildlife opportunity to escape from open pits. Note that SGI may implement closed loop pitless drilling systems at its own discretion to avoid the need to fence and net reserve pits.

c) Management of activities in riparian zones to protect water quality and aquatic resources. In addition to installing standard stormwater erosion controls to protect water quality as required by the Colorado Department of Health and Environment (CDPHE), SGI will make efforts to comply with CPW and COGCC recommended buffers for aquatic habitats in the BMU (see LIDAR discussion below). SGI agrees to implement the following BMPs within the BMU:

- Except as outlined on **Figure 2** and excepting activities outlined below, no surface disturbance within 300 feet of a designated cutthroat trout stream.

- In other watersheds, well pads and facilities will not be sited, to the extent practicable, within 150 feet of any natural lake, wetland, or perennial or seasonally flowing stream or river.

- Roads crossing CPW mapped cutthroat trout streams will be bridged or use appropriately sized culverts to prevent stream bed damage and the transfer of disease organisms. Pipelines that cross cutthroat trout streams should be bored if practicable.

- Stream disturbances in or upstream of CPW-mapped cutthroat trout habitat will be avoided between June 1 and August 31 to avoid impacts to spawning cutthroat trout.

- All stream crossing and culverts on perennial and intermittent streams shall be designed to allow aquatic species passage.

- Minimum right-of-way widths will be used where pipelines cross riparian areas and streams and crossing will be constructed at right angles to the stream channel.

- Native riparian canopy cover and stream bank vegetation will be left intact to the extent practicable.

- Chemical dust suppression activities will be avoided within 300 feet of the ordinary high water mark of any reservoir, lake, wetland, or natural perennial or seasonally flowing stream or river, unless required by surface owner, county or state requirements.

- Screen water suction hoses to exclude fish and amphibians.

- Disinfect heavy equipment, hand tools, boots and any other equipment that was previously used in a river, stream, lake, pond, or wetland in a different watershed prior to moving the equipment to another water body. The disinfection practice applies field-wide and follows the procedure outlined in COGCC Rule 1204.a.2.

2) Field-wide operating practices that reduce impacts on terrestrial species.

SGI agrees to implement specific field-wide standard operating practices to reduce impacts on terrestrial wildlife species. These practices typically reduce traffic and/or the extent of human activities occurring on a daily basis across the BMU. These practices include:

- Installation of a produced water gathering system – where applicable, each new facility is tied into a field-wide produced water gathering system for water disposal. This water gathering system, when used in conjunction with temporary surface poly lines, results in a significant reduction in truck traffic and consolidation of water handling facilities;

- Use of multiple-well pad sites - the use of multiple-well pad sites reduces surface disturbance and overall habitat fragmentation and may result in a reduction of heavy equipment on road traffic due to fewer rig mobilizations and de-mobilizations;

- Use of wildlife friendly seed mixes – SGI will use a CPW-recommended wildlife friendly seed mix for interim and final reclamation where approved by the surface owner. The CPW-recommended wildlife friendly seed mixes for the BMU are found in **Appendix A**;

- Co-locating of pipelines and other utilities adjacent to road rights-of-way where practicable

3) Design Features to Avoid and/or Minimize Impacts to Wintering Big Game

In addition to the site-specific operational BMPs identified above, SGI has undertaken several additional measures to address the cumulative indirect impacts from their current and future operations in the Bull Mountain Unit. These measures include:

Light Detection and Ranging (LIDAR) Landscape Modeling. SGI used LIDAR, a remote sensing technology that employs lasers to determine distances, elevations and other properties of the target area to gather data for the Unit. SGI utilized the LIDAR data collected as well as data collected in field visits or obtained from publicly available sources to develop a site suitability and constraints model that ranked the appropriateness of areas in the unit for well pad placement. The in-put data consisted of:

- Slope of the existing site
- Sensitivity to visual impacts from Highway 133 and County Road 265 travel corridors
- Proximity to existing road networks
- Proximity to existing gathering pipeline system
- Proximity to delineated wetlands and wetland buffer zones
- Proximity to stream networks and stream buffer zones
- Proximity to known streams containing Cutthroat Trout
- Soil erosion factors
- Vegetated areas and open meadows

An analysis was performed on multiple models employing different weighted factors to study the project area under distinct scenarios that prioritized different criteria. Following review of the model results, one model was selected to utilize as the primary baseline for siting the proposed well pads within the unit. The site selection process involved review of the model results within each legal section of the unit because of well-spacing requirements and identifying those areas with an appropriate rank and an area large enough to construct a drilling pad. A number of successive reviews were performed to continually refine the resulting pad locations, pipeline routes, and road corridors. Wetlands and hydrology data sets were cross-referenced to refine the location of pads near sensitive buffer zones. Existing road networks and slope data were utilized to understand accessibility of the proposed site and feasibility of road construction. Ultimately, the process of modeling, data refinement, and discussions between BLM and SGI yielded a final count of 36 well pads. This process provided BLM a means to analyze the approximate sites for pads, roads, pipelines, and other facilities such as compressor stations. The outcome of this process was SGI's Proposed Action (Alternative B and Alternative A combined) as presented in the BLM's BMU DEIS.

4) Seasonal Closures to Avoid and/or Minimize Impacts to Wintering Big Game

During the two year negotiation process, CPW evaluated the impacts from SGI's proposed development activities, including a review of CPW-mapped habitats as well as a review of wildlife inventories conducted by CPW and others within the BMU. Based on the information provided for full build out under SGI's BMU MDP, CPW estimated potential direct and indirect impacts to big game. CPW assessed both the "direct impacts" (those related to physical land disturbance and vegetation removal resulting in habitat loss) and the "indirect impacts" (impacts that extend beyond physical disturbance and vegetation removal). Indirect impacts are those that may reduce habitat functionality. Indirect impacts may also limit wildlife access to otherwise productive habitats because of their proximity to development and associated human activities.

Based on the scale of the BMU development, CPW expressed concerns about the direct and indirect impacts from the BMU development on existing big game populations. Specifically, CPW expressed concerns that year-round development in critical winter range habitats, which may be a limiting factor for big game populations in the area, could negatively affect big game populations and reduce hunting opportunities in the BMU and surrounding areas.

To address potential direct and indirect impacts to wintering big game, SGI agrees to voluntarily limit winter activities in portions of the BMU that have been identified by CPW as the most critical to wintering big game. See **Figure 1**, Winter Closure Areas.

During discussions and negotiations with SGI, CPW reviewed existing federal lease stipulations related to winter activities. CPW agreed that where the voluntary Winter Closure Areas do not overlap with the existing federal lease timing stipulations related to big game, BLM should waive the existing federal lease timing stipulations. In areas with federal lease stipulations regarding winter activities, BLM should apply the voluntary Winter Closure Area stipulations.

Within the voluntary big game "Winter Closure Areas" identified on **Figure 1**, SGI agrees to limit activities to the following between December 1 and April 15 each year:

Well production and routine maintenance activities. In this context, well production and routine maintenance activities include:

Emergency work-overs or other emergency actions necessary to remedy equipment failures or unanticipated declines in production, or as required by local, state, or federal regulatory agencies.

Non-routine pipeline facility maintenance necessary to remedy unanticipated production problems, to address safety issues, or as required by local, state, and federal regulatory agencies.

Normal daily production activities including "pumping" of wells, generally requiring up to two (2) vehicle trips per day or less to a well pad. Normal daily production activities require snow plowing and the minimum amount of road maintenance necessary to access the well. Daily access to each well pad is necessary for safe and environmentally responsible operations. For example, formation water produced from wells in the BMU and stored temporarily in tanks on each location, require daily site visits to ensure prudent and environmentally responsible operations. The combination of large volumes of stored water and extreme low temperatures can potentially result in mechanical failures that can only be effectively monitored by daily site visits. Roads to each location must be plowed to ensure minimal response times for necessary equipment to address any issue which could result in damage to environmental resources. Remote telemetry monitoring cannot provide the same level of assurance and environmental protection that human daily site visits ensure.

SGI agrees that the activities listed below will not be allowed within the voluntary big game "Winter Closure Areas" between December 1 and April 15 each year:

Drilling of new wells.

Well work-over and completion activity intended to increase the production of a well.

Reclamation activities and existing road maintenance activities that can be delayed until after April 15 each year.

New surface-disturbing activities, including pipeline construction and installation, road and pad construction, and other general construction and facility installation.

Where activities prohibited within the Winter Closure Areas between December 1 and April 15 of each year are initiated in a timely fashion and where it is anticipated that the date of completion will be prior to December 1, but where operational or regulatory restraints require continuing operations after December 1, BLM shall not unreasonably withhold individual waivers allowing for such continuing activity.

In order to implement the voluntary big game winter closures, SGI has agreed to install gates and signage to limit access to the extent permitted by the landowners at all entry points to the Voluntary Big Game Closure Areas shown on **Figure 1**.

5) Remote Monitoring

In addition to the daily site inspections at each well pad location outlined in No. 4 above (Seasonal Closures to Avoid and/or Minimize Impacts to Wintering Big Game), SGI agrees to remotely monitor specific aspects of well production. This remote monitoring is proposed as a way to provide monitoring between the daily site inspections by SGI personnel. Additionally, this proposed remote monitoring will be conducted at all fee and federal well pad locations as proposed in SGI's Proposed Action under Alternative A and Alternative B.

SGI will monitor the following aspects of well production using remote telemetry:

1. Tubing pressure,
2. Casing pressure,
3. Gathering system line pressure,
4. Wellhead differential pressure,
5. Wellhead gas temperature
6. Wellhead gas rate, and
7. Production tank level alarms

SGI agrees to implement this proposed remote monitoring under the following time limits:

1. Wells existing in the BMU on the effective date of this WMP shall be retrofitted and become compliant with the seven (7) monitored aspects of well production listed above within twenty-four (24) months of the effective date of this WMP.

2. Wells not yet existing in the BMU on the effective date of this WMP shall be compliant with the seven (7) monitored aspects of the well production listed above within six (6) months of such a well being placed on production.

6) Verified Elk Winter Concentration Area Avoidance (Figure 3)

The BMU DEIS identifies verified Elk Winter Concentration areas identified by E. Petterson in 2012. These areas were identified by field observations of elk concentrations in 2012 at a specific point in time. See Figure 3-13 in BMU DEIS.

The majority of these verified Elk Winter Concentration Areas are not impacted by well pads as identified in SGI's proposed action. This avoidance was achieved as a result of design features implemented during the site selection process in SGI's proposed action as outlined in No. 3 above.

There are well pads in SGI's proposed action that overlap with these verified Elk Winter Concentration areas (See **Figure 3**). In some cases, well pads and other infrastructure in SGI's proposed action are inside identified Elk Concentration areas. Where such overlap occurs, SGI agrees to avoid the verified Elk Winter Concentration areas where practicable in re-siting the well pad. The primary constraint in avoiding these areas will be the 40-acre analysis area within which the well pad can be relocated under the MDP EIS analysis. Other resources such as slope, soil, and wetlands will also factor into any re-siting analysis. Where this conflict occurs and cannot be resolved, site-specific mitigations will be addressed during any future required site specific NEPA analysis.

7) Drill Rig Count Limitation to Avoid and/or Minimize Impacts to Wintering Big Game

In addition to the voluntary Winter Closure Areas, SGI has proposed through the BMU MDP to limit the number of drilling rigs operating in the BMU during those times when wintering big game could be most impacted. Under SGI's Proposed Action, SGI will operate up to three (3) drilling rigs between April 15 and December 1 of each year. Only one drilling rig would operate from December 1 through April 15 each year. This operator-proposed mitigation ensures that only a small percentage of the acreage identified as potentially indirectly impacted by drilling operations would actually be affected during any given winter season.

The operator proposed Winter Closure Areas restrict activity in the BMU as outlined in No. 4 above on approximately 64% of the surface of the BMU. Application of the Winter Closure Areas as shown in this WMP **(Figure 1)** dictates that SGI would already be limited to drilling activities on only 40 of the locations on approximately 7,140 acres in the BMU during the winter season. This restriction alone would allow drilling (and other) activity on only approximately 36% of the surface of the BMU during the winter months. Because SGI would be using only one (1) drilling rig during the winter months, only a small portion of the acreage (36% of BMU) and well locations available to SGI (those not restricted by the voluntary Winter Closure Areas), could be indirectly impacted. A single drill rig might move from location to location during the winter months, but would not create indirect impacts to big game at more than a single location at a given point in time. This SGI-proposed mitigation limiting the number of drill rigs in the BMU during the winter months dramatically reduces any potential direct or indirect impacts to big game across those portions on the BMU not restricted by the Winter Closure Areas.

8) Summary of Protections and Cumulative Benefits to Wildlife

Approximately 6,391 acres of federal mineral leases within the BMU currently contain lease stipulations providing seasonal timing limitations for big game (**Figure 2**). The voluntary big game Winter Closure Areas agreed to by SGI in this WMP and as shown on **Figure 1** cover approximately 12,505 acres as compared to the 6,391 acres of current federally stipulated winter closures. The Winter Closure Areas in this WMP do overlap in areas with the current federal lease timing stipulations.

The BLM could waive the current federal lease timing stipulations existing outside the Winter Closure Areas proposed for seasonal closure in this WMP. Any such waiver by the BLM would remain in effect only while the WMP is in effect. At the termination of this WMP, the original federal lease seasonal timing stipulations would replace the limitations under the WMP. Such action by the BLM would increase the amount of acreage in the BMU subject to winter closure for big game wintering by over 6,000 acres while this WMP is in effect. This is not only a significant increase in the acres closed for the benefit of wintering big game in the BMU, but the voluntary Winter Closures Areas in this WMP would occur in areas within the BMU that have been identified by CPW biologists as the most critical for wintering big game. Thus, the benefits of waiving current federal lease timing stipulations in favor of the Winter Closure Areas in **Figure 1** is twofold: first the amount of acreage closed for protection of wintering big game increases by over 6,000 acres and secondly, the Winter Closure Areas protect higher value habitat for wintering big game. It must also be acknowledged that the areas of higher habitat value are located primarily on private surface and development activity would not otherwise be restricted without adoption of this voluntary WMP.

SGI's Responsibilities

For the facilities described and shown in **Figure 1**, SGI agrees to implement its impact avoidance and minimization measures outlined in this WMP. SGI agrees to meet annually with BLM by December 31 each year to summarize its development and mitigation activities for the previous 12-months and to forecast with best available information the next year's development and mitigation activities as they relate to this WMP.

Due to the sensitivity and irreplaceable nature of RSO resources, the mitigation offsets contemplated in this document do not adequately address these resources. For the facilities described in **Figure 1**, SGI agrees to observe the RSO buffer restrictions contained in COGCC Rules. If SGI cannot comply with the RSO buffer restrictions for a particular facility, SGI agrees to enter into an individual consultation with CPW on that facility under Rule 306.c. to evaluate options for avoidance, minimization, and mitigation.

General Terms

This WMP shall expire (1) when the facilities described in **Figure 1** and described in SGI's Proposed Action are constructed, (2) when any development phase under any future supplement to the BMU EIS is fully completed, or (3) six years from the signature date of the Record of Decision for the BMU EIS, whichever occurs later. Obligations and commitments made under this WMP related to

measures to avoid and minimize impacts may extend beyond the expiration term of this document, until such projects are deemed complete by both SGI and BLM.

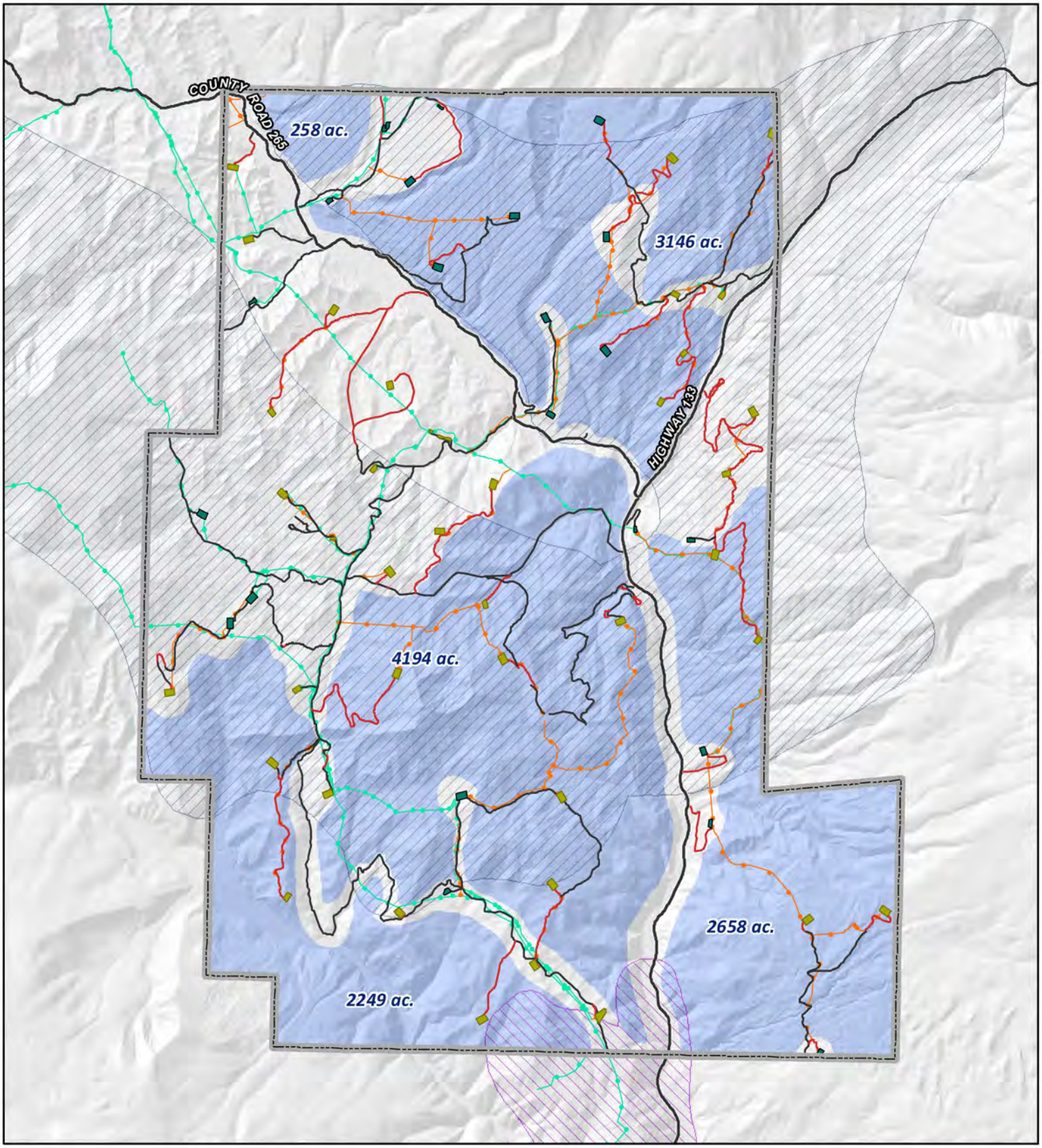
SGI hopes that this WMP will enable the BLM to waive the current timing stipulations in the federal leases in the BMU. Waiver of these current timing stipulations and implementation of the voluntary Winter Closure Areas as shown in **Figure 1** will ensure that those areas most critical to wildlife and big game will be protected. If BLM does not accept and adopt this plan, including waiver of existing federal lease timing stipulations as outlined above, SGI will by necessity withdraw from this WMP and move forward under the current federal lease timing stipulations.

The terms of this WMP may be extended by SGI to additional SGI-proposed facilities and for additional duration with the mutual express written consent of both parties. SGI agrees that the terms of this WMP shall inure to the benefit and be binding upon the parties hereto and the parties' respective successors and assigns of SGI.

SG Interests I, Ltd.

6/16/2015

Date



Existing/Proposed Pad by Subsurface Ownership

- *Federal (40 SG pads)*
- *Fee (21 SG pads)*

Pipeline by Status

- *Existing*
- *Proposed*

Road by Status*

- *Existing*
- *Proposed*

**Roads most likely to be upgraded & used for oil & gas*

- *Winter Closure Area (12,505 ac.; 21 SG pads inside, 40 SG pads outside)*
- *Elk Winter Concentration Area*
- *Mule Deer Winter Concentration Area*

SG Interests I - 77330
BMU Proposed Action

Figure 1:
Winter Closure Areas

0 4,000 8,000 Feet

1 in = 5,000 feet

Disclaimer: This product is for informational purposes and may not have been prepared for, or be suitable for legal, engineering, or surveying purposes. Users of this information should review or consult the primary data and information sources to ascertain the usability of the information.

Prepared for SG Interests, Inc. by TerraCognito GIS, Inc. June 2015

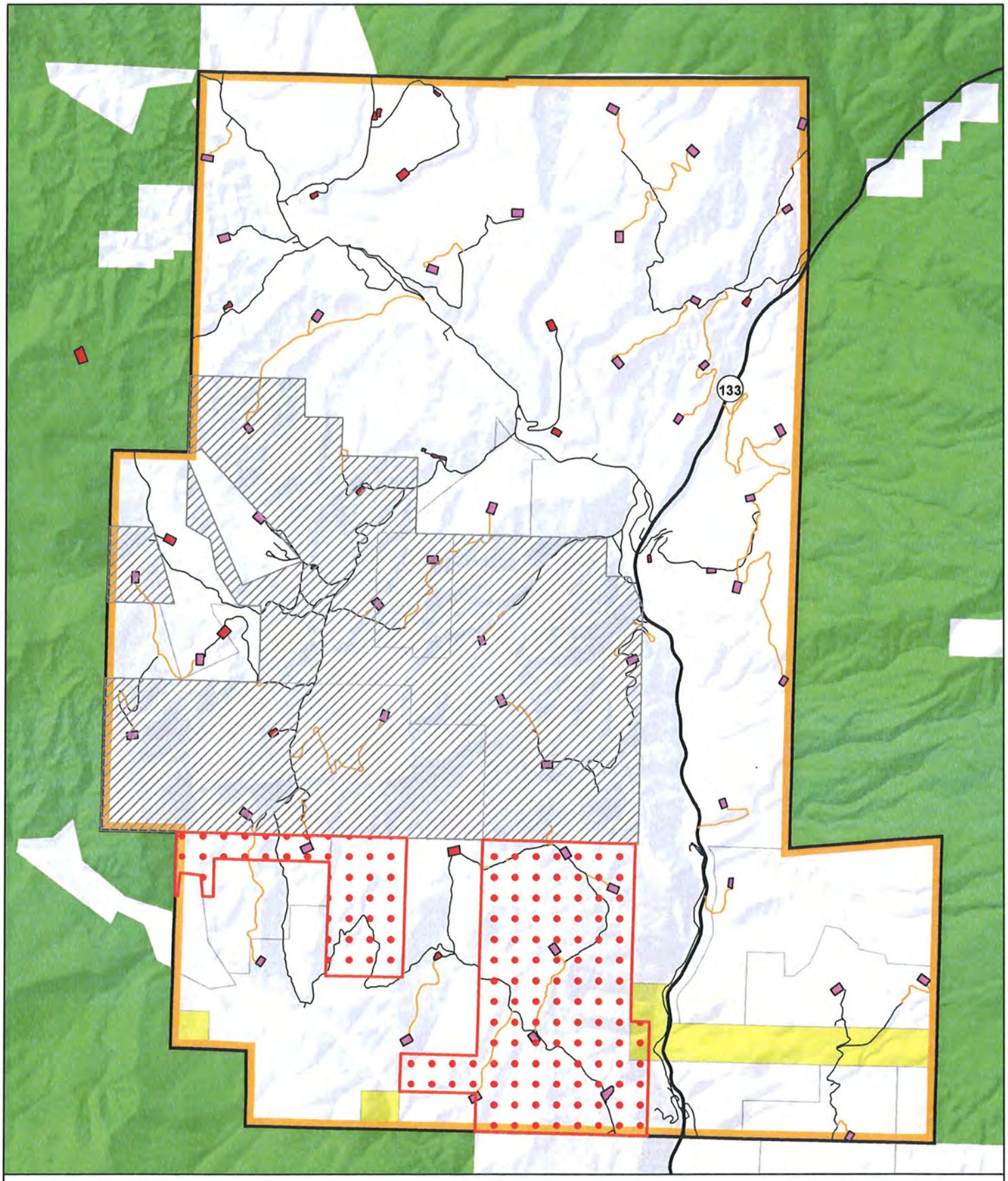


Figure 2 - Federal Lease Containing Winter Closures Within the Bull Mountain Unit

GIS Unit

Existing Facilities
- Well Pads
- Existing SG Gas Field Roads

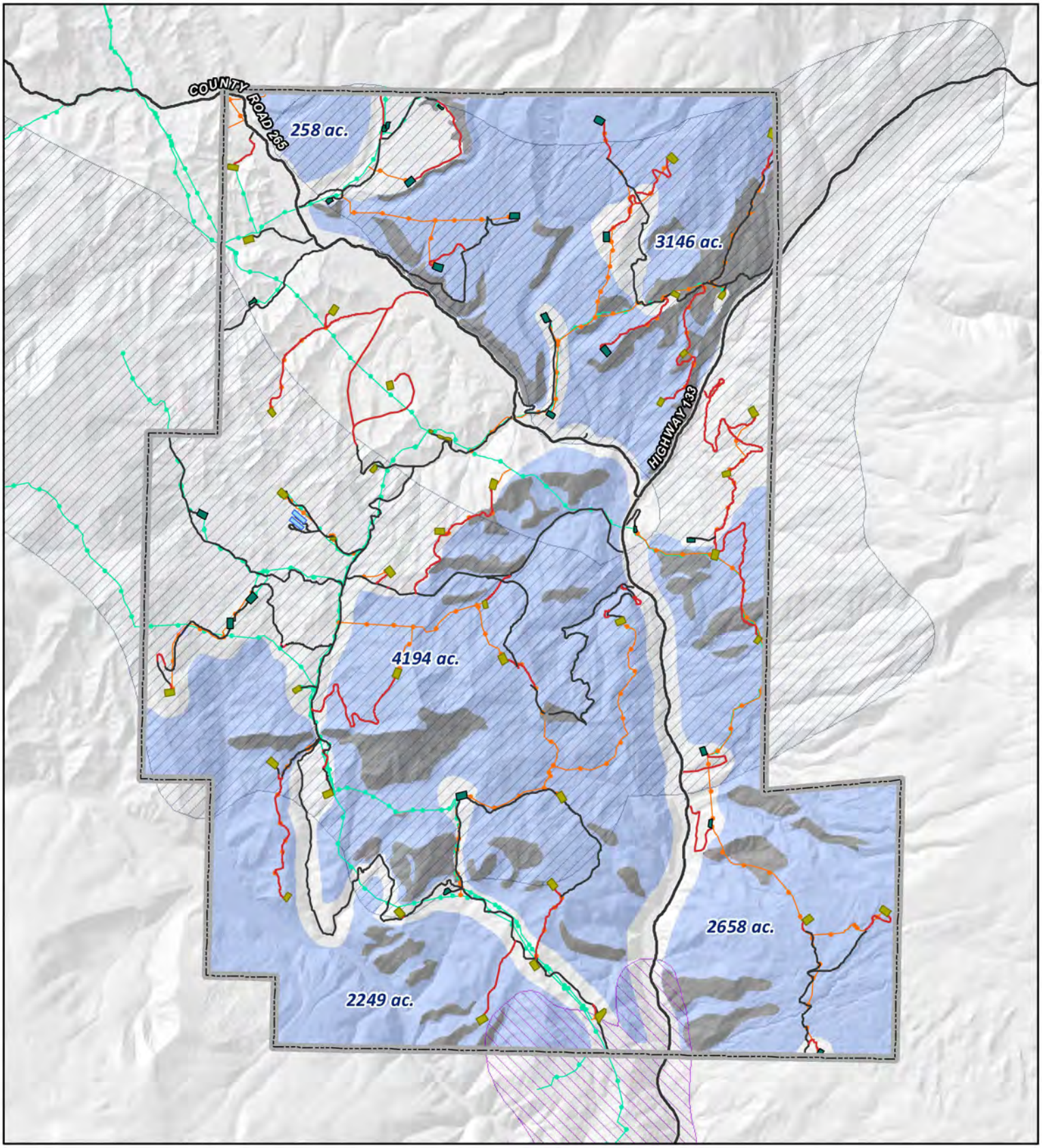
Proposed Facilities
- Well Pads
- Roads

Winter Closure Stipulations
- NSO - Timing: 11/30 - 5/1
- NSO - Timing: 12/1 - 4/30

Land Ownership
- Bureau of Land Management
- U.S. Forest Service
- Private

0 0.25 0.5 1 1.5 2 Miles

N



Existing/Proposed Pad by Subsurface Ownership

- *Federal (40 SG pads)*
- *Fee (21 SG pads)*

Pipeline by Status

- *Existing*
- *Proposed*

Road by Status*

- *Existing*
- *Proposed*

**Roads most likely to be upgraded & used for oil & gas*

- *Verified Elk Winter Concentration Area*
- *Winter Closure Area (12505 ac.; 21 SG pads inside, 40 SG pads outside)*
- *Elk Winter Concentration Area*
- *Mule Deer Winter Concentration Area*

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BMU Proposed Action

Figure 3: Winter Closure Areas and Elk Habitat

0 4,000 8,000 Feet

1 in = 5,000 feet

Disclaimer: This product is for informational purposes and may not have been prepared for, or be suitable for legal, engineering, or surveying purposes. Users of this information should review or consult the primary data and information sources to ascertain the usability of the information.

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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.

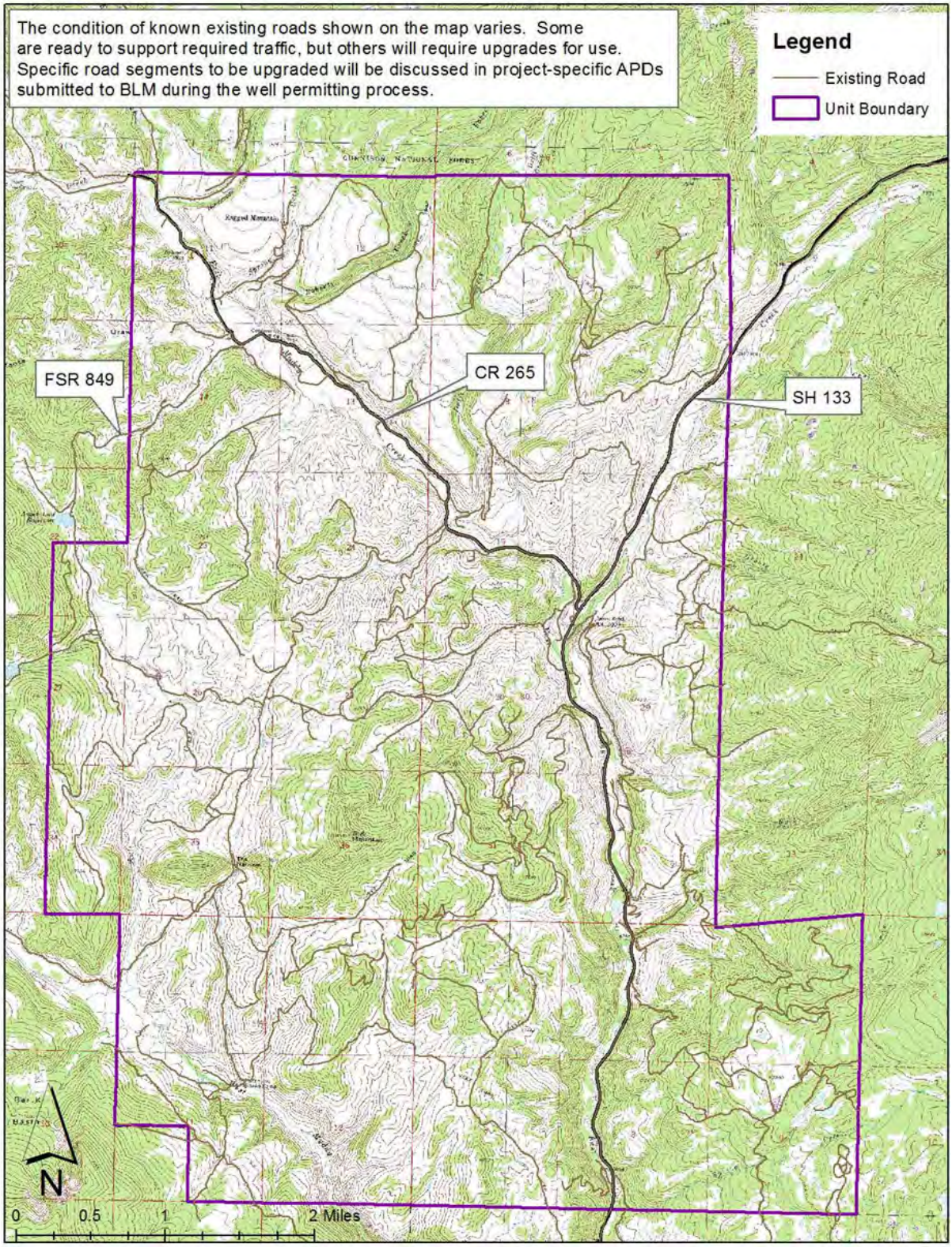
D.2 NEW OR RECONSTRUCTED ACCESS

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

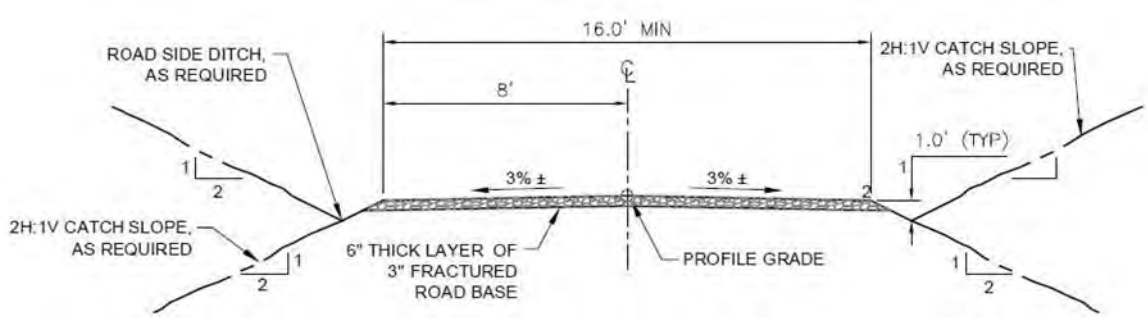


For example:

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.

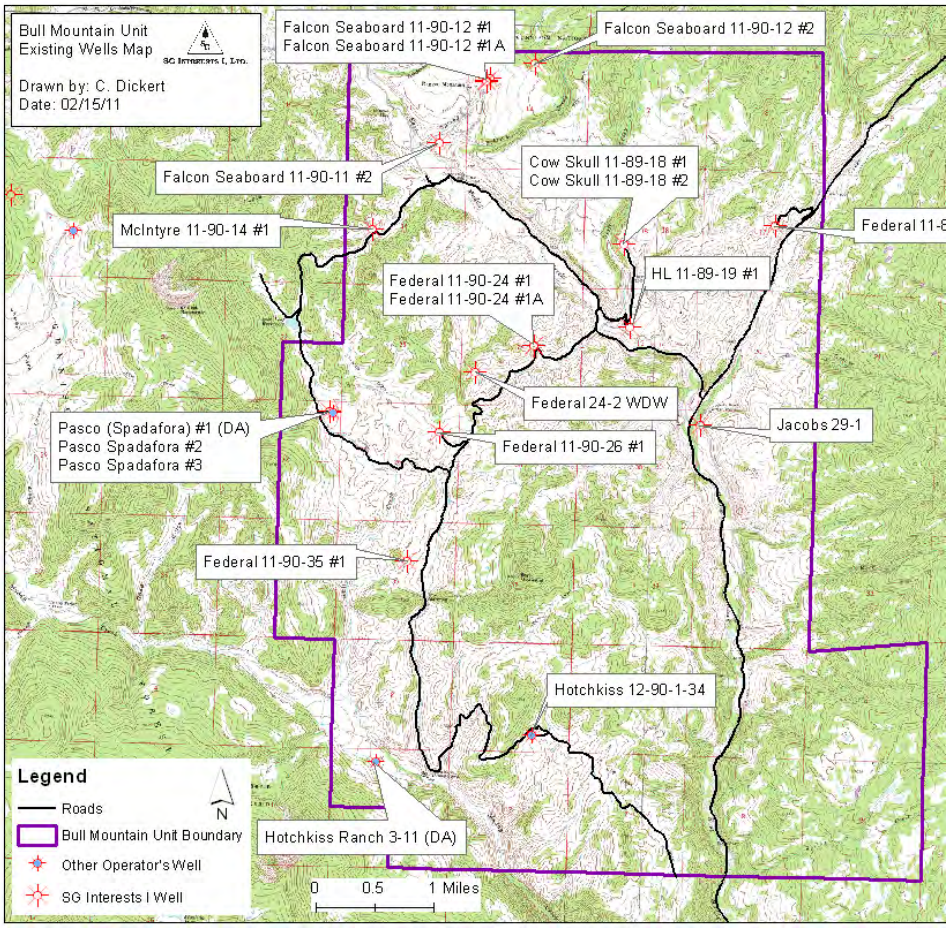
Figure D-2. Typical Access Road Cross-section



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.

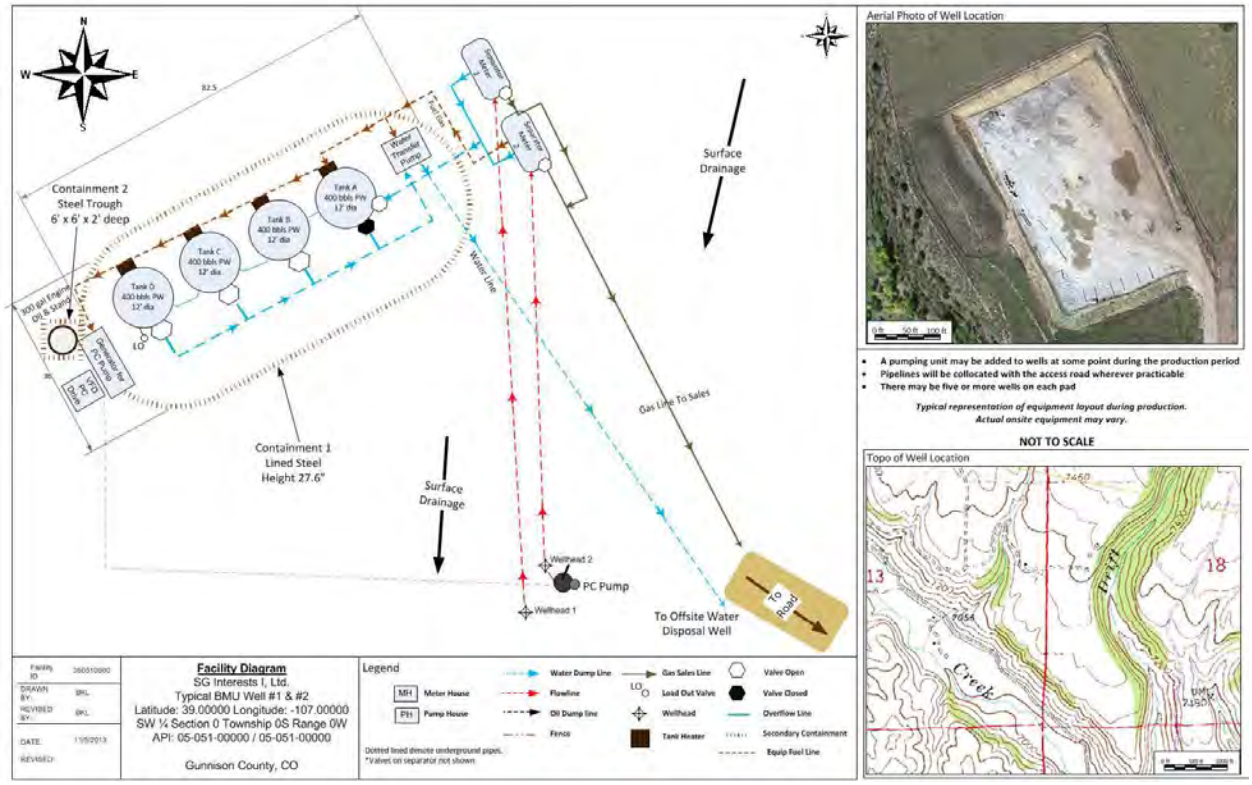
Figure D-3. Existing Wells in the Bull Mountain Unit



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 S-Shaped Mancos Well Directional Mancos Well	18,000 BBL per stage with an average of 3 stages per well.
Vertical Coal Well S-Shaped Coal Well Directional Coal Well	1,800 BBL for Cameo Coal and 1,500 BBL for South Canyon Coal
Vertical Cozzette or Corcoran Well S-Shaped Cozzette or Corcoran Well 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

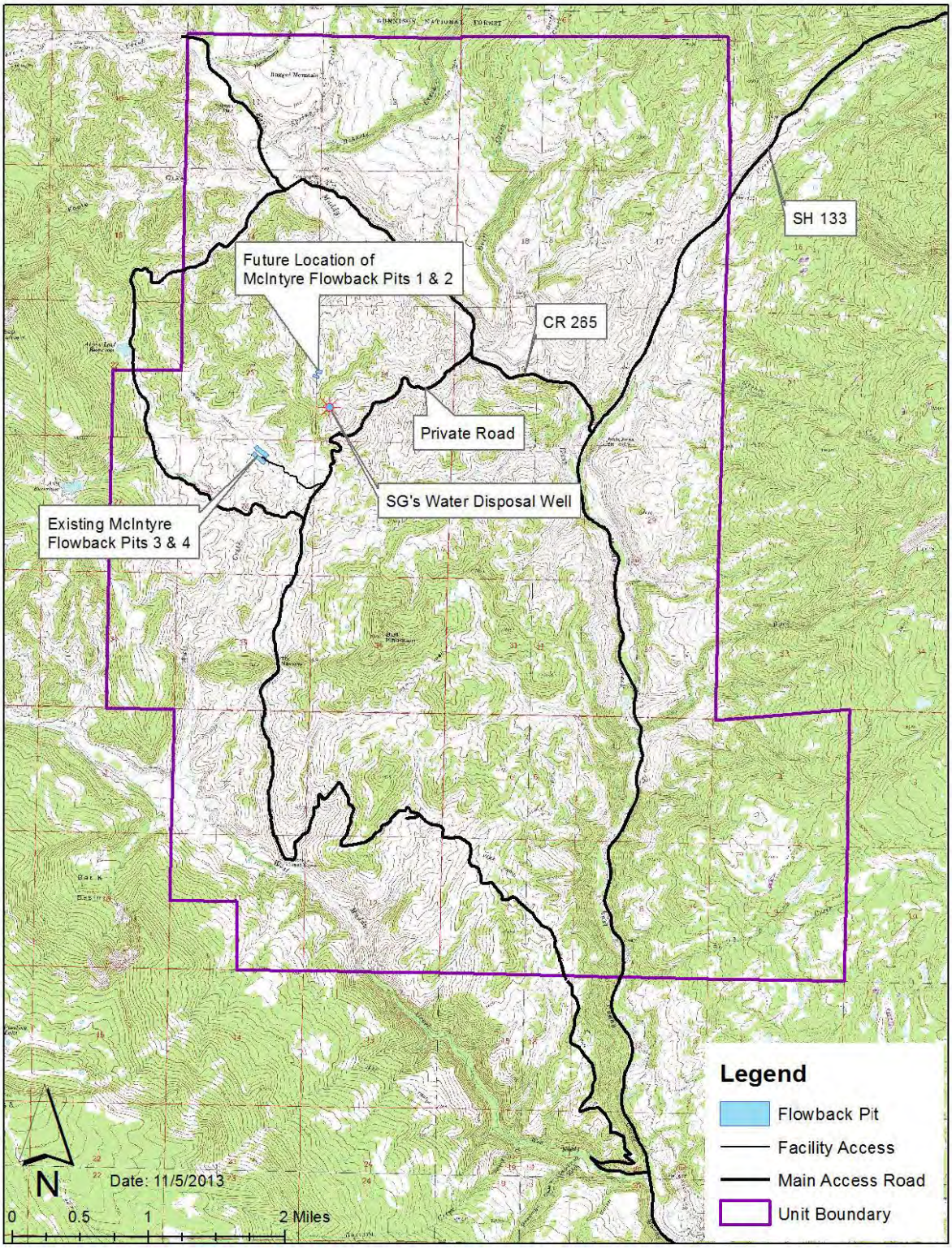
The types and uses of construction materials will vary according to the specific conditions at an individual well site. Subsequent wells that will be collocated on existing well pads will require less construction materials than those wells that will be first on a new well pad. Wells added to existing 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.

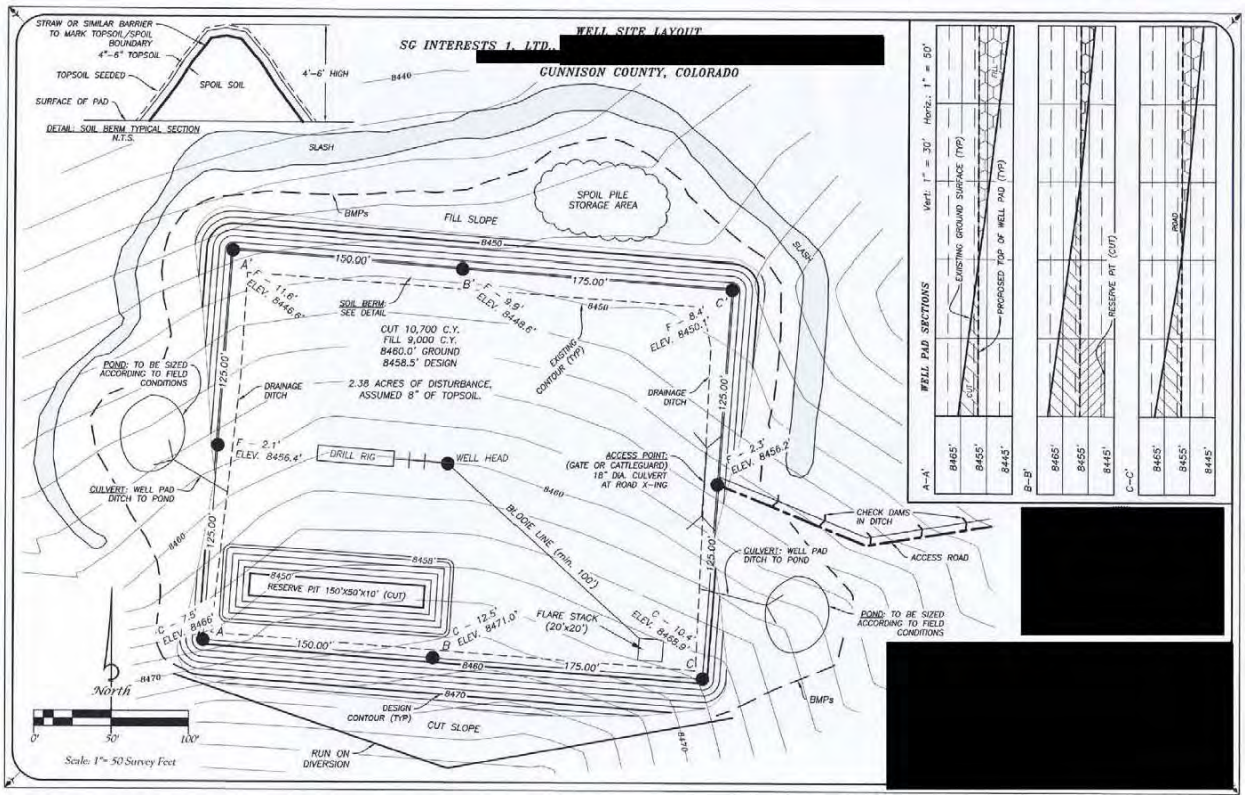
SGI may need another storage yard located on private property to store materials and equipment. It would be approximately 250’ X 400’ in size. It would be located in section 14 T11S R90W on property owned by Rock Creek Ranch I, Ltd. an entity owned by the principals of SGI (see Chapter 2, Alternative 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

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 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

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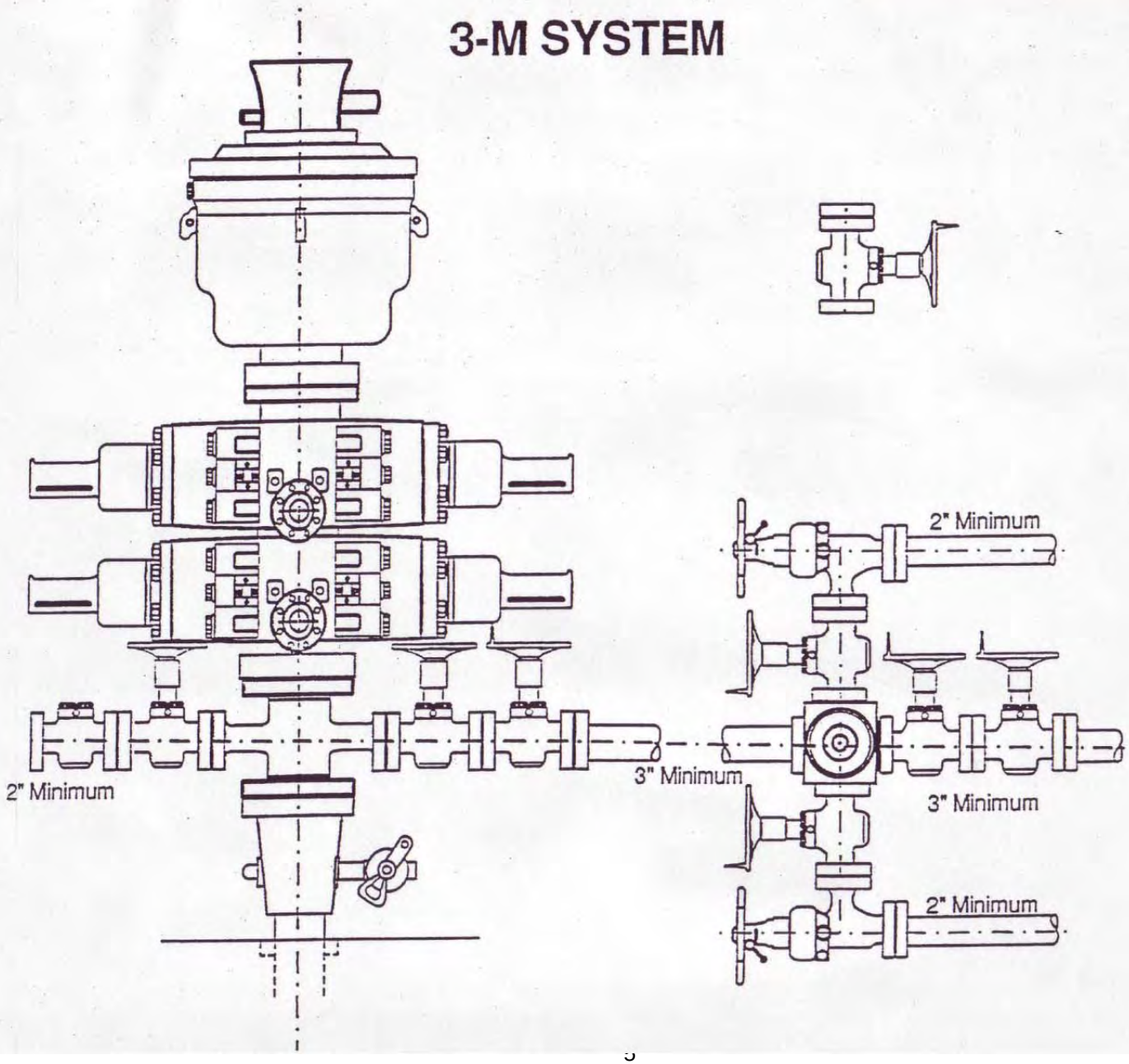
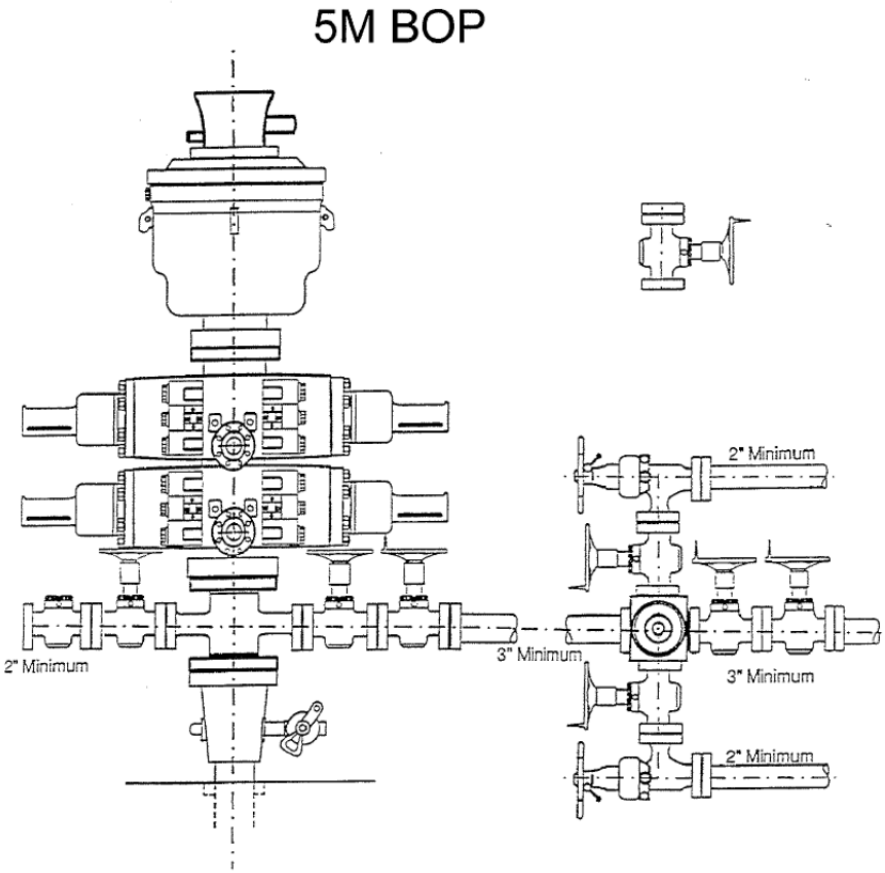
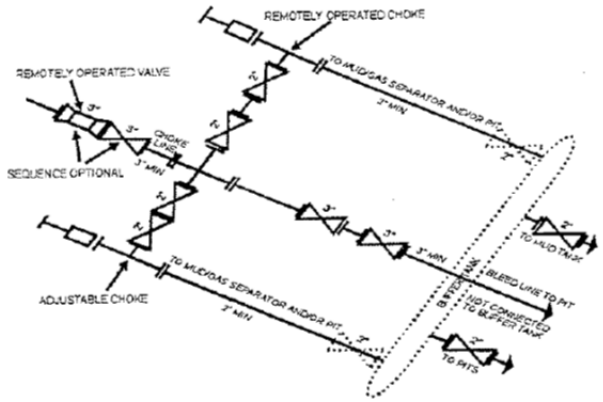
3-M SYSTEM



5-M Choke Manifold Diagram



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. When 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

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SG INTERESTS

TYPICAL AS DRILLED WBD VERTICAL MANCOS WELL

Lease: Typical Vertical Mancos Well **Location :**
Well : **BHL:**
Area: Gunnison County, Colorado **Survey:**
Field: Bull Mountain **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'	8.5 PPG KCL	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	
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	3,031'	3,031'					
					8.5 PPG KCL	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 **Location :**
Well : **BHL:**
Area: Gunnison County, Colorado **Survey:**
Field: Bull Mountain **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	
None			400'	400'		12-1/4" Hole	9-5/8" 40# J-55 LTC	Water Spud Mud MW=9.1	<1°/100'
KOP 2.5°/100'		KOP 2.5°/100'	607'	607'		8-1/2" Hole		9.1 WBM	2°/100'
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'					
					8.5 PPG KCL	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 **Location :**
Well : **BHL:**
Area: Gunnison County, Colorado **Survey:**
Field: Bull Mountain **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	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'
KOP 2°/100'		KOP 2°/100'	3,163'	3,163'				9.1 WBM	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'	8.5 PPG KCL	8-1/2" Hole			
		Float Collar	9,060'	9,118'					
TD		Float Shoe	9,100'	9,158'			5-1/2" 17# P-110 LTC	WBM 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	
				400'		12-1/4" Hole	9-5/8" 40# J-55 LTC	Water Spud Mud MW=9.1	<1°/100'
KOP 2.5°/100'		KOP 2.5°/100'	607'	607'		8-1/2" Hole		9.1 WBM	2°/100'
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'					
					8.5 PPG KCL	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:	LEASE / WELL:	SURVEY LOCATION:	DATE
SG Interests	**Typical Horizontal Mancos w/ Protection Casing**		10/15/2013
DRILLING RIG:	COUNTY / STATE:	SURFACE LOCATION:	FIELD:
COMPLETION RIG:	Gunnison County, CO.		Bull Mountain Unit

20/40

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'	
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							

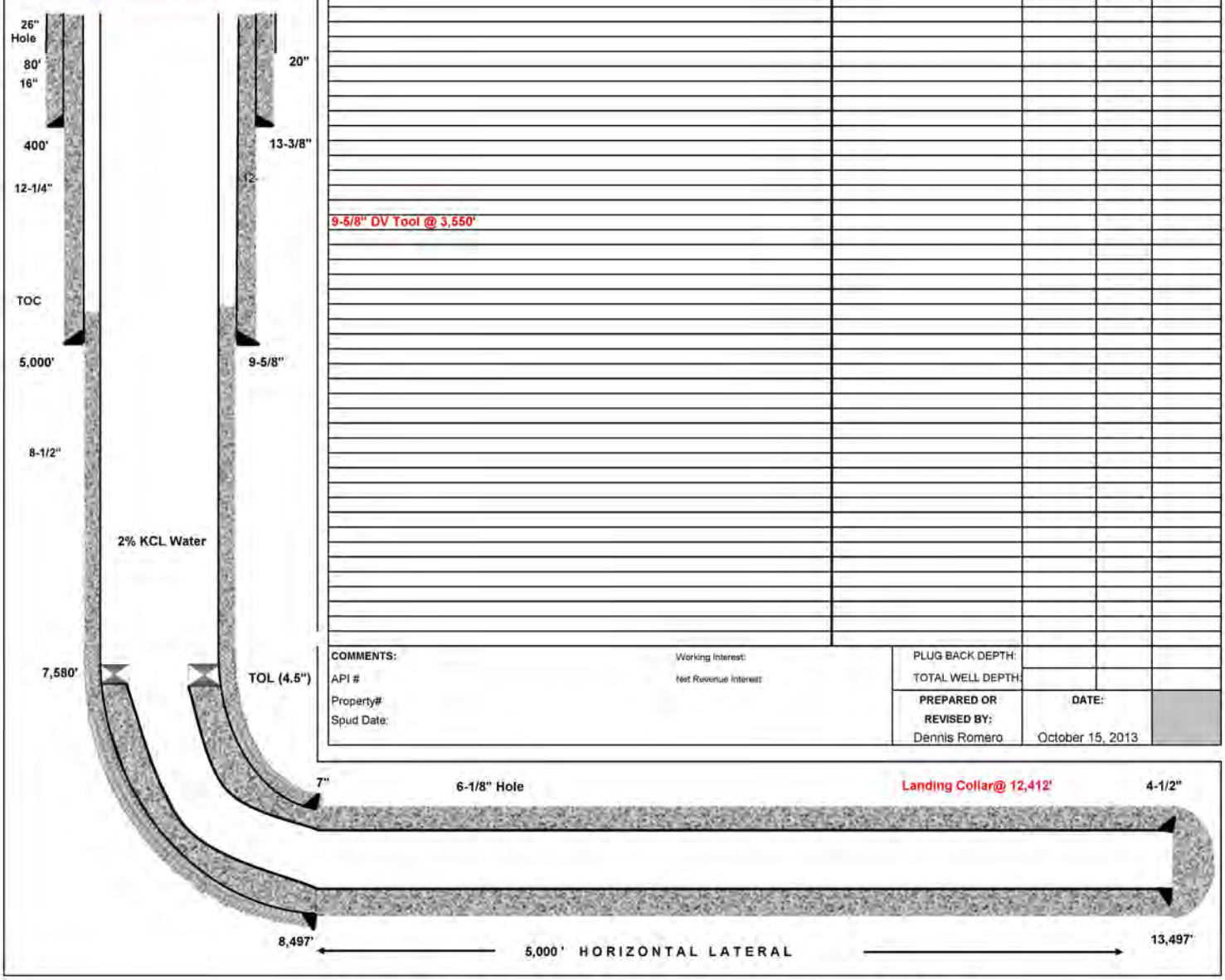
ESTIMATED DAYS

Est. Drill Case & Suspend Days:	64
Est. Completion Days:	21
Est Total Days:	85

ELEVATIONS:	GROUND ELEVATION
RKB:	
RKB-ELEV:	

WELLBORE SKETCH

DRAWING NOT TO SCALE



Formation Tops (TVD)				DEPTH MD	INCL DEG	DEPTH TVD

COMMENTS:	Working Interest:	PLUG BACK DEPTH:
API #	Net Revenue Interest:	TOTAL WELL DEPTH:
Property#		PREPARED OR REVISED BY: Dennis Romero
Spud Date:		DATE: 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: / COMPLETION RIG:	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

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							

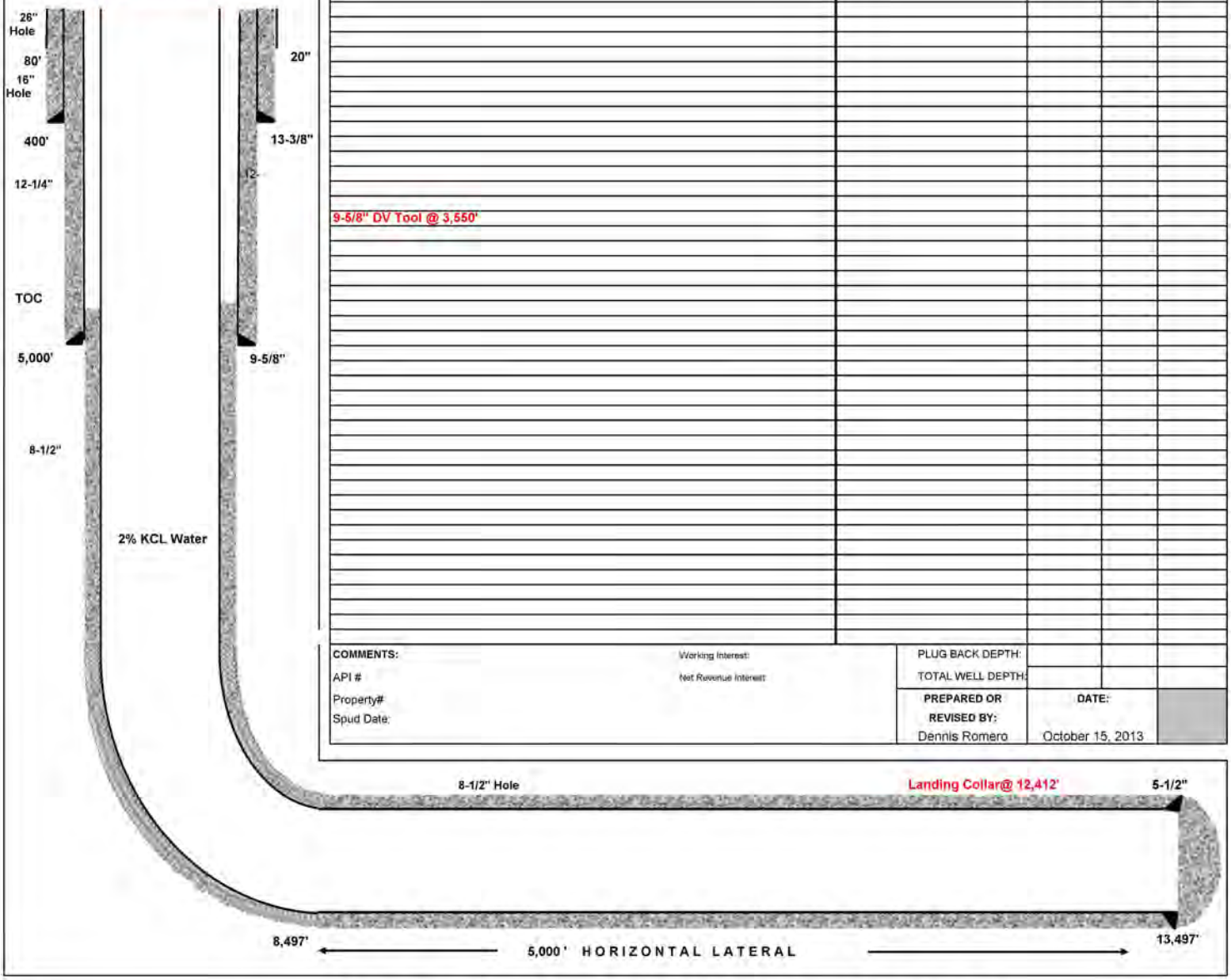
ESTIMATED DAYS

Est. Drill Case & Suspend Days:	57
Est. Completion Days:	21
Est Total Days:	78

ELEVATIONS:	GROUND ELEVATION
RKB:	
RKB-ELEV:	

WELLBORE SKETCH

DRAWING NOT TO SCALE



Formation Tops (TVD)				DEPTH MD	INCL DEG	DEPTH TVD

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:	COUNTY / STATE:	SURFACE LOCATION:	FIELD:
20/40	Gunnison County, CO.		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							

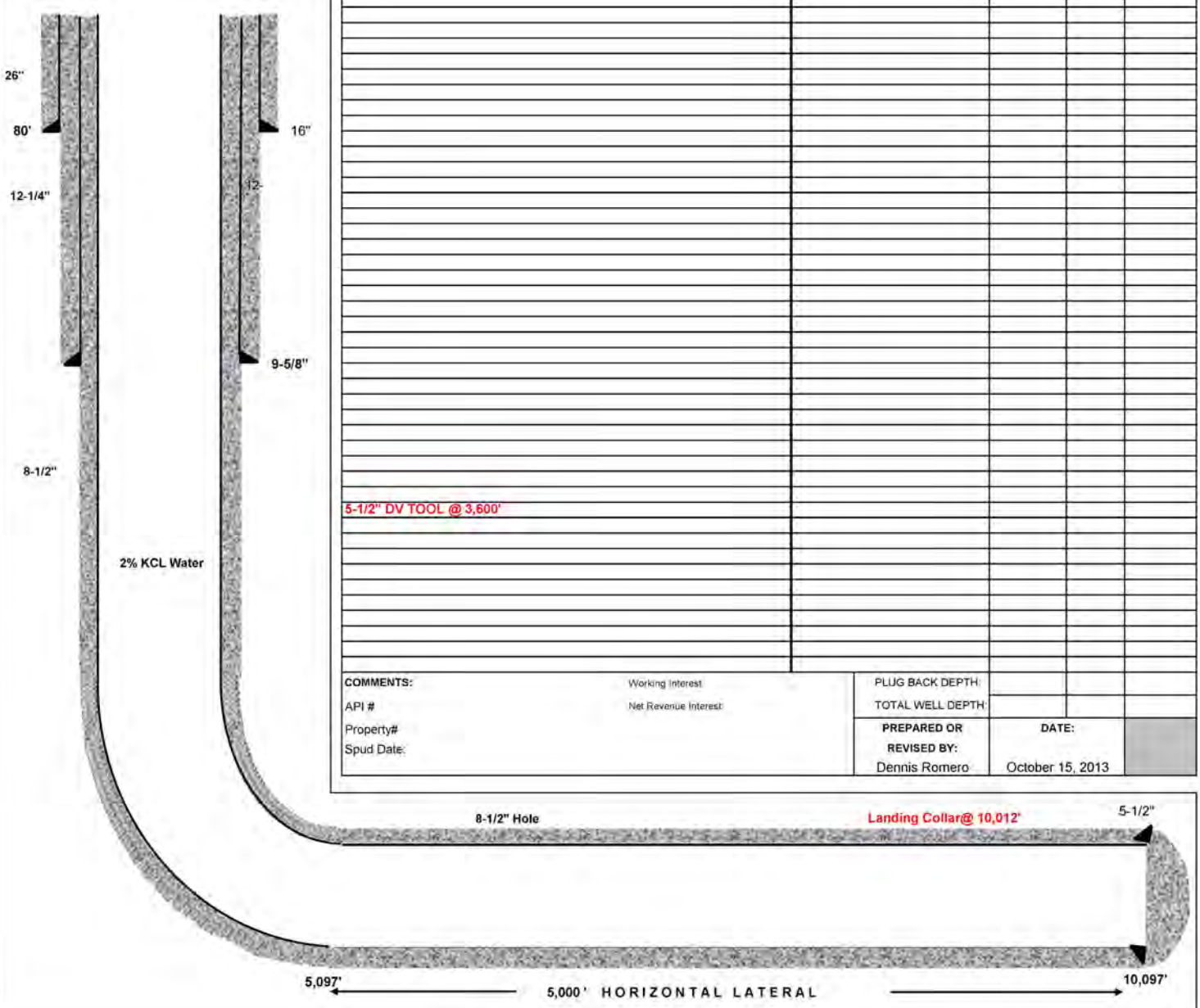
ESTIMATED DAYS

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:	LEASE / WELL:	SURVEY LOCATION:	DATE:
SG Interests	Typical Horizontal Coal Well		10/15/2013
DRILLING RIG: / COMPLETION RIG: 20/40	COUNTY / STATE: Gunnison County, CO.	SURFACE LOCATION:	FIELD: Bull Mountain

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							

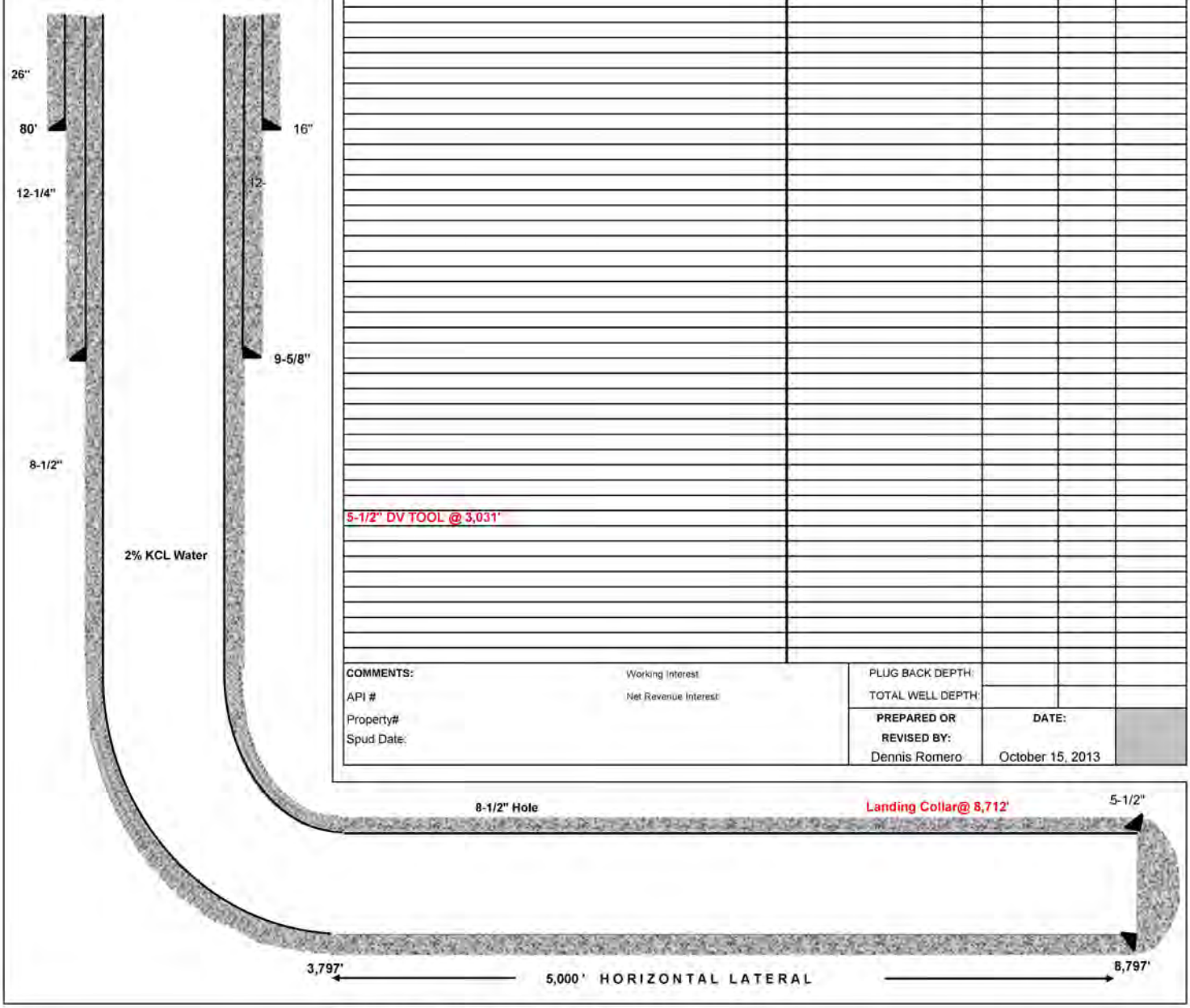
ESTIMATED DAYS

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
5-1/2" DV TOOL @ 3,031'						

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 COAL HORIZONTAL

Appendix F

Summary of Lease Stipulations

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 Year: 1971	T11S, R90W, 6th P.M., Gunnison County, Colorado 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. 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 Year: 2000	T11S, R90W, 6th P.M., Gunnison County, Colorado Section 11: Lots 3, 4, 8-10 Section 13: Lots 5, 12-14, S2SW	--	Standard stipulations of the original lease authorization shall apply. No additional stipulations from the 1989 UBRMP ROD are applicable to this lease parcel. 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
COC-64164 Year: 2000	T11S, R89W, 6th P.M., Gunnison County, Colorado Section 7: Lots 1, 2, E2NW Section 8: N2, E2SW, SE Section 17: NE, E2NW, N2SW, SESW, SE 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. Lease parcel #587 authorized by NEPA action CO-150-00-66DNA. 11/9/2000 competitive oil and gas sale.
COC-64165 Year: 2000	T11S, R89W, 6th P.M., Gunnison County, Colorado Section 19: Lots 3-11, SESW, SWSE 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. Lease parcel #588 authorized by NEPA action CO-150-00-66DNA. 11/9/2000 competitive oil and gas sale.
COC-64166 Year: 2000	T11S, R89W, 6th P.M., Gunnison County, Colorado Section 30: Lots 1-4, 7, W2NE, E2W2, SE 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. **TIMING LIMITATION STIPULATION**: 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. Lease parcel #589 authorized by NEPA action CO-150-00-66DNA. 11/9/2000 competitive oil and gas sale.
COC-64167 Year: 2000	T11S, R89W, 6th P.M., Gunnison County, Colorado 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. Lease parcel #594 authorized by NEPA action CO-150-00-66DNA. 11/9/2000 competitive oil and gas sale.
COC-64170 Year: 2000	T11S, R90W, 6th P.M., Gunnison County, Colorado Section 22: Lots 1-3, NWSE Section 23: Lots 1-7, N2N2, S2NE, SENW,	11-90-24 #1	Standard stipulations of the original lease authorization shall apply. 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
	N2SE, SESE Section 24: Lots 1-4, W2E2, W2		
COC-64170 Year: 2000	T11S, R90W, 6th P.M., Gunnison County, Colorado Section 23: Lots 1-7, N2NW, NWNE, S2NE, SENW, N2SE, SESE 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. **TIMING LIMITATION STIPULATION**: 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. 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 Year: 2000	T11S, R90W, 6th P.M., Gunnison County, Colorado Section 27: Lots 1-2, W2NE Section 34: E2 Section 35: ALL 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. **TIMING LIMITATION STIPULATION**: 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. Lease parcel #591 authorized by NEPA action CO-150-00-66DNA. 11/9/2000 competitive oil and gas sale.
COC-64172 Year: 2000	T11S, R90W, 6th P.M., Gunnison County, Colorado Section 25: Lots 1-4, W2E2, W2 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. **TIMING LIMITATION STIPULATION**: 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. 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 Year: 2003	T12S, R89W, 6th P.M., Gunnison County, Colorado Section 4: Lots 1-4, S2N2, S2 Section 5: Lot 4, SWNW, W2SW, SESW, S2SE Section 6: Lots 1-7, S2NE, SENW, E2SW, SE 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. **LEASE NOTICE:** To alert lessee of potential habitat for threatened, endangered, candidate, or other special status plant or animal. Lease parcel #1975 authorized by NEPA action CO-150-2003-0021DNA. 05/08/2003 competitive oil and gas sale.
COC-66704 Year: 2003	T12S, R89W, 6th P.M., Gunnison County, Colorado Section 6: Lots 1-7, S2NE, SENW, E2SW, SE 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. **TIMING LIMITATION STIPULATION**: 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. Lease parcel #1975 authorized by NEPA action CO-150-2003-0021DNA. 05/08/2003 competitive oil and gas sale.
COC-66705 Year: 2003	T12S, R89W, 6th P.M., Gunnison County, Colorado Section 8: N2, SW, N2SE, SWSE 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. **LEASE NOTICE:** To alert lessee of potential habitat for threatened, endangered, candidate, or other special status plant or animal. Lease parcel #1976 authorized by NEPA action CO-150-2003-0021DNA. 05/08/2003 competitive oil and gas sale.
COC-66705 Year: 2003	T12S, R89W, 6th P.M., Gunnison County, Colorado 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. **TIMING LIMITATION STIPULATION**: 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.

Table F-1
Summary of Lease Stipulations within BMMDP Area

Lease	Description of Lands	Federal Pad[1]	Lease Stipulations
			Lease parcel #1976 authorized by NEPA action CO-150-2003-0021DNA. 05/08/2003 competitive oil and gas sale.
COC-66714 Year: 2003	T11S, R90W, 6th P.M., Gunnison County, Colorado 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. **LEASE NOTICE:** To alert lessee of potential habitat for threatened, endangered, candidate, or other special status plant or animal. Lease parcel #1917 authorized by NEPA action CO-150-2003-0021DNA. 05/08/2003 competitive oil and gas sale.
COC-66715 Year: 2003	T12S, R90W, 6th P.M., Gunnison County, Colorado Section 1: Lots 3-4, S2NW, SW Section 2: Lots 1-9, SWNE, SENW, NESW, W2SE Section 11: Lot 2, SENE, SWNW, SE 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. **LEASE NOTICE:** To alert lessee of potential habitat for threatened, endangered, candidate, or other special status plant or animal. Lease parcel #1984 authorized by NEPA action CO-150-2003-0021DNA. 05/08/2003 competitive oil and gas sale.
COC-66715 Year: 2003	T12S, R90W, 6th P.M., Gunnison County, Colorado Section 1: Lots 3-4, S2NW, SW 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. **TIMING LIMITATION STIPULATION**: 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. 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 Year: 2004	T11S, R89W, 6th P.M., Gunnison County, Colorado Section 19: Lot 12 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. **LEASE NOTICE:** To alert lessee of potential habitat for threatened, endangered, candidate, or other special status plant or animal. Lease parcel #2098 authorized by NEPA action CO-150-2003-0045DNA. 11/13/2003 competitive oil and gas sale.
COC-67120X Bull Mountain Unit Agreement Year: 2003	All Federal mineral estate mentioned above.	11-89-17 #2 11-90-24 #1 11-90-24 #2 WDW 11-90-35 #1	**Item 18. <u>Leases and Contracts Conformed and Extended</u>** 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

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

APPENDIX H
WATER QUALITY SAMPLING CONSTITUENTS FOR THE BULL MOUNTAIN UNIT

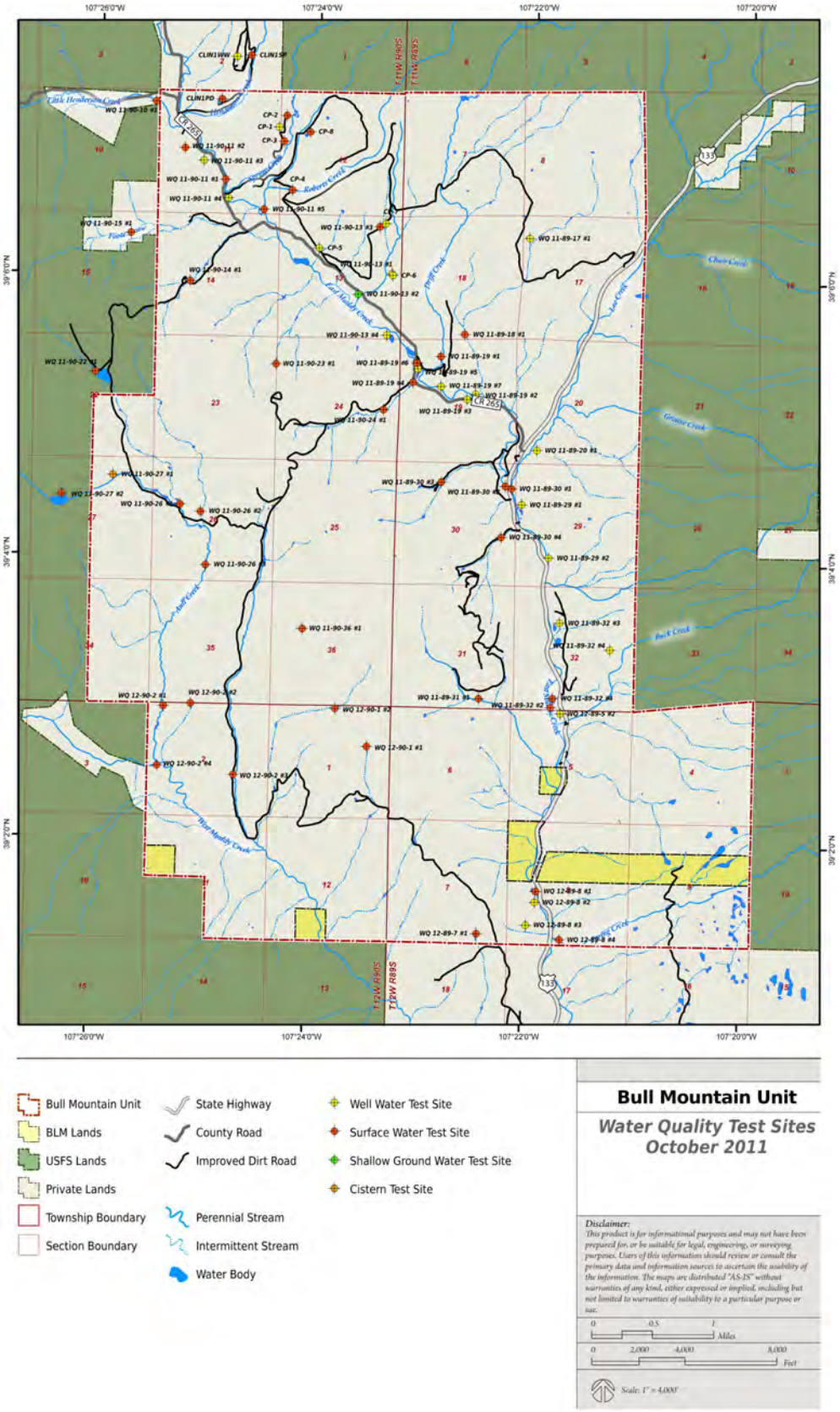
Constituents for Gunnison County Surface Water (Based on COGCC Rule 910 – Table 910-1)[1]	
Inorganic	**Organic**
Metals Analysis	BTEX/Volatile Hydrocarbons
Arsenic	Benzene
Barium	Toluene
Calcium	Ethylbenzene
Chromium	m p Xylene
Iron	o Xylene
Magnesium	Total Xylenes
Selenium	TVH (Total Volatile Hydrocarbons)
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

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

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

September 2015

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TABLE OF CONTENTS

Chapter Page

1. INTRODUCTION J-1-1

1.1 Project Description J-1-2
1.1.1 Existing Development J-1-2
1.1.2 Alternative A (No Action) J-1-4
1.1.3 Alternative B (Proposed Action) J-1-4
1.2 Outline of the Air Quality Technical Support Document J-1-5

2. PROJECT EMISSIONS J-2-1

2.1 Field Development Emissions J-2-1
2.2 Production Emissions J-2-1
2.3 Maximum Project Emissions J-2-2

3. NEAR-FIELD ANALYSIS J-3-1

3.1 Modeling Methodology J-3-1
3.2 Meteorological Data J-3-2
3.3 Background Data J-3-3
3.4 Criteria Pollutant Impact Assessment J-3-7
3.5 HAPS Modeling J-3-16

4. FAR-FIELD ANALYSIS J-4-1

4.1 Modeling Methodology J-4-3
4.2 Meteorological Data J-4-7
4.3 Ozone and Ammonia Data J-4-7
4.4 Criteria Pollutant Impact Assessment J-4-9
4.5 Visibility J-4-14
4.6 Deposition J-4-16
4.7 Lake Chemistry J-4-18

5. REFERENCES J-5-1

TABLES

Page

2-1 Existing Emissions by Activity (tons per year) J-2-2
2-2 No Action Year 2 Emissions by Activity (tons per year) J-2-3
2-3 Proposed Action Year 5 Emissions by Activity (tons per year) J-2-4
3-1 Near-Field Analysis Background Ambient Air Quality Concentrations J-3-3
3-2 NAAQS, CAAQS, and PSD Class II Increments for Comparison to Near-Field Analysis Results (µg/m^3) J-3-7
3-3 PM_{10}/$PM_{2.5}$ Modeling Results for Well Pad and Access Road Construction J-3-9
3-4 Criteria Pollutant Modeling Results for Field Production Activities J-3-15
3-5 Criteria Pollutant Modeling Results for Field Development Activities J-3-15
3-6 1-Hour NO_2 Modeling Summary for Field Development Activities J-3-16
3-7 Acute RELs (1-Hour Exposure) J-3-17
3-8 Non-Carcinogenic HAPs RfCs (Annual Average) [1] J-3-17
3-9 HAPs Modeling Results for Field Production Activities J-3-17
3-10 Carcinogenic HAPs RfCs and Exposure Adjustment Factors J-3-18
3-11 Unit Risk Analysis for Field Production Activities J-3-19
4-1 Sensitive Lakes Analyzed in Far-Field Analysis J-4-3
4-2 PSD Class I and Class II Increments for Comparison to Far-Field Analysis Results (µg/m^3) J-4-9
4-3 Project Alternatives - Maximum Modeled Pollutant Concentrations at Class I and Sensitive Class II Areas J-4-9
4-4 Project Alternatives and Existing Sources - Maximum Modeled Pollutant Concentrations at Class I and Sensitive Class II Areas J-4-12
4-5 Project Alternatives - Maximum Visibility Impacts at Class I and Sensitive Class II Areas J-4-15
4-6 Project Alternatives and Existing Sources - Maximum Visibility Impacts at Class I and Sensitive Class II Areas J-4-15
4-7 No Action – Maximum Nitrogen and Sulfur Deposition Impacts at Class I and Sensitive Class II Areas J-4-16
4-8 Proposed Action – Maximum Nitrogen and Sulfur Deposition Impacts at Class I and Sensitive Class II Areas J-4-17
4-9 No Action and Existing Sources – Maximum Nitrogen and Sulfur Deposition Impacts at Class I and Sensitive Class II Areas J-4-17
4-10 Proposed Action and Existing Sources – Maximum Nitrogen and Sulfur Deposition Impacts at Class I and Sensitive Class II Areas J-4-18
4-11 Background ANC Values for Acid Sensitive Lakes[1] J-4-19
4-12 No Action – Maximum Impacts to Lakes within the Class I and Sensitive Class II Areas J-4-20
4-13 Proposed Action – Maximum Impacts to Lakes within the Class I and Sensitive Class II Areas J-4-21
4-14 No Action and Existing Sources – Maximum Impacts to Lakes within the Class I and Sensitive Class II Areas J-4-22
4-15 Proposed Action and Existing Sources – Maximum Impacts to Lakes within the Class I and Sensitive Class II Areas J-4-23

FIGURES

Page

1-1 Bull Mountain Unit J-1-3
3-1 Site Locations for Bull Mountain Unit Meteorology Data J-3-4
3-2 Bull Mountain Unit Windrose – North Site J-3-5
3-3 Bull Mountain Unit Windrose – South Site J-3-6
3-4 Near-Field Analysis, Well Pad and Access Road Construction Modeling Scenario J-3-8
3-5 Near-Field Analysis, Well Production Modeling Scenario J-3-10
3-6 Near-Field Analysis, Well Development Modeling Scenario J-3-11
3-7 Near-Field Analysis, Well Production Receptor Grid J-3-12
3-8 Near-Field Analysis, Well Development Receptor Grid J-3-13
4-1 Class I and Sensitive Class II Areas located within 200 kilometers of the Bull Mountain Unit J-4-2
4-2 Class I and Sensitive Class II Area Receptors Analyzed in the Far-Field Modeling Analysis J-4-5
4-3 Far-Field Analysis, Source Locations J-4-6
4-4 Ozone Monitoring Sites Located within the CALPUFF Modeling Domain J-4-8

APPENDICES

A Air Quality Impact Assessment Protocol for the Bull Mountain Unit Master Development Plan Environmental Impact Statement
B Bull Mountain Project Emissions Inventories
C Meteorology Data Analyses
D Sample AERMOD Model and CALPUFF Model Input Files

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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.

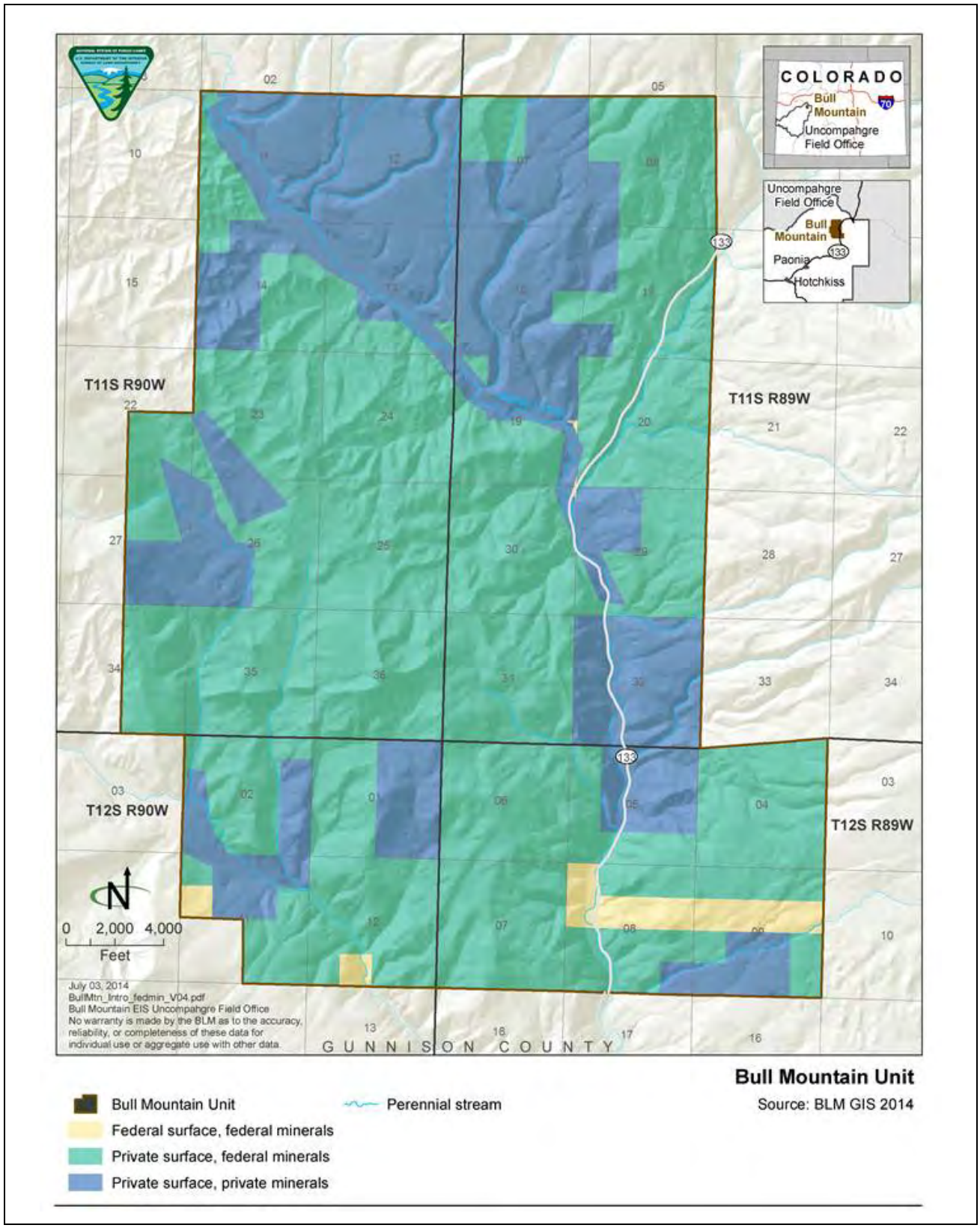

Figure 1-1: Bull Mountain Unit

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	0.000	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.

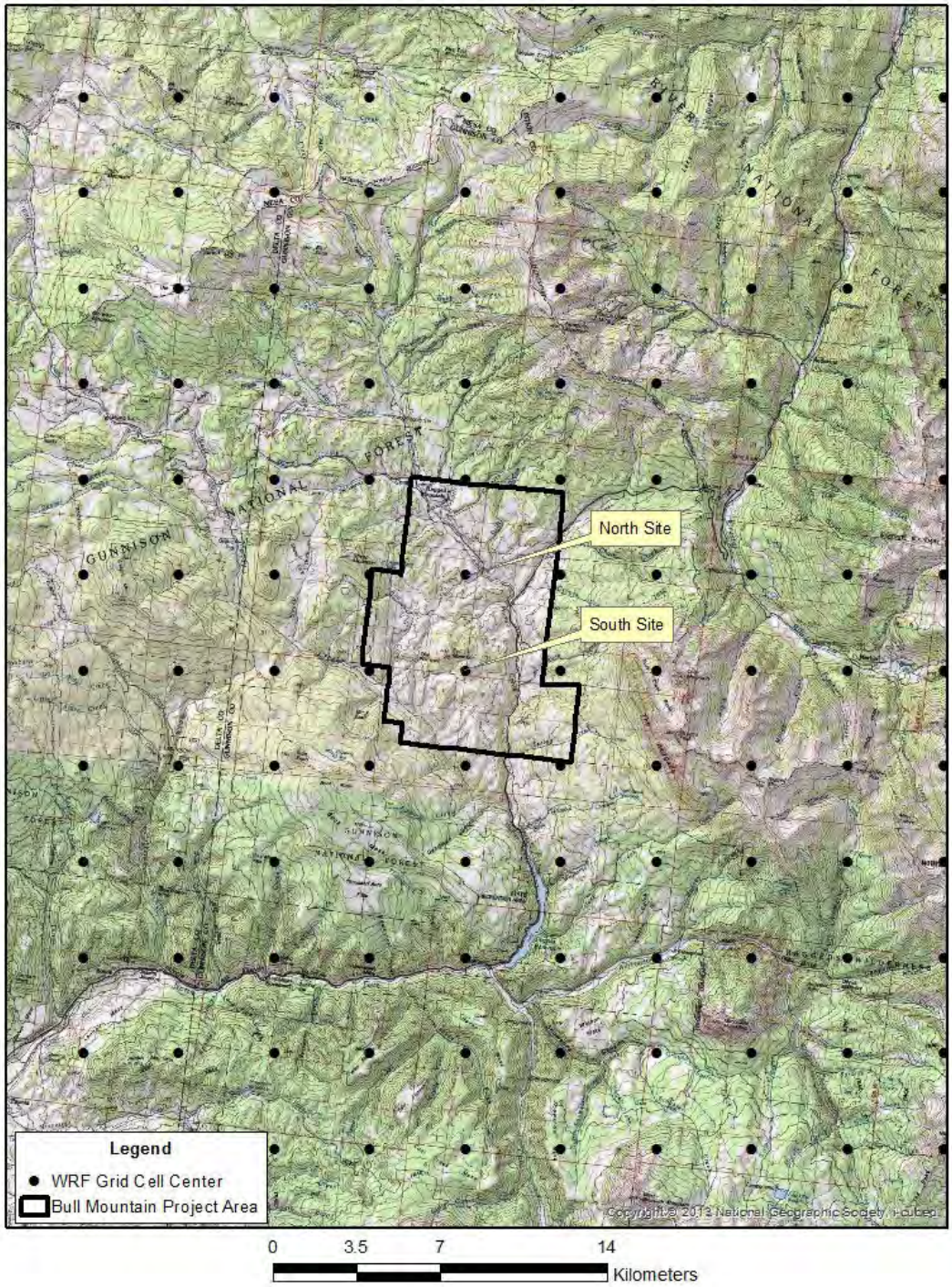

Figure 3-1: Site Locations for Bull Mountain Unit Meteorology Data

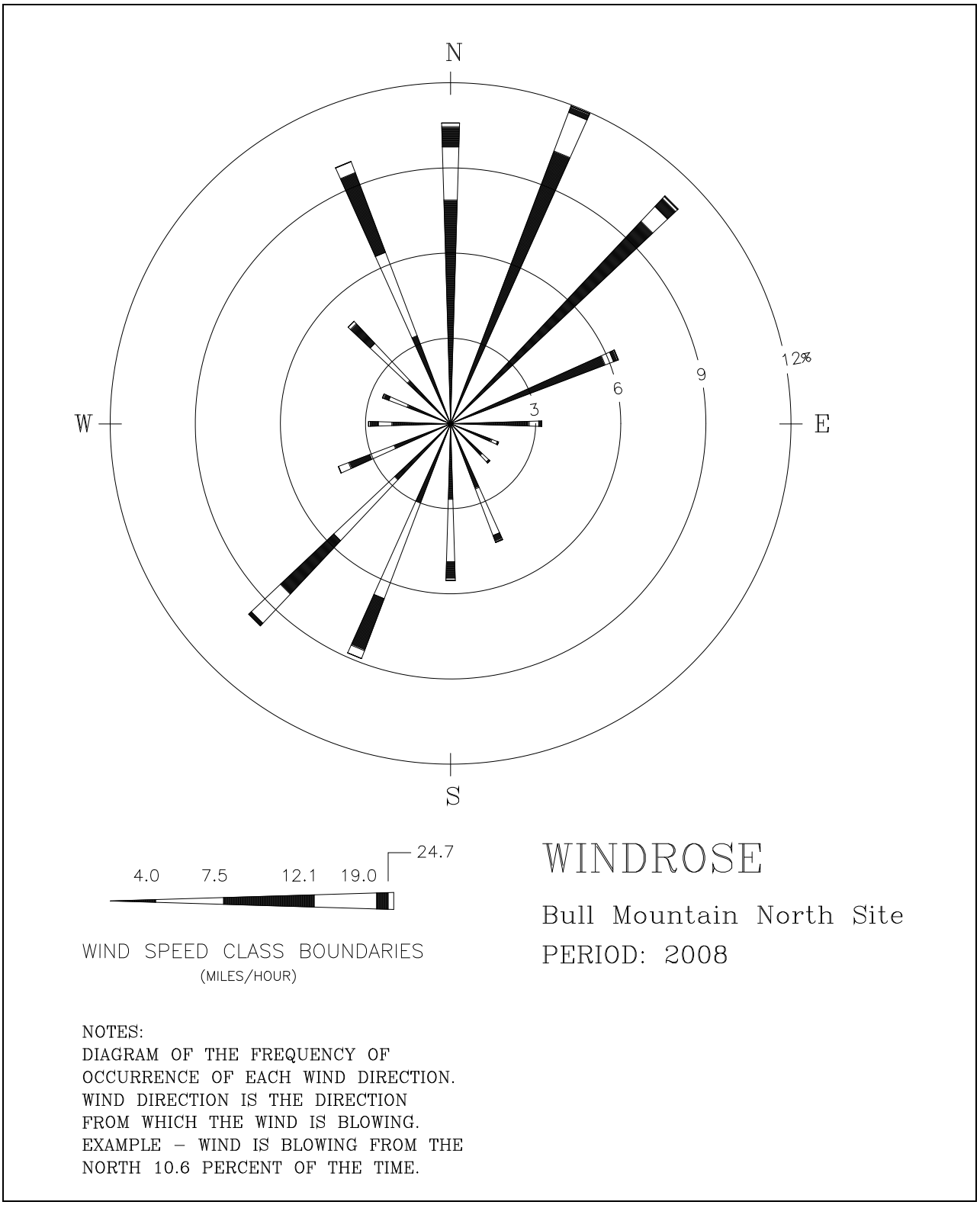

Figure 3-2: Bull Mountain Unit Windrose – North Site

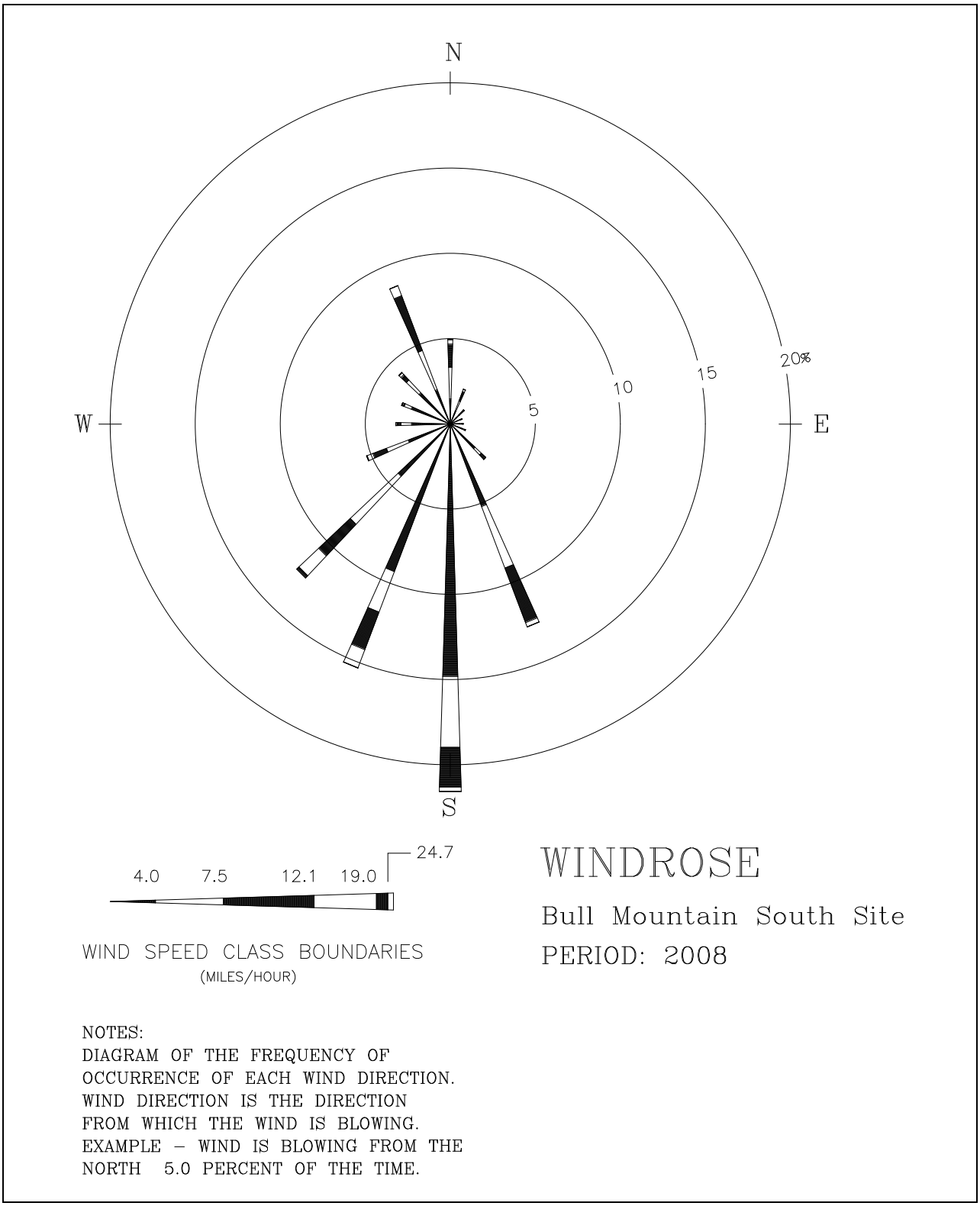

Figure 3-3: Bull Mountain Unit Windrose – South Site

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/m^3)

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**.

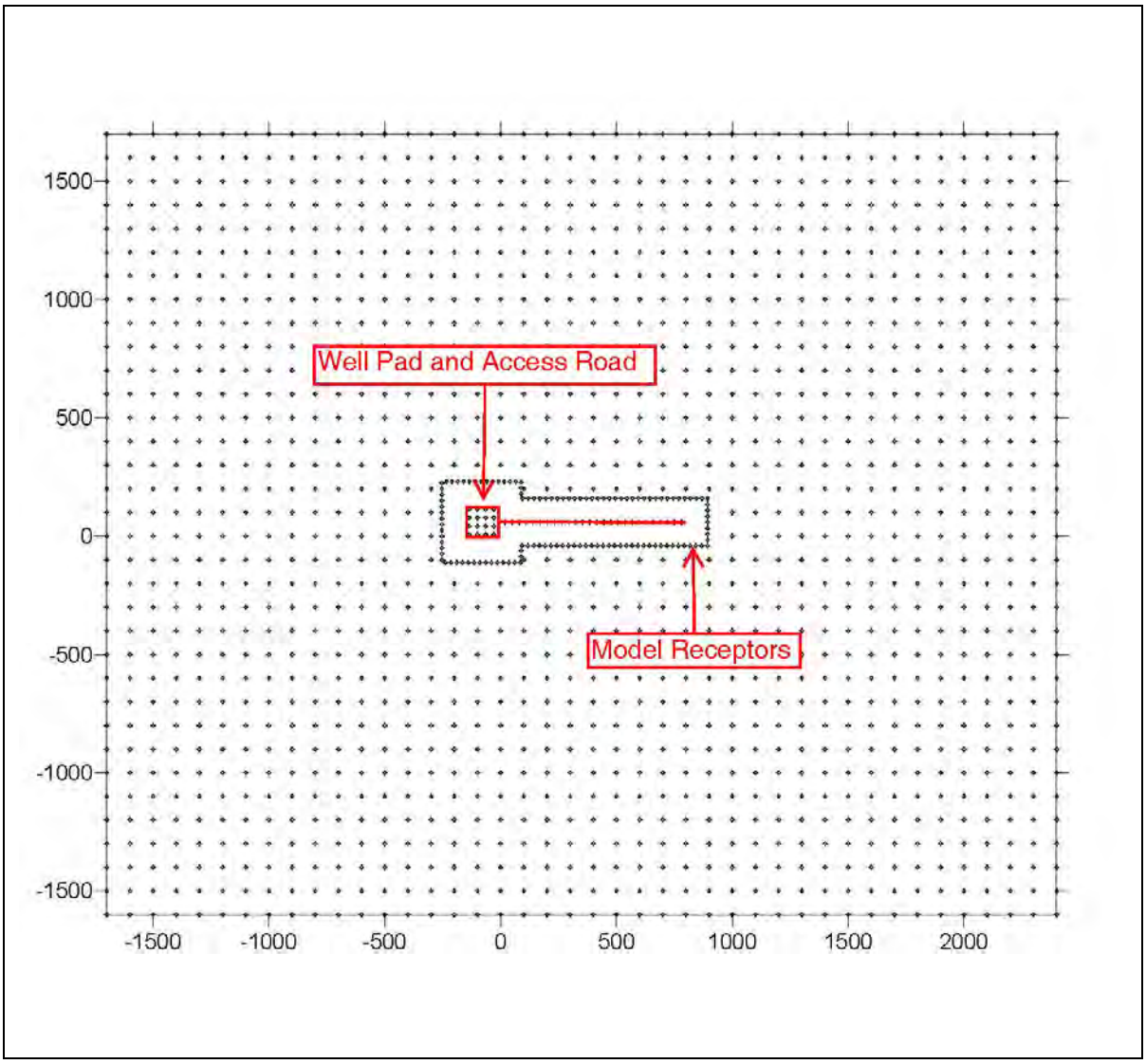

Figure 3-4: Near-Field Analysis, Well Pad and Access Road Construction Modeling Scenario

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 8th 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.

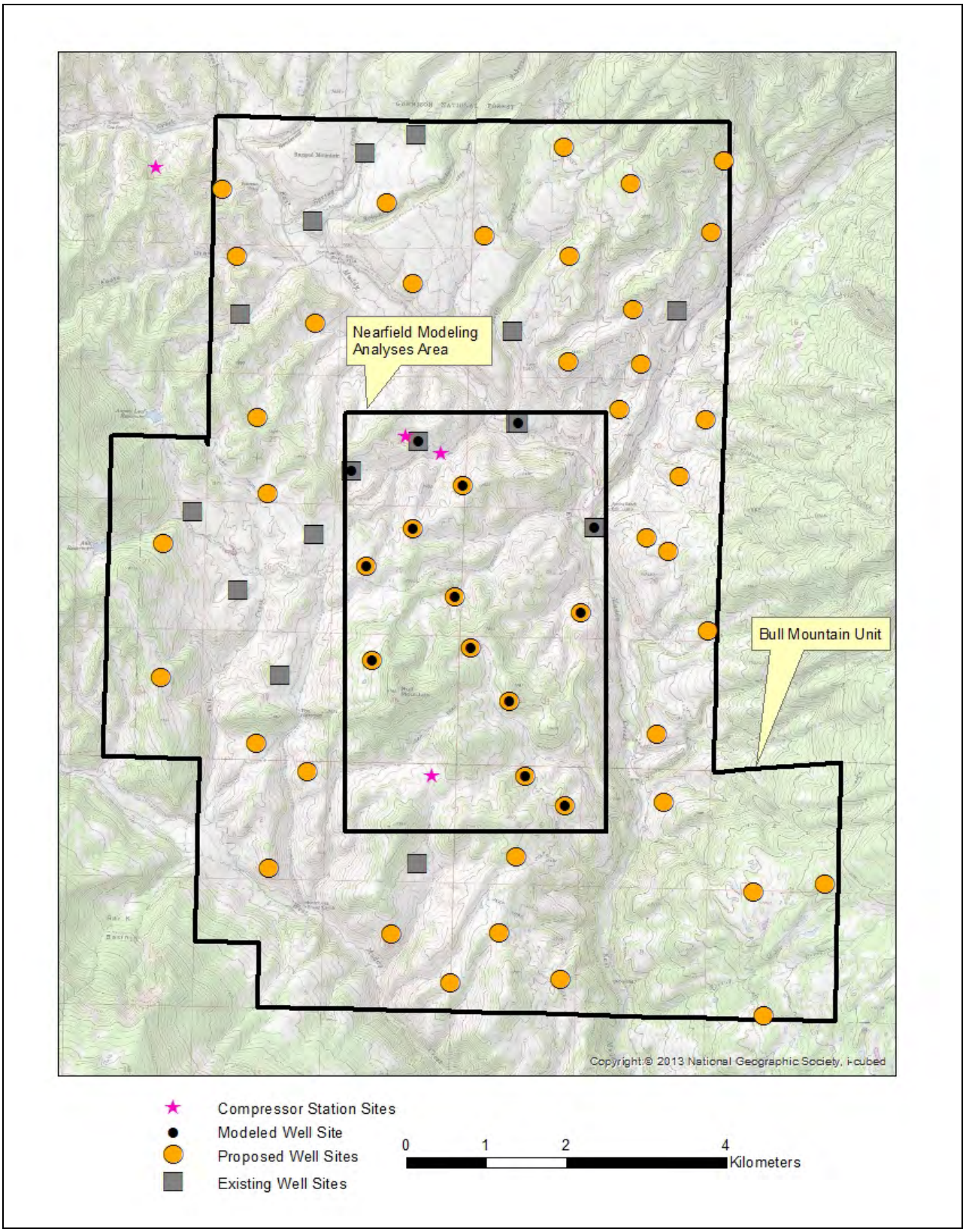

Figure 3-5: Near-Field Analysis, Well Production Modeling Scenario

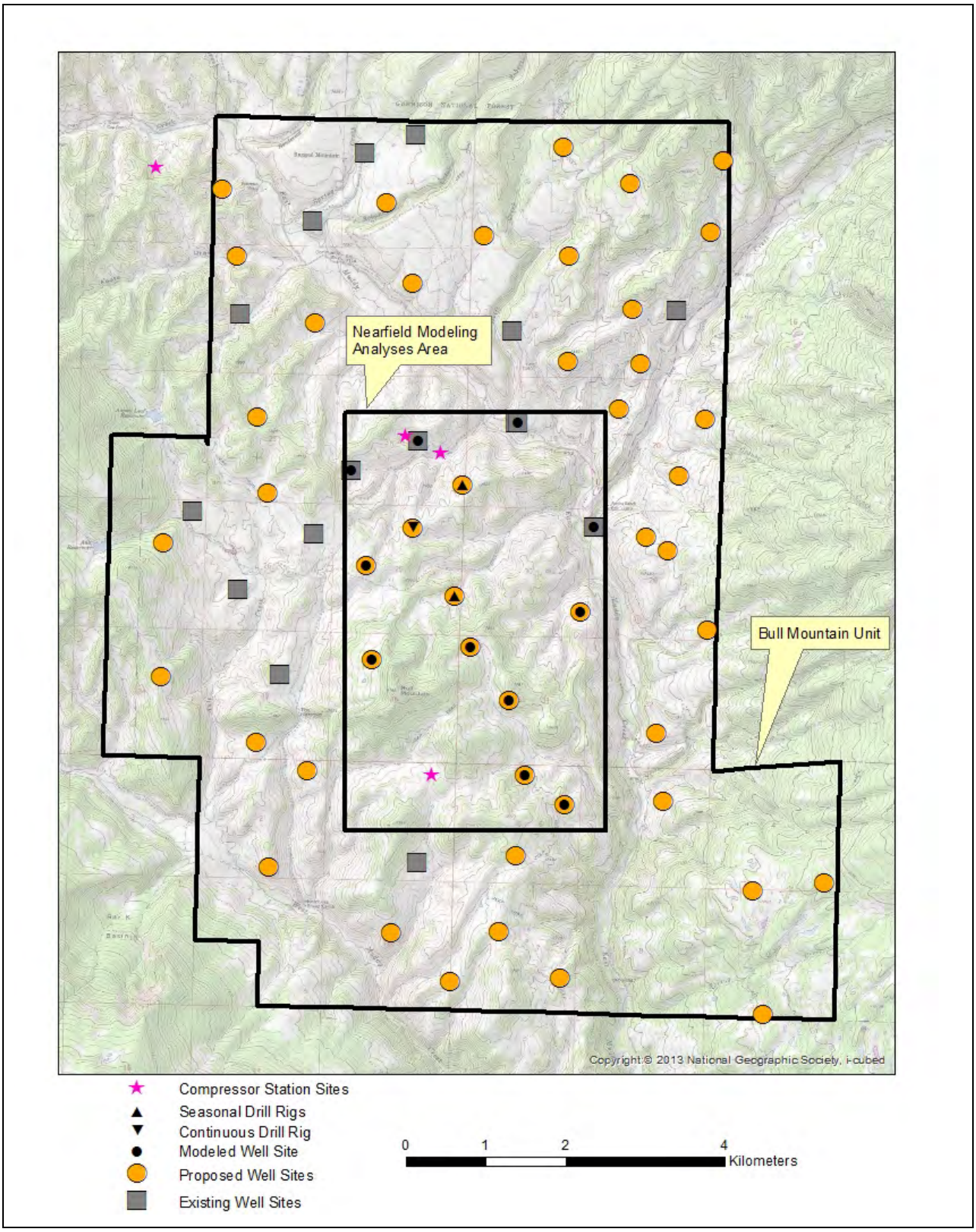

Figure 3-6: Near-Field Analysis, Well Development Modeling Scenario

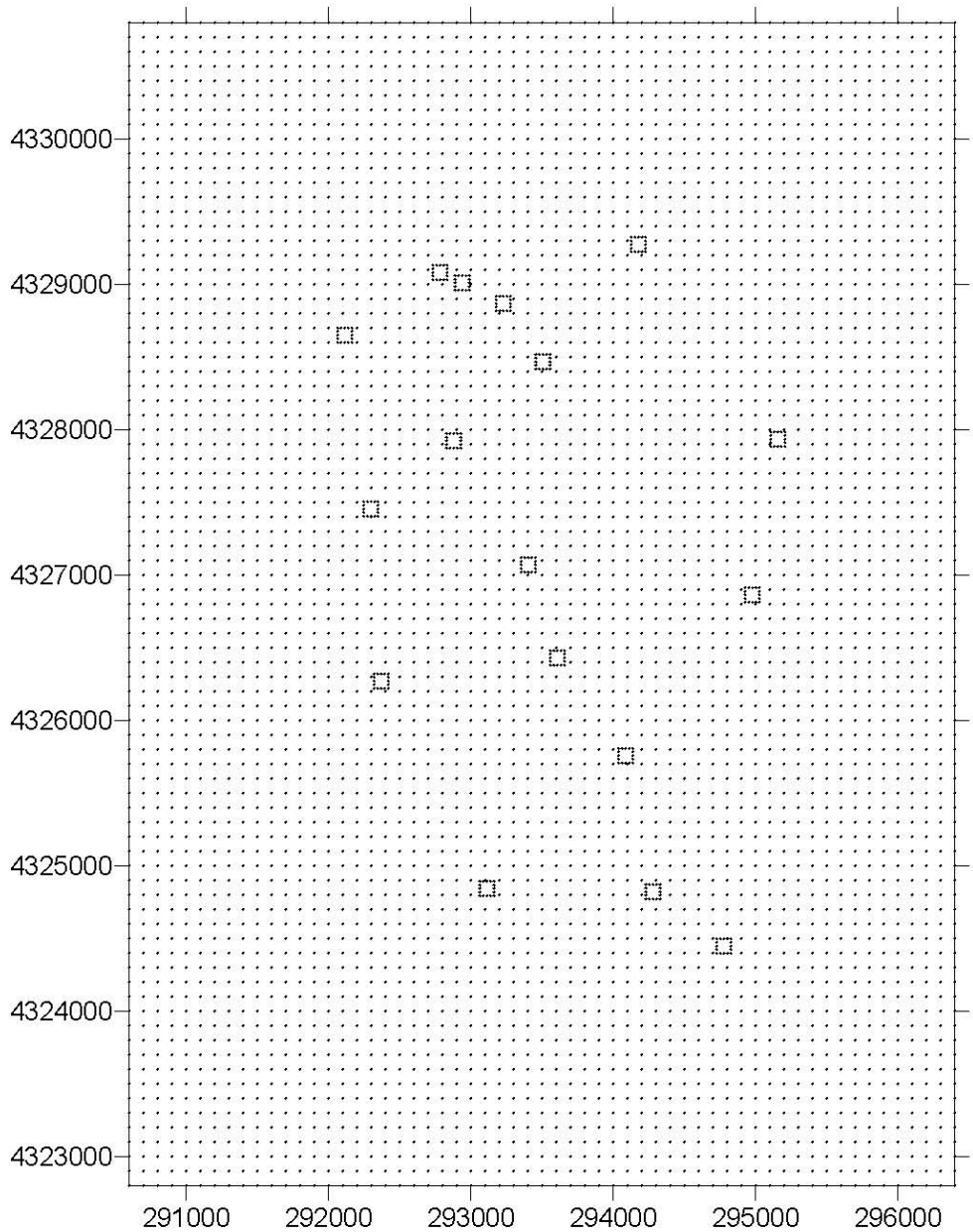

Figure 3-7: Near-Field Analysis, Well Production Receptor Grid

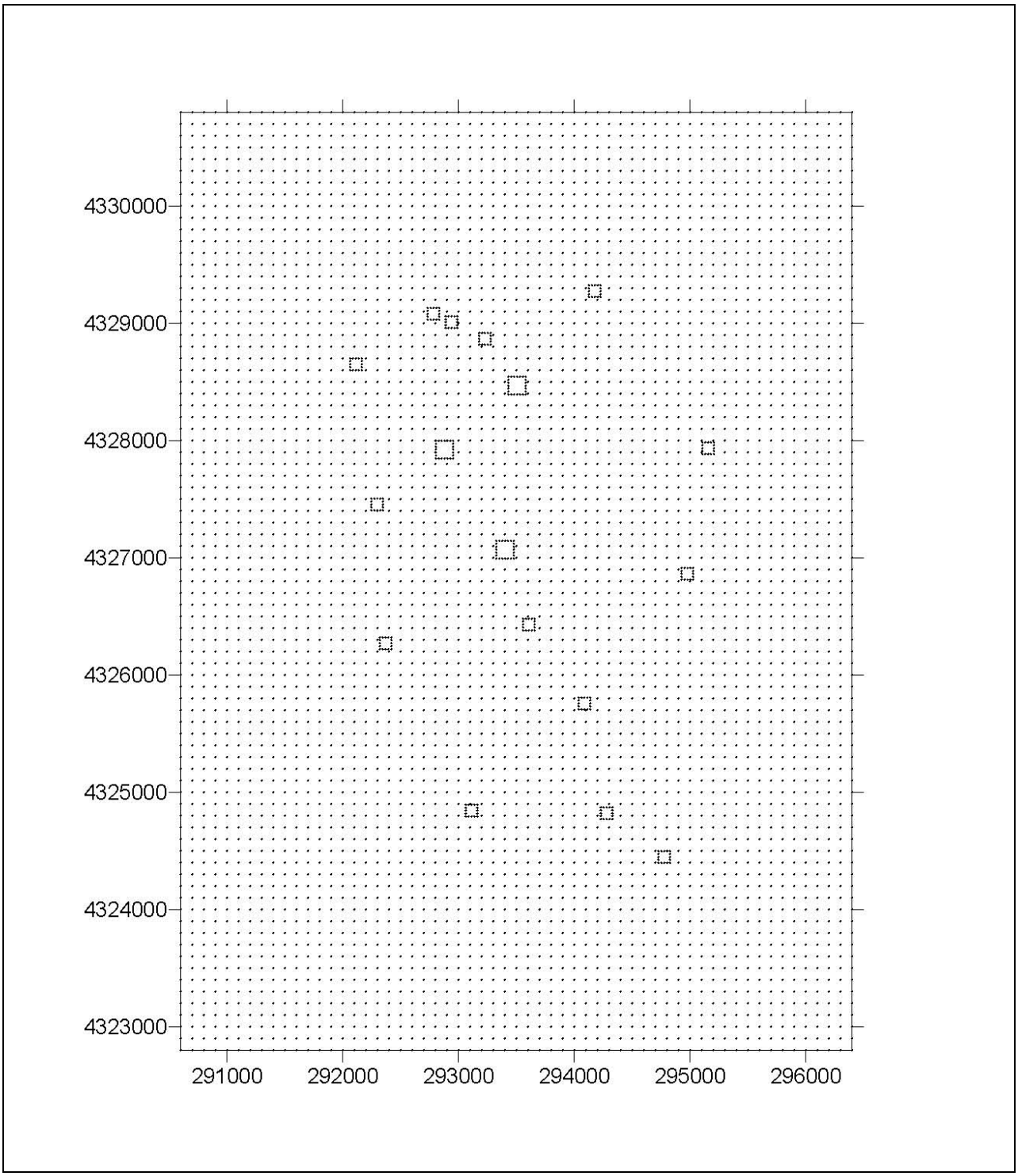

Figure 3-8: Near-Field Analysis, Well Development Receptor Grid

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 8th 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 8th 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 ($\mu g/m^3$)	Maximum 8th 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);

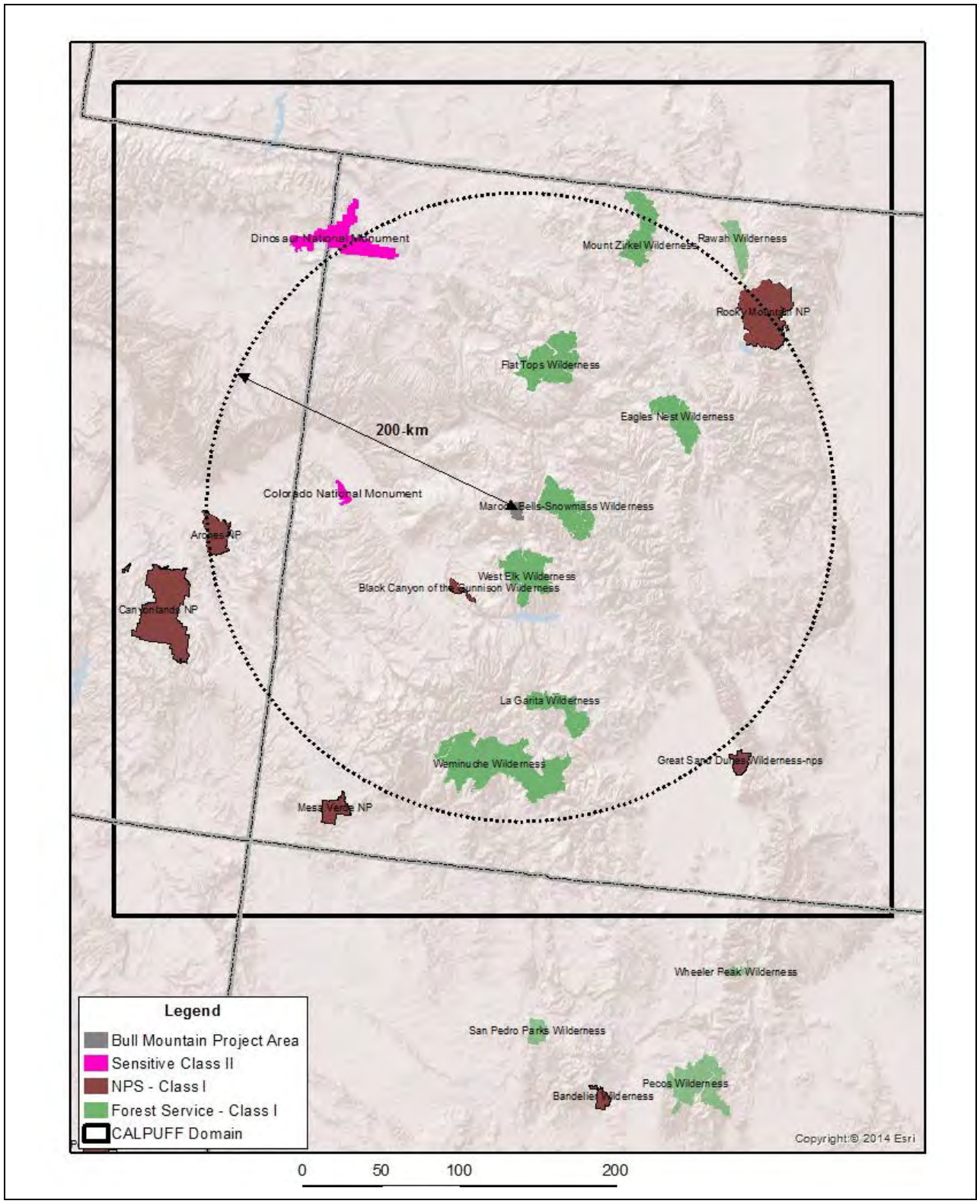

Figure 4-1: Class I and Sensitive Class II Areas located within 200 kilometers of the Bull Mountain Unit

- 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.

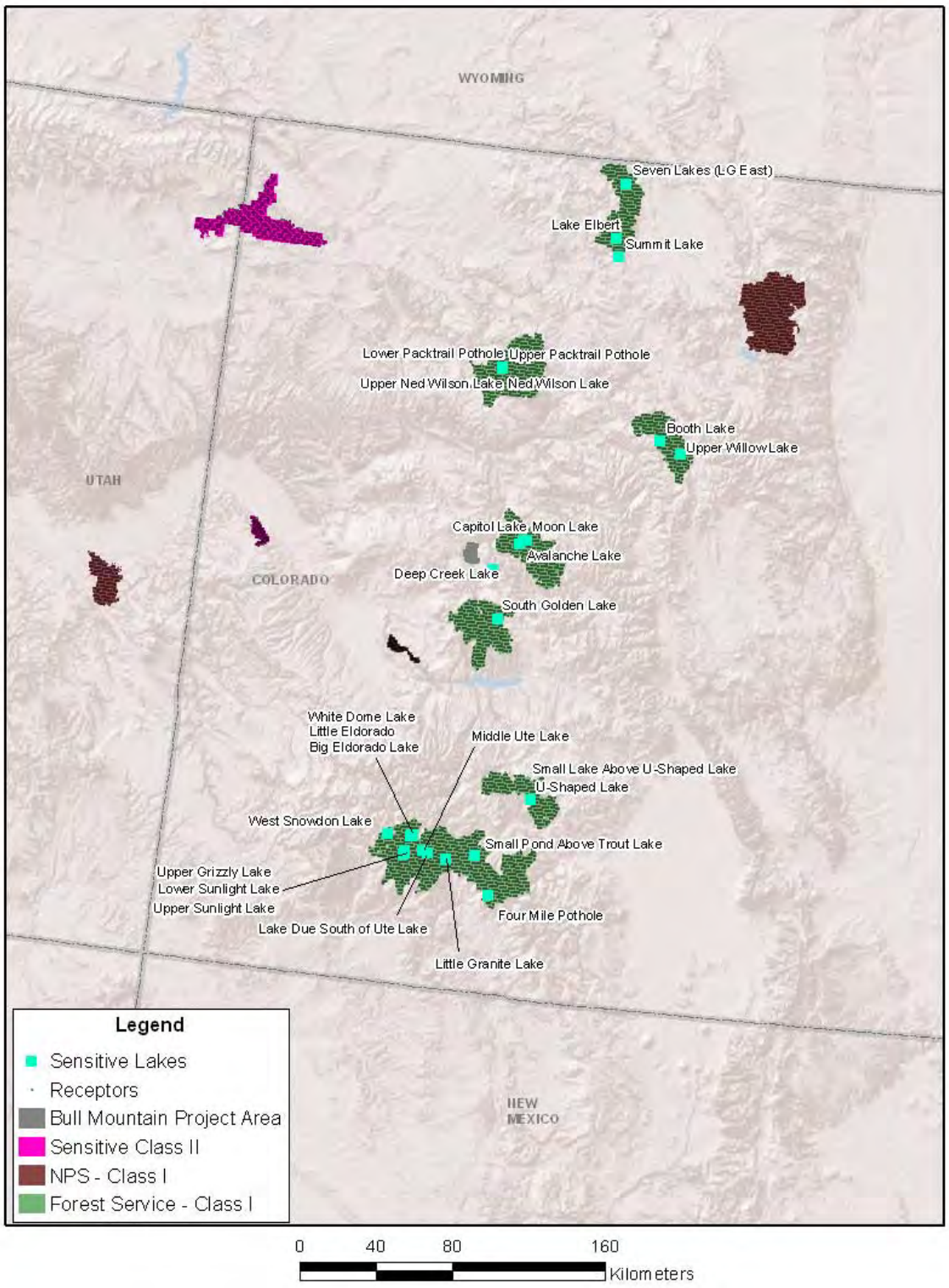

Figure 4-2: Class I and Sensitive Class II Area Receptors Analyzed in the Far-Field Modeling Analysis

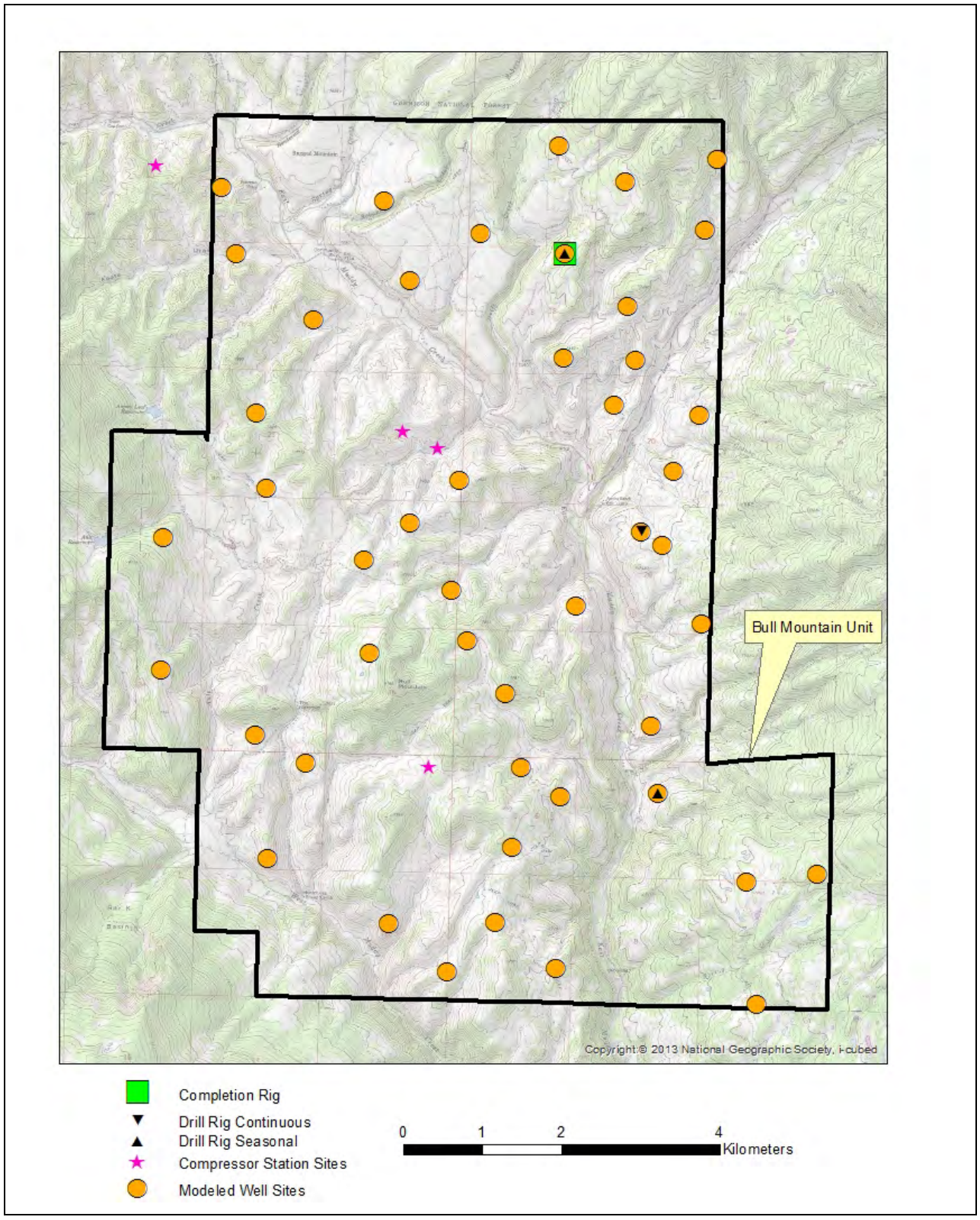

Figure 4-3: Far-Field Analysis, Source Locations

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.

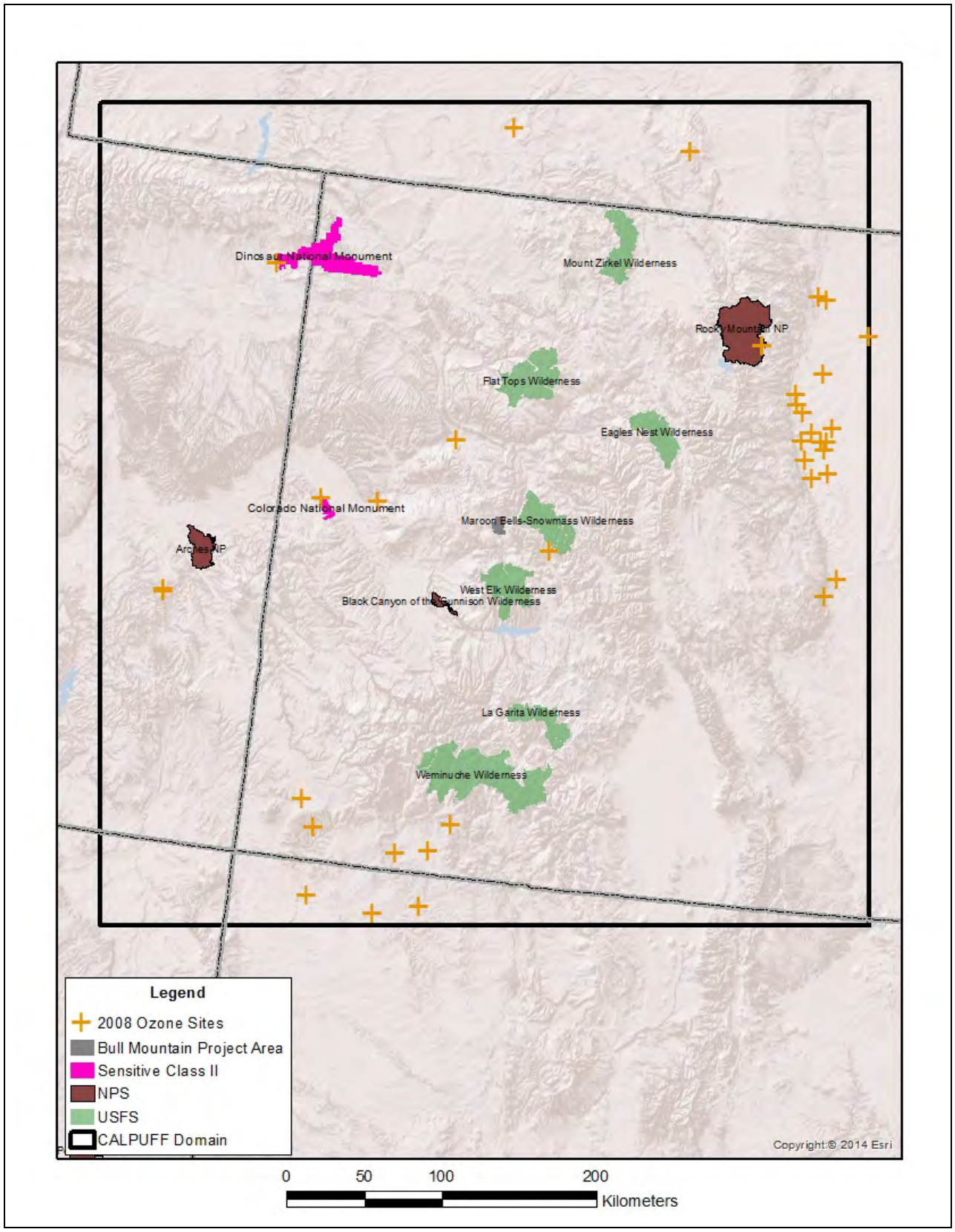

Figure 4-4: Ozone Monitoring Sites Located within the CALPUFF Modeling Domain

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/m^3)

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/m^3)	Proposed Action Direct Modeled Concentration (µg/m^3)	PSD Increment (µg/m^3)
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 ($\mu g/m^3$)	Proposed Action Direct Modeled Concentration ($\mu g/m^3$)	PSD Increment ($\mu g/m^3$)
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 ($\mu g/m^3$)	Proposed Action Direct Modeled Concentration ($\mu g/m^3$)	PSD Increment ($\mu g/m^3$)
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.

AIR QUALITY IMPACT ASSESSMENT PROTOCOL 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
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TABLE OF CONTENTS

1.0 INTRODUCTION 1
1.1 PROJECT DESCRIPTION 3
1.1.1 Existing Development 3
1.1.2 Alternative A (No Action) 4
1.1.3 Proposed Action 4
1.2 PROPOSED WORK TASKS 6
2.0 PROJECT EMISSIONS 7
2.1 FIELD DEVELOPMENT EMISSIONS 7
2.2 PRODUCTION EMISSIONS 7
2.3 MAXIMUM PROJECT EMISSIONS 7
3.0 NEAR-FIELD ANALYSIS 11
3.1 MODELING METHODOLOGY 11
3.2 METEOROLOGICAL DATA 11
3.3 BACKGROUND DATA 14
3.4 CRITERIA POLLUTANT MODELING 14
3.5 HAPS MODELING 16
4.0 FAR-FIELD ANALYSIS 19
4.1 METEOROLOGICAL DATA 25
4.2 OZONE AND AMMONIA DATA 25
4.3 VISIBILITY 27
4.4 DEPOSITION 27
4.5 LAKE CHEMISTRY 27
5.0 AIR QUALITY IMPACT ASSESSMENTS 28
5.1 NEAR-FIELD 28
5.2 FAR-FIELD 28
5.2.1 Ambient Concentration Impacts 29
5.2.2 Visibility 29
5.2.3 Deposition 31
5.2.4 ANC 31
6.0 REFERENCES 32

List of Figures

Figure 1-1: Bull Mountain Unit Project Area 2

Figure 3-1: Site Location for Bull Mountain Unit Meteorology Data 12

Figure 3-2: Bull Mountain Unit Project Area Windrose 13

Figure 4-1: Class I and Sensitive Class II Areas located within 200 km of the Bull Mountain Unit Project Area 21

Figure 4-2: Class I and Sensitive Class II Area Receptors to be Analyzed in the Far-Field Modeling Analysis 22

Figure 4-3: Ozone Monitoring Sites Located within the Proposed Calpuff Modeling Domain 26

List of Tables

Table 1-1 Number of New or Upgraded Facilities and Surface Disturbance under Alternative A (No Action) 4

Table 1-2 Number of New or Upgraded Facilities and Surface Disturbance under the Proposed Action 5

Table 2-1 Existing Emissions by Activity (tons per year) 8

Table 2-2 No Action Year 3 Emissions by Activity (tons per year) 9

Table 2-3 Proposed Action Year 5 Emissions by Activity (tons per year) 10

Table 3-1 Near-Field Analysis Background Ambient Air Quality Concentrations 14

Table 3-4 Acute RELs (1-Hour Exposure) 17

Table 3-5 Non-Carcinogenic HAPs RfCs (Annual Average) [1] 17

Table 3-6 Carcinogenic HAPs RfCs and Exposure Adjustment Factors 17

Table 4-1 Class I and Sensitive Class II Areas 20

Table 4-2 Background ANC Values for Acid Sensitive Lakes[1] 23

Table 5-1 NAAQS, CAAQS, and PSD Class I and Class II Increments for Comparison to Analysis Results ($\mu g/m^3$) 30

1.0 INTRODUCTION

Carter Lake Consulting (Carter Lake), AECOM Technical Services, Inc. (AECOM) , and Environmental Management and Planning Solutions, Inc. (EMPSi) have prepared this Air Quality Impact Assessment Protocol (Protocol) to identify the methodologies for quantifying potential air quality impacts from the Bull Mountain Unit Master Development Plan (MDP) Project (the Project). These methodologies are being provided prior to study initiation to ensure that the approach, input data, and computation methods are acceptable to the Bureau of Land Management (BLM) and other air quality stakeholders.

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), 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 total project area 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.

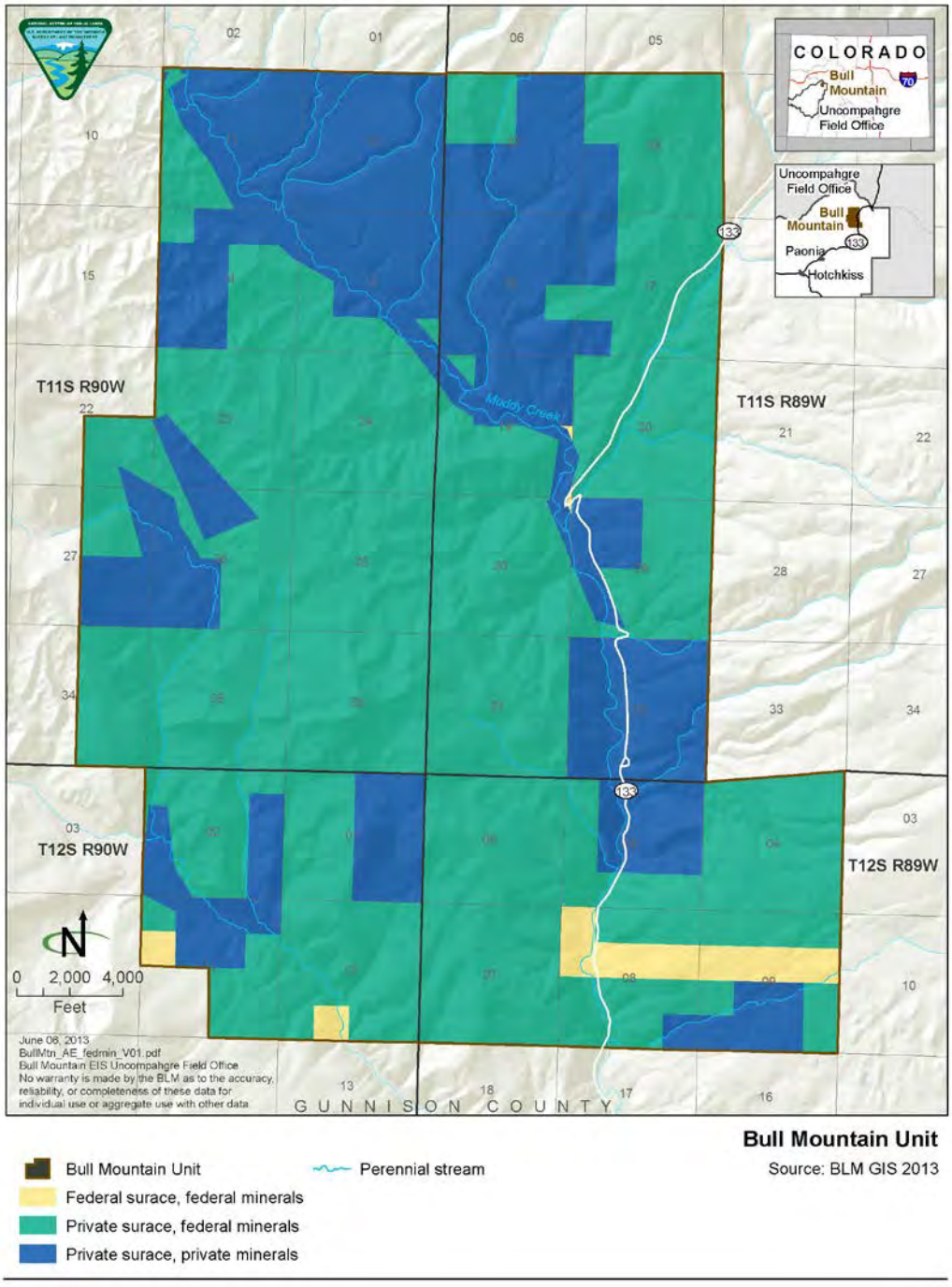

Figure 1-1: Bull Mountain Unit Project Area

The proposed analysis described in this protocol includes an assessment of the potential impacts to ambient air quality concentrations and air quality related values (AQRVs) from the potential pollutant emissions associated with the proposed Bull Mountain Unit Project Alternatives. The Bull Mountain Unit Alternative A (No Action) and Proposed Action Alternatives will be analyzed. These alternatives represent the proposed minimum and maximum levels of development that could occur within the Bull Mountain Unit.

The analysis proposes to utilize 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 Bull Mountain Unit Project Area, and the EPA Guideline model CALPUFF 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 (km) of the Project Area.

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 Protocol. 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

1.1.1 Existing Development

There are currently 13 well pads with 16 producing gas wells, one water disposal well, four flowback pits, and one storage area in the Bull Mountain Unit. The Project Area 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.

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 13 existing well pads, continued operation of existing fee wells targeting fee minerals, and development of 11 new well pads and 55 new wells on fee surface targeting fee minerals lines (Table 1-1). In addition, 11 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 one compression station.

Table 1-1
Number of New or Upgraded Facilities and Surface Disturbance under Alternative A (No Action)

Facility	Number of Wells/ Facilities or Miles	Disturbance by Facility (initial/residual)	Total Initial Disturbance (acres)	Total Residual Disturbance (acres)
Gas Wells/ Well Pads	55 new wells, 11 new pads	3.5 ac/1.8 ac	39 - new	20 – new
			23 - existing	23 – existing
Roads	3 miles new	25 ft/16 ft width	9 - new	6 – new
	2 miles upgrade to existing		7 – upgrades to existing	5 – upgrades to existing
Pipelines	11 miles (2 co-located with roads, 9 not co-located with roads)	4 ac/0 ac - Co-located with roads	54	0
		50 ac/0 ac - not co-located with roads		
Compressor Station	1	5.0 ac/1.8 ac	5.0	1.8

1.1.3 Proposed Action

The Proposed Action entails constructing, drilling, completing, and producing up to 146 new natural gas wells and 4 new water disposal wells in the Bull Mountain Unit Project Area, along with the construction of access roads, pipelines, compressor stations, and power lines (Table 1-2). 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.

Table 1-2
Number of New or Upgraded Facilities and Surface Disturbance under the Proposed Action

Facility	Number of Wells/ Facilities or Miles	Disturbance by Facility (initial/residual)	Total Initial Disturbance (acres)	Total Residual Disturbance (acres)
Wells/ Well Pads	146 new gas wells,4 new water wells, 36 new pads	3.5 ac/1.8 ac	127 - new	65 – new
			9 - existing	9 – existing
Roads	12 miles new	25 ft/16 ft width	36 - new	23 – new
	13 miles upgrade to existing		41 – upgrades to existing	26 – upgrades to existing
Pipelines	22 miles (11 co-located with roads, 11 not co-located with roads)	20 ac/0 ac - Co-located with roads	82	0
		62 ac/0 ac - not co-located with roads		
Compressor Stations	4	5.0 ac/1.8 ac	20	7.2

1.2 PROPOSED WORK TASKS

The air quality analysis will address 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. Potential ambient air pollutant concentration impacts will be quantified and compared to applicable state and federal standards, and AQRV impacts (impacts on visibility [regional haze], atmospheric deposition, and potential increases in acidification to acid sensitive lakes) will be quantified and compared to applicable thresholds as defined in the Federal Land Managers' (FLMs') Air Quality Related Values Workgroup (FLAG) guidance document (FLAG, 2010), and other state and federal agency guidance. Impact assessment criteria are discussed in further detail in Section 5.0 of this Protocol.

The assessment of impacts will include the completion of the following tasks:

- Generate air emissions inventories for project development and operation (see Section 2.0).
- Assess near-field ambient impacts from project emissions sources (see Sections 3.0 and 5.1).
- Assess far-field impacts from project emissions sources, including pollutant concentrations, visibility and atmospheric deposition impacts, and potential increases in acidification of acid sensitive lakes at Class I and other sensitive areas (see Sections 4.0 and 5.2).

2.0 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 will be reported over the life of the project and the results placed in context. For example, the percentage of total Colorado GHGs that is made up by potential Bull Mountain Unit project emissions would be reported. The emissions inventory was developed using field-specific emission test results, manufacturer's emissions data, AP-42 (EPA, 1995), Gas Research Institute (GRI) emission factors/emission models 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 and vehicle travel, and engines used in periodic well workovers. Four new central production facilities will include new compressor engines as well as separator 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 developed for each year, for the first 5 project years, for the No Action Alternative, and for the first 10 project years for the Proposed Action Alternative. The maximum potential field-wide emissions are expected to occur in project year 3 for the No Action Alternative and in project year 5 for the Proposed Action Alternative. These project years include both project development and construction activities. In addition, maximum field-wide emissions from existing Bull Mountain Unit production activities were developed. The 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

and for the No Action and Proposed Action Project Alternatives are shown in Tables 2-1, 2-2, and 2.3, respectively. In Table 2-1 the emissions from existing Bull Mountain Unit sources are shown for both federal mineral estate lands and fee lands.

For the proposed far-field modeling analysis these maximum year, field-wide project emissions of NO_x, SO_2, PM_{10}, and $PM_{2.5}$ will be modeled to assess impacts to air quality and AQRVs (atmospheric deposition and visibility) at several Class I and sensitive Class II areas that are within 200 kilometers of the Project Area. The far-field assessment will include the emissions from the existing production sources.

Maximum potential NO_2, CO, SO_2, PM_{10}, $PM_{2.5}$ and HAP impacts that could occur within and nearby the Project Area will be assessed in the near-field analysis, described below in Section 3.0. In addition a discussion of how potential ozone formation from project VOC and NO_x emissions will be analyzed is included 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	0.35	0.20	0.03	0.02	0.0003	0.01	0.01
Production Traffic	0.02	0.15	0.0001	0.01	--	0.85	0.08
Separator Heaters	0.13	0.07	--	0.04	0.006	--	--
Tank Heaters	0.18	0.09	--	0.06	0.008	--	--
Fugitives	--	--	--	0.14	0.03	--	--
Water Transfer Pumps	6.00	1.24	--	0.42	0.001	--	--
Pumping Units	7.50	1.55	--	0.53	0.001	--	--
Total Emissions	**14.18**	**3.29**	**0.03**	**1.22**	**0.05**	**0.86**	**0.10**
Private Lands							
Workover Rigs	0.76	0.44	0.07	0.05	0.001	0.03	0.03
Production Traffic	0.05	0.32	0.003	0.03	--	1.86	0.19
Separator Heaters	0.30	0.15	--	0.09	0.01	--	--
Tank Heaters	0.39	0.20	--	0.12	0.02	--	--
Fugitives	--	--	--	0.30	0.08	--	--
Water Transfer Pumps	13.50	2.78	--	0.95	0.003	--	--
Pumping Units	16.50	3.40	--	1.16	0.002	--	--
Total Emissions	**31.50**	**7.29**	**0.07**	**2.70**	**0.11**	**1.89**	**0.21**
Total Emissions from Existing Activities	**45.69**	**10.58**	**0.10**	**3.92**	**0.16**	**2.75**	**0.31**

Table 2-2
No Action Year 3 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 Dust	--	--	--	--	--	0.32	0.03
Well Pad and Road Construction – Traffic	0.06	0.06	0.0002	0.01	--	0.35	0.04
Well Pad and Road Construction – Heavy	0.40	0.37	0.02	0.03	--	0.02	0.02
Pipeline Construction - Fugitive Dust	--	--	--	--	--	0.30	0.03
Pipeline Construction – Traffic	0.01	0.02	0.0001	0.0001	--	0.14	0.01
Pipeline Construction – Heavy Equipment	0.30	0.17	0.01	0.03	--	0.01	0.01
Drill Rig Engines	23.13	13.37	2.43	1.54	0.02	0.77	0.77
Drilling Traffic	1.93	1.97	0.01	0.22	--	12.03	1.29
Completion Engines – Fracturing	6.22	3.60	0.25	0.41	0.01	0.21	0.21
Completion Engines – Mobile Rigs	1.25	0.72	0.05	0.08	0.001	0.04	0.04
Completion Traffic	0.10	0.08	0.0004	0.01	--	0.49	0.05
Completion Flaring	0.61	3.32	--	0.25	0.09	--	--
Total Construction Emissions	**34.01**	**23.66**	**2.76**	**2.58**	**0.12**	**14.68**	**2.51**
Production Emissions							
Workover Rigs	1.88	1.08	0.07	0.13	0.002	0.06	0.06
Production Traffic	0.21	1.31	0.001	0.11	--	7.56	0.76
Separator Heaters	1.48	0.74	--	0.47	0.07	--	--
Tank Heaters	1.97	0.98	--	0.62	0.09	--	--
Fugitives	--	--	--	1.51	0.38	--	--
Compressors	6.15	13.16	--	2.52	1.90	--	--
Compressor Station Separator Heaters	0.05	0.03	--	0.02	0.002	--	--
Water Transfer Pumps	16.50	3.40	--	1.16	0.57	--	--
Pumping Units	42.00	8.66	--	2.94	1.45	--	--
Total Production Emissions	**70.23**	**29.36**	**0.07**	**9.47**	**4.46**	**7.63**	**0.82**
Total Emissions	**104.24**	**53.02**	**2.83**	**12.05**	**4.57**	**22.31**	**3.33**

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 Dust	--	--	--	--	--	1.91	0.18
Well Pad and Road Construction – Traffic	0.36	0.34	0.001	0.04	--	2.10	0.23
Well Pad and Road Construction – Heavy	2.37	2.20	0.11	0.17	--	0.13	0.13
Pipeline Construction - Fugitive Dust	--	--	--	--	--	1.80	0.17
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	3.65	2.31	0.03	1.16	1.16
Drilling Traffic	2.44	2.49	0.01	0.28	--	15.25	15.25
Completion Engines – Fracturing	9.43	5.45	0.37	0.63	0.01	0.31	0.31
Completion Engines – Mobile Rigs	1.88	1.08	0.07	0.13	0.002	0.06	0.06
Completion Traffic	0.13	0.10	0.0005	0.01	--	0.62	0.07
Completion Flaring	0.91	4.97	--	0.37	0.09	--	--
Total Construction Emissions	**54.11**	**37.87**	**4.27**	**4.11**	**0.14**	**24.25**	**17.71**
Production Emissions							
Workover Rigs	4.33	2.50	0.16	0.29	0.004	0.14	0.14
Production Traffic	0.63	3.98	0.003	0.33	--	23.02	2.30
Separator Heaters	3.64	1.82	--	1.15	0.16	--	--
Tank Heaters	4.86	2.43	--	1.54	0.22	--	--
Fugitives	--	--	--	3.75	0.95	--	--
Compressors	24.60	52.65	--	10.09	7.61	--	--
Compressor Station Separator Heaters	0.21	0.11	--	0.07	0.01	--	--
Water Transfer Pumps	50.22	10.35	--	3.52	1.73	--	--
Pumping Units	101.84	20.99	--	7.14	3.50	--	--
Total Production Emissions	**190.33**	**94.84**	**0.16**	**27.86**	**14.18**	**23.17**	**2.45**
Total Emissions	**244.44**	**132.71**	**4.43**	**31.97**	**14.32**	**47.41**	**20.15**

3.0 NEAR-FIELD ANALYSIS

3.1 MODELING METHODOLOGY

The near-field ambient air quality impact assessment will be performed to quantify maximum pollutant impacts within and near the Project Area resulting from project development (construction) and operation (production) emissions. Criteria pollutant emissions of PM_{10}, $PM_{2.5}$, NO_x, SO_2, and CO, and emissions of HAPs (benzene, toluene, ethyl benzene, xylene, n-hexane, and formaldehyde) will be evaluated as part of the near-field study. Emissions of each pollutant analyzed will be examined to determine 1) the maximum emissions phase during well/field development and 2) the maximum emissions phase during production, and it will be these scenarios that will be modeled to determine near-field project impacts. Modeling will be conducted for the Proposed Action as well as the No Action Alternative.

The U.S. EPA's Guideline (EPA, 2005) model, AERMOD (Version 12345), will be used to assess these near-field impacts. Regulatory model settings will be utilized, with the exception of the non-regulatory Ozone Limiting Method (OLM) option, which will be used for modeling NO_2 concentration estimates. Modeling analyses for NO_2 concentration estimates will also utilize hourly ozone concentration data collected at the Clean Air Status and Trends Network (CASTNET) Gothic ozone site located in Gunnison County, Colorado.

Ozone (O_3) formation and impacts will not be modeled as part of the air quality assessment. The assessment of the project's potential contribution to regional ozone formation will be based on the results from the ongoing CARMMS project. Bull Mountain Unit project emissions are included in the CARMMS study.

3.2 METEOROLOGICAL DATA

Due to the absence of any available representative monitored meteorology data for the 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., 2012a) will be used to generate a meteorological dataset for the AERMOD modeling. The WRF model was run by WRAP for an extensive 4-km 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. When compared to other simulations, the 2008 WestJump WRF simulation showed model performance that was as good, or better, than other prognostic model applications including the 2002 MM5 simulation by WRAP. Figure 3-1 shows the area surrounding the Bull Mountain Project area and the center points to each 4-km 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 2012b) such as AERMOD. The latest EPA approved MMIF version 2.3 (dated 2013-04-30) was used to produce AERMOD ready meteorology files (surface and profile files) by extracting

appropriate information from the 2008 WestJumpAQMS WRF dataset. The grid cell used as the extraction point for the Bull Mountain Project meteorology data is shown in Figure 3-1. A wind rose for the 2008 data for the Project-specific location is provided in Figure 3-2.

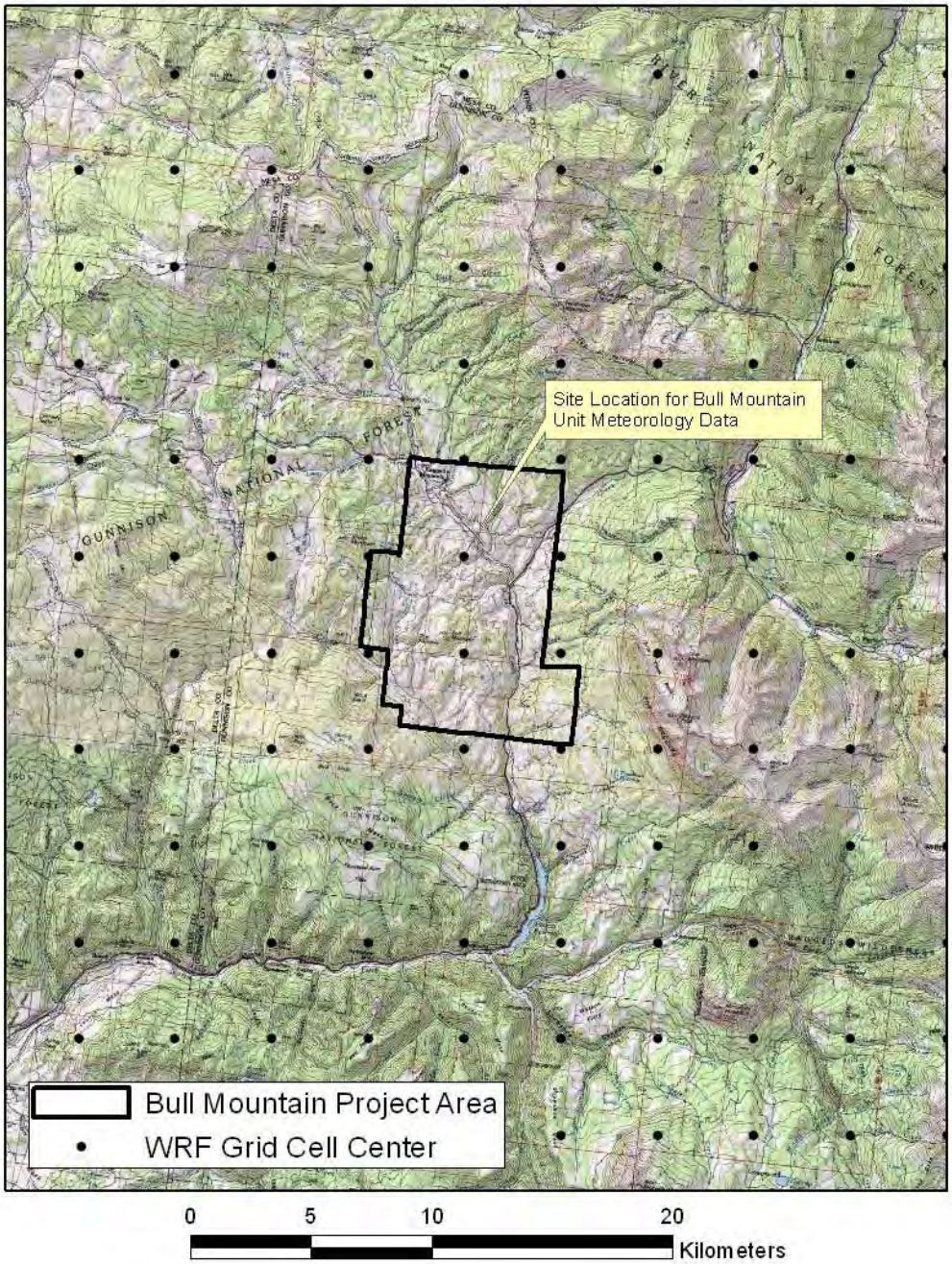

Figure 3-1: Site Location for Bull Mountain Unit Meteorology Data

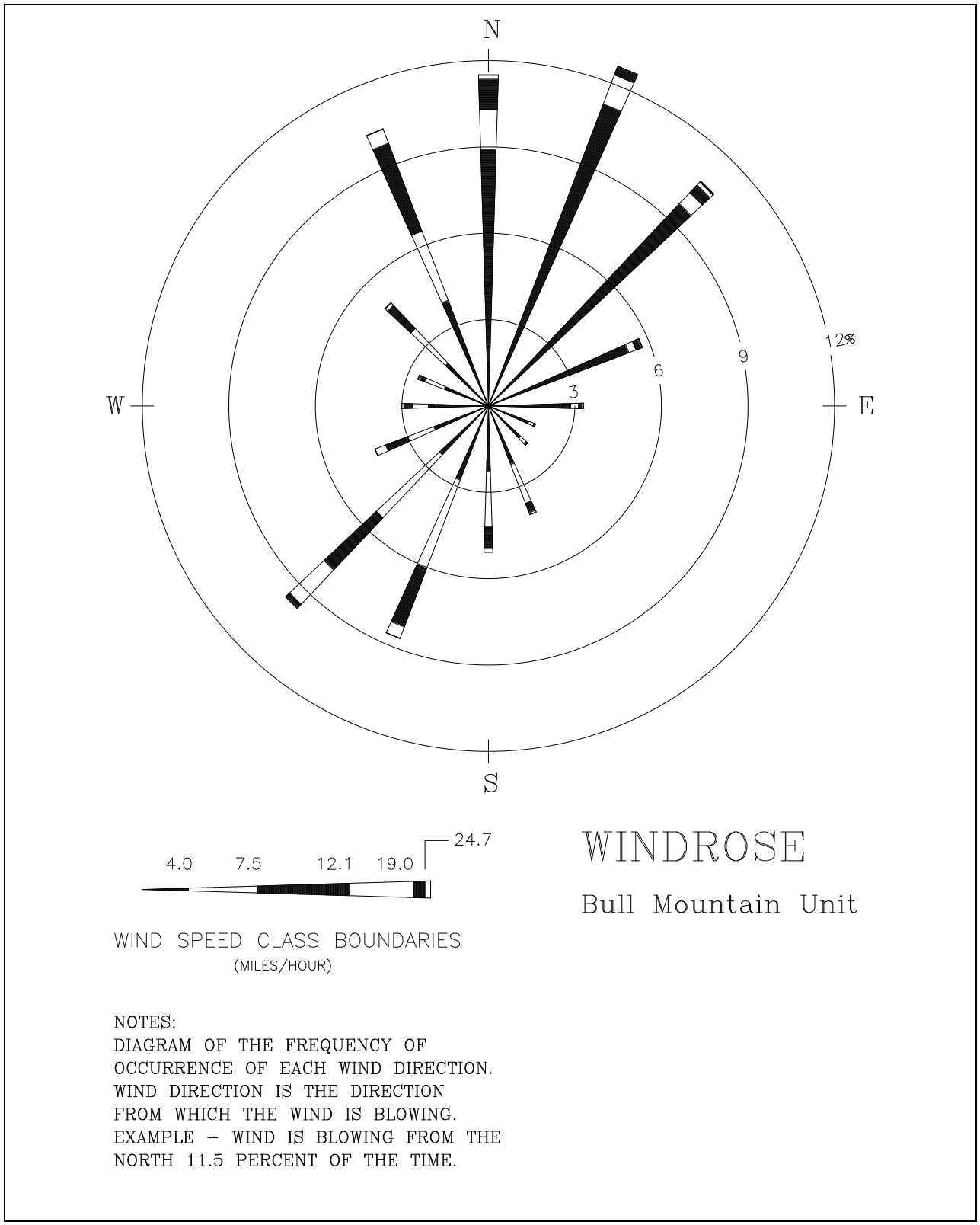

Figure 3-2: Bull Mountain Unit Project Area Windrose

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 proposed background values. 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).

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 8-hour	1150 1150
Nitrogen dioxide (NO_2)[1]	1-hour Annual	21 1.9
PM_{10}[2]	24-hour Annual	36 15
$PM_{2.5}$[1]	24-hour Annual	14 3
Sulfur dioxide (SO_2)[1]	1-hour 3-hour 24-hour Annual	3 3 3 3

[1] Data collected at Williams Willow Creek during 2012.

[2] Data from S. Ute, collected 1 mile NE of Ignacio during 2003-2005.

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3.4 CRITERIA POLLUTANT MODELING

A near-field criteria pollutant assessment will be performed to estimate maximum potential impacts of PM_{10}, $PM_{2.5}$, NO_x, SO_2, and CO from Project emission sources operating during the development and production phases of the Bull Mountain Project Proposed Action and No Action Alternatives. Emissions from each phase of field development and production will be evaluated to determine which emissions activities are likely to produce the maximum pollutant impacts. Modeling scenarios will be developed and evaluated for each case.

As mentioned in Section 3.1, modeling to predict NO_2 concentrations will be performed using the OLM methodologies with the AERMOD model. The NO_2 modeling will utilize hourly ozone concentration data collected at the Gothic CASTNET site during 2008. These data are concurrent with the Bull Mountain meteorological data that will be used for the analysis.

For modeling field development activities, modeling scenarios will be constructed using one-section land areas (1 square mile) and locating sources throughout that area. Various scenarios will be evaluated for well pad/access road construction activities based on operator-provided well density and well pad construction details to provide a range of impacts from typical field construction activities, including well pad construction and drilling operations. Hourly emission rate adjustment factors will be applied to sources emitting only during specific diurnal periods. Scenarios that include well development activities combined with well production operations will be also be modeled in one-section land areas. In accordance with averaging periods for which ambient standards and/or PSD increments exist, NO_2 concentrations will be calculated for the 1-hour and annual averaging period, CO concentrations for 1-hour and 8-hour averaging periods, SO_2 concentrations for 1-hour, 3-hour, 24-hour and annual averaging periods, and PM_{10} and $PM_{2.5}$ concentrations for 24-hour and annual averaging periods.

Modeling scenarios to evaluate production activities will be determined from operator-provided field assumptions within the Project Area. Scenarios including well production, field compression and ancillary facilities will be evaluated to determine the maximum pollutant impacts that could occur from sources operating throughout the Project Area. For the production scenarios, 1-hour and annual average nitrogen dioxide (NO_2) concentrations, 1-hour and 8-hour CO concentrations, and SO_2 concentrations for 1-hour, 3-hour, 24-hour, and annual averaging periods will be predicted.

Point sources will be used for modeling emissions from compressors, pumping units, and drilling rigs. Volume sources will be used for modeling well-site activities, road travel, and wind erosion during development activities. The most recent version of the Building Profile Input Program (BPIP-Prime) will be used to determine appropriate direction-specific building dimension downwash parameters for each affected source.

Discrete modeling receptor sets will be used for each modeling scenario. For modeling well site activities the receptor grids will consist of discrete modeling receptors placed at 25-meter intervals along a boundary defined at 100 meters from the perimeter of the well pad, with receptors placed in a rectangular grid at 100-meter intervals out to 1.5 kilometers from the boundary. The estimated disturbed area well pad size will be used for well development activities and the reclaimed well pad area will be used for well production activities. For modeling central production facility sources, such as compressor engines, discrete modeling receptors will be placed at 25-meter intervals along a boundary defined at 100 meters from the source, with receptors placed in a rectangular grid at 100-meter intervals out to 1.5 kilometers from the boundary.

The receptor grid used for modeling well pad and access road construction will utilize discrete modeling receptors placed at 25-meter intervals along a boundary defined at 100 meters from the perimeter of the well pad and access road with receptors placed in a rectangular grid at 100-meter intervals out to 1.5 kilometers from the boundary. An additional receptor set will be used for modeling well pad and access road construction, which is similar to the first set; however the boundary will be located 250 meters from the perimeter of the well pad and access road.

This modeling approach is consistent with other ongoing NEPA analyses and has been demonstrated to capture maximum pollutant impacts from the types of emissions activities that are proposed for this project.

The AERMAP processor will be used to generate AERMOD terrain parameters for receptors where source locations are known. Flat terrain receptors will be used for modeling analyses of sources where source locations cannot be adequately defined.

3.5 HAPS MODELING

Near-field HAPs concentrations will be calculated for assessing impacts both in the immediate vicinity of Project Area emission sources for short-term (acute) exposure assessment and for calculation of long-term risk. Maximum HAPs emissions are expected to include those from well-site fugitive emissions and natural gas fired compressor engines. Because HAPs will be emitted predominantly during the production phase, it is anticipated that only emissions from production activities will be analyzed.

The modeling methodology for the short-term and long-term HAPs impact assessments is nearly identical to the methodology outlined in Section 3.1. Volume sources will be used for modeling well-site fugitive emissions during production, and point sources will be used to represent compressor engine emissions. A maximum emissions case will be developed for each HAP for representative one-section land areas, and each case modeled. A single section of producing wells with compressor station(s) and/or a processing facility, whichever produces maximum emissions, is expected to be analyzed.

Similar to the criteria pollutant modeling, two sets of flat terrain discrete modeling receptor sets will be used for each modeling scenario. The first set will consist of discrete modeling receptors placed at 25-meter intervals along a boundary defined at 100 meters from the source, with receptors placed in a rectangular grid at 100-meter intervals out to 1.5 kilometers from the boundary. The second receptor set will be similar to the first set; however, the boundary will be located 250 meters from the source. For long-term incremental risk determinations, receptors will also be placed at the nearest residence locations, or polar receptor grids will be used to determine the distance required to predict concentrations below a one-in-one-million cancer risk factor. Should polar receptor grids be used, these will be applied using 1-degree radial spacing with rings placed at 0.25 mile increments to determine the distance to be below a one-in-one-million cancer risk factor.

Short-term (1-hour) HAPs concentrations will be compared to acute Reference Exposure Levels (RELs), shown in Table 3-4. 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 the Proposed Action will be 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 will be compared directly to the non-carcinogenic RfCs shown in Table 3-5.

Table 3-4
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 3-5
Non-Carcinogenic HAPs RfCs (Annual Average) [1]

HAP	Non-CarcinogenicRfC[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).

RfCs for suspected carcinogens benzene, ethyl benzene, and formaldehyde are expressed as unit risk factors, shown in Table 3-6. Accepted methods for risk assessment will be used to evaluate the incremental cancer risk for these pollutants.

Table 3-6
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	7.8×10^{-6}	0.0949
MLE	Ethyl Benzene	2.5×10^{-6}	0.0949
MLE	Formaldehyde	1.3×10^{-5}	0.0949
MEI	Benzene	7.8×10^{-6}	0.71
MEI	Ethyl Benzene	2.5×10^{-6}	0.71
MEI	Formaldehyde	1.3×10^{-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.

Annual modeled concentrations will be multiplied by EPA's unit risk factors (URF) (based on 70-year exposure) for those pollutants, and then the product will be multiplied by an adjustment factor, which represents the ratio of projected exposure time to 70 years. The adjustment factors represent two scenarios: a most likely exposure (MLE) scenario and one reflective of the maximally exposed individual (MEI).

The MLE duration will be 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 is assumed to be 50 years (i.e., the LOP), corresponding to an adjustment factor of 50/70 = 0.71.

A second adjustment will be 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 will be assumed that during the rest of the day the individual would remain in an area where annual HAPs concentrations would be one quarter as large as the maximum annual average concentration. Therefore, the MLE adjustment factor will be (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% of the time, for a final adjustment factor of (0.71 x 1.0) = 0.71. EPA unit risk factors and adjustment factors are shown in Table 3-6.

The cancer risks for each constituent will be summed to provide an estimate of the total inhalation cancer risk.

4.0 FAR-FIELD ANALYSIS

The purpose of the far-field analysis is to quantify potential air quality impacts to both ambient air concentrations and AQRVs from air pollutant emissions of NO_x, SO_2, PM_{10} and $PM_{2.5}$ expected to result from construction and operation of the both the Proposed Action and Alternative A (No Action). Ambient air quality impacts of NO_2, SO_2, PM_{10}, and $PM_{2.5}$, and AQRVs will be analyzed at far-field Class I and sensitive Class II areas that are within 200 km of the Project Area. The analyses will be performed using the EPA-approved version of the CALPUFF modeling system (Version 5.8) with the exception of the use of Mesoscale Model Interface Program (MMIF) Version 2.3rc1 (ENVIRON, 2012b) to develop a meteorological windfield rather than CALMET. All CALPUFF model options will conform to the 2009 EPA guidance (EPA, 2009) and all CALPOST model options and inputs will conform to FLAG 2010 guidance (FLAG, 2010). Maximum field-wide project emissions, described in Section 2.0, will be modeled for the far-field analysis. Sources will be placed at estimated locations throughout the Project Area.

The far-field analysis for the project will estimate impacts at PSD Class I and sensitive Class II areas of concern that are within 200 km of the Project Area. The Class I and sensitive Class II areas located within 200 km of the Project Area are shown on Figure 4-1. The proposed CALPUFF domain is also indicated in Figure 4-1. The Class I and sensitive Class II areas within 200 km of the Project are contained within the proposed domain with sufficient buffer for potential recirculation effects.

Table 4-1 provides a list of the Class I and sensitive Class II areas that will be analyzed. Table 4-1 also lists the agency responsible for managing the area, and the PSD classification. Although Rocky Mountain National Park (RMNP) is within 200 km of the Bull Mountain project area, impacts to the park will not be modeled in this study, given that the Eagles Nest Wilderness Area is upwind in the same direction and any impacts at the more distant RMNP would be considerably less.

Proposed CALPUFF model receptors for these areas are shown in Figure 4-2. The receptors for the Class I areas will be obtained the FLM receptor database. The receptors for sensitive Class II areas will be obtained from prior regional CALPUFF air quality analyses, i.e. the Fram and Black Hills Environmental Assessments, or created for this project.

Ambient air impacts of NO_2, SO_2, PM_{10}, $PM_{2.5}$ and AQRVs (visibility and acid deposition) will be analyzed at the each of the Class I and sensitive Class II areas. In addition, 31 lakes that are designated as acid sensitive will be assessed for potential lake acidification from atmospheric deposition impacts. These lakes are listed in Table 4-2. Proposed CALPUFF model receptors for the lakes are shown in Figure 4-2.

The CALPUFF-predicted concentration impacts will be compared with ambient air quality standards and Class I and II Increments, and post-processed to compute: (1) AQRV impacts due to light extinction change for comparison to visibility impact thresholds in Class I and sensitive Class II areas; and (2) AQRV impacts due to deposition rates for comparison to sulfur (S) and nitrogen (N) deposition thresholds, and to calculate change in acid neutralizing capacity (ANC) for sensitive water bodies.

Table 4-1
Class I and Sensitive Class II Areas

Area of Concern	Managing Agency	PSD Classification
Mount Zirkel Wilderness Area	US Forest Service	I
Flat Tops Wilderness Area	US Forest Service	I
Eagles Nest Wilderness	US Forest Service	I
Maroon Bells-Snowmass Wilderness	US Forest Service	I
West Elk Wilderness	US Forest Service	I
Weminuche Wilderness	US Forest Service	I
La Garita Wilderness	US Forest Service	I
Rocky Mountain National Park	US Park Service	I
Black Canyon of the Gunnison National Park	US Park Service	I
Arches National Park	US Park Service	I
Colorado National Monument	US Park Service	II
Dinosaur National Monument	US Park Service	II

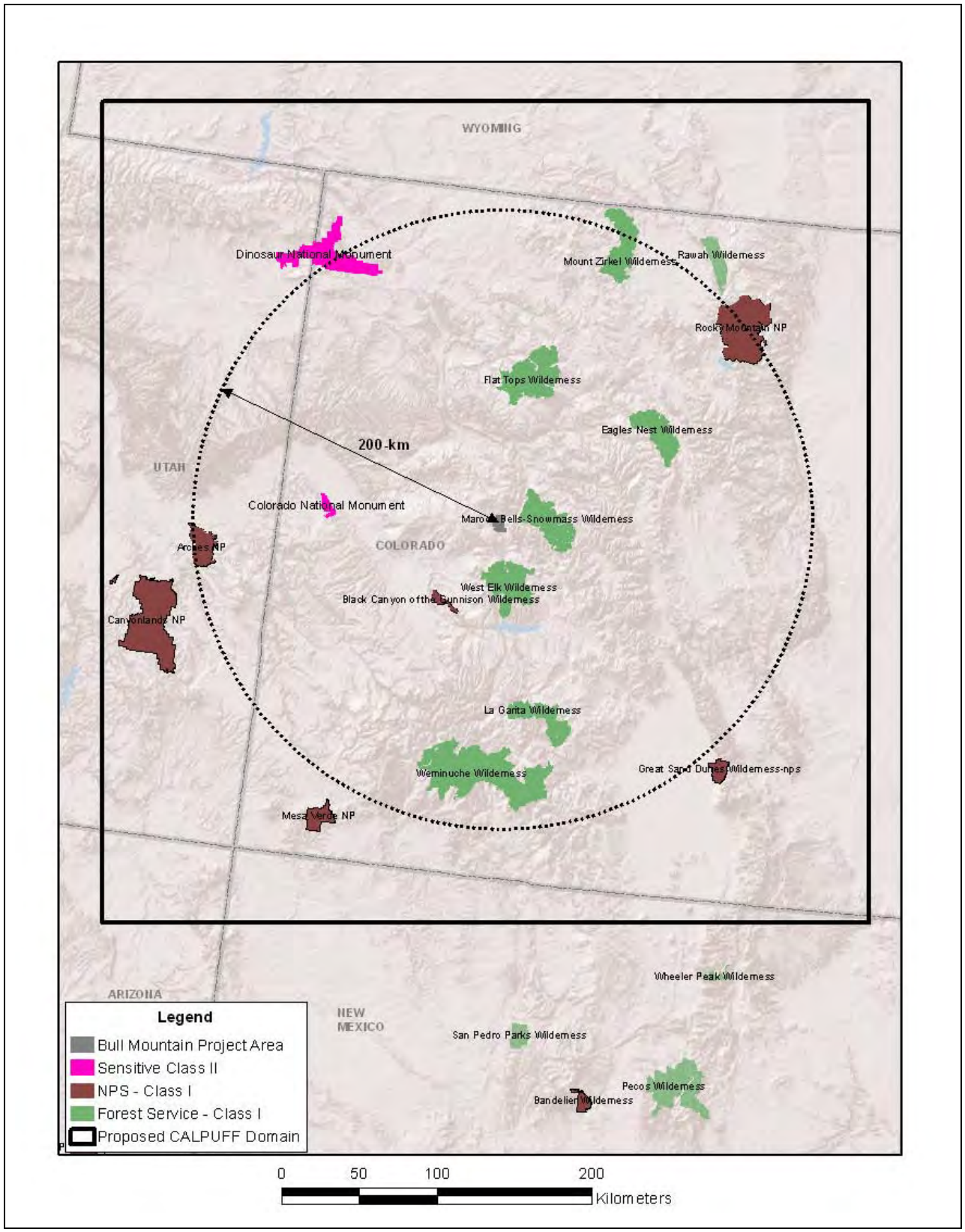

Figure 4-1: Class I and Sensitive Class II Areas located within 200 km of the Bull Mountain Unit Project Area

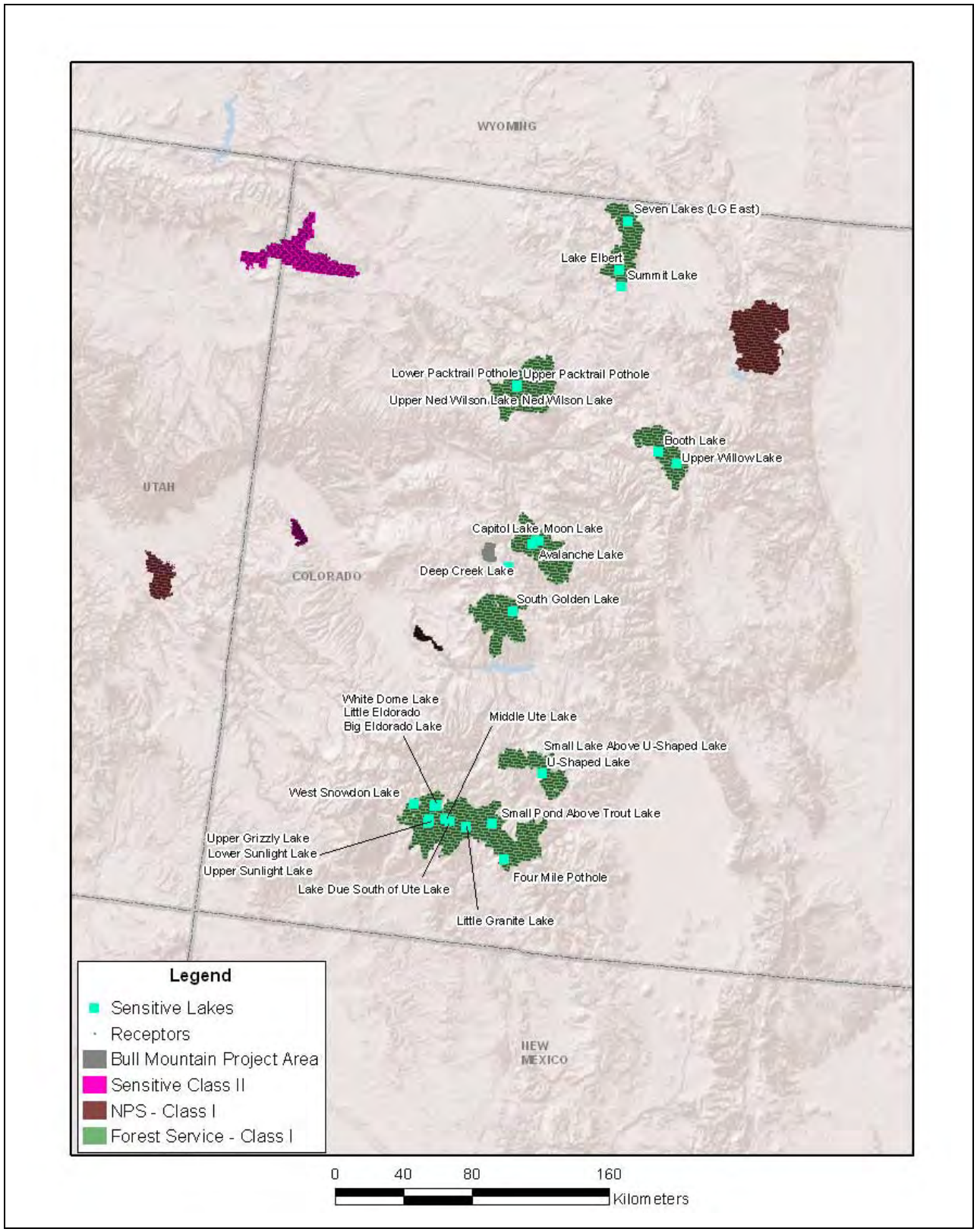

Figure 4-2: Class I and Sensitive Class II Area Receptors to be Analyzed in the Far-Field Modeling Analysis

Table 4-2
Background ANC Values for Acid Sensitive Lakes[1]

Wilderness Area	Lake	Latitude (Degs)	Longitude (Degs)	10th Percentile Lowest ANC Value (μeq/l)[2]	Number of Samples	Monitoring Period
Eagles Nest	Booth Lake	39.698	106.304	83.8	48	1993-2010
Eagles Nest	Upper Willow Lake	39.647	106.174	132.5	49	1990-2010
Flat Tops	Ned Wilson Lake	39.961	107.324	39.0	192	1981-2007
Flat Tops	Upper Ned Wilson Lake	39.963	107.324	12.9	143	1983-2007
Flat Tops	Lower NWL Packtrail Pothole	39.968	107.324	29.7	96	1987-2007
Flat Tops	Upper NWL Packtrail Pothole	39.966	107.324	48.7	96	1987-2007
La Garita	Small Lake Above U-Shaped Lake	37.944	106.865	59.9	24	1992-2007
La Garita	U-Shaped Lake	37.943	106.862	81.4	23	1992-2007
Maroon Bells-Snowmass	Avalanche Lake	39.144	107.100	163.3	52	1991-2009
Maroon Bells-Snowmass	Capitol Lake	39.163	107.082	167.6	54	1991-2009
Maroon Bells-Snowmass	Moon Lake	39.164	107.059	52.2	51	1991-2009
Mount Zirkel	Lake Elbert	40.634	106.707	53.6	67	1985-2007
Mount Zirkel	Seven Lakes	40.896	106.682	36.2	67	1985-2007
Mount Zirkel	Summit Lake (not within WA)	40.545	106.682	48.3	124	1985-2007
Raggeds	Deep Creek Lake	39.009	107.240	20.6	24	1995-2009
Weminuche	Big Eldorado	37.713	107.543	7.8	55	1985-2007

Wilderness Area	Lake	Latitude (Degs)	Longitude (Degs)	10th Percentile Lowest ANC Value (μeq/l)[2]	Number of Samples	Monitoring Period
Weminuche	Four Mile Pothole	37.468	107.052	123.4	19	2000-2009
Weminuche	Lake Due South of Ute Lake	37.636	107.443	13.2	24	1992-2009
Weminuche	Little Eldorado Lake	37.713	107.546	-3.3	54	1985-2007
Weminuche	Little Granite Lake	37.621	107.332	80.7	20	2000-2009
Weminuche	Lower Sunlight	37.633	107.583	80.9	52	1985-2007
Weminuche	Middle Ute Lake	37.648	107.475	42.8	29	1985-2009
Weminuche	Small Pond Above Trout Lake	37.652	107.156	25.5	27	1992-2009
Weminuche	Upper Grizzly	37.620	107.584	29.9	45	1985-2007
Weminuche	Upper Sunlight	37.628	107.580	28.0	51	1985-2007
Weminuche	West Snowdon Lake (not within WA)	37.710	107.694	39.4	26	2000-2009
Weminuche	White Dome Lake	37.709	107.553	1.7	49	1985-2007
West Elk	South Golden Lake	38.778	107.183	111.4	25	1995-2008

[1] From VIEWS (2013).

[2] 10th Percentile Lowest ANC Values reported.

4.1 METEOROLOGICAL DATA

The 2008 WRF meteorological model output produced as part of the WRAP WestJumpAQMS (ENVIRON et. al., 2012a) will also be used as the meteorological dataset for input into the CALPUFF modeling. A subset of the WestJumpAQMS modeling output will be extracted for the air quality modeling domain and processed into CALPUFF-ready format using the MMIF meteorological preprocessor

The WRF model output will be processed with MMIF with the following options selected:

- Output for CALPUFF version 5.8;
- The WRF vertical layers will be interpolated to the FLM/EPA-recommended vertical layers using the TOP option;
- The PG stability classes will be calculated with the Golder option; and
- Planetary boundary layer heights will be recalculated.

This will result in the CALPUFF-ready meteorological files with the following specifications:

- Projection of LCC with RLAT0 = 40N, RLON0 = 97W, XLAT1 = 33N and XLAT2 = 45N;
- Datum = NWS-84;
- NX =124;
- NY =133;
- NZ =10;
- DGRIDKM = 4.; and
- ZFACE = 0., 20., 40., 80., 160., 320., 640., 1200., 2000., 3000., 4000.

The MMIF output, for the entire year of 2008, will be consistent with the both original WRF model output and EPA-recommended settings as applicable.

4.2 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 will be used in the analysis. The sites with ozone data available for 2008 are illustrated in Figure 4-3.

The background ammonia value that will be used in the CALPUFF modeling will be 1.0 parts per billion (ppb) for each month of the year following FLAG 2010 guidance for arid lands.

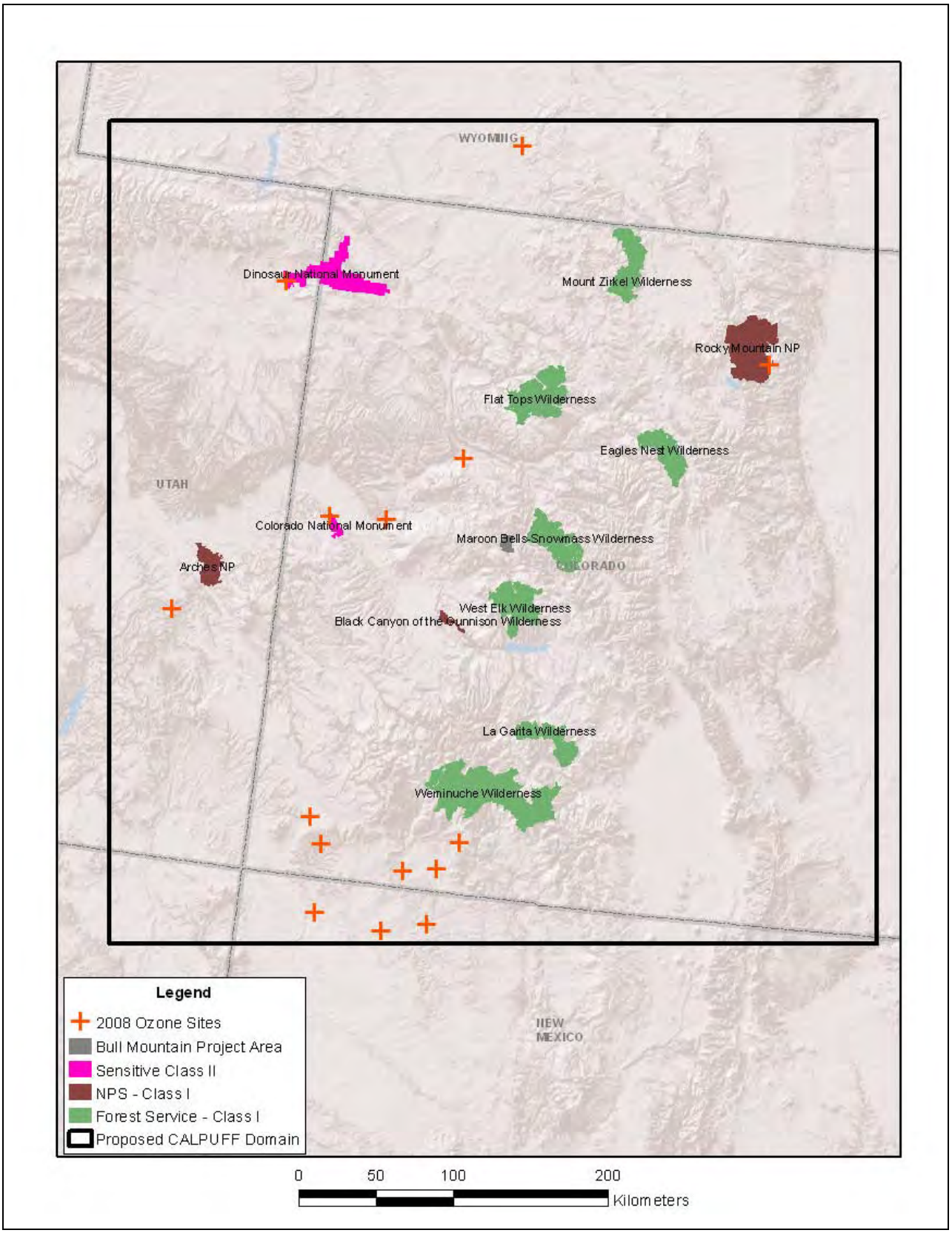

Figure 4-3: Ozone Monitoring Sites Located within the Proposed Calpuff Modeling Domain

4.3 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 will be processed using CALPOST following the procedures described in the FLAG 2010 document to estimate potential change in light extinction. A first level screening analysis will be 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 will be used.

4.4 DEPOSITION

The POSTUTIL and CALPOST processor will be used to determine annual deposition of total S and total N from CALPUFF modeled deposition results at each Class I and sensitive Class II area. The results will be expressed in kilograms per hectare per year (kg/ha-yr).

4.5 LAKE CHEMISTRY

CALPUFF modeled annual N and S deposition impacts at sensitive lake locations will be used to estimate changes in ANC. The changes in ANC will be calculated following the January 2000, USFS Rocky Mountain Region's *Screening Methodology for Calculating ANC Change to High Elevation Lakes, User's Guide* (Forest Service, 2000). The most recent lake chemistry background ANC data available from the Forest Service for the 31 sensitive lakes were obtained from the Visibility Information Exchange Web System (VIEWS 2013). 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 4-2. Of the 31 lakes listed in Table 4-2, 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 will be obtained from the Parameter-elevation Regressions on Independent Slopes Model (PRISM) (PRISM, 2012) climate mapping system data base, and these precipitation values will be used in the calculation of ANC changes.

5.0 AIR QUALITY IMPACT ASSESSMENTS

5.1 NEAR-FIELD

AERMOD-predicted concentrations in the vicinity of project emissions sources will be compared with the Colorado Ambient Air Quality Standards (CAAQS), National Ambient Air Quality Standards (NAAQS), and applicable PSD Class II increments shown in Table 5-1. Modeled concentrations will be added to the existing ambient air quality background concentrations shown in Table 3-1, and the total concentrations will be compared to corresponding NAAQS and CAAQS as shown in Table 5-1. Direct project impacts will also be compared to Class II PSD Increments. This PSD demonstration is for information only and is not a regulatory PSD Increment consumption analysis, which would be completed as necessary during the CDPHE permitting process. Near-field HAP impacts from short-term (acute) exposure and for calculation of long-term risk will be assessed as described in Section 3.4. 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 Protocol. 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.

5.2 FAR-FIELD

CALPUFF-predicted pollutant concentration impacts at Class I and sensitive Class II areas will be compared with the applicable ambient air quality standards and PSD increments. CALPUFF model results will be 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 will be compared with applicable thresholds for these areas of concern. CALPUFF deposition impacts at the sensitive lakes will be used to estimate potential lake acidification.

As described earlier in Section 1.0 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 Protocol. The CARMMS analysis will be used to assess potential ozone formation in the vicinity of the Bull Mountain Unit and for assessing both cumulative air quality and AQRV impacts.

5.2.1 Ambient Concentration Impacts

Modeled concentrations at the Class I and sensitive Class II areas will be compared to ambient air quality standards and PSD increments, shown in Table 5-1. Modeled impacts including applicable background concentrations will be compared with ambient air quality standards. Project impacts will be compared to applicable PSD increments. The PSD demonstrations are for information only and are not regulatory PSD Increment consumption analyses, which would be completed as necessary by the CDPHE.

5.2.2 Visibility

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 (dv). A 5% change in light extinction (approximately equal to a 0.5 change in deciviews [dv]) is the threshold recommended in FLAG (2010) and is considered to contribute to regional haze visibility impairment. A 10% change in light extinction (approximately equal to 1.0 dv) is considered to represent a noticeable change in visibility when compared to background conditions. The BLM considers a 1.0 dv change as a significant adverse impact; however, there are no applicable local, state, tribal, or Federal regulatory visibility standards. It is the responsibility of the jurisdictional Federal Land Manager or Tribal government responsible for that land to determine when adverse impacts are significant or not, and these may differ from BLM levels for significant adverse impacts.

Visibility conditions calculated for the Project alone (Proposed Action) using the FLAG screening method will be evaluated at each Class I and sensitive Class II area of concern to determine if the 98th percentile change in light extinction exceeds both 5% and 10% change in light extinction thresholds (equivalent to 0.5 dv and 1.0 dv). Results will be reported for each threshold, and will be evaluated to determine whether a more refined analysis is required.

Table 5-1
NAAQS, CAAQS, and PSD Class I and Class II Increments for Comparison to Analysis Results ($\mu g/m^3$)

Pollutant/Averaging Time	NAAQS	CAAQS	PSD Class I Increment[1]	PSD Class II Increment[1]
CO				
1-hour[2]	40,000	40,000	--[3]	--[3]
8-hour[2]	10,000	10,000	--[3]	--[3]
NO_2				
1-hour[4]	188	188	--[3]	--[3]
Annual[5]	100	100	2.5	25
PM_{10}				
24-hour[2]	150	150	8	30
Annual[5]	--[6]	--[6]	4	17
$PM_{2.5}$				
24-hour[7]	35	35	2	9
Annual[5]	12	12	1	4
SO_2				
1-hour[8]	196	196	--[3]	--[3]
3-hour[2]	1,300	700	25	512
24-hour[2]	--[9]	--[6]	5	91
Annual[5]	--[9]	--[6]	2	20

[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–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.

5.2.3 Deposition

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 will be compared to these thresholds.

Deposition results from project alone impacts will also be compared to critical load thresholds established for the Rocky Mountain region. BLM has compiled currently available research data on critical load values for Class I areas in the vicinity of this project. Critical load thresholds published by Fox et al (Fox 1989) established pollutant loadings for total nitrogen of 3-5 kilograms per hectare per year (kg/ha/yr) and for total sulfur of 5 kg/ha/yr for the Bob Marshall Wilderness Area in Montana and the Bridger Wilderness Area in Wyoming. However, NPS has recently stated that these pollutant loadings are not protective of sensitive resources and in its *"Technical Guidance on Assessing Impacts to Air Quality in NEPA and Planning Documents,"* January 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 suggests 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. Project alone N and S deposition impacts will be compared to the following critical load values: 1.5 kg/ha/yr will be used as a surrogate for total N deposition and 3 kg/ha/yr will used for total S deposition for the Class I and Class II areas evaluated in this analysis.

5.2.4 ANC

The CALPUFF-predicted annual deposition fluxes of S and N at sensitive lake receptors listed in Section 4.5 will be used to estimate the change in ANC. The predicted changes in ANC will be compared with the Forest Service's Level of Acceptable Change (LAC) thresholds of 10% 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.

6.0 REFERENCES

Baron, Jill S. 2006. Hindcasting Nitrogen Deposition to Determine and Ecological Critical Load. Ecological Applications, 16(2), 2006, pp 433-439.

Bureau of Indian Affairs. 2008. Riverton Dome Coal Bed Natural Gas and Conventional Gas Development Project. Bureau of Indian Affairs, Wind River Agency, Fort Washakie, Wyoming. August 2008.

Bureau of Land Management. 2011. Draft Air Resources Management Plan, Lander Resource Management Plan, Wyoming. U.S. Department of Interior, Bureau of Land Management, Lander Field Office, Wyoming, July 2011.

Bureau of Land Management. 2012. Draft Environmental Impact Statement, Continental Divide-Creston Natural Gas Development Project, Department of Interior, Bureau of Land Management Wyoming High Desert District - Rawlins Field Office, Wyoming, November 2012.

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. 2012a. Alpine Geophysics, and University of North Carolina. 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. 2012b. Draft User's Manual – The Mesoscale Model Interface Program (MMIF) Version 2.3, 2013-04-30. 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. April 30, 2013.

Environmental Protection Agency. 1993. Superfund's Standard Default Exposure Factors for the Central Tendency and Reasonable Maximum Exposure. Preliminary Review Draft.

_____. 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.

_____. 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.

_____. 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).

_____. 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).

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.

Fox, Douglas, Ann M. Bartuska, James G. Byrne, Ellis Cowling, Rich Fisher, Gene E. Likens, Steven E. Lindberg, Rick A. Linthurst, Jay Messer, and Dale 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.

PRISM 2012. Parameter-elevation Regressionson Independent Slopes Model (PRISM), PRISM Climate Group, Oregon State University. Online at http://prism.oregonstate.edu/.

Saros, J.E., Clow, D.W., Blett, T. & 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.

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.

_____. 2010. Lake water chemistry provided by the USDA Forest Service, April 2010. www.fs.fed.us/armdata.

WDEQ 2012. Background pollutant concentration data provided the Wyoming Department of Environmental Quality Air Quality Division, March 2012.

Visibility Information Exchange Web System (VIEWS). 2013. 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 August.

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Appendix B

Bull Mountain Project Emissions Inventories

Bull Mountain
No Action Alternative Emissions Inventory
Table of Contents

Page	Title
B2-1	Emissions Summary
B2-2	Yearly Emissions Summary - PM_{10}
B2-3	Yearly Emissions Summary - $PM_{2.5}$
B2-4	Yearly Emissions Summary - NO_x
B2-5	Yearly Emissions Summary - CO
B2-6	Yearly Emissions Summary - SO_2
B2-7	Yearly Emissions Summary - VOC
B2-8	Yearly Emissions Summary - CO2e
B2-9	Yearly Emissions Summary - Benzene
B2-10	Yearly Emissions Summary - Toluene
B2-11	Yearly Emissions Summary - Ethylbenzene
B2-12	Yearly Emissions Summary - Xylene
B2-13	Yearly Emissions Summary - n-Hexane
B2-14	Yearly Emissions Summary - Formaldehyde
B2-15	Yearly Emissions Summary - Total HAPs
B2-16	Well Pad and Road Construction
B2-17	Well Pad and Road Construction Traffic
B2-18	Well Construction Heavy Equipment Tailpipe
B2-19	Pipeline Construction
B2-20	Pipeline Construction Traffic
B2-21	Pipeline Construction Heavy Equipment Tailpipe
B2-22	Drill Rig Engines
B2-23	Drilling Traffic
B2-24	Drilling Heavy Equipment Tailpipe
B2-25	Completion Rig Engines
B2-26	Completion Flaring
B2-27	Completion Faring
B2-28	Completion Traffic
B2-29	Fracturing Engines
B2-30	Workover Rig Engines
B2-31	Production Traffic
B2-32	Separator Heaters
B2-33	Tank Heaters
B2-34	Production Fugitives
B2-35	Production Fugitives
B2-36	Production Fugitives
B2-37	Screw Compressors
B2-38	Compressor Station Separator Heaters
B2-39	Water Transfer Pumps
B2-40	Pumping Units
B2-41	Natural Gas Composition
B2-42	Natural Gas Composition

Bull Mountain

No Action Emissions Summary

TPY	Year 1	Year 2	Year 3	Year 4	Year 5
NOx	87.12	127.02	115.78	112.05	112.05
CO	45.99	67.03	39.40	36.83	36.83
VOC	7.80	13.89	15.12	14.82	14.82
SO2	0.40	0.40	0.02	0.00	0.00
PM10	24.26	24.68	2.04	0.75	0.75
PM2.5	17.78	17.85	1.38	0.13	0.13
CO2e (metric tons/yr)	10815.53	17560.66	13518.53	13005.93	13005.93
HAPs	0.62	2.57	3.07	3.20	3.31

Bull Mountain
Year-by-Year Emissions Summary

Activity	PM_{10} Pollutant Emission Rate (tpy) Year 1	Year 2	Year 3	Year 4	Year 5
Construction Emissions					
Well Pad and Road Construction	1.6677	1.6677	--	--	--
Well Pad and Road Construction Traffic	2.7794	2.7794	--	--	--
Well Pad and Road Construction Heavy Equipment	0.1270	0.1270	--	--	--
Pipeline Construction	0.9414	0.9414	--	--	--
Pipeline Construction Traffic	0.8509	0.8509	--	--	--
Pipeline Construction Heavy Equipment	0.0595	0.0595	--	--	--
Drill Rig Engines	1.1571	1.1571	0.0856	--	--
Drilling Traffic	15.2486	15.2486	1.1284	--	--
Drilling Heavy Equipment	0.0020	0.0020	0.0001	--	--
Fracturing Engines	0.3143	0.3143	0.0233	--	--
Completion Rig Engines	0.0893	0.0893	0.0066	--	--
Completion Traffic	0.6192	0.6192	0.0458	--	--
Completion Flaring	0.0000	0.0000	0.0000	--	--
Production Emissions					
Workover Rig Engines	0.0279	0.0574	0.0625	0.0625	0.0625
Production Traffic	0.3714	0.7634	0.6877	0.6877	0.6877
Separator Heaters	--	--	--	--	--
Tank Heaters	--	--	--	--	--
Production Fugitives	--	--	--	--	--
Screw Compressors	--	--	--	--	--
C.S. Separators	--	--	--	--	--
Water Transfer Pumps	--	--	--	--	--
Pumping Units	--	--	--	--	--
Total Construction Emissions	23.86	23.86	1.29	0.00	0.00
Total Production Emissions	0.40	0.82	0.75	0.75	0.75
Total Emissions	24.26	24.68	2.04	0.75	0.75

Bull Mountain
Year-by-Year Emissions Summary

Activity	$PM_{2.5}$ Pollutant Emission Rate (tpy) Year 1	Year 2	Year 3	Year 4	Year 5
Construction Emissions					
Well Pad and Road Construction	0.1663	0.1663	--	--	--
Well Pad and Road Construction Traffic	0.2999	0.2999	--	--	--
Well Pad and Road Construction Heavy Equipment	0.1270	0.1270	--	--	--
Pipeline Construction	0.0939	0.0939	--	--	--
Pipeline Construction Traffic	0.0888	0.0888	--	--	--
Pipeline Construction Heavy Equipment	0.0595	0.0595	--	--	--
Drill Rig Engines	1.1571	1.1571	0.0856	--	--
Drilling Traffic	15.2486	15.2486	1.1284	--	--
Drilling Heavy Equipment	0.0060	0.0060	0.0004	--	--
Fracturing Engines	0.3143	0.3143	0.0233	--	--
Completion Rig Engines	0.0893	0.0893	0.0066	--	--
Completion Traffic	0.0682	0.0682	0.0050	--	--
Completion Flaring	0.0000	0.0000	0.0000	--	--
Production Emissions					
Workover Rig Engines	0.0279	0.0574	0.0625	0.0625	0.0625
Production Traffic	0.0371	0.0763	0.0687	0.0687	0.0687
Separator Heaters	--	--	--	--	--
Tank Heaters	--	--	--	--	--
Production Fugitives	--	--	--	--	--
Screw Compressors	--	--	--	--	--
C.S. Separators	--	--	--	--	--
Water Transfer Pumps	--	--	--	--	--
Pumping Units	--	--	--	--	--
Total Construction Emissions	17.72	17.72	1.25	0.00	0.00
Total Production Emissions	0.07	0.13	0.13	0.13	0.13
Total Emissions	17.78	17.85	1.38	0.13	0.13

Bull Mountain
Year-by-Year Emissions Summary

Activity	NO_x Pollutant Emission Rate (tpy) Year 1	Year 2	Year 3	Year 4	Year 5
Construction Emissions					
Well Pad and Road Construction	--	--	--	--	--
Well Pad and Road Construction Traffic	0.4655	0.4655	--	--	--
Well Pad and Road Construction Heavy Equipment	2.3704	2.3704	--	--	--
Pipeline Construction	--	--	--	--	--
Pipeline Construction Traffic	0.0877	0.0877	--	--	--
Pipeline Construction Heavy Equipment	1.7857	1.7857	--	--	--
Drill Rig Engines	34.7143	34.7143	2.5689	--	--
Drilling Traffic	2.4412	2.4412	0.1807	--	--
Drilling Heavy Equipment	0.1786	0.1786	0.0132	--	--
Fracturing Engines	9.4286	9.4286	0.6977	--	--
Completion Rig Engines	2.6786	2.6786	0.1982	--	--
Completion Traffic	0.1284	0.1284	0.0095	--	--
Completion Flaring	0.9143	0.9143	0.0677	--	--
Production Emissions					
Workover Rig Engines	0.8375	1.7215	1.8750	1.8750	1.8750
Production Traffic	0.0110	0.0225	0.0203	0.0203	0.0203
Separator Heaters	0.7050	1.4492	1.4755	1.4755	1.4755
Tank Heaters	0.9400	1.9323	1.9674	1.9674	1.9674
Production Fugitives	--	--	--	--	--
Screw Compressors	--	6.1509	6.1509	6.1509	6.1509
C.S. Separators	--	0.0537	0.0537	0.0537	0.0537
Water Transfer Pumps	9.7203	19.9807	18.0006	18.0006	18.0006
Pumping Units	19.7107	40.5164	82.5029	82.5029	82.5029
Total Construction Emissions	55.19	55.19	3.74	0.00	0.00
Total Production Emissions	31.92	71.83	112.05	112.05	112.05
Total Emissions	87.12	127.02	115.78	112.05	112.05

Bull Mountain
Year-by-Year Emissions Summary

	CO				
	Pollutant Emission Rate (tpy)				
Activity	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**
Construction Emissions					
Well Pad and Road Construction	--	--	--	--	--
Well Pad and Road Construction Traffic	0.4503	0.4503	--	--	--
Well Pad and Road Construction Heavy Equipment	2.2011	2.2011	--	--	--
Pipeline Construction	--	--	--	--	--
Pipeline Construction Traffic	0.1482	0.1482	--	--	--
Pipeline Construction Heavy Equipment	1.0317	1.0317	--	--	--
Drill Rig Engines	20.0571	20.0571	1.4842	--	--
Drilling Traffic	2.4918	2.4918	0.1844	--	--
Drilling Heavy Equipment	0.1032	0.1032	0.0076	--	--
Fracturing Engines	5.4476	5.4476	0.4031	--	--
Completion Rig Engines	1.5476	1.5476	0.1145	--	--
Completion Traffic	0.0957	0.0957	0.0071	--	--
Completion Flaring	4.9748	4.9748	0.3681	--	--
Production Emissions					
Workover Rig Engines	0.4839	0.9947	1.0833	1.0833	1.0833
Production Traffic	0.0641	0.1317	0.1187	0.1187	0.1187
Separator Heaters	0.3525	0.7246	0.7378	0.7378	0.7378
Tank Heaters	0.4700	0.9661	0.9837	0.9837	0.9837
Production Fugitives	--	--	--	--	--
Screw Compressors	--	13.1630	13.1630	13.1630	13.1630
C.S. Separators	--	0.0268	0.0268	0.0268	0.0268
Water Transfer Pumps	2.0038	4.1189	3.7107	3.7107	3.7107
Pumping Units	4.0633	8.3522	17.0075	17.0075	17.0075
Total Construction Emissions	38.55	38.55	2.57	0.00	0.00
Total Production Emissions	7.44	28.48	36.83	36.83	36.83
Total Emissions	45.99	67.03	39.40	36.83	36.83

Bull Mountain
Year-by-Year Emissions Summary

Activity	SO_2 Pollutant Emission Rate (tpy) Year 1	Year 2	Year 3	Year 4	Year 5
Construction Emissions					
Well Pad and Road Construction	--	--	--	--	--
Well Pad and Road Construction Traffic	0.0019	0.0019	--	--	--
Well Pad and Road Construction Heavy Equipment	0.1101	0.1101	--	--	--
Pipeline Construction	--	--	--	--	--
Pipeline Construction Traffic	0.0004	0.0004	--	--	--
Pipeline Construction Heavy Equipment	0.0516	0.0516	--	--	--
Drill Rig Engines	0.1096	0.1096	0.0081	--	--
Drilling Traffic	0.0099	0.0099	0.0007	--	--
Drilling Heavy Equipment	0.0052	0.0052	0.0004	--	--
Fracturing Engines	0.1064	0.1064	0.0079	--	--
Completion Rig Engines	0.0030	0.0030	0.0002	--	--
Completion Traffic	0.0005	0.0005	0.0000	--	--
Completion Flaring	0.0000	0.0000	0.0000	--	--
Production Emissions					
Workover Rig Engines	0.0009	0.0019	0.0021	0.0021	0.0021
Production Traffic	0.0001	0.0001	0.0021	0.0021	0.0021
Separator Heaters	--	--	--	--	--
Tank Heaters	--	--	--	--	--
Production Fugitives	--	--	--	--	--
Screw Compressors	--	--	--	--	--
C.S. Separators	--	--	--	--	--
Water Transfer Pumps	--	--	--	--	--
Pumping Units	--	--	--	--	--
Total Construction Emissions	0.40	0.40	0.02	0.00	0.00
Total Production Emissions	0.00	0.00	0.00	0.00	0.00
Total Emissions	0.40	0.40	0.02	0.00	0.00

Bull Mountain
Year-by-Year Emissions Summary

	VOC				
	Pollutant Emission Rate (tpy)				
Activity	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**
Construction Emissions					
Well Pad and Road Construction	--	--	--	--	--
Well Pad and Road Construction Traffic	0.0508	0.0508	--	--	--
Well Pad and Road Construction Heavy Equipment	0.1693	0.1693	--	--	--
Pipeline Construction	--	--	--	--	--
Pipeline Construction Traffic	0.0144	0.0144	--	--	--
Pipeline Construction Heavy Equipment	0.1587	0.1587	--	--	--
Drill Rig Engines	2.3143	2.3143	0.1713	--	--
Drilling Traffic	0.2761	0.2761	0.0204	--	--
Drilling Heavy Equipment	0.2540	0.2540	0.0188	--	--
Fracturing Engines	0.6286	0.6286	0.0465	--	--
Completion Rig Engines	0.1786	0.1786	0.0132	--	--
Completion Traffic	0.0118	0.0118	0.0009	--	--
Completion Flaring	0.3715	0.3715	0.0275	--	--
Production Emissions					
Workover Rig Engines	0.0558	0.1148	0.1250	0.1250	0.1250
Production Traffic	0.0053	0.0109	0.0098	0.0098	0.0098
Separator Heaters	0.2230	0.4584	0.4667	0.4667	0.4667
Tank Heaters	0.2974	0.6112	0.6223	0.6223	0.6223
Production Fugitives	0.7250	1.4903	4.0156	4.0156	4.0156
Screw Compressors	--	2.5219	2.5219	2.5219	2.5219
C.S. Separators	--	0.0170	0.0170	0.0170	0.0170
Water Transfer Pumps	0.6812	1.4002	1.2614	1.2614	1.2614
Pumping Units	1.3813	2.8393	5.7816	5.7816	5.7816
Total Construction Emissions	4.43	4.43	0.30	0.00	0.00
Total Production Emissions	3.37	9.46	14.82	14.82	14.82
Total Emissions	7.80	13.89	15.12	14.82	14.82

Bull Mountain
Year-by-Year Emissions Summary

Activity	CO_2e Pollutant Emission Rate (tpy) Year 1	Year 2	Year 3	Year 4	Year 5
Construction Emissions					
Well Pad and Road Construction	--	--	--	--	--
Well Pad and Road Construction Traffic	56.9070	56.9070	--	--	--
Well Pad and Road Construction Heavy Equipment	69.4902	69.4902	--	--	--
Pipeline Construction	--	--	--	--	--
Pipeline Construction Traffic	13.2339	13.2339	--	--	--
Pipeline Construction Heavy Equipment	52.1177	52.1177	--	--	--
Drill Rig Engines	3635.4099	3635.4099	269.0203	--	--
Drilling Traffic	301.0915	301.0915	22.2808	--	--
Drilling Heavy Equipment	5.2118	5.2118	0.3857	--	--
Fracturing Engines	987.3953	987.3953	73.0673	--	--
Completion Rig Engines	280.5100	280.5100	20.7577	--	--
Completion Traffic	15.1218	15.1218	1.1190	--	--
Completion Flaring	1702.2276	1702.2276	125.9648	--	--
Production Emissions					
Workover Rig Engines	87.7061	180.2848	196.3570	196.3570	196.3570
Production Traffic	2.4218	4.9781	4.4848	4.4848	4.4848
Separator Heaters	763.6159	1569.6548	1598.1306	1598.1306	1598.1306
Tank Heaters	1018.1545	2092.8731	2130.8408	2130.8408	2130.8408
Production Fugitives	0.6096	1.2532	3.3843	3.3843	3.3843
Screw Compressors	--	2784.8152	2784.8152	2784.8152	2784.8152
C.S. Separators	--	58.1138	58.1138	58.1138	58.1138
Water Transfer Pumps	602.5243	1238.5222	1115.7857	1115.7857	1115.7857
Pumping Units	1221.7854	2511.4477	5114.0179	5114.0179	5114.0179
Total Construction Emissions	7118.72	7118.72	512.60	0.00	0.00
Total Production Emissions	3696.82	10441.94	13005.93	13005.93	13005.93
Total Emissions	10815.53	17560.66	13518.53	13005.93	13005.93

Bull Mountain
Year-by-Year Emissions Summary

Activity	Benzene Pollutant Emission Rate (tpy) Year 1	Year 2	Year 3	Year 4	Year 5
Construction Emissions					
Well Pad and Road Construction	--	--	--	--	--
Well Pad and Road Construction Traffic	--	--	--	--	--
Well Pad and Road Construction Heavy Equipment	--	--	--	--	--
Pipeline Construction	--	--	--	--	--
Pipeline Construction Traffic	--	--	--	--	--
Pipeline Construction Heavy Equipment	--	--	--	--	--
Drill Rig Engines	0.0190	0.0190	0.0014	--	--
Drilling Traffic	--	--	--	--	--
Drilling Heavy Equipment	--	--	--	--	--
Fracturing Engines	0.0052	0.0052	0.0004	--	--
Completion Rig Engines	0.0015	0.0015	0.0001	--	--
Completion Traffic	--	--	--	--	--
Completion Flaring	0.0184	0.0184	0.0014	--	--
Production Emissions					
Workover Rig Engines	0.00046	0.0009	0.0010	0.0010	0.0010
Production Traffic	--	--	--	--	--
Separator Heaters	0.0089	0.0183	0.0187	0.0187	0.0174
Tank Heaters	0.0119	0.0244	0.0249	0.0249	0.0232
Production Fugitives	0.0359	0.0737	0.1991	0.1991	0.1851
Screw Compressors	--	0.0115	0.0115	0.0115	0.0115
C.S. Separators	--	0.0007	0.0007	0.0007	0.0007
Water Transfer Pumps	0.0080	0.0165	0.0149	0.0149	0.0139
Pumping Units	0.0163	0.0335	0.0683	0.0683	0.0635
Total Construction Emissions	0.04	0.04	0.00	0.00	0.00
Total Production Emissions	0.08	0.18	0.34	0.34	0.32
Total Emissions	0.13	0.22	0.34	0.34	0.32

Bull Mountain
Year-by-Year Emissions Summary

Activity	Toluene Pollutant Emission Rate (tpy) Year 1	Year 2	Year 3	Year 4	Year 5
Construction Emissions					
Well Pad and Road Construction	--	--	--	--	--
Well Pad and Road Construction Traffic	--	--	--	--	--
Well Pad and Road Construction Heavy Equipment	--	--	--	--	--
Pipeline Construction	--	--	--	--	--
Pipeline Construction Traffic	--	--	--	--	--
Pipeline Construction Heavy Equipment	--	--	--	--	--
Drill Rig Engines	0.0069	0.0069	0.0005	--	--
Drilling Traffic	--	--	--	--	--
Drilling Heavy Equipment	--	--	--	--	--
Fracturing Engines	0.0019	0.0019	0.0001	--	--
Completion Rig Engines	0.0005	0.0005	0.0000	--	--
Completion Traffic	--	--	--	--	--
Completion Flaring	0.0277	0.0277	0.0021	--	--
Production Emissions					
Workover Rig Engines	0.00017	0.0003	0.0004	0.0004	0.0004
Production Traffic	--	--	--	--	--
Separator Heaters	0.0045	0.0092	0.0093	0.0093	0.0093
Tank Heaters	0.0059	0.0122	0.0124	0.0124	0.0124
Production Fugitives	0.0540	0.1111	0.3000	0.3000	0.3000
Screw Compressors	--	0.0107	0.0107	0.0107	0.0107
C.S. Separators	--	0.0003	0.0003	0.0003	0.0003
Water Transfer Pumps	0.0003	0.0006	0.0005	0.0005	0.0005
Pumping Units	0.0006	0.0012	0.0024	0.0024	0.0024
Total Construction Emissions	0.04	0.04	0.00	0.00	0.00
Total Production Emissions	0.07	0.15	0.34	0.34	0.34
Total Emissions	0.10	0.18	0.34	0.34	0.34

Bull Mountain
Year-by-Year Emissions Summary

Activity	Ethylbenzene Pollutant Emission Rate (tpy) Year 1	Year 2	Year 3	Year 4	Year 5
Construction Emissions					
Well Pad and Road Construction	–	–	–	–	–
Well Pad and Road Construction Traffic	–	–	–	–	–
Well Pad and Road Construction Heavy Equipment	–	–	–	–	–
Pipeline Construction	–	–	–	–	–
Pipeline Construction Traffic	–	–	–	–	–
Pipeline Construction Heavy Equipment	–	–	–	–	–
Drill Rig Engines	–	–	–	–	–
Drilling Traffic	–	–	–	–	–
Drilling Heavy Equipment	–	–	–	–	–
Fracturing Engines	–	–	–	–	–
Completion Rig Engines	–	–	–	–	–
Completion Traffic	–	–	–	–	–
Completion Flaring	0.0010	0.0010	0.0001	–	–
Production Emissions					
Workover Rig Engines	–	–	–	–	–
Production Traffic	–	–	–	–	–
Separator Heaters	–	–	–	–	–
Tank Heaters	–	–	–	–	–
Production Fugitives	0.0020	0.0041	0.0111	0.0111	0.0111
Screw Compressors	–	0.0010	0.0010	0.0010	0.0010
C.S. Separators	–	–	–	–	–
Water Transfer Pumps	0.0007	0.0015	0.0014	0.0014	0.0014
Pumping Units	0.0015	0.0030	0.0062	0.0062	0.0062
Total Construction Emissions	0.00	0.00	0.00	0.00	0.00
Total Production Emissions	0.00	0.01	0.02	0.02	0.02
Total Emissions	0.01	0.01	0.02	0.02	0.02

Bull Mountain
Year-by-Year Emissions Summary

Activity	Xylene Pollutant Emission Rate (tpy) Year 1	Year 2	Year 3	Year 4	Year 5
Construction Emissions					
Well Pad and Road Construction	--	--	--	--	--
Well Pad and Road Construction Traffic	--	--	--	--	--
Well Pad and Road Construction Heavy Equipment	--	--	--	--	--
Pipeline Construction	--	--	--	--	--
Pipeline Construction Traffic	--	--	--	--	--
Pipeline Construction Heavy Equipment	--	--	--	--	--
Drill Rig Engines	0.0047	0.0047	0.0003	--	--
Drilling Traffic	--	--	--	--	--
Drilling Heavy Equipment	--	--	--	--	--
Fracturing Engines	0.0013	0.0013	0.0001	--	--
Completion Rig Engines	0.0004	0.0004	0.0000	--	--
Completion Traffic	--	--	--	--	--
Completion Flaring	0.0118	0.0118	0.0009	--	--
Production Emissions					
Workover Rig Engines	0.00011	0.0002	0.0003	0.0003	0.0003
Production Traffic	--	--	--	--	--
Separator Heaters	--	--	--	--	--
Tank Heaters	--	--	--	--	--
Production Fugitives	0.02302	0.0473	0.1278	0.1278	0.1278
Screw Compressors	--	0.0048	0.0048	0.0048	0.0048
C.S. Separators	--	--	--	--	--
Water Transfer Pumps	0.00293	0.0060	0.0054	0.0054	0.0054
Pumping Units	0.00593	0.0122	0.0248	0.0248	0.0248
Total Construction Emissions	0.02	0.02	0.00	0.00	0.00
Total Production Emissions	0.03	0.07	0.16	0.16	0.16
Total Emissions	0.05	0.09	0.16	0.16	0.16

Bull Mountain
Year-by-Year Emissions Summary

Activity	n-Hexane Pollutant Emission Rate (tpy) Year 1	Year 2	Year 3	Year 4	Year 5
Construction Emissions					
Well Pad and Road Construction	–	–	–	–	–
Well Pad and Road Construction Traffic	–	–	–	–	–
Well Pad and Road Construction Heavy Equipment	–	–	–	–	–
Pipeline Construction	–	–	–	–	–
Pipeline Construction Traffic	–	–	–	–	–
Pipeline Construction Heavy Equipment	–	–	–	–	–
Drill Rig Engines	–	–	–	–	–
Drilling Traffic	–	–	–	–	–
Drilling Heavy Equipment	–	–	–	–	–
Fracturing Engines	–	–	–	–	–
Completion Rig Engines	–	–	–	–	–
Completion Traffic	–	–	–	–	–
Completion Flaring	0.0354	0.0354	0.0026	–	–
Production Emissions					
Workover Rig Engines	–	–	–	–	–
Production Traffic	–	–	–	–	–
Separator Heaters	–	–	–	–	–
Tank Heaters	–	–	–	–	–
Production Fugitives	0.06902	0.1419	0.3831	0.3831	0.3831
Screw Compressors	–	0.0291	0.0291	0.0291	0.0291
C.S. Separators	–	–	–	–	–
Water Transfer Pumps	0.00146	0.0030	0.0027	0.0027	0.0027
Pumping Units	0.00297	0.0061	0.0124	0.0124	0.0124
Total Construction Emissions	0.04	0.04	0.00	0.00	0.00
Total Production Emissions	0.07	0.18	0.43	0.43	0.43
Total Emissions	0.11	0.22	0.43	0.43	0.43

Bull Mountain
Year-by-Year Emissions Summary

Activity	Formaldehyde Pollutant Emission Rate (tpy) Year 1	Year 2	Year 3	Year 4	Year 5
Construction Emissions					
Well Pad and Road Construction	--	--	--	--	--
Well Pad and Road Construction Traffic	--	--	--	--	--
Well Pad and Road Construction Heavy Equipment	--	--	--	--	--
Pipeline Construction	--	--	--	--	--
Pipeline Construction Traffic	--	--	--	--	--
Pipeline Construction Heavy Equipment	--	--	--	--	--
Drill Rig Engines	0.0019	0.0019	0.0019	0.0019	0.0019
Drilling Traffic	--	--	--	--	--
Drilling Heavy Equipment	--	--	--	--	--
Fracturing Engines	0.0005	0.0005	0.0005	0.0005	0.0005
Completion Rig Engines	0.0001	0.0001	0.0001	0.0001	0.0001
Completion Traffic	--	--	--	--	--
Completion Flaring	--	--	--	--	--
Production Emissions					
Workover Rig Engines	0.00005	0.0001	0.0001	0.0001	0.0001
Production Traffic	--	--	--	--	--
Separator Heaters	0.01784	0.0367	0.0205	0.0276	0.0347
Tank Heaters	0.02379	0.0489	0.0274	0.0368	0.0463
Production Fugitives	--	--	--	--	--
Screw Compressors	--	1.3853	1.3853	1.3853	1.3853
C.S. Separators	--	0.0014	0.0027	0.0041	0.0054
Water Transfer Pumps	0.05926	0.1218	0.0604	0.0812	0.1021
Pumping Units	0.12018	0.2470	0.2767	0.3722	0.4678
Total Construction Emissions	0.00	0.00	0.00	0.00	0.00
Total Production Emissions	0.22	1.84	1.77	1.91	2.04
Total Emissions	0.22	1.84	1.78	1.91	2.04

Bull Mountain
Year-by-Year Emissions Summary

Activity	Total HAPs Pollutant Emission Rate (tpy) Year 1	Year 2	Year 3	Year 4	Year 5
Construction Emissions					
Well Pad and Road Construction	–	–	–	–	–
Well Pad and Road Construction Traffic	–	–	–	–	–
Well Pad and Road Construction Heavy Equipment	–	–	–	–	–
Pipeline Construction	–	–	–	–	–
Pipeline Construction Traffic	–	–	–	–	–
Pipeline Construction Heavy Equipment	–	–	–	–	–
Drill Rig Engines	0.0326	0.0326	0.0042	0.0019	0.00
Drilling Traffic	–	–	–	–	–
Drilling Heavy Equipment	–	–	–	–	–
Fracturing Engines	0.0088	0.0088	0.0011	0.0005	0.0005
Completion Rig Engines	0.0025	0.0025	0.0003	0.0001	0.0001
Completion Traffic	0.0000	0.0000	0.0000	0.0000	0.0000
Completion Flaring	0.0944	0.0944	0.0070	0.0000	0.0000
Production Emissions					
Workover Rig Engines	0.0008	0.0016	0.0017	0.0017	0.0017
Production Traffic	0.0000	0.0000	0.0000	0.0000	0.0000
Separator Heaters	0.0312	0.0642	0.0485	0.0556	0.0614
Tank Heaters	0.0416	0.0856	0.0647	0.0742	0.0819
Production Fugitives	0.1839	0.3781	1.0211	1.0211	1.0071
Screw Compressors	0.0000	1.4425	1.4425	1.4425	1.4425
C.S. Separators	0.0000	0.0024	0.0037	0.0051	0.0064
Water Transfer Pumps	0.0727	0.1495	0.0853	0.1061	0.1259
Pumping Units	0.1474	0.3031	0.3908	0.4864	0.5772
Total Construction Emissions	0.14	0.14	0.01	0.00	0.00
Total Production Emissions	0.48	2.43	3.06	3.19	3.30
Total Emissions	0.62	2.57	3.07	3.20	3.31

Activity or Equipment	Size	Units	Duration	Units	Pads Constructed per year	Control	Efficiency	Emission Factor PM10	Emission Factor PM2.5	units	Emissions (tons/pad) PM10	Emissions (tons/pad) PM2.5	Emissions (tons/year) PM10	Emissions (tons/year) PM2.5
Pad Construction Fugitives	5	acres	12	days	6	water	50%	0.11	0.011	tons/acre-mo	0.21290	0.02129	1.27742	0.12774
Wind Erosion - Pad Construction	5	acres	12	days	6	water	50%	0.1368	0.013	ton/acre-yr	0.01124	0.00107	0.06746	0.00641
Road Construction Fugitives	1.8	acres	8	days	6	water	50%	0.11	0.011	tons/acre-mo	0.05110	0.00511	0.30658	0.03066
Wind Erosion - Road Construction	1.8	acres	8	days	6	water	50%	0.1368	0.013	ton/acre-yr	0.00270	0.00026	0.01619	0.00154
											0.278	0.028	1.668	0.166

Short-term emissions estimates should be based on 10 hours per day construction duration for both pad and road construction.
Emissions estimates based on 6 pads/year, 4 wells/pad, 2 years construction duration.

Calculation Details:

Construction Fugitives

Emission Factors

PM_{10}	0.11	WRAP Fugitive Dist Handbook Section 3.4.1, Western Regional Air Partnership 2006
$PM_{2.5}$	0.011 10 % of PM_{10}	WRAP Fugitive Dist Handbook Section 3.4.1, Western Regional Air Partnership 2006

Note: Control Efficiency of 50% for watering assumed in emission factor

Calculations

PM_{10} (tons/pad) = EF_{PM10} * (acres) * month (days/31)
$PM_{2.5}$ (tons/pad) = $EF_{PM2.5}$ * (acres) * month (days/31)
PM_{10} (tons/year) = Emission $rate_{PM10}$ (tons/pad) * pads per year
$PM_{2.5}$ (tons/year) = Emission $rate_{PM2.5}$ (tons/pad) * pads per year

Wind Erosion

Emission Factors

Total Suspended Particulate (TSP)	0.38 tons/acre-year	EPA, AP-42, Volume I, Section 11.9 "Western Surface Coal Mining" (7/98)
PM_{10}	0.36 36 % of TSP	EPA, AP-42, Volume I, Section 13.2.2 "Unpaved Roads" (2004)
$PM_{2.5}$	0.095 9.5 % of PM_{10}	EPA, AP-42, Volume I, Section 13.2.2 "Unpaved Roads" (2004)

Calculations

PM_{10} (tons/pad) = EF_{PM10} * (acres) * year (days/365) * watering control efficiency (50%)
$PM_{2.5}$ (tons/pad) = $EF_{PM2.5}$ * (acres) * year (days/365) * watering control efficiency (50%)
PM_{10} (tons/year) = Emission $rate_{PM10}$ (tons/pad) * pads per year
$PM_{2.5}$ (tons/year) = Emission $rate_{PM2.5}$ (tons/pad) * pads per year

Description	Total Road and Well Pad Construction Traffic Emissions (tons per pad)												Fugitive	
	NOx	VOC	CO	PM10	PM2.5	SO2	CO2	CH4	PM_filt	PM_cond	N2O		PM10	PM2.5
Construction Traffic, Road and Well pad (LD)	0.0027	0.0016	0.0192	0.0001	0.0001	0.0000	0.6481	0.0001	0.0000	0.0000	0.0000		0.1019	0.0101
Construction Traffic, Road and Well pad (HD)	0.0749	0.0069	0.0558	0.0045	0.0043	0.0003	8.7776	0.0003	0.0000	0.0000	0.0001		0.3567	0.0354
							Metric Tons	Metric Tons			Metric Tons			

Well Road Traffic Exhaust Emissions (lbs per well pad)

	Pollutant	MOVES Emission Factors (g/mile)	Emissions (lb/well pad)
Light Duty	NOx	2.52	5.334
	SO2	0.01	0.030
	CO	18.19	38.492
	CO2	675.15	1429
	VOC	1.48	3.129
	PM10	0.09	0.184
	PM2.5	0.08	0.175
	PM_filt	-	0.000
	PM_cond	-	0.000
	CH4	0.08	0.180
	N2O	0.05	0.097
Heavy-Duty Truck	NOx	20.23	149.821
	SO2	0.08	0.595
	CO	15.07	111.613
	CO2	2612.44	19351.372
	VOC	1.86	13.788
	PM10	1.21	8.946
	PM2.5	1.17	8.672
	PM_filt	-	0.000
	PM_cond	-	0.000
	CH4	0.09	0.668
	N2O	0.04	0.263

Equipment Utilization

Equipment Type	Mean Vehicle Speed (mph)	Round Trip Off-Road Trip Distance (miles)	Number of Round Trips Per Pad/Road
Average Truck	20.5	16	60
Heavy Truck	20.5	16	210

Fugitive Particulate Emissions - Construction Traffic Pad and Road

Source for Data for Constants: EPA (1995), AP-42, Section 13.2.2 Unpaved Roads (9/98). Table 13.2.2-2.

$$E\ [lb/VMT] = \frac{k(s/12)^a(S/30)d}{(M/0.5)^c} \cdot \frac{(365-P)}{365} \cdot (\text{Control Efficiency})$$

Constant	PM_{10}	$PM_{2.5}$
k	1.8	0.18
a	1.00	1.00
d	0.50	0.50
c	0.2	0.2
C	0.00047	0.00036

Variable Description	Value	Reference
E = size-specific emission factor (lb/VMT)		
s = surface material silt content (%)	5.1	EPA, *AP-42*, Volume I, Section 13.2.2 Unpaved Roads (9/98)
W = mean vehicle weight (tons)	55	
W = mean vehicle weight (tons)	3	
M = surface material moisture content (%)	2.4	AP-42 Table 11.9-3
Average control efficiency for watering (9 mi) and mag chloride (1 mi) (%) =	54	EPA, *Control of Open Fugitive Dust Sources*, EPA-450 / 3-88-001, Sept 1988.
P = Precipitation Days (>0.01" rainfall)	82	Precipitation days at Paonia, Colorado from NCDC climatology

Activity	Vehicle Type	Av. Vehicle Weight (lb)	Mean vehicle speed (mph)	# of Visits per Year	Total # of Round Trips	Round Trip Distance (mi)	Total Miles Traveled	PM_{10}		$PM_{2.5}$	
								Em. Factor (lb/VMT)	Emissions (tpy/pad)	Em. Factor (lb/VMT)	Emissions (tpy/pad)
Travel to well	Light truck	6,000	20.5	60	60	16	960	0.21	0.102	0.02	0.010
Travel to well	Heavy Truck	110,000	20.5	210	210	16	3360	0.21	0.357	0.02	0.035
							Total	**0.42**	**0.46**	**0.04**	**0.05**

Well Pad and Road Construction Heavy Equipment Tailpipe Emissions

Equipment Type	Engine Horesepower	Quantity	Operating Load Factor[1]	Pollutant Emission Factor (g/hp-hr)[2]					Construction Activity Duration		Pollutant Emissions (lb/pad)				
				NOx	CO	VOC	SO2	PM10	(days)	(hours/day)	NOx	CO	VOC	SO2	PM10
Well Pad Construction															
Haul Truck	250	3	0.4	2.8	2.6	0.2	0.13	0.15	8	10	148.1	137.6	10.6	6.9	7.9
Trackhoe	250	1	0.4	2.8	2.6	0.2	0.13	0.15	8	10	49.4	45.9	3.5	2.3	2.6
Dozer	250	2	0.4	2.8	2.6	0.2	0.13	0.15	8	10	98.8	91.7	7.1	4.6	5.3
Grader	250	1	0.4	2.8	2.6	0.2	0.13	0.15	8	10	49.4	45.9	3.5	2.3	2.6
Compactor	250	1	0.4	2.8	2.6	0.2	0.13	0.15	8	10	49.4	45.9	3.5	2.3	2.6
Water Truck	250	1	0.4	2.8	2.6	0.2	0.13	0.15	8	10	49.4	45.9	3.5	2.3	2.6
Road Construction															
Dozer	250	2	0.4	2.8	2.6	0.2	0.13	0.15	8	10	98.8	91.7	7.1	4.6	5.3
Grader	250	1	0.4	2.8	2.6	0.2	0.13	0.15	8	10	49.4	45.9	3.5	2.3	2.6
Trackhoe	250	1	0.4	2.8	2.6	0.2	0.13	0.15	8	10	49.4	45.9	3.5	2.3	2.6
Haul Truck	250	3	0.4	2.8	2.6	0.2	0.13	0.15	8	10	148.1	137.6	10.6	6.9	7.9
											790.1	733.7	56.4	36.7	42.3

[1] Taken from "Surface Mining" (Pfleider 1972) for average surface duty.
[2] Emission factors based on assumption that nonroad engines, on average, meet Tier 3 EPA Emission Standards.

Equipment Type	Construction Activity Duration		Average Speed (mph)	Miles Traveled	Pollutant Emission Factor (g/mile)[1]			Pollutant Emissions (tons)			Part 98 Global Warming Potential [2]		Pollutant Emissions (tons/pad)
	(days)	(hours/day)			CO2	CH4	N2O	CO2	CH4	N2O	CH4	N2O	CO2e
Well Pad Construction													
Haul Truck	8	10	5	400	2612	0.09	0.04	1.152	3.97E-05	1.76E-05	21	310	1.16
Trackhoe	8	10	5	400	2612	0.09	0.04	1.152	3.97E-05	1.76E-05	21	310	1.16
Dozer	8	10	5	400	2612	0.09	0.04	1.152	3.97E-05	1.76E-05	21	310	1.16
Grader	8	10	5	400	2612	0.09	0.04	1.152	3.97E-05	1.76E-05	21	310	1.16
Compactor	8	10	5	400	2612	0.09	0.04	1.152	3.97E-05	1.76E-05	21	310	1.16
Water Truck	8	10	5	400	2612	0.09	0.04	1.152	3.97E-05	1.76E-05	21	310	1.16
Road Construction													
Dozer	8	10	5	400	2612	0.09	0.04	1.152	3.97E-05	1.76E-05	21	310	1.16
Grader	8	10	5	400	2612	0.09	0.04	1.152	3.97E-05	1.76E-05	21	310	1.16
Trackhoe	8	10	5	400	2612	0.09	0.04	1.152	3.97E-05	1.76E-05	21	310	1.16
Compactor	8	10	5	400	2612	0.09	0.04	1.152	3.97E-05	1.76E-05	21	310	1.16
											Total Emissions (tons/year/pad)		**11.58**

[1] Heavy-duty vehicle emission factors from MOVES emission model.
[2] Global warming potential for CH4 and N2O from Table A-1 of 40 CFR Part 98, Mandatory Reporting of Greenhouse Gases, Final Rule.

Calculation Details:	CH4	GWP =	21
	N2O	GWP =	310

Activity or Equipment	Size	Units	Duration	Units	Pads Constructed per year	Control	Efficiency	Emission Factor PM10	Emission Factor PM2.5	units	Emissions (tons/pad) PM10	Emissions (tons/pad) PM2.5	Emissions (tons/year) PM10	Emissions (tons/year) PM2.5
Pipeline Construction Fugitives	4.2	acres	10	days	6	water	50%	0.11	0.011	tons/acre-mo	0.14903	0.01490	0.89419	0.08942
Wind Erosion - Pipeline Construction	4.2	acres	10	days	6	water	50%	0.1368	0.013	ton/acre-yr	0.00787	0.00075	0.04722	0.00449
											0.1569	0.0157	0.9414	0.0939

Annual emissions based on 6 pads constructed per year, one pipeline segment per pad, 2 years construction duration.
Short-term emissions should assume 10 hours per day duration.

Calculation Details:

Construction Fugitives

Emission Factors

PM_{10}	0.11		WRAP Fugitive Dist Handbook Section 3.4.1, Western Regional Air Partnership 2006
$PM_{2.5}$	0.011	10 % of PM_{10}	WRAP Fugitive Dist Handbook Section 3.4.1, Western Regional Air Partnership 2006

Note: Control Efficiency of 50% for watering assumed in emission factor

Calculations

PM_{10} (tons/pad) = EF_{PM10} * (acres) * month (days/31)
$PM_{2.5}$ (tons/pad) = $EF_{PM2.5}$ * (acres) * month (days/31)
PM_{10} (tons/year) = Emission $rate_{PM10}$ (tons/pad) * pads per year
$PM_{2.5}$ (tons/year) = Emission $rate_{PM2.5}$ (tons/pad) * pads per year

Wind Erosion

Emission Factors

Total Suspended Particulate (TSP)	0.38	tons/acre-year	EPA, AP-42, Volume I, Section 11.9 "Western Surface Coal Mining" (7/98)
PM_{10}	0.36	36 % of TSP	EPA, AP-42, Volume I, Section 13.2.2 "Unpaved Roads" (2004)
$PM_{2.5}$	0.095	9.5 % of PM_{10}	EPA, AP-42, Volume I, Section 13.2.2 "Unpaved Roads" (2004)

Calculations

PM_{10} (tons/pad) = EF_{PM10} * (acres) * year (days/365) * watering control efficiency (50%)
$PM_{2.5}$ (tons/pad) = $EF_{PM2.5}$ * (acres) * year (days/365) * watering control efficiency (50%)
PM_{10} (tons/year) = Emission $rate_{PM10}$ (tons/pad) * pads per year
$PM_{2.5}$ (tons/year) = Emission $rate_{PM2.5}$ (tons/pad) * pads per year

Description	Total Pipeline Construction Traffic Emissions (tons per well pad)												Fugitive	
	NOx	VOC	CO	PM10	PM2.5	SO2	CO2	CH4	PM_filt	PM_cond	N2O		PM10	PM2.5
Construction Traffic, F	0.0021	0.0013	0.0154	0.0001	0.0001	0.0000	0.5716	0.0001	0.0000	0.0000	0.0000		0.0815	0.0081
Construction Traffic, F	0.0125	0.0011	0.0093	0.0007	0.0007	0.0000	1.6126	0.0001	0.0000	0.0000	0.0000		0.0595	0.0059

Pipeline Construction Traffic

	Pollutant	MOVES Emission Factors (g/mile)	Emissions (lb/well pad)
Light Duty	NOx	2.52	4.267
	SO2	0.01	0.024
	CO	18.19	30.793
	CO2	675.15	1143
	VOC	1.48	2.503
	PM10	0.09	0.147
	PM2.5	0.08	0.140
	PM_filt	-	0.000
	PM_cond	-	0.000
	CH4	0.08	0.144
	N2O	0.05	0.077
Heavy-Duty Truck	NOx	20.23	24.970
	SO2	0.08	0.099
	CO	15.07	18.602
	CO2	2612.44	3225.229
	VOC	1.86	2.298
	PM10	1.21	1.491
	PM2.5	1.17	1.445
	PM_filt	-	0.000
	PM_cond	-	0.000
	CH4	0.09	0.111
	N2O	0.04	0.044

Equipment Utilization

Equipment Type	Mean Vehicle Speed (mph)	Round Trip Off-Road Trip Distance (miles)	Number of Round Trips Per Pad
Light Truck	20.5	16	48
Heavy Truck	20.5	16	35

Fugitive Particulate Emissions - Pipeline Construction Traffic

Source for Data for Constants: EPA (1995), AP-42, Section 13.2.2 Unpaved Roads (9/98). Table 13.2.2-2.

$$E\ [lb/VMT] = \frac{k(s/12)^a(S/30)d}{(M/0.5)^c} \cdot \frac{(365-P)}{365} \cdot (\text{Control Efficiency})$$

Constant	PM_{10}	$PM_{2.5}$
k	1.8	0.18
a	1.00	1.00
d	0.50	0.50
c	0.2	0.2
C	0.00047	0.00036

Variable Description	Value	Reference
E = size-specific emission factor (lb/VMT)		
s = surface material silt content (%)	5.1	EPA, *AP-42* , Volume I, Section 13.2.2 Unpaved Roads (9/98)
W = mean vehicle weight (tons)	30	
W = mean vehicle weight (tons)	2.75	
M = surface material moisture content (%)	2.4	AP-42 Table 11.9-3
Average control efficiency for watering (9 mi) and mag chloride (1 mi) (%) =	54	EPA, *Control of Open Fugitive Dust Sources,* EPA-450 / 3-88-001, Sept 1988.
P = Precipitation Days (>0.01" rainfall)	82	Precipitation days at Paonia, Colorado from NCDC climatology

Activity	Vehicle Type	Av. Vehicle Weight (lb)	Mean vehicle speed (mph)	# of Visits per Year	Total # of Round Trips	Round Trip Distance (mi)	Total Miles Traveled	PM_{10}		$PM_{2.5}$	
								Em. Factor (lb/VMT)	Emissions (tpy/pad)	Em. Factor (lb/VMT)	Emissions (tpy/pad)
Travel to well	Light truck	5,500	20.5	48	48	16	768	0.21	0.082	0.02	0.008
Travel to well	Heavy Truck	60,000	20.5	35	35	16	560	0.21	0.059	0.02	0.006
							Total	**0.42**	**0.14**	**0.04**	**0.01**

Equipment Type	Engine Horesepower	Quantity	Operating Load Factor[1]	Pollutant Emission Factor (g/hp-hr)[2]					Construction Activity Duration		Pollutant Emissions (lb/pad)				
				NOx	CO	VOC	SO2	PM10	(days)	(hours/day)	NOx	CO	VOC	SO2	PM10
Dozer	250	1	0.4	4.5	2.6	0.4	0.13	0.15	10	10	99.2	57.3	8.8	2.9	3.3
Grader	250	1	0.4	4.5	2.6	0.4	0.13	0.15	10	10	99.2	57.3	8.8	2.9	3.3
Trackhoe	250	1	0.4	4.5	2.6	0.4	0.13	0.15	10	10	99.2	57.3	8.8	2.9	3.3
Bending Mach	250	1	0.4	4.5	2.6	0.4	0.13	0.15	10	10	99.2	57.3	8.8	2.9	3.3
Sideboom	250	1	0.4	4.5	2.6	0.4	0.13	0.15	10	10	99.2	57.3	8.8	2.9	3.3
Utility Tractor	250	1	0.4	4.5	2.6	0.4	0.13	0.15	10	10	99.2	57.3	8.8	2.9	3.3
											595.2	343.9	52.9	17.2	19.8

[1] Taken from "Surface Mining" (Pfleider 1972) for average surface duty.

[2] Emission factors based on assumption that nonroad engines, on average, meet Tier 3 EPA Emission Standards.

Equipment Type	Construction Activity Duration		Average Speed (mph)	Miles Traveled	Pollutant Emission Factor (g/mile)[1]			Pollutant Emissions (tons)			Part 98 Global Warming Potential [2]		Pollutant Emissions (tons/pad)
	(days)	(hours/day)			CO2	CH4	N2O	CO2	CH4	N2O	CH4	N2O	CO2e
Dozer	10	10	5	500	2612	0.09	0.04	1.440	4.96E-05	2.20E-05	21	310	1.45
Grader	10	10	5	500	2612	0.09	0.04	1.440	4.96E-05	2.20E-05	21	310	1.45
Trackhoe	10	10	5	500	2612	0.09	0.04	1.440	4.96E-05	2.20E-05	21	310	1.45
Bending Mach	10	10	5	500	2612	0.09	0.04	1.440	4.96E-05	2.20E-05	21	310	1.45
Sideboom	10	10	5	500	2612	0.09	0.04	1.440	4.96E-05	2.20E-05	21	310	1.45
Utility Tractor	10	10	5	500	2612	0.09	0.04	1.440	4.96E-05	2.20E-05	21	310	1.45
											Total Emissions (tons/year/pad)		**8.69**

[1] Heavy-duty vehicle emission factors from MOVES emission model.

[2] Global warming potential for CH4 and N2O from Table A-1 of 40 CFR Part 98, Mandatory Reporting of Greenhouse Gases, Final Rule.

Calculation Details: CH4 GWP = 21
N2O GWP = 310

Pollutant	Emission Factor	Emission Factor Units	Horsepower (hp) or Heat Input (mmbtu/hr)	Operating Load Factor	Activity Duration (hours/well)	Wells per year	Activity Duration (hours/yr)	Maximum Short-Term Emissions (lb/hr)	Annual Emissions (tons/well)	Annual Emissions (tons/year)
CO	2.60	g/hp-hr	1200	0.40	540	27	14580	2.75	0.7429	20.0571
NOx	4.50	g/hp-hr	1200	0.40	540	27	14580	4.76	1.2857	34.7143
SO2	0.02	lb/hr	1200	0.40	540	27	14580	0.02	0.0043	0.1096
VOC	0.30	g/hp-hr	1200	0.40	540	27	14580	0.32	0.0857	2.3143
PM10	0.15	g/hp-hr	1200	0.40	540	27	14580	0.16	0.0429	1.1571
Benzene	7.76E-04	lb/mmbtu	8.40	0.40	540	27	14580	2.61E-03	0.0007	0.0190
Toluene	2.81E-04	lb/mmbtu	8.40	0.40	540	27	14580	9.44E-04	0.0003	0.0069
Xylene	1.93E-04	lb/mmbtu	8.40	0.40	540	27	14580	6.48E-04	0.0002	0.0047
Formaldehyde	7.89E-05	lb/mmbtu	8.40	0.40	540	27	14580	2.65E-04	0.0001	0.0019
									Total HAPs	0.0326
									(metric tons/well)	**(metric tons/yr)**
CO2	73.96	kg/mmbtu	8.40	0.40	540	27	14580		134.1930	3623.2116
CH4	0.0030	kg/mmbtu	8.40	0.40	540	27	14580		0.0054	0.1470
N2O	0.0006	kg/mmbtu	8.40	0.40	540	27	14580		0.0011	0.0294
CO2e									134.6448	3635.4099

Emission factors for CO, NOx, VOC, and PM10: Tier 2 based on Tier 2 Emissions Standards for Nonroad Engines.
SO2 emissions based on an average brake-specific fuel consumption of 7,000 Btu/hp-hr, 138,000 Btu/gal diesel fuel, 7.2 lb/gal and 15 ppm S.
Fuel Consumption 69.6 gal/hr
HAP emission factors from EPA AP-42, Volume I, Fifth Edition, October 1996, Table 3.4-3 and 3.4-4.
GHG emission factors from Tables C-1 and C-2 of 40 CFR Part 98, Mandatory Reporting of Greenhouse Gases; Final Rule.
Global warming potential for CH4 and N2O from Table A-1 of 40 CFR Part 98, Mandatory Reporting of Greenhouse Gases, Final Rule.
Calculation Details: CH4 GWP = 21
N2O GWP = 310
Heat input in mmbtu/hr based on a heat rate of 7,000 btu/hp-hr.
Coal well drilling 10 days per well, shale well drilling 35 days per well, average 22.5 days.
Hours per well is based on average drilling duration of 22.5 days x 24 hours per day
Hours per year is based on 27 wells/year developed, average of coal and shale drilling duration of 22.5 days, and 24 hours per day.
LOP drilling 55 wells. 27 wells/year first two years, 1 gas well and 1 water well in third year.
One Tier 2 rig will operate year-round, two Tier 2 rigs will operate in summer season (April 1 - November 30)

Description	Total Pipeline Construction Traffic Emissions (tons per well pad)												Fugitive	
	NOx	VOC	CO	PM10	PM2.5	SO2	CO2	CH4	PM_filt	PM_cond	N2O		PM10	PM2.5
Drilling Traffic (LD)	0.0173	0.0102	0.1251	0.0006	0.0006	0.0001	4.2129	0.0005	0.0000	0.0000	0.0003		0.6625	0.0658
Drilling Traffic (HD)	0.3895	0.0358	0.2902	0.0233	0.0225	0.0015	45.6438	0.0016	0.0000	0.0000	0.0006		1.8551	0.1842
							Metric Tons	Metric Tons			Metric Tons			

Calendar Year	Pollutant	MOVES Emission Factors (g/mile)	Emissions (lb/well pad)
Light Duty	NOx	2.52	34.671
	SO2	0.01	0.198
	CO	18.19	250.196
	CO2	675.15	9288
	VOC	1.48	20.339
	PM10	0.09	1.196
	PM2.5	0.08	1.135
	PM_filt	-	0.000
	PM_cond	-	0.000
	CH4	0.08	1.169
	N2O	0.05	0.629
Heavy-Duty Truck	NOx	20.23	779.071
	SO2	0.08	3.095
	CO	15.07	580.389
	CO2	2612.44	100627.133
	VOC	1.86	71.699
	PM10	1.21	46.518
	PM2.5	1.17	45.094
	PM_filt	-	0.000
	PM_cond	-	0.000
	CH4	0.09	3.476
	N2O	0.04	1.370

Equipment Utilization

Equipment Type	Mean Vehicle Speed (mph)	Round Trip Off-Road Trip Distance (miles)	Number of Round Trips Per Pad
Light Truck	20.5	16	390
Heavy Truck	20.5	16	1,092

Fugitive Particulate Emissions

Source for Data for Constants: EPA (1995), AP-42, Section 13.2.2 Unpaved Roads (9/98). Table 13.2.2-2.

$$E\ [lb/VMT] = \frac{k(s/12)^a(S/30)d}{(M/0.5)^c} \quad \frac{*(365-P)}{365} \quad *(\text{Control Efficiency})$$

Constant	PM_{10}	$PM_{2.5}$
k	1.8	0.18
a	1.00	1.00
d	0.50	0.50
c	0.2	0.2
C	0.00047	0.00036

Variable Description	Value	Reference
E = size-specific emission factor (lb/VMT)		
s = surface material silt content (%)	5.1	EPA, *AP-42* , Volume I, Section 13.2.2 Unpaved Roads (9/98)
W = mean vehicle weight (tons)	30.5	
W = mean vehicle weight (tons)	3	
M = surface material moisture content (%)	2.4	AP-42 Table 11.9-3
Average control efficiency for watering (9 mi) and mag chloride (1 mi) (%) =	54	EPA, *Control of Open Fugitive Dust Sources*, EPA-450 / 3-88-001, Sept 1988.
P = Precipitation Days (>0.01" rainfall)	82	Precipitation days at Paonia, Colorado from NCDC climatology

Fugitive Dust Emissions

Activity	Vehicle Type	Av. Vehicle Weight (lb)	Mean vehicle speed (mph)	# of Visits per Year	Total # of Round Trips	Round Trip Distance (mi)	Total Miles Traveled	PM_{10}		$PM_{2.5}$	
								Em. Factor (lb/VMT)	Emissions (tpy/pad)	Em. Factor (lb/VMT)	Emissions (tpy/pad)
Travel to well	Light truck	6,000	20.5	390	390	16	6240	0.21	0.663	0.02	0.066
Travel to well	Heavy Truck	61,000	20.5	1,092	1,092	16	17472	0.21	1.855	0.02	0.184
							Total	**0.42**	**2.52**	**0.04**	**0.25**

Equipment Type	Engine Horesepower	Quantity	Operating Load Factor[1]	Pollutant Emission Factor (g/hp-hr)[2]					Construction Activity Duration		Pollutant Emissions (lb/pad)				
				NOx	CO	VOC	SO2	PM10	(days)	(hours/day)	NOx	CO	VOC	SO2	PM10
Backhoe	250	1	0.4	4.5	2.6	0.4	0.13	0.15	2	10	19.8	11.5	1.8	0.6	0.7
FEL	250	1	0.4	4.5	2.6	0.4	0.13	0.15	2	10	19.8	11.5	1.8	0.6	0.7
Boom/Winch	250	1	0.4	4.5	2.6	0.4	0.13	0.15	2	10	19.8	11.5	1.8	0.6	0.7
											59.5	34.4	5.3	1.7	2.0

[1] Taken from "Surface Mining" (Pfleider 1972) for average surface duty.

[2] Emission factors based on assumption that nonroad engines, on average, meet Tier 3 EPA Emission Standards.

Equipment Type	Construction Activity Duration		Average Speed (mph)	Miles Traveled	Pollutant Emission Factor (g/mile)[1]			Pollutant Emissions (tons)			Part 98 Global Warming Potential [2]		Pollutant Emissions (tons/pad)
	(days)	(hours/day)			CO2	CH4	N2O	CO2	CH4	N2O	CH4	N2O	CO2e
Backhoe	2	10	5	100	2612	0.09	0.04	0.288	9.92E-06	4.41E-06	21	310	0.29
FEL	2	10	5	100	2612	0.09	0.04	0.288	9.92E-06	4.41E-06	21	310	0.29
Boom/Winch	2	10	5	100	2612	0.09	0.04	0.288	9.92E-06	4.41E-06	21	310	0.29
											Total Emissions (tons/year/pad)		**0.87**

[1] Heavy-duty vehicle emission factors from MOVES emission model.

[2] Global warming potential for CH4 and N2O from Table A-1 of 40 CFR Part 98, Mandatory Reporting of Greenhouse Gases, Final Rule.

Calculation Details: CH4 GWP = 21
N2O GWP = 310

Bull Mountain Project
Completion Rig Emissions

Pollutant	Emission Factor	Emission Factor Units	Horsepower (hp) or Heat Input (mmbtu/hr)	Operating Load Factor	Activity Duration (hours/well)	Activity Duration (hrs/year)	Maximum Short-Term Emissions (lb/hr)	Annual Emissions (tons/well)	Annual Emissions (tons/year)
CO	2.60	g/hp-hr	500	0.40	100	2700	1.15	0.0573	1.5476
NOx	4.50	g/hp-hr	500	0.40	100	2700	1.98	0.0992	2.6786
SO2	0.01	lb/hr	500	0.40	100	2700	0.00	0.0003	0.0030
VOC	0.30	g/hp-hr	500	0.40	100	2700	0.13	0.0066	0.1786
PM10	0.15	g/hp-hr	500	0.40	100	2700	0.07	0.0033	0.0893
Benzene	7.76E-04	lb/mmbtu	3.50	0.40	100	2700	5.43E-07	5.43E-05	0.0015
Toluene	2.81E-04	lb/mmbtu	3.50	0.40	100	2700	1.97E-05	1.97E-05	0.0005
Xylene	1.93E-04	lb/mmbtu	3.50	0.40	100	2700	1.35E-05	1.35E-05	0.0004
Formaldehye	7.89E-05	lb/mmbtu	3.50	0.40	100	2700	5.52E-06	5.52E-06	0.0001
								Total HAPs	0.0025
								(metric tons/well)	**(metric tons/yr)**
CO2	73.96	kg/mmbtu	3.50	0.40	100	2700		10.3544	279.5688
CH4	0.0030	kg/mmbtu	3.50	0.40	100	2700		0.0004	0.0113
N2O	0.0006	kg/mmbtu	3.50	0.40	100	2700		0.0001	0.0023
CO2e								10.3893	280.5100

Emission factors for CO, NOx, VOC, and PM10 based on EPA Tier 2 Emissions Standards for Nonroad Engines.
SO2 emissions based on an average brake-specific fuel consumption of 7,000 Btu/hp-hr, 138,000 Btu/gal diesel fuel, 7.2 lb/gal and 15 ppm S.
Fuel Consumption 25.36 gal/hr
HAP emission factors from EPA AP-42, Volume I, Fifth Edition, October 1996, Table 3.4-3 and 3.4-4.
GHG emission factors from Tables C-1 and C-2 of 40 CFR Part 98, Mandatory Reporting of Greenhouse Gases; Final Rule.
Global warming potential for CH4 and N2O from Table A-1 of 40 CFR Part 98, Mandatory Reporting of Greenhouse Gases, Final Rule.
Heat input in mmbtu/hr based on a heat rate of 7,000 btu/hp-hr.

Calculation Details:	CH4	GWP =	21
	N2O	GWP =	310

Hours based on single well completion duration of 10 days, 10 hours per day.
Annual hours based on 27 wells completed per year, 100 hours per well.
Year-by-year annual emissions based on 27 wells completed per year in first two years, 1 completed in year three.

Emissions

Equipment Type	Pollutant	Per Well Emissions (tons per well)		Average Per Well Controlled Emissions (tons per well)	Method
		Shale Well	CBM Well		
Completion Flaring	NOx	0.0333	0.0344	0.0339	AP-42
	VOC	0.0158	0.0117	0.0138	Assumed 98% control
	CO	0.1813	0.1872	0.1843	AP-42
	PM10	0.0000	0.0000	0.0000	not applicable
	PM2.5	0.0000	0.0000	0.0000	not applicable
	SO2	0.0000	0.0000	0.0000	not applicable
	CO2	54.9384	54.9604	54.9494	Carbon balance assuming 98%destruction efficiency
	CH4	0.3690	0.3809	0.3749	Assumed 98% control
	N2O	0.0007	0.0007	0.0007	API Compendium
	Benzene	0.0007	0.0007	0.0007	Assumed 98% control
	Toluene	0.0011	0.0010	0.0010	Assumed 98% control
	Ethylbenzene	0.0000	0.0000	0.0000	Assumed 98% control
	Xylenes	0.0004	0.0004	0.0004	Assumed 98% control
	n-hexane	0.0013	0.0013	0.0013	Assumed 98% control
	formaldahyde	3.9984	4.1252	4.0618	EPA Speciate Profile 0051

Inputs

Fraction of vented gas controlled per well	98%	
Volume Flared Per Well	1,000	MCF/well
HHV of Flared Gas (Shale)	980	Btu/scf
HHV of Flared Gas (CBM)	1012	Btu/scf

Ideal Gas Law Conversions

R	0.0821	L atm / K-mol
Standard Temp	298.15	K
Standard Pressure	1	atm
L/mol	24.47	L/mol
	28.32	L/SCF
	453.5924	g/lb

Number of Wells

Shale Wells	CBM Wells	Total Wells
73	73	146

Completion Flaring Emissions

Pollutant	Emission Factor	Unit	Emissions	
			Shale Well (Tons Per Well)	CBM Well (Tons Per Well)
NO_X[1]	0.068	lb/MMBtu	0.0333	0.0344
CO[1]	0.37	lb/MMBtu	0.1813	0.1872
VOC	-	lb/MMBtu	0.0158	0.0117
CO_2[2]	-	-	54.9384	54.9604
CH_4[2]	-	-	0.3690	0.3809
PM	0	lb/MCF	0.0000	0.0000
SO_2	0	lb/MCF	0.0000	0.0000
N2O [3]	1.436	lb/MMCF	0.0007	0.0007

[1] Emission factors for NO_X and CO are based on AP-42, Chapter 13, Section 13.5, Table 13.5-1, dated 9/91 (reformated 1/95).

[2] The emission factors for VOC, CO_2 and CH_4 are based on the the lbs/MMscf gas composition below. The total lb CO_2/MMscf is multiplied by 98% combustion efficiency for the conversion of flare gas carbon to CO_2 (based on the API Compendium of Greenhouse Gas Emissions Methodologies for the Oil and Gas Industry, 2004). The lbs VOC and CH_4/MMscf are multiplied by 2% to represent the non-combusted portion.

[3] Emission Factor from API Compendium of greenhouse gas emissions methodologies for the oil and natural gas industry,2009 Table 4-11, GHG Emission Factors for Gas Flares in Developed Countries - Footnote C

Shale Well Gas Composition

Chemical	Mole %	Molecular Weight (g/mol)[1]	Weight %	lb/ MCF	lb CO_2/MCF	HHV (Btu/scf)[1]	CO2 emission potential of gas sample species (tons/well)	UNCONTROLLED - VOC emission potential of gas sample species (tons/well)	CONTROLLED - VOC emission potential of gas sample species (tons/well)	UNCONTROLLED - Emission potential of gas sample species (tons/well)	CONTROLLED - Emission potential of gas sample species (tons/well)
Carbon Dioxide	6.6600%	44.010	15.7195%	7.48	7.33		3.66			3.74	0.0748
Nitrogen	0.1600%	28.010	0.2404%	0.11			0.00			0.06	0.0011
Methane	90.1500%	16.040	77.5503%	36.90	99.21	1010	49.61			18.45	0.3690
Ethane	1.9600%	30.070	3.1608%	1.50	2.16	1769.7	1.08			0.75	0.0150
Propane	0.5200%	44.100	1.2299%	0.59	0.57	2516.2	0.29	0.29	0.0059	0.29	0.0059
Isobutane	0.1200%	58.120	0.3740%	0.18	0.13	3252	0.07	0.09	0.0018	0.09	0.0018
n-Butane	0.1000%	58.120	0.3117%	0.15	0.11	3262.4	0.06	0.07	0.0015	0.07	0.0015
Isopentane	0.0600%	72.150	0.2322%	0.11	0.07	4000.9	0.03	0.06	0.0011	0.06	0.0011
n-Pentane	0.0300%	72.150	0.1161%	0.06	0.03	4008.7	0.02	0.03	0.0006	0.03	0.0006
Helium	0.0100%	4.003	0.0021%	0.00	0.01	4756	0.01			0.00	0.0000
Hexane+	0.2300%	86.180	1.0630%	0.51	0.25	4481.6	0.13	0.25	0.0051	0.25	0.0051
Total	**100.0000%**	**18.65**	**100.0000%**	**47.58**	**109.88**	**979.83659**	**54.94**	**0.79**	**0.0158**	**23.79**	**0.4758**
Total NMHC	**3.0300%**		**6.4899%**	**3.09**							
Total VOC	**1.0700%**		**3.3290%**	**1.58**							
Total TOG	**93.1700%**		**84.0380%**	**39.98**							

[1] The molecular weights and the higher heating values are from GSPA Engineering Data Book, 12th Edition.

CBM Well Gas Composition

Chemical	Mole %	Molecular Weight (g/mol)[1]	Weight %	lb/ MCF	lb CO_2/MCF	HHV (Btu/scf)[1]	CO2 emission potential of gas sample species (tons/well)	UNCONTROLLED - VOC emission potential of gas sample species (tons/well)	CONTROLLED - VOC emission potential of gas sample species (tons/well)	UNCONTROLLED - Emission potential of gas sample species (tons/well)	CONTROLLED - Emission potential of gas sample species (tons/well)
Carbon Dioxide	3.3300%	44.010	8.2956%	3.74	3.66		1.83			1.87	0.0374
Nitrogen	0.1200%	28.010	0.1903%	0.09			0.00			0.04	0.0009
Methane	93.0600%	16.040	84.4928%	38.09	102.42	1010	51.21			19.04	0.3809
Ethane	2.6000%	30.070	4.4255%	1.99	2.86	1769.7	1.43			1.00	0.0199
Propane	0.5600%	44.100	1.3979%	0.63	0.62	2516.2	0.31	0.32	0.0063	0.32	0.0063
Isobutane	0.1000%	58.120	0.3290%	0.15	0.11	3252	0.06	0.07	0.0015	0.07	0.0015
n-Butane	0.1000%	58.120	0.3290%	0.15	0.11	3262.4	0.06	0.07	0.0015	0.07	0.0015
Isopentane	0.0300%	72.150	0.1225%	0.06	0.03	4000.9	0.02	0.03	0.0006	0.03	0.0006
n-Pentane	0.0300%	72.150	0.1225%	0.06	0.03	4008.7	0.02	0.03	0.0006	0.03	0.0006
Helium	0.0100%	4.003	0.0023%	0.00	0.01	4756	0.01			0.00	0.0000
Hexane+	0.0600%	86.180	0.2927%	0.13	0.07	4481.6	0.03	0.07	0.0013	0.07	0.0013
Total	**100.0000%**	**17.67**	**100.0000%**	**45.08**	**109.92**	**1012.09076**	**54.96**	**0.58**	**0.0117**	**22.54**	**0.4508**
Total NMHC	**3.4900%**		**7.0213%**	**3.17**							
Total VOC	**0.8900%**		**2.5959%**	**1.17**							
Total TOG	**96.5400%**		**91.5119%**	**41.25**							

[1] The molecular weights and the higher heating values are from GSPA Engineering Data Book, 12th Edition.

Emission Factor (lb/MMBtu)*			Fraction of THC as CH4	N2O (lb/MMSCF)[b]	VOC/THC
NOx	CO	THC			
0.068	0.37	0.14	25%	1.44	63%

*Emission Factors are from AP-42

b Emission Factor from API Compendium of greenhouse gas emissions methodologies for the oil and natural gas industry, 2009 Table 4-11, GHG Emission Factors for Gas Flares in Developed Countries - Footnote C

c EPA SPECIATE Profile 0051

	MW (lb/lb-mol)	lb/well
TOG	31.47	171.47
CO	28.01	362.54

Flaring Speciation Profile (EPA SPECIATE 0051)

Name	HC?	VOC?	WEIGHT_PER	Molecular Weight (lb/lb-mol)[2]
Ethane	Y	N	30	30.07
Formaldehyde	N	Y	20	30.03
Methane	Y	N	20	16.04
Propane	Y	Y	30	44.10
			100	

CH4 wt%	20
VOC wt%	50
THC wt%	80
VOC/THC (wt)	63%
CH4/THC (wt)	25%
HAPS/VOC (wt)	31.95%

Description	Total Construction Traffic Emissions (tons per well pad)												Fugitive	
	NOx	VOC	CO	PM10	PM2.5	SO2	CO2	CH4	PM_filt	PM_cond	N2O		PM10	PM2.5
Completion Traffic (LD)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		0.0000	0.0000
Completion Traffic (HD)	0.0214	0.0020	0.0159	0.0013	0.0012	0.0001	2.5079	0.0001	0.0000	0.0000	0.0000		0.1019	0.0101
							Metric Tons	Metric Tons			Metric Tons			

	Pollutant	MOVES Emission Factors (g/mile)	Emissions (lb/well pad)
Light Duty	NOx	2.52	0.000
	SO2	0.01	0.000
	CO	18.19	0.000
	CO2	675.15	0
	VOC	1.48	0.000
	PM10	0.09	0.000
	PM2.5	0.08	0.000
	PM_filt	-	0.000
	PM_cond	-	0.000
	CH4	0.08	0.000
	N2O	0.05	0.000
Heavy-Duty Truck	NOx	20.23	42.806
	SO2	0.08	0.170
	CO	15.07	31.890
	CO2	2612.44	5528.963
	VOC	1.86	3.940
	PM10	1.21	2.556
	PM2.5	1.17	2.478
	PM_filt	-	0.000
	PM_cond	-	0.000
	CH4	0.09	0.191
	N2O	0.04	0.075

Equipment Utilization

Equipment Type	Mean Vehicle Speed (mph)	Round Trip Off-Road Trip Distance (miles)	Number of Round Trips Per Pad
Light Truck	20.5	0	0
Heavy Truck	20.5	16	60

Fugitive Particulate Emissions

Source for Data for Constants: EPA (1995), AP-42, Section 13.2.2 Unpaved Roads (9/98). Table 13.2.2-2.

$$E\ [lb/VMT] = \frac{k(s/12)^a(S/30)d}{(M/0.5)^c} \cdot \frac{(365-P)}{365} \cdot (\text{Control Efficiency})$$

Constant	PM_{10}	$PM_{2.5}$
k	1.8	0.18
a	1.00	1.00
d	0.50	0.50
c	0.2	0.2
C	0.00047	0.00036

Variable Description	Value	Reference
E = size-specific emission factor (lb/VMT)		
s = surface material silt content (%)	5.1	EPA, *AP-42*, Volume I, Section 13.2.2 Unpaved Roads (9/98)
W = mean vehicle weight (tons)	39.25	
W = mean vehicle weight (tons)	0	
M = surface material moisture content (%)	2.4	AP-42 Table 11.9-3
Average control efficiency for watering (9 mi) and mag chloride (1 mi)	54	EPA, *Control of Open Fugitive Dust Sources,* EPA-450 / 3-88-001, Sept 1988.
P = Precipitation Days (>0.01" rainfall)	82	Precipitation days at Paonia, Colorado from NCDC climatology

Fugitive Dust Emissions

Activity	Vehicle Type	Av. Vehicle Weight (lb)	Mean vehicle speed (mph)	# of Visits per Year	Total # of Round Trips	Round Trip Distance (mi)	Total Miles Traveled	PM_{10}		$PM_{2.5}$	
								Em. Factor (lb/VMT)	Emissions (tpy/pad)	Em. Factor (lb/VMT)	Emissions (tpy/pad)
Travel to well	Light truck	0	20.5	0	0	0	0	0.21	0.000	0.02	0.000
Travel to well	Heavy Truck	78,500	20.5	60	60	16	960	0.21	0.102	0.02	0.010
							Total	**0.42**	**0.102**	**0.04**	**0.010**

Short-term emissions should be based on 12 days per completion/testing event, 10 hours per day.

Shale Wells

Pollutant	Quantity	Emission Factor	Emission Factor Units	Horsepower (hp) or Heat Input (mmbtu/hr)	Operating Load Factor	Activity Duration (hours/well)	Activity Duration (hrs/well/year)	Maximum Short-Term Emissions (lb/hr)	Annual Emissions (tons/well)	Annual Emissions (tons/year)
CO	6	2.60	g/hp-hr	2000	0.40	24	312	68.78	0.3302	4.2921
NOx	6	4.50	g/hp-hr	2000	0.40	24	312	119.05	0.5714	7.4286
SO2	6	0.02	lb/hr	2000	0.40	24	312	0.13	0.0016	0.0082
VOC	6	0.30	g/hp-hr	2000	0.40	24	312	7.94	0.0381	0.4952
PM10	6	0.15	g/hp-hr	2000	0.40	24	312	3.97	0.0190	0.2476
Benzene	6	7.76E-04	lb/mmbtu	14.00	0.40	24	312	1.30E-05	3.13E-04	0.0041
Toluene	6	2.81E-04	lb/mmbtu	14.00	0.40	24	312	4.72E-06	1.13E-04	0.0015
Xylene	6	1.93E-04	lb/mmbtu	14.00	0.40	24	312	3.24E-06	7.78E-05	0.0010
Formaldehye	6	7.89E-05	lb/mmbtu	14.00	0.40	24	312	1.33E-06	3.18E-05	0.0004
									(metric tons/well)	**(metric tons/yr)**
CO2	6	73.96	kg/mmbtu	14.00	0.40	24	312		59.6413	775.3375
CH4	6	0.0030	kg/mmbtu	14.00	0.40	24	312		0.0024	0.0314
N2O	6	0.0006	kg/mmbtu	14.00	0.40	24	312		0.0005	0.0063
CO2e									59.8421	777.9478

CBM Wells

Pollutant	Quantity	Emission Factor	Emission Factor Units	Horsepower (hp) or Heat Input (mmbtu/hr)	Operating Load Factor	Activity Duration (hours/well)	Activity Duration (hrs/year)	Maximum Short-Term Emissions (lb/hr)	Annual Emissions (tons/well)	Annual Emissions (tons/year)
CO	2	2.60	g/hp-hr	1500	0.40	24	336	17.20	0.0825	1.1556
NOx	2	4.50	g/hp-hr	1500	0.40	24	336	29.76	0.1429	2.0000
SO2	2	0.73	lb/hr	1500	0.40	24	336	1.46	0.0175	0.0982
VOC	2	0.30	g/hp-hr	1500	0.40	24	336	1.98	0.0095	0.1333
PM10	2	0.15	g/hp-hr	1500	0.40	24	336	0.99	0.0048	0.0667
Benzene	2	7.76E-04	lb/mmbtu	10.50	0.40	24	336	3.26E-06	7.82E-05	0.0011
Toluene	2	2.81E-04	lb/mmbtu	10.50	0.40	24	336	1.18E-06	2.83E-05	0.0004
Xylene	2	1.93E-04	lb/mmbtu	10.50	0.40	24	336	8.11E-07	1.95E-05	0.0003
Formaldehye	2	7.89E-05	lb/mmbtu	10.50	0.40	24	336	3.31E-07	7.95E-06	0.0001
									(metric tons/well)	**(metric tons/yr)**
CO2	2	73.96	kg/mmbtu	10.50	0.40	24	336		14.9103	208.7447
CH4	2	0.0030	kg/mmbtu	10.50	0.40	24	336		0.0006	0.0085
N2O	2	0.0006	kg/mmbtu	10.50	0.40	24	336		0.0001	0.0017
CO2e									14.9605	209.4475

Emission factors for CO, NOx, VOC, and PM10 based on EPA Tier 2 Emissions Standards for Nonroad Engines.
SO2 emissions based on an average brake-specific fuel consumption of 7,000 Btu/hp-hr, 138,000 Btu/gal diesel fuel, 7.2 lb/gal and 15 ppm S.
Fuel Consumption 101.45 gal/hr
HAP emission factors from EPA AP-42, Volume I, Fifth Edition, October 1996, Table 3.4-3 and 3.4-4.
GHG emission factors from Tables C-1 and C-2 of 40 CFR Part 98, Mandatory Reporting of Greenhouse Gases; Final Rule.
Global warming potential for CH4 and N2O from Table A-1 of 40 CFR Part 98, Mandatory Reporting of Greenhouse Gases, Final Rule.
Heat input in mmbtu/hr based on a heat rate of 7,000 btu/hp-hr.

Calculation Details:			
	CH4	GWP =	21
	N2O	GWP =	310

Hours based on duration of 24 hours per well fracturing event, 27 wells completed per year total, 13 shale wells and 14 CBM wells.
Average tons per well calculated as (shale tons/well + CBM tons/well) / 2.
Year-by-year annual emissions based on 27 wells fractured per year in first two years, 1 fractured in year three.

Pollutant	Emission Factor	Emission Factor Units	Horsepower (hp) or Heat Input (mmbtu/hr)	Operating Load Factor	Activity Duration (hours/well)	Activity Duration (hrs/year)	Maximum Short-Term Emissions (lb/hr)	Annual Emissions (tons/well)	Annual Emissions (tons/year)
CO	2.60	g/hp-hr	500	0.40	70	1890	2.87	0.0401	1.0833
NOx	4.50	g/hp-hr	500	0.40	70	1890	4.96	0.0694	1.8750
SO2	0.01	lb/hr	500	0.40	70	1890	0.01	0.0002	0.0021
VOC	0.30	g/hp-hr	500	0.40	70	1890	0.33	0.0046	0.1250
PM10	0.15	g/hp-hr	500	0.40	70	1890	0.17	0.0023	0.0625
Benzene	7.76E-04	lb/mmbtu	3.50	0.40	70	1890	5.43E-07	3.80E-05	0.0010
Toluene	2.81E-04	lb/mmbtu	3.50	0.40	70	1890	1.38E-05	1.38E-05	0.0004
Xylene	1.93E-04	lb/mmbtu	3.50	0.40	70	1890	9.46E-06	9.46E-06	0.0003
Formaldehye	7.89E-05	lb/mmbtu	3.50	0.40	70	1890	3.87E-06	3.87E-06	0.0001
								Total HAPs	0.0018
								(metric tons/well)	**(metric tons/yr)**
CO2	73.96	kg/mmbtu	3.50	0.40	70	1890		7.2481	195.6982
CH4	0.0030	kg/mmbtu	3.50	0.40	70	1890		0.0003	0.0079
N2O	0.0006	kg/mmbtu	3.50	0.40	70	1890		0.0001	0.0016
CO2e								7.2725	196.3570

Emission factors for CO, NOx, VOC, and PM10 based on EPA Tier 2 Emissions Standards for Nonroad Engines.
SO2 emissions based on an average brake-specific fuel consumption of 7,000 Btu/hp-hr, 138,000 Btu/gal diesel fuel, 7.2 lb/gal and 15 ppm S.
Fuel Consumption 25.36 gal/hr
HAP emission factors from EPA AP-42, Volume I, Fifth Edition, October 1996, Table 3.4-3 and 3.4-4.
GHG emission factors from Tables C-1 and C-2 of 40 CFR Part 98, Mandatory Reporting of Greenhouse Gases; Final Rule.
Global warming potential for CH4 and N2O from Table A-1 of 40 CFR Part 98, Mandatory Reporting of Greenhouse Gases, Final Rule.
Heat input in mmbtu/hr based on a heat rate of 7,000 btu/hp-hr.

Calculation Details:	CH4	GWP =	21
	N2O	GWP =	310

Total project emissions based on 27 workovers per year (half of 55-well development, occurring once all wells have been developed).

Description	Total Construction Traffic Emissions (tons per well pad per year)												Fugitive	
	NOx	VOC	CO	PM10	PM2.5	SO2	CO2	CH4	PM_filt	PM_cond	N2O		PM10	PM2.5
Production Traffic (LD)	0.0013	0.0008	0.0096	0.0000	0.0000	0.000008	0.3241	0.0000	0.0000	0.0000	0.0000		0.0554	0.0055
Production Traffic (HD)	0.0004	0.0000	0.0003	0.0000	0.0000	0.000001	0.0418	0.0000	0.0000	0.0000	0.0000		0.0018	0.0002
							Metric Tons	Metric Tons			Metric Tons			

	Pollutant	MOVES Emission Factors (g/mile)	Emissions (lb/well pad)
Light Duty	NOx	2.52	2.667
	SO2	0.01	0.015
	CO	18.19	19.246
	CO2	675.15	714
	VOC	1.48	1.565
	PM10	0.09	0.092
	PM2.5	0.08	0.087
	PM_filt	-	0.000
	PM_cond	-	0.000
	CH4	0.08	0.090
	N2O	0.05	0.048
Heavy-Duty Truck	NOx	20.23	0.713
	SO2	0.08	0.003
	CO	15.07	0.531
	CO2	2612.44	92.149
	VOC	1.86	0.066
	PM10	1.21	0.043
	PM2.5	1.17	0.041
	PM_filt	-	0.000
	PM_cond	-	0.000
	CH4	0.09	0.003
	N2O	0.04	0.001

Equipment Utilization

Equipment Type	Mean Vehicle Speed (mph)	Round Trip Off-Road Trip Distance (miles)	Annual Number of Round Trips Per Pad
Light Truck	20.5	16	30
Heavy Truck	20.5	16	1

Fugitive Particulate Emissions

Source for Data for Constants: EPA (1995), AP-42, Section 13.2.2 Unpaved Roads (9/98). Table 13.2.2-2.

$$E\ [lb/VMT] = \frac{k(s/12)^a(S/30)d}{(M/0.5)^c} \quad \frac{*(365-P)}{365} \quad *(\text{Control Efficiency})$$

Constant	PM_{10}	$PM_{2.5}$
k	1.8	0.18
a	1.00	1.00
d	0.50	0.50
c	0.2	0.2
C	0.00047	0.00036

Variable Description	Value	Reference
E = size-specific emission factor (lb/VMT)		
s = surface material silt content (%)	5.1	EPA, *AP-42* , Volume I, Section 13.2.2 Unpaved Roads (9/98)
W = mean vehicle weight (tons)	60	
W = mean vehicle weight (tons)	4	
M = surface material moisture content (%)	2.4	AP-42 Table 11.9-3
Average control efficiency for watering (9 mi) and mag chloride (1 mi) (%) =	50	EPA, *Control of Open Fugitive Dust Sources,* EPA-450 / 3-88-001, Sept 1988.
P = Precipitation Days (>0.01" rainfall)	82	Precipitation days at Paonia, Colorado from NCDC climatology

Activity	Vehicle Type	Av. Vehicle Weight (lb)	Mean vehicle speed (mph)	# of Visits per Year	Total # of Round Trips	Round Trip Distance (mi)	Total Miles Traveled	PM_{10}		$PM_{2.5}$	
								Em. Factor (lb/VMT)	Emissions (tpy/pad)	Em. Factor (lb/VMT)	Emissions (tpy/pad)
Travel to well	Light truck	8,000	20.5	30.0	30.0	16.0	480.0	0.2308	0.0554	0.0229	0.0055
Travel to well	Heavy Truck	120,000	20.5	1.0	1.0	16.0	16.0	0.2308	0.0018	0.0229	0.0002
							Total	**0.4616**	**0.0572**	**0.0458**	**0.0057**

Bull Mountain Project
Separator Heater Emissions

1 - 0.125 mmbtu/hr separator heater per well
Operates 12 hours/day year-round

Description	Wells	Fuel	Heat Input (mmbtu/hr)	Operating Schedule (hr/yr)	Pollutant	Emission Factor (lb/mmbtu)	Maximum ST Emis Rate (lb/hr)	Emission Rate (tons/well/yr)	Emission Rate (tons/year)
Natural Gas-Fired	55	Nat Gas	0.125	4380	NOx	0.098	0.0123	0.0268	1.4755
Separator Heaters	55	Nat Gas	0.125	4380	CO	0.049	0.0061	0.0134	0.7378
	55	Nat Gas	0.125	4380	VOC	0.031	0.0039	0.0085	0.4667
						(percent of VOC)			
	55	Nat Gas	0.125	4380	Benzene	4.0%	0.0002	0.0003	0.0187
	55	Nat Gas	0.125	4380	Toluene	2.0%	0.0001	0.0002	0.0093
	55	Nat Gas	0.125	4380	Formaldehyde	8.0%	0.0003	0.0007	0.0373
								Total HAPs	0.0653
						(kg/mmbtu)		**(metric tons/well)**	**(metric tons/yr)**
	55	Nat Gas	0.125	4380	CO2	53.02		29.0285	1596.5648
	55	Nat Gas	0.125	4380	CH4	0.001		0.0005	0.0301
	55	Nat Gas	0.125	4380	N2O	0.0001		0.0001	0.0030
					CO2e			29.0569	1598.1306

Emission factors for NOx, CO, HC from AP-42, Volume I, Fifth Edition, Table 1.4-1.
Emission factors for HAPs from SPECIATE4 Profile 0003 for natural gas external combustion (boiler/heater)
Emission factors for CO2, CH4, and N2O from Tables C-1 and C-2 of 40 CFR Part 98, Mandatory Reporting of Greenhouse Gases; Final Rule.

4 - 0.25 mmbtu/hr tank heaters per well

Description	Wells	Fuel	Heat Input (mmbtu/hr)	Quantity	Operating Schedule (hr/yr)	Pollutant	Emission Factor (lb/mmbtu)	Maximum ST Emis Rate (lb/hr)	Emission Rate (tons/well/yr)	Emission Rate (tons/year)
Natural Gas-Fired	55	Nat Gas	0.25	4	730	NOx	0.098	0.098	0.0358	1.9674
Tank Heaters	55	Nat Gas	0.25	4	730	CO	0.049	0.049	0.0179	0.9837
	55	Nat Gas	0.25	4	730	VOC	0.031	0.031	0.0113	0.6223
							(percent of VOC)			
	55	Nat Gas	0.25	4	730	Benzene	4.0%	0.0012	0.0005	0.0249
	55	Nat Gas	0.25	4	730	Toluene	2.0%	0.0006	0.0002	0.0124
	55	Nat Gas	0.25	4	730	Formaldehyde	8.0%	0.0025	0.0009	0.0498
									Total HAPs	0.087
							(kg/mmbtu)		**(metric tons/well)**	**(metric tons/yr)**
	55	Nat Gas	0.25	4	730	CO2	53.02		38.7046	2128.7530
	55	Nat Gas	0.25	4	730	CH4	0.001		0.0007	0.0402
	55	Nat Gas	0.25	4	730	N2O	0.0001		0.0001	0.0040
						CO2e			38.7426	2130.8408

Emission factors for NOx, CO, HC from AP-42, Volume I, Fifth Edition, Table 1.4-1.
Emission factors for HAPs from SPECIATE4 Profile 0003 for natural gas external combustion (boiler/heater)
Emission factors for CO2, CH4, and N2O from Tables C-1 and C-2 of 40 CFR Part 98, Mandatory Reporting of Greenhouse Gases; Final Rule.
Heaters operate for two hours, twice a day, during winter months only (assumed maximum period of 6 months, Oct-Mar)

Emissions

Equipment Type	Pollutant	Per Well Emissions (lb/year-well)		Average Per Well Emissions (lb/year-well)	Average Per Well Emissions (tpy/year-well)
		Shale Well	CBM Well		
Fugitive Devices	NOx	0.0	0.0	0.00	0.00
	VOC	64.3	46.0	55.01	0.03
	CO	0.0	0.0	0.00	0.00
	PM10	0.0	0.0	0.00	0.00
	PM2.5	0.0	0.0	0.00	0.00
	SO2	0.0	0.0	0.00	0.00
	CO2	303.9	147.3	224.13	0.11
	CH4	1499.1	1499.9	1,499.46	0.75
	N2O	0.0	0.0	0.00	0.00
	Benzene	2.8	2.6	2.73	0.00
	Toluene	4.3	3.9	4.11	0.00
	Ethylbenzene	0.2	0.1	0.15	0.00
	Xylenes	1.8	1.7	1.75	0.00
	n-hexane	5.5	5.0	5.25	0.00

Number of Wells

Shale Wells	CBM Wells	Total Wells
27	28	55

Media	Type	Well Equipment		TOC Emission Factor (kg / hr / component)	TOC Emissions (lbs/yr)		VOC Emissions (lbs/yr)	
		Shale Well	CBM Well		Shale Well	CBM Well	Shale Well	CBM Well
Gas	valves	10	10	4.50E-03	869	869	34.41	24.64
	pump seals			2.40E-03	0	0	0.00	0.00
	others	4	4	8.80E-03	680	680	26.92	19.27
	connectors			2.00E-04	0	0	0.00	0.00
	flanges	10	10	3.90E-04	75	75	2.98	2.14
	open-ended lines			2.00E-03	0	0	0.00	0.00
Light Oil >20º API	valves			2.50E-03	0	0	0.00	0.00
	pump seals			1.30E-02	0	0	0.00	0.00
	others			7.50E-03	0	0	0.00	0.00
	connectors			2.10E-04	0	0	0.00	0.00
	flanges			1.10E-04	0	0	0.00	0.00
	open-ended lines			1.40E-03	0	0	0.00	0.00
Heavy Oil <20º API	valves			8.40E-06	0	0	0.00	0.00
	pump seals			3.20E-05	0	0	0.00	0.00
	others			3.20E-05	0	0	0.00	0.00
	connectors			7.50E-06	0	0	0.00	0.00
	flanges			3.90E-07	0	0	0.00	0.00
	open-ended lines			1.40E-04	0	0	0.00	0.00
Water/Oil	valves			9.80E-05	0	0	0.00	0.00
	pump seals			2.40E-05	0	0	0.00	0.00
	others			1.40E-02	0	0	0.00	0.00
	connectors			1.10E-04	0	0	0.00	0.00
	flanges			2.90E-06	0	0	0.00	0.00
	open-ended lines			2.50E-04	0	0	0.00	0.00

Annual Hours of Operat 8760

	Shale Well	CBM Well
VOC Fraction (weight)	3.33%	2.59%
CO2 Fraction (weight)	15.72%	8.30%
CH4 Fraction (weight)	77.55%	84.49%

TOC Emission Factor (kg/hr/component)

Well Equipment Component	Gas	Light Oil >20º API	Heavy Oil <20º API	Water/Oil
valves	4.50E-03	2.50E-03	8.40E-06	9.80E-05
pump seals	2.40E-03	1.30E-02	3.20E-05	2.40E-05
others	8.80E-03	7.50E-03	3.20E-05	1.40E-02
connectors	2.00E-04	2.10E-04	7.50E-06	1.10E-04
flanges	3.90E-04	1.10E-04	3.90E-07	2.90E-06
open-ended lines	2.00E-03	1.40E-03	1.40E-04	2.50E-04

Emission Factors are from EPA, 1995 -AP-42 Table 2-4. "Oil and Gas Production Operations Average Emission Factors"
Do not calculate fugitives from pipelines containing only water
"Other" category includes compressor seals, pressure relief valves, diaphragms, drains, dump arms, hatches, instruments, meters, polished rods and vents

Assumptions
Hours of operation was assumed to be year round 24-7

Equation

$$E_{fugitive} = EF_i \times N \times t_{annual} \times Y$$

where:
$E_{fugitive}$ is the fugitive VOC emissions per well [ton-VOC/yr]
EF_i is the emission factor of TOC [kg/hr/source]
N is the total number of devices
Y is the ratio of VOC to TOC in the vented gas

CH4 and CO2 emissions

Emissions.CH4 = Emission.VOC * WtFraction.CH4 / WtFraction.CO2
Emissions.CO2 = Emission.VOC * WtFraction.CO2 / WtFraction.VOC

Description	Fuel	Quantity	Engine Size (hp)	Heat Input (mmbtu/hr)	Operating Schedule (hr/yr)	Pollutant	Emission Factor (g/hp-hr)	Emission Factor (lb/mmbtu)	Emission Rate 1 Engine (tons/year)
Screw Compressor	Nat Gas	1	637	--	8760	NOx	1	--	6.1509
		1	637	--	8760	CO	2.14	--	13.1630
		1	637	--	8760	VOC	0.41	--	2.5219
		1	--	5.99	8760	Benzene	--	4.40E-04	0.0115
		1	--	5.99	8760	Toluene	--	4.08E-04	0.0107
		1	--	5.99	8760	Ethylbenzene	--	3.97E-05	0.0010
		1	--	5.99	8760	Xylene	--	1.84E-04	0.0048
		1	--	5.99	8760	n-hexane	--	1.11E-03	0.0291
		1	--	5.99	8760	Formaldehyde	--	5.28E-02	1.3853
								Total HAPs	1.9025
							(kg/mmbtu)		**(metric tons/yr)**
	Nat Gas	1	--	5.99	8760	CO2	53.02		2782.0866
		1	--	5.99	8760	CH4	0.001		0.0525
		1	--	5.99	8760	N2O	0.0001		0.0052
						CO2e			2784.8152

Emission factor for NOx based on CDPHE BACT
Emission factors for CO, HC, and fuel consumption from Caterpillar G3412C specification sheet, reference data set DM8627-02-001.
Emission factors for HAPs from EPA AP-42, Volume I, Fifth Edition, October 1996, Table 3.2-2.
Emission factors for CO2, CH4, and N2O from Tables C-1 and C-2 of 40 CFR Part 98, Mandatory Reporting of Greenhouse Gases; Final Rule.
Heat input based on fuel consumption at HHV of 9398 Btu/bhp-hr: (9398 btu/bhp-hr)x(637 bhp)/1000000= 5.99 mmbtu/hr.

Bull Mountain Project
Compressor Station Separator

1 - 0.25 mmbtu/hr separator heater per compressor station
1 compressor station in field
Operates 12 hours/day year-round

Description	Quantity	Fuel	Heat Input (mmbtu/hr)	Operating Schedule (hr/yr)	Pollutant	Emission Factor (lb/mmbtu)	Maximum ST Emis Rate (lb/hr)	Emission Rate (tons/unit/yr)	Emission Rate (tons/year)
Natural Gas-Fired	1	Nat Gas	0.25	4380	NOx	0.098	0.0245	0.0537	0.0537
Separator Heater	1	Nat Gas	0.25	4380	CO	0.049	0.0123	0.0268	0.0268
	1	Nat Gas	0.25	4380	VOC	0.031	0.0078	0.0170	0.0170
						(percent of VOC)			
	1	Nat Gas	0.25	4380	Benzene	4.0%	0.0003	0.0007	0.0007
	1	Nat Gas	0.25	4380	Toluene	2.0%	0.0002	0.0003	0.0003
	1	Nat Gas	0.25	4380	Formaldehyde	8.0%	0.0006	0.0014	0.0014
								Total HAPs	0.0024
						(kg/mmbtu)		**(metric tons/unit)**	**(metric tons/yr)**
	1	Nat Gas	0.25	4380	CO2	53.02		58.0569	58.0569
	1	Nat Gas	0.25	4380	CH4	0.001		0.0011	0.0011
	1	Nat Gas	0.25	4380	N2O	0.0001		0.0001	0.0001
					CO2e			58.1138	58.1138

Emission factors for NOx, CO, HC from AP-42, Volume I, Fifth Edition, Table 1.4-1.
Emission factors for HAPs from SPECIATE4 Profile 0003 for natural gas external combustion (boiler/heater)
Emission factors for CO2, CH4, and N2O from Tables C-1 and C-2 of 40 CFR Part 98, Mandatory Reporting of Greenhouse Gases; Final Rule.

1 - 0.2 mmbtu/hr, 14.2 kW pump per pad

Description	Pads	Fuel	Engine Size (kW)	Heat Input (mmbtu/hr)	Quantity	Operating Schedule (hr/yr)	Pollutant	Emission Factor (g/kW-hr)	Emission Factor (lb/mmbtu)	Maximum ST Emis Rate (lb/hr/pad)	Emission Rate (tons/yr/pad)	Emission Rate (tons/year)
Natural Gas-Fired	12	Nat Gas	14.2	0.2	1	8760	NOx	10.94	--	0.3425	1.50	18.00
Water Transfer Pumps	12	Nat Gas	14.2	0.2	1	8760	CO	--	0.353	0.0706	0.31	3.71
	12	Nat Gas	14.2	0.2	1	8760	VOC	--	0.12	0.024	0.11	1.26
									(VOC %)			
	12	Nat Gas	14.2	0.2	1	8760	Benzene	--	1.18%	2.84E-04	1.24E-03	1.49E-02
	12	Nat Gas	14.2	0.2	1	8760	Toluene	--	0.04%	9.79E-06	4.29E-05	5.15E-04
	12	Nat Gas	14.2	0.2	1	8760	Ethylbenzene	--	0.11%	2.58E-05	1.13E-04	1.35E-03
	12	Nat Gas	14.2	0.2	1	8760	Xylene	--	0.43%	1.03E-04	4.52E-04	5.42E-03
	12	Nat Gas	14.2	0.2	1	8760	n-hexane	--	0.21%	5.16E-05	2.26E-04	2.71E-03
	12	Nat Gas	14.2	0.2	1	8760	Formaldehyde	--	8.70%	2.09E-03	9.15E-03	0.11
											Total HAPs	0.13
								(kg/mmbtu)			**(metric tons/yr/pad)**	**(metric tons/yr)**
	12	Nat Gas	14.2	0.2	1	8760	CO2	53.02			92.891	1114.69
	12	Nat Gas	14.2	0.2	1	8760	CH4	0.001			0.002	2.10E-02
	12	Nat Gas	14.2	0.2	1	8760	N2O	0.0001			0.000	2.10E-03
							CO2e				92.98	1115.79

Emission factors for NOx from EPA Nonroad Spark-Ignition Engines 19 kW and Below - Exhaust Emission Standards, Phase 2, Class II Engine.
Emission factors for CO and VOC from AP-42, Volume I, Fifth Edition, Table 3.2-1.
Emission factors for CO2, CH4, and N2O from Tables C-1 and C-2 of 40 CFR Part 98, Mandatory Reporting of Greenhouse Gases; Final Rule.
Emission factors for HAPs from EPA SPECIATE4, Profile 1001

1 - 0.2 mmbtu/hr, 14.2 kW pump at 73 wells

Description	Wells	Fuel	Engine Size (kW)	Heat Input (mmbtu/hr)	Quantity	Operating Schedule (hr/yr)	Pollutant	Emission Factor (g/kW-hr)	Emission Factor (lb/mmbtu)	Maximum ST Emis Rate (lb/hr/pad)	Emission Rate (tons/yr/well)	Emission Rate (tons/year)
Natural Gas-Fired	55	Nat Gas	14.2	0.2	1	8760	NOx	10.94	--	0.3425	1.50	82.50
Pumping Units	55	Nat Gas	14.2	0.2	1	8760	CO	--	0.353	0.0706	0.31	17.01
	55	Nat Gas	14.2	0.2	1	8760	VOC	--	0.12	0.024	0.11	5.78
									(VOC %)			
	55	Nat Gas	14.2	0.2	1	8760	Benzene	--	1.18%	2.84E-04	1.24E-03	6.83E-02
	55	Nat Gas	14.2	0.2	1	8760	Toluene	--	0.04%	9.79E-06	4.29E-05	2.36E-03
	55	Nat Gas	14.2	0.2	1	8760	Ethylbenzene	--	0.11%	2.58E-05	1.13E-04	6.21E-03
	55	Nat Gas	14.2	0.2	1	8760	Xylene	--	0.43%	1.03E-04	4.52E-04	2.48E-02
	55	Nat Gas	14.2	0.2	1	8760	n-hexane	--	0.21%	5.16E-05	2.26E-04	1.24E-02
	55	Nat Gas	14.2	0.2	1	8760	Formaldehyde	--	8.70%	2.09E-03	9.15E-03	0.50
											Total HAPs	0.62
								(kg/mmbtu)			**(metric tons/yr/pad)**	**(metric tons/yr)**
	55	Nat Gas	14.2	0.2	1	8760	CO2	53.02			92.891	5109.01
	55	Nat Gas	14.2	0.2	1	8760	CH4	0.001			0.002	9.64E-02
	55	Nat Gas	14.2	0.2	1	8760	N2O	0.0001			0.000	9.64E-03
							CO2e				92.98	5114.02

Emission factors for NOx from EPA Nonroad Spark-Ignition Engines 19 kW and Below - Exhaust Emission Standards, Phase 2, Class II Engine.
Emission factors for CO and VOC from AP-42, Volume I, Fifth Edition, Table 3.2-1.
Emission factors for CO2, CH4, and N2O from Tables C-1 and C-2 of 40 CFR Part 98, Mandatory Reporting of Greenhouse Gases; Final Rule.
Emission factors for HAPs from EPA SPECIATE4, Profile 1001

Natural Gas Composition Summary

Property	Shale Well Gas	CBM Well Gas
VOC Fraction (molar)	1.06%	0.88%
VOC/TOC (weight)	3.96%	2.83%
VOC MW	63.37	55.06
VOC Fraction (weight)	3.33%	2.59%
CO2 Fraction (weight)	15.72%	8.30%
CH4 Fraction (weight)	77.55%	84.49%
H2S Fraction (weight)	0.00%	0.00%
Heat Content (BTU/SCF)	986	1017
hexane+/VOC (weight)	31.95%	11.29%

Shale Well Gas

Component	Component Moles Percent	Normalized Mole	MW	Gas g/mol	% Wt	VOC species?	VOC renormalized wt%	VOC g/mol	HAPS species?
Carbon Dioxide	6.6600%	6.66%	44.0	2.9	15.7195%	N			N
Nitrogen	0.1600%	0.16%	28.0	0.0	0.2404%	N			N
Methane	90.1500%	90.15%	16.0	14.5	77.5503%	N			N
Ethane	1.9600%	1.96%	30.1	0.6	3.1608%	N			N
Propane	0.5200%	0.52%	44.1	0.2	1.2299%	Y	36.97%	16.30	N
Isobutane	0.1200%	0.12%	58.1	0.1	0.3740%	Y	11.24%	6.53	N
n-Butane	0.1000%	0.10%	58.1	0.1	0.3117%	Y	9.37%	5.45	N
Isopentane	0.0600%	0.06%	72.2	0.0	0.2322%	Y	6.98%	5.03	N
n-Pentane	0.0300%	0.03%	72.2	0.0	0.1161%	Y	3.49%	2.52	N
Helium	0.0100%	0.01%	4.0	0.0	0.0021%	N			N
Hexane+	0.2300%	0.23%	86.2	0.2	1.0630%	Y	31.95%	27.54	N
Total	**100.0000%**	**100.00%**		**18.6**	**100.00%**		**100.00%**	**63.4**	

CBM Well Gas

Component	Component Moles Percent	Normalized Mole	MW	Gas g/mol	% Wt	VOC species?	VOC renormalized wt%	VOC g/mol	HAPS species?
Carbon Dioxide	3.3300%	3.33%	44.0	1.5	8.2956%	N			N
Nitrogen	0.1200%	0.12%	28.0	0.0	0.1903%	N			N
Methane	93.0600%	93.06%	16.0	14.9	84.4928%	N			N
Ethane	2.6000%	2.60%	30.1	0.8	4.4255%	N			N
Propane	0.5600%	0.56%	44.1	0.2	1.3979%	Y	53.90%	23.77	N
Isobutane	0.1000%	0.10%	58.1	0.1	0.3290%	Y	12.68%	7.37	N
n-Butane	0.1000%	0.10%	58.1	0.1	0.3290%	Y	12.68%	7.37	N
Isopentane	0.0300%	0.03%	72.2	0.0	0.1225%	Y	4.72%	3.41	N
n-Pentane	0.0300%	0.03%	72.2	0.0	0.1225%	Y	4.72%	3.41	N
Helium	0.0100%	0.01%	4.0	0.0	0.0023%	N			N
Hexane+	0.0600%	0.06%	86.2	0.1	0.2927%	Y	11.29%	9.73	N
Total	**100.0000%**	**100.00%**		**17.7**	**100.00%**		**100.00%**	**55.1**	

BTEX	Mole %	Wt %
Benzene	0.0364%	0.1472%
Toluene	0.0465%	0.2218%
Ethylbenzene	0.0015%	0.0082%
Xylenes	0.0172%	0.0945%
n-hexane	0.0635%	0.2833%

Fraction of VOC (Wt)	Shale Well Gas	CBM Well Gas
Benzene	4.42%	5.68%
Toluene	6.67%	8.55%
Ethylbenzene	0.25%	0.32%
Xylenes	2.84%	3.64%
n-hexane	8.52%	10.92%

BTEX COMPONENTS	MOLE%	WT%
BENZENE	0.0364	0.1472
TOLUENE	0.0465	0.2218
ETHYLBENZENE	0.0015	0.0082
XYLENES	0.0172	0.0945
TOTAL BTEX	0.1016	0.4717

	BTU @	14.650	14.730
LOW	NET DRY REAL :	981.8 /scf	987.2 /scf
	NET WET REAL :	964.6 /scf	970.0 /scf
HIGH	GROSS DRY REAL :	1086.0 /scf	1091.9 /scf
	GROSS WET REAL :	1067.0 /scf	1072.9 /scf
	NET DRY REAL :	19318.5 /lb	19423.9 /lb
	GROSS DRY REAL :	21367.2 /lb	21483.9 /lb

Bull Mountain
Proposed Action Emissions Inventory
Table of Contents

Page	Title
B1-1	Emissions Summary
B1-2	Yearly Emissions Summary - PM_{10}
B1-3	Yearly Emissions Summary - $PM_{2.5}$
B1-4	Yearly Emissions Summary - NO_x
B1-5	Yearly Emissions Summary - CO
B1-6	Yearly Emissions Summary - SO_2
B1-7	Yearly Emissions Summary - VOC
B1-8	Yearly Emissions Summary - CO2e
B1-9	Yearly Emissions Summary - Benzene
B1-10	Yearly Emissions Summary - Toluene
B1-11	Yearly Emissions Summary - Ethylbenzene
B1-12	Yearly Emissions Summary - Xylene
B1-13	Yearly Emissions Summary - n-Hexane
B1-14	Yearly Emissions Summary - Formaldehyde
B1-15	Yearly Emissions Summary - Total HAPs
B1-16	Well Pad and Road Construction
B1-17	Well Pad and Road Construction Traffic
B1-18	Well Construction Heavy Equipment Tailpipe
B1-19	Pipeline Construction
B1-20	Pipeline Construction Traffic
B1-21	Pipeline Construction Heavy Equipment Tailpipe
B1-22	Drill Rig Engines
B1-23	Drilling Traffic
B1-24	Drilling Heavy Equipment Tailpipe
B1-25	Completion Rig Engines
B1-26	Completion Flaring
B1-27	Completion Faring
B1-28	Completion Traffic
B1-29	Fracturing Engines
B1-30	Workover Rig Engines
B1-31	Production Traffic
B1-32	Separator Heaters
B1-33	Tank Heaters
B1-34	Production Fugitives
B1-35	Production Fugitives
B1-36	Production Fugitives
B1-37	Screw Compressors
B1-38	Compressor Station Separator Heaters
B1-39	Water Transfer Pumps
B1-40	Pumping Units
B1-41	Natural Gas Composition
B1-42	Natural Gas Composition

Bull Mountain
Proposed Action Emissions Summary

TPY	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
NOx	87.12	127.02	165.15	205.05	244.96	233.05	202.18	202.18	202.18	202.18
CO	45.99	67.03	87.65	108.70	129.74	115.42	94.08	94.08	94.08	94.08
VOC	7.80	13.89	19.80	25.89	31.99	31.33	28.87	28.87	28.87	28.87
SO2	0.40	0.40	0.40	0.40	0.40	0.28	0.01	0.01	0.01	0.01
PM10	24.26	24.68	24.57	25.50	25.92	18.24	2.22	2.22	2.22	2.22
PM2.5	17.78	17.85	17.92	18.02	18.05	10.58	0.36	0.36	0.36	0.36
CO2e (metric tons/yr)	10815.53	17560.66	24100.41	30845.53	37590.66	35502.80	31909.59	31909.59	31909.59	31909.59
HAPs	0.62	2.57	4.49	6.44	8.39	8.49	8.43	8.43	8.43	8.43

Bull Mountain
Year-by-Year Emissions Summary

	PM_{10}									
	Pollutant Emission Rate (tpy)									
Activity	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 6**	**Year 7**	**Year 8**	**Year 9**	**Year 10**
Construction Emissions										
Well Pad and Road Construction	1.6677	1.6677	1.6677	1.6677	1.6677	1.6677	--	--	--	--
Well Pad and Road Construction Traffic	2.7794	2.7794	2.7794	2.7794	2.7794	2.7794	--	--	--	--
Well Pad and Road Construction Heavy Equipment	0.1270	0.1270	0.1270	0.1270	0.1270	0.1270	--	--	--	--
Pipeline Construction	0.9414	0.9414	0.9414	0.9414	0.9414	0.9414	--	--	--	--
Pipeline Construction Traffic	0.8509	0.8509	0.8509	0.8509	0.8509	0.8509	--	--	--	--
Pipeline Construction Heavy Equipment	0.0595	0.0595	0.0595	0.0595	0.0595	0.0595	--	--	--	--
Drill Rig Engines	1.1571	1.1571	1.1571	1.1571	1.1571	0.6480	--	--	--	--
Drilling Traffic	15.2486	15.2486	15.2486	15.2486	15.2486	8.5392	--	--	--	--
Drilling Heavy Equipment	0.0020	0.0020	0.0020	0.0020	0.0020	0.0011	--	--	--	--
Fracturing Engines	0.3143	0.3143	0.3143	0.3143	0.3143	0.1257	--	--	--	--
Completion Rig Engines	0.0893	0.0893	0.0893	0.0893	0.0893	0.0357	--	--	--	--
Completion Traffic	0.6192	0.6192	0.6192	0.6192	0.6192	0.2477	--	--	--	--
Completion Flaring	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	--	--	--	--
Production Emissions										
Workover Rig Engines	0.0279	0.0574	0.0853	0.1148	0.1442	0.1551	0.1551	0.1551	0.1551	0.1551
Production Traffic	0.3714	0.7634	0.6241	1.5267	1.9187	2.0631	2.0631	2.0631	2.0631	2.0631
Separator Heaters	--	--	--	--	--	--	--	--	--	--
Tank Heaters	--	--	--	--	--	--	--	--	--	--
Production Fugitives	--	--	--	--	--	--	--	--	--	--
Screw Compressors	--	--	--	--	--	--	--	--	--	--
C.S. Separators	--	--	--	--	--	--	--	--	--	--
Water Transfer Pumps	--	--	--	--	--	--	--	--	--	--
Pumping Units	--	--	--	--	--	--	--	--	--	--
Total Construction Emissions	23.86	23.86	23.86	23.86	23.86	16.02	0.00	0.00	0.00	0.00
Total Production Emissions	0.40	0.82	0.71	1.64	2.06	2.22	2.22	2.22	2.22	2.22
Total Emissions	24.26	24.68	24.57	25.50	25.92	18.24	2.22	2.22	2.22	2.22

Bull Mountain
Year-by-Year Emissions Summary

	$PM_{2.5}$									
	Pollutant Emission Rate (tpy)									
Activity	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 6**	**Year 7**	**Year 8**	**Year 9**	**Year 10**
Construction Emissions										
Well Pad and Road Construction	0.1663	0.1663	0.1663	0.1663	0.1663	0.1663	--	--	--	--
Well Pad and Road Construction Traffic	0.2999	0.2999	0.2999	0.2999	0.2999	0.2999	--	--	--	--
Well Pad and Road Construction Heavy Equipment	0.1270	0.1270	0.1270	0.1270	0.1270	0.1270	--	--	--	--
Pipeline Construction	0.0939	0.0939	0.0939	0.0939	0.0939	0.0939	--	--	--	--
Pipeline Construction Traffic	0.0888	0.0888	0.0888	0.0888	0.0888	0.0888	--	--	--	--
Pipeline Construction Heavy Equipment	0.0595	0.0595	0.0595	0.0595	0.0595	0.0595	--	--	--	--
Drill Rig Engines	1.1571	1.1571	1.1571	1.1571	1.1571	0.6480	--	--	--	--
Drilling Traffic	15.2486	15.2486	15.2486	15.2486	15.2486	8.5392	--	--	--	--
Drilling Heavy Equipment	0.0060	0.0060	0.0060	0.0060	0.0060	0.0033	--	--	--	--
Fracturing Engines	0.3143	0.3143	0.3143	0.3143	0.3143	0.1257	--	--	--	--
Completion Rig Engines	0.0893	0.0893	0.0893	0.0893	0.0893	0.0357	--	--	--	--
Completion Traffic	0.0682	0.0682	0.0682	0.0682	0.0682	0.0273	--	--	--	--
Completion Flaring	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	--	--	--	--
Production Emissions										
Workover Rig Engines	0.0279	0.0574	0.0853	0.1442	0.1442	0.1551	0.1551	0.1551	0.1551	0.1551
Production Traffic	0.0371	0.0763	0.1134	0.1526	0.1918	0.2062	0.2062	0.2062	0.2062	0.2062
Separator Heaters	--	--	--	--	--	--	--	--	--	--
Tank Heaters	--	--	--	--	--	--	--	--	--	--
Production Fugitives	--	--	--	--	--	--	--	--	--	--
Screw Compressors	--	--	--	--	--	--	--	--	--	--
C.S. Separators	--	--	--	--	--	--	--	--	--	--
Water Transfer Pumps	--	--	--	--	--	--	--	--	--	--
Pumping Units	--	--	--	--	--	--	--	--	--	--
Total Construction Emissions	17.72	17.72	17.72	17.72	17.72	10.21	0.00	0.00	0.00	0.00
Total Production Emissions	0.07	0.13	0.20	0.30	0.34	0.36	0.36	0.36	0.36	0.36
Total Emissions	17.78	17.85	17.92	18.02	18.05	10.58	0.36	0.36	0.36	0.36

Bull Mountain
Year-by-Year Emissions Summary

	NO_x									
	Pollutant Emission Rate (tpy)									
Activity	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 6**	**Year 7**	**Year 8**	**Year 9**	**Year 10**
Construction Emissions										
Well Pad and Road Construction	--	--	--	--	--	--	--	--	--	--
Well Pad and Road Construction Traffic	0.4655	0.4655	0.4655	0.4655	0.4655	0.4655	--	--	--	--
Well Pad and Road Construction Heavy Equipment	2.3704	2.3704	2.3704	2.3704	2.3704	2.3704	--	--	--	--
Pipeline Construction	--	--	--	--	--	--	--	--	--	--
Pipeline Construction Traffic	0.0877	0.0877	0.0877	0.0877	0.0877	0.0877	--	--	--	--
Pipeline Construction Heavy Equipment	1.7857	1.7857	1.7857	1.7857	1.7857	1.7857	--	--	--	--
Drill Rig Engines	34.7143	34.7143	34.7143	34.7143	34.7143	19.4400	--	--	--	--
Drilling Traffic	2.4412	2.4412	2.4412	2.4412	2.4412	1.3671	--	--	--	--
Drilling Heavy Equipment	0.1786	0.1786	0.1786	0.1786	0.1786	0.1000	--	--	--	--
Fracturing Engines	9.4286	9.4286	9.4286	9.4286	9.4286	3.7714	--	--	--	--
Completion Rig Engines	2.6786	2.6786	2.6786	2.6786	2.6786	1.0714	--	--	--	--
Completion Traffic	0.1284	0.1284	0.1284	0.1284	0.1284	0.0514	--	--	--	--
Completion Flaring	0.9143	0.9143	0.9143	0.9143	0.9143	0.3657	--	--	--	--
Production Emissions										
Workover Rig Engines	0.8375	1.7215	2.5590	3.4431	4.3271	4.6528	4.6528	4.6528	4.6528	4.6528
Production Traffic	0.0110	0.0225	0.0335	0.0450	0.0566	0.0608	0.0608	0.0608	0.0608	0.0608
Separator Heaters	0.7050	1.4492	2.1542	2.8984	3.6426	3.9168	3.9168	3.9168	3.9168	3.9168
Tank Heaters	0.9400	1.9323	2.8723	3.8646	4.8569	5.2224	5.2224	5.2224	5.2224	5.2224
Production Fugitives	--	--	--	--	--	--	--	--	--	--
Screw Compressors	--	6.1509	12.3019	18.4528	24.6037	24.6037	24.6037	24.6037	24.6037	24.6037
C.S. Separators	--	0.0537	0.1073	0.1610	0.2146	0.2146	0.2146	0.2146	0.2146	0.2146
Water Transfer Pumps	9.7203	19.9807	29.7011	39.9614	50.2218	54.0019	54.0019	54.0019	54.0019	54.0019
Pumping Units	19.7107	40.5164	60.2271	81.0329	101.8386	109.5039	109.5039	109.5039	109.5039	109.5039
Total Construction Emissions	55.19	55.19	55.19	55.19	55.19	30.88	0.00	0.00	0.00	0.00
Total Production Emissions	31.92	71.83	109.96	149.86	189.76	202.18	202.18	202.18	202.18	202.18
Total Emissions	87.12	127.02	165.15	205.05	244.96	233.05	202.18	202.18	202.18	202.18

Bull Mountain
Year-by-Year Emissions Summary

CO

Activity	Pollutant Emission Rate (tpy)									
	Year 1	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 6**	**Year 7**	**Year 8**	**Year 9**	**Year 10**
Construction Emissions										
Well Pad and Road Construction	--	--	--	--	--	--	--	--	--	--
Well Pad and Road Construction Traffic	0.4503	0.4503	0.4503	0.4503	0.4503	0.4503	--	--	--	--
Well Pad and Road Construction Heavy Equipment	2.2011	2.2011	2.2011	2.2011	2.2011	2.2011	--	--	--	--
Pipeline Construction	--	--	--	--	--	--	--	--	--	--
Pipeline Construction Traffic	0.1482	0.1482	0.1482	0.1482	0.1482	0.1482	--	--	--	--
Pipeline Construction Heavy Equipment	1.0317	1.0317	1.0317	1.0317	1.0317	1.0317	--	--	--	--
Drill Rig Engines	20.0571	20.0571	20.0571	20.0571	20.0571	11.2320	--	--	--	--
Drilling Traffic	2.4918	2.4918	2.4918	2.4918	2.4918	1.3954	--	--	--	--
Drilling Heavy Equipment	0.1032	0.1032	0.1032	0.1032	0.1032	0.0578	--	--	--	--
Fracturing Engines	5.4476	5.4476	5.4476	5.4476	5.4476	2.1790	--	--	--	--
Completion Rig Engines	1.5476	1.5476	1.5476	1.5476	1.5476	0.6190	--	--	--	--
Completion Traffic	0.0957	0.0957	0.0957	0.0957	0.0957	0.0383	--	--	--	--
Completion Flaring	4.9748	4.9748	4.9748	4.9748	4.9748	1.9899	--	--	--	--
Production Emissions										
Workover Rig Engines	0.4839	0.9947	1.4785	1.9893	2.5001	2.6883	2.6883	2.6883	2.6883	2.6883
Production Traffic	0.0641	0.1317	0.1958	0.2634	0.3311	0.3560	0.3560	0.3560	0.3560	0.3560
Separator Heaters	0.3525	0.7246	1.0771	1.4492	1.8213	1.9584	1.9584	1.9584	1.9584	1.9584
Tank Heaters	0.4700	0.9661	1.4362	1.9323	2.4284	2.6112	2.6112	2.6112	2.6112	2.6112
Production Fugitives	--	--	--	--	--	--	--	--	--	--
Screw Compressors	--	13.1630	26.3260	39.4889	52.6519	52.6519	52.6519	52.6519	52.6519	52.6519
C.S. Separators	--	0.0268	0.0537	0.0805	0.1073	0.1073	0.1073	0.1073	0.1073	0.1073
Water Transfer Pumps	2.0038	4.1189	6.1227	8.2378	10.3530	11.1322	11.1322	11.1322	11.1322	11.1322
Pumping Units	4.0633	8.3522	12.4155	16.7045	20.9935	22.5736	22.5736	22.5736	22.5736	22.5736
Total Construction Emissions	38.55	38.55	38.55	38.55	38.55	21.34	0.00	0.00	0.00	0.00
Total Production Emissions	7.44	28.48	49.11	70.15	91.19	94.08	94.08	94.08	94.08	94.08
Total Emissions	45.99	67.03	87.65	108.70	129.74	115.42	94.08	94.08	94.08	94.08

Bull Mountain
Year-by-Year Emissions Summary

SO_2

Activity	Pollutant Emission Rate (tpy) Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Construction Emissions										
Well Pad and Road Construction	--	--	--	--	--	--	--	--	--	--
Well Pad and Road Construction Traffic	0.0019	0.0019	0.0019	0.0019	0.0019	0.0019	--	--	--	--
Well Pad and Road Construction Heavy Equipment	0.1101	0.1101	0.1101	0.1101	0.1101	0.1101	--	--	--	--
Pipeline Construction	--	--	--	--	--	--	--	--	--	--
Pipeline Construction Traffic	0.0004	0.0004	0.0004	0.0004	0.0004	0.0004	--	--	--	--
Pipeline Construction Heavy Equipment	0.0516	0.0516	0.0516	0.0516	0.0516	0.0516	--	--	--	--
Drill Rig Engines	0.1096	0.1096	0.1096	0.1096	0.1096	0.0614	--	--	--	--
Drilling Traffic	0.0099	0.0099	0.0099	0.0099	0.0099	0.0055	--	--	--	--
Drilling Heavy Equipment	0.0052	0.0052	0.0052	0.0052	0.0052	0.0029	--	--	--	--
Fracturing Engines	0.1064	0.1064	0.1064	0.1064	0.1064	0.0425	--	--	--	--
Completion Rig Engines	0.0030	0.0030	0.0030	0.0030	0.0030	0.0012	--	--	--	--
Completion Traffic	0.0005	0.0005	0.0005	0.0005	0.0005	0.0002	--	--	--	--
Completion Flaring	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	--	--	--	--
Production Emissions										
Workover Rig Engines	0.0009	0.0019	0.0028	0.0038	0.0048	0.0051	0.0051	0.0051	0.0051	0.0051
Production Traffic	0.0001	0.0001	0.0002	0.0002	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
Separator Heaters	--	--	--	--	--	--	--	--	--	--
Tank Heaters	--	--	--	--	--	--	--	--	--	--
Production Fugitives	--	--	--	--	--	--	--	--	--	--
Screw Compressors	--	--	--	--	--	--	--	--	--	--
C.S. Separators	--	--	--	--	--	--	--	--	--	--
Water Transfer Pumps	--	--	--	--	--	--	--	--	--	--
Pumping Units	--	--	--	--	--	--	--	--	--	--
Total Construction Emissions	0.40	0.40	0.40	0.40	0.40	0.28	0.00	0.00	0.00	0.00
Total Production Emissions	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01
Total Emissions	0.40	0.40	0.40	0.40	0.40	0.28	0.01	0.01	0.01	0.01

Bull Mountain
Year-by-Year Emissions Summary

VOC

Activity	Pollutant Emission Rate (tpy) Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Construction Emissions										
Well Pad and Road Construction	--	--	--	--	--	--	--	--	--	--
Well Pad and Road Construction Traffic	0.0508	0.0508	0.0508	0.0508	0.05	0.0508	--	--	--	--
Well Pad and Road Construction Heavy Equipment	0.1693	0.1693	0.1693	0.1693	0.17	0.1693	--	--	--	--
Pipeline Construction	--	--	--	--	--	--	--	--	--	--
Pipeline Construction Traffic	0.0144	0.0144	0.0144	0.0144	0.01	0.0144	--	--	--	--
Pipeline Construction Heavy Equipment	0.1587	0.1587	0.1587	0.1587	0.16	0.1587	--	--	--	--
Drill Rig Engines	2.3143	2.3143	2.3143	2.3143	2.31	1.2960	--	--	--	--
Drilling Traffic	0.2761	0.2761	0.2761	0.2761	0.28	0.1546	--	--	--	--
Drilling Heavy Equipment	0.2540	0.2540	0.2540	0.2540	0.25	0.1422	--	--	--	--
Fracturing Engines	0.6286	0.6286	0.6286	0.6286	0.6286	0.2514	--	--	--	--
Completion Rig Engines	0.1786	0.1786	0.1786	0.1786	0.1786	0.0714	--	--	--	--
Completion Traffic	0.0118	0.0118	0.0118	0.0118	0.0118	0.0047	--	--	--	--
Completion Flaring	0.3715	0.3715	0.3715	0.3715	0.3715	0.1486	--	--	--	--
Production Emissions										
Workover Rig Engines	0.0558	0.1148	0.1706	0.2295	0.2885	0.3102	0.3102	0.3102	0.3102	0.3102
Production Traffic	0.0053	0.0109	0.0161	0.0217	0.0273	0.0293	0.0293	0.0293	0.0293	0.0293
Separator Heaters	0.2230	0.4584	0.6814	0.9169	1.1523	1.2390	1.2390	1.2390	1.2390	1.2390
Tank Heaters	0.2974	0.6112	0.9086	1.2225	1.5364	1.6520	1.6520	1.6520	1.6520	1.6520
Production Fugitives	0.7250	1.4903	2.2153	2.9805	3.7458	4.0277	4.0277	4.0277	4.0277	4.0277
Screw Compressors	--	2.5219	5.0438	7.5656	10.0875	10.0875	10.0875	10.0875	10.0875	10.0875
C.S. Separators	--	0.0170	0.0339	0.0509	0.0679	0.0679	0.0679	0.0679	0.0679	0.0679
Water Transfer Pumps	0.6812	1.4002	2.0814	2.8004	3.5194	3.7843	3.7843	3.7843	3.7843	3.7843
Pumping Units	1.3813	2.8393	4.2206	5.6786	7.1366	7.6738	7.6738	7.6738	7.6738	7.6738
Total Construction Emissions	4.43	4.43	4.43	4.43	4.43	2.46	0.00	0.00	0.00	0.00
Total Production Emissions	3.37	9.46	15.37	21.47	27.56	28.87	28.87	28.87	28.87	28.87
Total Emissions	7.80	13.89	19.80	25.89	31.99	31.33	28.87	28.87	28.87	28.87

Bull Mountain
Year-by-Year Emissions Summary

Activity	CO_2e Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
	Pollutant Emission Rate (tpy)									
Construction Emissions										
Well Pad and Road Construction	--	--	--	--	--	--	--	--	--	--
Well Pad and Road Construction Traffic	56.9070	56.9070	56.9070	56.9070	56.9070	56.9070	--	--	--	--
Well Pad and Road Construction Heavy Equipment	69.4902	69.4902	69.4902	69.4902	69.4902	69.4902	--	--	--	--
Pipeline Construction	--	--	--	--	--	--	--	--	--	--
Pipeline Construction Traffic	13.2339	13.2339	13.2339	13.2339	13.2339	13.2339	--	--	--	--
Pipeline Construction Heavy Equipment	52.1177	52.1177	52.1177	52.1177	52.1177	52.1177	--	--	--	--
Drill Rig Engines	3635.4099	3635.4099	3635.4099	3635.4099	3635.4099	2035.8295	--	--	--	--
Drilling Traffic	301.0915	301.0915	301.0915	301.0915	301.0915	168.6112	--	--	--	--
Drilling Heavy Equipment	5.2118	5.2118	5.2118	5.2118	5.2118	2.9186	--	--	--	--
Fracturing Engines	987.3953	987.3953	987.3953	987.3953	987.3953	394.9581	--	--	--	--
Completion Rig Engines	280.5100	280.5100	280.5100	280.5100	280.5100	112.2040	--	--	--	--
Completion Traffic	15.1218	15.1218	15.1218	15.1218	15.1218	6.0487	--	--	--	--
Completion Flaring	1702.2276	1702.2276	1702.2276	1702.2276	1702.2276	680.8910	--	--	--	--
Production Emissions										
Workover Rig Engines	87.7061	180.2848	267.9910	360.5697	453.1484	487.2563	487.2563	487.2563	487.2563	487.2563
Production Traffic	2.4218	4.9781	7.3999	9.9562	12.5125	13.4543	13.4543	13.4543	13.4543	13.4543
Separator Heaters	763.6159	1569.6548	2333.2707	3139.3096	3945.3486	4242.3103	4242.3103	4242.3103	4242.3103	4242.3103
Tank Heaters	1018.1545	2092.8731	3111.0276	4185.7462	5260.4648	5656.4138	5656.4138	5656.4138	5656.4138	5656.4138
Production Fugitives	0.6096	1.2532	1.8628	2.5063	3.1498	3.3869	3.3869	3.3869	3.3869	3.3869
Screw Compressors	--	2784.8152	5569.6304	8354.4456	11139.2609	11139.2609	11139.2609	11139.2609	11139.2609	11139.2609
C.S. Separators	--	58.1138	116.2277	174.3415	232.4554	232.4554	232.4554	232.4554	232.4554	232.4554
Water Transfer Pumps	602.5243	1238.5222	1841.0465	2477.0443	3113.0422	3347.3572	3347.3572	3347.3572	3347.3572	3347.3572
Pumping Units	1221.7854	2511.4477	3733.2331	5022.8954	6312.5578	6787.6965	6787.6965	6787.6965	6787.6965	6787.6965
Total Construction Emissions	7118.72	7118.72	7118.72	7118.72	7118.72	3593.21	0.00	0.00	0.00	0.00
Total Production Emissions	3696.82	10441.94	16981.69	23726.81	30471.94	31909.59	31909.59	31909.59	31909.59	31909.59
Total Emissions	10815.53	17560.66	24100.41	30845.53	37590.66	35502.80	31909.59	31909.59	31909.59	31909.59

Bull Mountain
Year-by-Year Emissions Summary

Benzene

Activity	Pollutant Emission Rate (tpy) Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Construction Emissions										
Well Pad and Road Construction	--	--	--	--	--	--	--	--	--	--
Well Pad and Road Construction Traffic	--	--	--	--	--	--	--	--	--	--
Well Pad and Road Construction Heavy Equipment	--	--	--	--	--	--	--	--	--	--
Pipeline Construction	--	--	--	--	--	--	--	--	--	--
Pipeline Construction Traffic	--	--	--	--	--	--	--	--	--	--
Pipeline Construction Heavy Equipment	--	--	--	--	--	--	--	--	--	--
Drill Rig Engines	0.0190	0.0190	0.0190	0.0190	0.0190	0.0106	--	--	--	--
Drilling Traffic	--	--	--	--	--	--	--	--	--	--
Drilling Heavy Equipment	--	--	--	--	--	--	--	--	--	--
Fracturing Engines	0.0052	0.0052	0.0052	0.0052	0.0052	0.0021	--	--	--	--
Completion Rig Engines	0.0015	0.0015	0.0015	0.0015	0.0015	0.0006	--	--	--	--
Completion Traffic	--	--	--	--	--	--	--	--	--	--
Completion Flaring	0.0184	0.0184	0.0184	0.0184	0.0184	0.0074	--	--	--	--
Production Emissions										
Workover Rig Engines	0.00046	0.0009	0.0014	0.0019	0.0024	0.0025	0.0025	0.0025	0.0025	0.0025
Production Traffic	--	--	--	--	--	--	--	--	--	--
Separator Heaters	0.0089	0.0183	0.0273	0.0367	0.0461	0.0496	0.0496	0.0496	0.0496	0.0496
Tank Heaters	0.0119	0.0244	0.0363	0.0489	0.0615	0.0661	0.0661	0.0661	0.0661	0.0661
Production Fugitives	0.0359	0.0737	0.1096	0.1474	0.1853	0.1992	0.1992	0.1992	0.1992	0.1992
Screw Compressors	--	0.0115	0.0231	0.0346	0.0462	0.0462	0.0462	0.0462	0.0462	0.0462
C.S. Separators	--	0.0007	0.0014	0.0020	0.0027	0.0027	0.0027	0.0027	0.0027	0.0027
Water Transfer Pumps	0.0080	0.0165	0.0246	0.0331	0.0416	0.0447	0.0447	0.0447	0.0447	0.0447
Pumping Units	0.0163	0.0335	0.0499	0.0671	0.0843	0.0907	0.0907	0.0907	0.0907	0.0907
Total Construction Emissions	0.04	0.04	0.04	0.04	0.04	0.02	0.00	0.00	0.00	0.00
Total Production Emissions	0.08	0.18	0.27	0.37	0.47	0.50	0.50	0.50	0.50	0.50
Total Emissions	0.13	0.22	0.32	0.42	0.51	0.52	0.50	0.50	0.50	0.50

Bull Mountain
Year-by-Year Emissions Summary

Activity	Toluene Pollutant Emission Rate (tpy) Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Construction Emissions										
Well Pad and Road Construction	--	--	--	--	--	--	--	--	--	--
Well Pad and Road Construction Traffic	--	--	--	--	--	--	--	--	--	--
Well Pad and Road Construction Heavy Equipment	--	--	--	--	--	--	--	--	--	--
Pipeline Construction	--	--	--	--	--	--	--	--	--	--
Pipeline Construction Traffic	--	--	--	--	--	--	--	--	--	--
Pipeline Construction Heavy Equipment	--	--	--	--	--	--	--	--	--	--
Drill Rig Engines	0.0069	0.0069	0.0069	0.0069	0.0069	0.0039	--	--	--	--
Drilling Traffic	--	--	--	--	--	--	--	--	--	--
Drilling Heavy Equipment	--	--	--	--	--	--	--	--	--	--
Fracturing Engines	0.0019	0.0019	0.0019	0.0019	0.0019	0.0007	--	--	--	--
Completion Rig Engines	0.0005	0.0005	0.0005	0.0005	0.0005	0.0002	--	--	--	--
Completion Traffic	--	--	--	--	--	--	--	--	--	--
Completion Flaring	0.0277	0.0277	0.0277	0.0277	0.0277	0.0111	--	--	--	--
Production Emissions										
Workover Rig Engines	0.00017	0.0003	0.0005	0.0007	0.0009	0.0009	0.0009	0.0009	0.0009	0.0009
Production Traffic	--	--	--	--	--	--	--	--	--	--
Separator Heaters	0.0045	0.0092	0.0136	0.0183	0.0230	0.0248	0.0248	0.0248	0.0248	0.0248
Tank Heaters	0.0059	0.0122	0.0182	0.0244	0.0307	0.0330	0.0330	0.0330	0.0330	0.0330
Production Fugitives	0.0540	0.1111	0.1651	0.2221	0.2792	0.3002	0.3002	0.3002	0.3002	0.3002
Screw Compressors	--	0.0107	0.0214	0.0321	0.0428	0.0428	0.0428	0.0428	0.0428	0.0428
C.S. Separators	--	0.0003	0.0007	0.0010	0.0014	0.0014	0.0014	0.0014	0.0014	0.0014
Water Transfer Pumps	0.0003	0.0006	0.0008	0.0011	0.0014	0.0015	0.0015	0.0015	0.0015	0.0015
Pumping Units	0.0006	0.0012	0.0017	0.0023	0.0029	0.0031	0.0031	0.0031	0.0031	0.0031
Total Construction Emissions	0.04	0.04	0.04	0.04	0.04	0.02	0.00	0.00	0.00	0.00
Total Production Emissions	0.07	0.15	0.22	0.30	0.38	0.41	0.41	0.41	0.41	0.41
Total Emissions	0.10	0.18	0.26	0.34	0.42	0.42	0.41	0.41	0.41	0.41

Bull Mountain
Year-by-Year Emissions Summary

	Ethylbenzene									
	Pollutant Emission Rate (tpy)									
Activity	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Construction Emissions										
Well Pad and Road Construction	--	--	--	--	--	--	--	--	--	--
Well Pad and Road Construction Traffic	--	--	--	--	--	--	--	--	--	--
Well Pad and Road Construction Heavy Equipment	--	--	--	--	--	--	--	--	--	--
Pipeline Construction	--	--	--	--	--	--	--	--	--	--
Pipeline Construction Traffic	--	--	--	--	--	--	--	--	--	--
Pipeline Construction Heavy Equipment	--	--	--	--	--	--	--	--	--	--
Drill Rig Engines	--	--	--	--	--	--	--	--	--	--
Drilling Traffic	--	--	--	--	--	--	--	--	--	--
Drilling Heavy Equipment	--	--	--	--	--	--	--	--	--	--
Fracturing Engines	--	--	--	--	--	--	--	--	--	--
Completion Rig Engines	--	--	--	--	--	--	--	--	--	--
Completion Traffic	--	--	--	--	--	--	--	--	--	--
Completion Flaring	0.0010	0.0010	0.0010	0.0010	0.0010	0.0004	--	--	--	--
Production Emissions										
Workover Rig Engines	--	--	--	--	--	--	--	--	--	--
Production Traffic	--	--	--	--	--	--	--	--	--	--
Separator Heaters	--	--	--	--	--	--	--	--	--	--
Tank Heaters	--	--	--	--	--	--	--	--	--	--
Production Fugitives	0.0020	0.0041	0.0061	0.0082	0.0103	0.0111	0.0111	0.0111	0.0111	0.0111
Screw Compressors	--	0.0010	0.0021	0.0031	0.0042	0.0042	0.0042	0.0042	0.0042	0.0042
C.S. Separators	--	--	--	--	--	--	--	--	--	--
Water Transfer Pumps	0.0007	0.0015	0.0022	0.0030	0.0038	0.0041	0.0041	0.0041	0.0041	0.0041
Pumping Units	0.0015	0.0030	0.0045	0.0061	0.0077	0.0082	0.0082	0.0082	0.0082	0.0082
Total Construction Emissions	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total Production Emissions	0.00	0.01	0.01	0.02	0.03	0.03	0.03	0.03	0.03	0.03
Total Emissions	0.01	0.01	0.02	0.02	0.03	0.03	0.03	0.03	0.03	0.03

Bull Mountain
Year-by-Year Emissions Summary

Activity	Xylene Pollutant Emission Rate (tpy) Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Construction Emissions										
Well Pad and Road Construction	--	--	--	--	--	--	--	--	--	--
Well Pad and Road Construction Traffic	--	--	--	--	--	--	--	--	--	--
Well Pad and Road Construction Heavy Equipment	--	--	--	--	--	--	--	--	--	--
Pipeline Construction	--	--	--	--	--	--	--	--	--	--
Pipeline Construction Traffic	--	--	--	--	--	--	--	--	--	--
Pipeline Construction Heavy Equipment	--	--	--	--	--	--	--	--	--	--
Drill Rig Engines	0.0047	0.0047	0.0047	0.0047	0.0047	0.0026	--	--	--	--
Drilling Traffic	--	--	--	--	--	--	--	--	--	--
Drilling Heavy Equipment	--	--	--	--	--	--	--	--	--	--
Fracturing Engines	0.0013	0.0013	0.0013	0.0013	0.0013	0.0005	--	--	--	--
Completion Rig Engines	0.0004	0.0004	0.0004	0.0004	0.0004	0.0001	--	--	--	--
Completion Traffic	--	--	--	--	--	--	--	--	--	--
Completion Flaring	0.0118	0.0118	0.0118	0.0118	0.0118	0.0047	--	--	--	--
Production Emissions										
Workover Rig Engines	0.00011	0.0002	0.0003	0.0005	0.0006	0.0006	0.0006	0.0006	0.0006	0.0006
Production Traffic	--	--	--	--	--	--	--	--	--	--
Separator Heaters	--	--	--	--	--	--	--	--	--	--
Tank Heaters	--	--	--	--	--	--	--	--	--	--
Production Fugitives	0.02302	0.0473	0.0703	0.0946	0.1189	0.1279	0.1279	0.1279	0.1279	0.1279
Screw Compressors	--	0.0048	0.0097	0.0145	0.0193	0.0193	0.0193	0.0193	0.0193	0.0193
C.S. Separators	--	--	--	--	--	--	--	--	--	--
Water Transfer Pumps	0.00293	0.0060	0.0089	0.0120	0.0151	0.0163	0.0163	0.0163	0.0163	0.0163
Pumping Units	0.00593	0.0122	0.0181	0.0244	0.0307	0.0330	0.0330	0.0330	0.0330	0.0330
Total Construction Emissions	0.02	0.02	0.02	0.02	0.02	0.01	0.00	0.00	0.00	0.00
Total Production Emissions	0.03	0.07	0.11	0.15	0.18	0.20	0.20	0.20	0.20	0.20
Total Emissions	0.05	0.09	0.13	0.16	0.20	0.21	0.20	0.20	0.20	0.20

Bull Mountain
Year-by-Year Emissions Summary

	n-Hexane									
	Pollutant Emission Rate (tpy)									
Activity	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Construction Emissions										
Well Pad and Road Construction	--	--	--	--	--	--	--	--	--	--
Well Pad and Road Construction Traffic	--	--	--	--	--	--	--	--	--	--
Well Pad and Road Construction Heavy Equipment	--	--	--	--	--	--	--	--	--	--
Pipeline Construction	--	--	--	--	--	--	--	--	--	--
Pipeline Construction Traffic	--	--	--	--	--	--	--	--	--	--
Pipeline Construction Heavy Equipment	--	--	--	--	--	--	--	--	--	--
Drill Rig Engines	--	--	--	--	--	--	--	--	--	--
Drilling Traffic	--	--	--	--	--	--	--	--	--	--
Drilling Heavy Equipment	--	--	--	--	--	--	--	--	--	--
Fracturing Engines	--	--	--	--	--	--	--	--	--	--
Completion Rig Engines	--	--	--	--	--	--	--	--	--	--
Completion Traffic	--	--	--	--	--	--	--	--	--	--
Completion Flaring	0.0354	0.0354	0.0354	0.0354	0.0354	0.0142	--	--	--	--
Production Emissions										
Workover Rig Engines	--	--	--	--	--	--	--	--	--	--
Production Traffic	--	--	--	--	--	--	--	--	--	--
Separator Heaters	--	--	--	--	--	--	--	--	--	--
Tank Heaters	--	--	--	--	--	--	--	--	--	--
Production Fugitives	0.06902	0.1419	0.2109	0.2837	0.3566	0.3834	0.3834	0.3834	0.3834	0.3834
Screw Compressors	--	0.0291	0.0582	0.0874	0.1165	0.1165	0.1165	0.1165	0.1165	0.1165
C.S. Separators	--	--	--	--	--	--	--	--	--	--
Water Transfer Pumps	0.00146	0.0030	0.0045	0.0060	0.0076	0.0081	0.0081	0.0081	0.0081	0.0081
Pumping Units	0.00297	0.0061	0.0091	0.0122	0.0153	0.0165	0.0165	0.0165	0.0165	0.0165
Total Construction Emissions	0.04	0.04	0.04	0.04	0.04	0.01	0.00	0.00	0.00	0.00
Total Production Emissions	0.07	0.18	0.28	0.39	0.50	0.52	0.52	0.52	0.52	0.52
Total Emissions	0.11	0.22	0.32	0.42	0.53	0.54	0.52	0.52	0.52	0.52

Bull Mountain
Year-by-Year Emissions Summary

Formaldehyde

Activity	Pollutant Emission Rate (tpy)									
	Year 1	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 6**	**Year 7**	**Year 8**	**Year 9**	**Year 10**
Construction Emissions										
Well Pad and Road Construction	--	--	--	--	--	--	--	--	--	--
Well Pad and Road Construction Traffic	--	--	--	--	--	--	--	--	--	--
Well Pad and Road Construction Heavy Equipment	--	--	--	--	--	--	--	--	--	--
Pipeline Construction	--	--	--	--	--	--	--	--	--	--
Pipeline Construction Traffic	--	--	--	--	--	--	--	--	--	--
Pipeline Construction Heavy Equipment	--	--	--	--	--	--	--	--	--	--
Drill Rig Engines	0.0019	0.0019	0.0019	0.0019	0.0019	0.0011	--	--	--	--
Drilling Traffic	--	--	--	--	--	--	--	--	--	--
Drilling Heavy Equipment	--	--	--	--	--	--	--	--	--	--
Fracturing Engines	0.0005	0.0005	0.0005	0.0005	0.0005	0.0002	--	--	--	--
Completion Rig Engines	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	--	--	--	--
Completion Traffic	--	--	--	--	--	--	--	--	--	--
Completion Flaring	--	--	--	--	--	--	--	--	--	--
Production Emissions										
Workover Rig Engines	0.00005	0.0001	0.0001	0.0002	0.0002	0.0003	0.0003	0.0003	0.0003	0.0003
Production Traffic	--	--	--	--	--	--	--	--	--	--
Separator Heaters	0.01784	0.0367	0.0545	0.0733	0.0922	0.0991	0.0991	0.0991	0.0991	0.0991
Tank Heaters	0.02379	0.0489	0.0727	0.0978	0.1229	0.1322	0.1322	0.1322	0.1322	0.1322
Production Fugitives	--	--	--	--	--	--	--	--	--	--
Screw Compressors	--	1.3853	2.7705	4.1558	5.5411	5.5411	5.5411	5.5411	5.5411	5.5411
C.S. Separators	--	0.0014	0.0027	0.0041	0.0054	0.0054	0.0054	0.0054	0.0054	0.0054
Water Transfer Pumps	0.05926	0.1218	0.1811	0.2436	0.3062	0.3292	0.3292	0.3292	0.3292	0.3292
Pumping Units	0.12018	0.2470	0.3672	0.4941	0.6209	0.6676	0.6676	0.6676	0.6676	0.6676
Total Construction Emissions	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total Production Emissions	0.22	1.84	3.45	5.07	6.69	6.77	6.77	6.77	6.77	6.77
Total Emissions	0.22	1.84	3.45	5.07	6.69	6.78	6.77	6.77	6.77	6.77

Bull Mountain
Year-by-Year Emissions Summary

	Total HAPs									
	Pollutant Emission Rate (tpy)									
Activity	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Construction Emissions										
Well Pad and Road Construction	--	--	--	--	--	--	--	--	--	--
Well Pad and Road Construction Traffic	--	--	--	--	--	--	--	--	--	--
Well Pad and Road Construction Heavy Equipment	--	--	--	--	--	--	--	--	--	--
Pipeline Construction	--	--	--	--	--	--	--	--	--	--
Pipeline Construction Traffic	--	--	--	--	--	--	--	--	--	--
Pipeline Construction Heavy Equipment	--	--	--	--	--	--	--	--	--	--
Drill Rig Engines	0.0326	0.0326	0.0326	0.0326	0.03	0.0182	0.0000	0.0000	0.0000	0.0000
Drilling Traffic	--	--	--	--	--	--	--	--	--	--
Drilling Heavy Equipment	--	--	--	--	--	--	--	--	--	--
Fracturing Engines	0.0088	0.0088	0.0088	0.0088	0.0088	0.0035	0.0000	0.0000	0.0000	0.0000
Completion Rig Engines	0.0025	0.0025	0.0025	0.0025	0.0025	0.0010	0.0000	0.0000	0.0000	0.0000
Completion Traffic	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Completion Flaring	0.0944	0.0944	0.0944	0.0944	0.0944	0.0378	0.0000	0.0000	0.0000	0.0000
Production Emissions										
Workover Rig Engines	0.0008	0.0016	0.0024	0.0032	0.0041	0.0044	0.0044	0.0044	0.0044	0.0044
Production Traffic	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Separator Heaters	0.0312	0.0642	0.0954	0.1284	0.1613	0.1735	0.1735	0.1735	0.1735	0.1735
Tank Heaters	0.0416	0.0856	0.1272	0.1711	0.2151	0.2313	0.2313	0.2313	0.2313	0.2313
Production Fugitives	0.1839	0.3781	0.5620	0.7562	0.9503	1.0219	1.0219	1.0219	1.0219	1.0219
Screw Compressors	0.0000	1.4425	2.8850	4.3275	5.7700	5.7700	5.7700	5.7700	5.7700	5.7700
C.S. Separators	0.0000	0.0024	0.0048	0.0071	0.0095	0.0095	0.0095	0.0095	0.0095	0.0095
Water Transfer Pumps	0.0727	0.1495	0.2222	0.2989	0.3757	0.4040	0.4040	0.4040	0.4040	0.4040
Pumping Units	0.1474	0.3031	0.4505	0.6062	0.7618	0.8191	0.8191	0.8191	0.8191	0.8191
Total Construction Emissions	0.14	0.14	0.14	0.14	0.14	0.06	0.00	0.00	0.00	0.00
Total Production Emissions	0.48	2.43	4.35	6.30	8.25	8.43	8.43	8.43	8.43	8.43
Total Emissions	0.62	2.57	4.49	6.44	8.39	8.49	8.43	8.43	8.43	8.43

Activity or Equipment	Size	Units	Duration	Units	Pads Constructed per year	Control	Efficiency	Emission Factor PM10	Emission Factor PM2.5	units	Emissions (tons/pad) PM10	Emissions (tons/pad) PM2.5	Emissions (tons/year) PM10	Emissions (tons/year) PM2.5
Pad Construction Fugitives	5	acres	12	days	6	water	50%	0.11	0.011	tons/acre-mo	0.21290	0.02129	1.27742	0.12774
Wind Erosion - Pad Construction	5	acres	12	days	6	water	50%	0.1368	0.013	ton/acre-yr	0.01124	0.00107	0.06746	0.00641
Road Construction Fugitives	1.8	acres	8	days	6	water	50%	0.11	0.011	tons/acre-mo	0.05110	0.00511	0.30658	0.03066
Wind Erosion - Road Construction	1.8	acres	8	days	6	water	50%	0.1368	0.013	ton/acre-yr	0.00270	0.00026	0.01619	0.00154
											0.278	0.028	1.668	0.166

Short-term emissions estimates should be based on 10 hours per day construction duration for both pad and road construction.
Emissions estimates based on 6 pads/year, 4 wells/pad, 6 years construction duration.

Calculation Details:

Construction Fugitives

Emission Factors

PM_{10}	0.11		WRAP Fugitive Dist Handbook Section 3.4.1, Western Regional Air Partnership 2006
$PM_{2.5}$	0.011	10 % of PM_{10}	WRAP Fugitive Dist Handbook Section 3.4.1, Western Regional Air Partnership 2006

Note: Control Efficiency of 50% for watering assumed in emission factor

Calculations

PM_{10} (tons/pad) = EF_{PM10} * (acres) * month (days/31)
$PM_{2.5}$ (tons/pad) = $EF_{PM2.5}$ * (acres) * month (days/31)
PM_{10} (tons/year) = Emission $rate_{PM10}$ (tons/pad) * pads per year
$PM_{2.5}$ (tons/year) = Emission $rate_{PM2.5}$ (tons/pad) * pads per year

Wind Erosion

Emission Factors

Total Suspended Particulate (TSP)	0.38	tons/acre-year	EPA, AP-42, Volume I, Section 11.9 "Western Surface Coal Mining" (7/98)
PM_{10}	0.36	36 % of TSP	EPA, AP-42, Volume I, Section 13.2.2 "Unpaved Roads" (2004)
$PM_{2.5}$	0.095	9.5 % of PM_{10}	EPA, AP-42, Volume I, Section 13.2.2 "Unpaved Roads" (2004)

Calculations

PM_{10} (tons/pad) = EF_{PM10} * (acres) * year (days/365) * watering control efficiency (50%)
$PM_{2.5}$ (tons/pad) = $EF_{PM2.5}$ * (acres) * year (days/365) * watering control efficiency (50%)
PM_{10} (tons/year) = Emission $rate_{PM10}$ (tons/pad) * pads per year
$PM_{2.5}$ (tons/year) = Emission $rate_{PM2.5}$ (tons/pad) * pads per year

Description	Total Road and Well Pad Construction Traffic Emissions (tons per pad)												Fugitive	
	NOx	VOC	CO	PM10	PM2.5	SO2	CO2	CH4	PM_filt	PM_cond	N2O		PM10	PM2.5
Construction Traffic, Road and Well pad (LD)	0.0027	0.0016	0.0192	0.0001	0.0001	0.0000	0.6481	0.0001	0.0000	0.0000	0.0000		0.1019	0.0101
Construction Traffic, Road and Well pad (HD)	0.0749	0.0069	0.0558	0.0045	0.0043	0.0003	8.7776	0.0003	0.0000	0.0000	0.0001		0.3567	0.0354
							Metric Tons	Metric Tons			Metric Tons			

Well Road Traffic Exhaust Emissions (lbs per well pad)

	Pollutant	MOVES Emission Factors (g/mile)	Emissions (lb/well pad)
Light Duty	NOx	2.52	5.334
	SO2	0.01	0.030
	CO	18.19	38.492
	CO2	675.15	1429
	VOC	1.48	3.129
	PM10	0.09	0.184
	PM2.5	0.08	0.175
	PM_filt	-	0.000
	PM_cond	-	0.000
	CH4	0.08	0.180
	N2O	0.05	0.097
Heavy-Duty Truck	NOx	20.23	149.821
	SO2	0.08	0.595
	CO	15.07	111.613
	CO2	2612.44	19351.372
	VOC	1.86	13.788
	PM10	1.21	8.946
	PM2.5	1.17	8.672
	PM_filt	-	0.000
	PM_cond	-	0.000
	CH4	0.09	0.668
	N2O	0.04	0.263

Equipment Utilization

Equipment Type	Mean Vehicle Speed (mph)	Round Trip Off-Road Trip Distance (miles)	Number of Round Trips Per Pad/Road
Average Truck	20.5	16	60
Heavy Truck	20.5	16	210

Fugitive Particulate Emissions - Construction Traffic Pad and Road

Source for Data for Constants: EPA (1995), AP-42, Section 13.2.2 Unpaved Roads (9/98). Table 13.2.2-2.

$$E\ [lb/VMT] = \frac{k(s/12)^a(S/30)d}{(M/0.5)^c} \cdot \frac{(365-P)}{365} \cdot (\text{Control Efficiency})$$

Constant	PM_{10}	$PM_{2.5}$
k	1.8	0.18
a	1.00	1.00
d	0.50	0.50
c	0.2	0.2
C	0.00047	0.00036

Variable Description	Value	Reference
E = size-specific emission factor (lb/VMT)		
s = surface material silt content (%)	5.1	EPA, *AP-42*, Volume I, Section 13.2.2 Unpaved Roads (9/98)
W = mean vehicle weight (tons)	55	
W = mean vehicle weight (tons)	3	
M = surface material moisture content (%)	2.4	AP-42 Table 11.9-3
Average control efficiency for watering (9 mi) and mag chloride (1 mi) (%) =	54	EPA, *Control of Open Fugitive Dust Sources*, EPA-450 / 3-88-001, Sept 1988.
P = Precipitation Days (>0.01" rainfall)	82	Precipitation days at Paonia, Colorado from NCDC climatology

Activity	Vehicle Type	Av. Vehicle Weight (lb)	Mean vehicle speed (mph)	# of Visits per Year	Total # of Round Trips	Round Trip Distance (mi)	Total Miles Traveled	PM_{10}		$PM_{2.5}$	
								Em. Factor (lb/VMT)	Emissions (tpy/pad)	Em. Factor (lb/VMT)	Emissions (tpy/pad)
Travel to well	Light truck	6,000	20.5	60	60	16	960	0.21	0.102	0.02	0.010
Travel to well	Heavy Truck	110,000	20.5	210	210	16	3360	0.21	0.357	0.02	0.035
							Total	**0.42**	**0.46**	**0.04**	**0.05**

Well Pad and Road Construction Heavy Equipment Tailpipe Emissions

Equipment Type	Engine Horesepower	Quantity	Operating Load Factor[1]	Pollutant Emission Factor (g/hp-hr)[2]					Construction Activity Duration		Pollutant Emissions (lb/pad)				
				NOx	CO	VOC	SO2	PM10	(days)	(hours/day)	NOx	CO	VOC	SO2	PM10
Well Pad Construction															
Haul Truck	250	3	0.4	2.8	2.6	0.2	0.13	0.15	8	10	148.1	137.6	10.6	6.9	7.9
Trackhoe	250	1	0.4	2.8	2.6	0.2	0.13	0.15	8	10	49.4	45.9	3.5	2.3	2.6
Dozer	250	2	0.4	2.8	2.6	0.2	0.13	0.15	8	10	98.8	91.7	7.1	4.6	5.3
Grader	250	1	0.4	2.8	2.6	0.2	0.13	0.15	8	10	49.4	45.9	3.5	2.3	2.6
Compactor	250	1	0.4	2.8	2.6	0.2	0.13	0.15	8	10	49.4	45.9	3.5	2.3	2.6
Water Truck	250	1	0.4	2.8	2.6	0.2	0.13	0.15	8	10	49.4	45.9	3.5	2.3	2.6
Road Construction															
Dozer	250	2	0.4	2.8	2.6	0.2	0.13	0.15	8	10	98.8	91.7	7.1	4.6	5.3
Grader	250	1	0.4	2.8	2.6	0.2	0.13	0.15	8	10	49.4	45.9	3.5	2.3	2.6
Trackhoe	250	1	0.4	2.8	2.6	0.2	0.13	0.15	8	10	49.4	45.9	3.5	2.3	2.6
Haul Truck	250	3	0.4	2.8	2.6	0.2	0.13	0.15	8	10	148.1	137.6	10.6	6.9	7.9
											790.1	733.7	56.4	36.7	42.3

[1] Taken from "Surface Mining" (Pfleider 1972) for average surface duty.
[2] Emission factors based on assumption that nonroad engines, on average, meet Tier 3 EPA Emission Standards.

Equipment Type	Construction Activity Duration		Average Speed (mph)	Miles Traveled	Pollutant Emission Factor (g/mile)[1]			Pollutant Emissions (tons)			Part 98 Global Warming Potential [2]		Pollutant Emissions (tons/pad)
	(days)	(hours/day)			CO2	CH4	N2O	CO2	CH4	N2O	CH4	N2O	CO2e
Well Pad Construction													
Haul Truck	8	10	5	400	2612	0.09	0.04	1.152	3.97E-05	1.76E-05	21	310	1.16
Trackhoe	8	10	5	400	2612	0.09	0.04	1.152	3.97E-05	1.76E-05	21	310	1.16
Dozer	8	10	5	400	2612	0.09	0.04	1.152	3.97E-05	1.76E-05	21	310	1.16
Grader	8	10	5	400	2612	0.09	0.04	1.152	3.97E-05	1.76E-05	21	310	1.16
Compactor	8	10	5	400	2612	0.09	0.04	1.152	3.97E-05	1.76E-05	21	310	1.16
Water Truck	8	10	5	400	2612	0.09	0.04	1.152	3.97E-05	1.76E-05	21	310	1.16
Road Construction													
Dozer	8	10	5	400	2612	0.09	0.04	1.152	3.97E-05	1.76E-05	21	310	1.16
Grader	8	10	5	400	2612	0.09	0.04	1.152	3.97E-05	1.76E-05	21	310	1.16
Trackhoe	8	10	5	400	2612	0.09	0.04	1.152	3.97E-05	1.76E-05	21	310	1.16
Compactor	8	10	5	400	2612	0.09	0.04	1.152	3.97E-05	1.76E-05	21	310	1.16
											Total Emissions (tons/year/pad)		**11.58**

[1] Heavy-duty vehicle emission factors from MOVES emission model.
[2] Global warming potential for CH4 and N2O from Table A-1 of 40 CFR Part 98, Mandatory Reporting of Greenhouse Gases, Final Rule.

Calculation Details: CH4 GWP = 21
N2O GWP = 310

Activity or Equipment	Size	Units	Duration	Units	Pads Constructed per year	Control	Efficiency	Emission Factor PM10	Emission Factor PM2.5	units	Emissions (tons/pad) PM10	Emissions (tons/pad) PM2.5	Emissions (tons/year) PM10	Emissions (tons/year) PM2.5
Pipeline Construction Fugitives	4.2	acres	10	days	6	water	50%	0.11	0.011	tons/acre-mo	0.14903	0.01490	0.89419	0.08942
Wind Erosion - Pipeline Construction	4.2	acres	10	days	6	water	50%	0.1368	0.013	ton/acre-yr	0.00787	0.00075	0.04722	0.00449
											0.1569	0.0157	0.9414	0.0939

Annual emissions based on 6 pads constructed per year, one pipeline segment per pad, 6 years construction duration.
Short-term emissions should assume 10 hours per day duration.

Calculation Details:

Construction Fugitives

Emission Factors

PM_{10}	0.11		WRAP Fugitive Dist Handbook Section 3.4.1, Western Regional Air Partnership 2006
$PM_{2.5}$	0.011	10 % of PM_{10}	WRAP Fugitive Dist Handbook Section 3.4.1, Western Regional Air Partnership 2006

Note: Control Efficiency of 50% for watering assumed in emission factor

Calculations

PM_{10} (tons/pad) = EF_{PM10} * (acres) * month (days/31)
$PM_{2.5}$ (tons/pad) = $EF_{PM2.5}$ * (acres) * month (days/31)
PM_{10} (tons/year) = Emission $rate_{PM10}$ (tons/pad) * pads per year
$PM_{2.5}$ (tons/year) = Emission $rate_{PM2.5}$ (tons/pad) * pads per year

Wind Erosion

Emission Factors

Total Suspended Particulate (TSP)	0.38	tons/acre-year	EPA, AP-42, Volume I, Section 11.9 "Western Surface Coal Mining" (7/98)
PM_{10}	0.36	36 % of TSP	EPA, AP-42, Volume I, Section 13.2.2 "Unpaved Roads" (2004)
$PM_{2.5}$	0.095	9.5 % of PM_{10}	EPA, AP-42, Volume I, Section 13.2.2 "Unpaved Roads" (2004)

Calculations

PM_{10} (tons/pad) = EF_{PM10} * (acres) * year (days/365) * watering control efficiency (50%)
$PM_{2.5}$ (tons/pad) = $EF_{PM2.5}$ * (acres) * year (days/365) * watering control efficiency (50%)
PM_{10} (tons/year) = Emission $rate_{PM10}$ (tons/pad) * pads per year
$PM_{2.5}$ (tons/year) = Emission $rate_{PM2.5}$ (tons/pad) * pads per year

Description	Total Pipeline Construction Traffic Emissions (tons per well pad)												Fugitive	
	NOx	VOC	CO	PM10	PM2.5	SO2	CO2	CH4	PM_filt	PM_cond	N2O		PM10	PM2.5
Construction Traffic, F	0.0021	0.0013	0.0154	0.0001	0.0001	0.0000	0.5716	0.0001	0.0000	0.0000	0.0000		0.0815	0.0081
Construction Traffic, F	0.0125	0.0011	0.0093	0.0007	0.0007	0.0000	1.6126	0.0001	0.0000	0.0000	0.0000		0.0595	0.0059

Pipeline Construction Traffic

	Pollutant	MOVES Emission Factors (g/mile)	Emissions (lb/well pad)
Light Duty	NOx	2.52	4.267
	SO2	0.01	0.024
	CO	18.19	30.793
	CO2	675.15	1143
	VOC	1.48	2.503
	PM10	0.09	0.147
	PM2.5	0.08	0.140
	PM_filt	-	0.000
	PM_cond	-	0.000
	CH4	0.08	0.144
	N2O	0.05	0.077
Heavy-Duty Truck	NOx	20.23	24.970
	SO2	0.08	0.099
	CO	15.07	18.602
	CO2	2612.44	3225.229
	VOC	1.86	2.298
	PM10	1.21	1.491
	PM2.5	1.17	1.445
	PM_filt	-	0.000
	PM_cond	-	0.000
	CH4	0.09	0.111
	N2O	0.04	0.044

Equipment Utilization

Equipment Type	Mean Vehicle Speed (mph)	Round Trip Off-Road Trip Distance (miles)	Number of Round Trips Per Pad
Light Truck	20.5	16	48
Heavy Truck	20.5	16	35

Fugitive Particulate Emissions - Pipeline Construction Traffic

Source for Data for Constants: EPA (1995), AP-42, Section 13.2.2 Unpaved Roads (9/98). Table 13.2.2-2.

$$E\ [lb/VMT] = \frac{k(s/12)^a(S/30)d}{(M/0.5)^c} \cdot \frac{(365-P)}{365} \cdot (\text{Control Efficiency})$$

Constant	PM_{10}	$PM_{2.5}$
k	1.8	0.18
a	1.00	1.00
d	0.50	0.50
c	0.2	0.2
C	0.00047	0.00036

Variable Description	Value	Reference
E = size-specific emission factor (lb/VMT)		
s = surface material silt content (%)	5.1	EPA, *AP-42* , Volume I, Section 13.2.2 Unpaved Roads (9/98)
W = mean vehicle weight (tons)	30	
W = mean vehicle weight (tons)	2.75	
M = surface material moisture content (%)	2.4	AP-42 Table 11.9-3
Average control efficiency for watering (9 mi) and mag chloride (1 mi) (%) =	54	EPA, *Control of Open Fugitive Dust Sources,* EPA-450 / 3-88-001, Sept 1988.
P = Precipitation Days (>0.01" rainfall)	82	Precipitation days at Paonia, Colorado from NCDC climatology

Activity	Vehicle Type	Av. Vehicle Weight (lb)	Mean vehicle speed (mph)	# of Visits per Year	Total # of Round Trips	Round Trip Distance (mi)	Total Miles Traveled	PM_{10}		$PM_{2.5}$	
								Em. Factor (lb/VMT)	Emissions (tpy/pad)	Em. Factor (lb/VMT)	Emissions (tpy/pad)
Travel to well	Light truck	5,500	20.5	48	48	16	768	0.21	0.082	0.02	0.008
Travel to well	Heavy Truck	60,000	20.5	35	35	16	560	0.21	0.059	0.02	0.006
							Total	**0.42**	**0.14**	**0.04**	**0.01**

Equipment Type	Engine Horesepower	Quantity	Operating Load Factor[1]	Pollutant Emission Factor (g/hp-hr)[2]					Construction Activity Duration		Pollutant Emissions (lb/pad)				
				NOx	CO	VOC	SO2	PM10	(days)	(hours/day)	NOx	CO	VOC	SO2	PM10
Dozer	250	1	0.4	4.5	2.6	0.4	0.13	0.15	10	10	99.2	57.3	8.8	2.9	3.3
Grader	250	1	0.4	4.5	2.6	0.4	0.13	0.15	10	10	99.2	57.3	8.8	2.9	3.3
Trackhoe	250	1	0.4	4.5	2.6	0.4	0.13	0.15	10	10	99.2	57.3	8.8	2.9	3.3
Bending Mach	250	1	0.4	4.5	2.6	0.4	0.13	0.15	10	10	99.2	57.3	8.8	2.9	3.3
Sideboom	250	1	0.4	4.5	2.6	0.4	0.13	0.15	10	10	99.2	57.3	8.8	2.9	3.3
Utility Tractor	250	1	0.4	4.5	2.6	0.4	0.13	0.15	10	10	99.2	57.3	8.8	2.9	3.3
											595.2	343.9	52.9	17.2	19.8

[1] Taken from "Surface Mining" (Pfleider 1972) for average surface duty.
[2] Emission factors based on assumption that nonroad engines, on average, meet Tier 3 EPA Emission Standards.

Equipment Type	Construction Activity Duration		Average Speed (mph)	Miles Traveled	Pollutant Emission Factor (g/mile)[1]			Pollutant Emissions (tons)			Part 98 Global Warming Potential [2]		Pollutant Emissions (tons/pad)
	(days)	(hours/day)			CO2	CH4	N2O	CO2	CH4	N2O	CH4	N2O	CO2e
Dozer	10	10	5	500	2612	0.09	0.04	1.440	4.96E-05	2.20E-05	21	310	1.45
Grader	10	10	5	500	2612	0.09	0.04	1.440	4.96E-05	2.20E-05	21	310	1.45
Trackhoe	10	10	5	500	2612	0.09	0.04	1.440	4.96E-05	2.20E-05	21	310	1.45
Bending Mach	10	10	5	500	2612	0.09	0.04	1.440	4.96E-05	2.20E-05	21	310	1.45
Sideboom	10	10	5	500	2612	0.09	0.04	1.440	4.96E-05	2.20E-05	21	310	1.45
Utility Tractor	10	10	5	500	2612	0.09	0.04	1.440	4.96E-05	2.20E-05	21	310	1.45
											Total Emissions (tons/year/pad)		**8.69**

[1] Heavy-duty vehicle emission factors from MOVES emission model.
[2] Global warming potential for CH4 and N2O from Table A-1 of 40 CFR Part 98, Mandatory Reporting of Greenhouse Gases, Final Rule.

Calculation Details: CH4 GWP = 21
N2O GWP = 310

Pollutant	Emission Factor	Emission Factor Units	Horsepower (hp) or Heat Input (mmbtu/hr)	Operating Load Factor	Activity Duration (hours/well)	Wells per Year	Activity Duration (hours/yr)	Maximum Short-Term Emissions (lb/hr)	Annual Emissions (tons/well)	Annual Emissions (tons/year)
CO	2.60	g/hp-hr	1200	0.40	540	27	14580	2.75	0.7429	20.0571
NOx	4.50	g/hp-hr	1200	0.40	540	27	14580	4.76	1.2857	34.7143
SO2	0.02	lb/hr	1200	0.40	540	27	14580	0.02	0.0043	0.1096
VOC	0.30	g/hp-hr	1200	0.40	540	27	14580	0.32	0.0857	2.3143
PM10	0.15	g/hp-hr	1200	0.40	540	27	14580	0.16	0.0429	1.1571
Benzene	7.76E-04	lb/mmbtu	8.40	0.40	840	27	14580	2.61E-03	0.0011	0.0190
Toluene	2.81E-04	lb/mmbtu	8.40	0.40	840	27	14580	9.44E-04	0.0004	0.0069
Xylene	1.93E-04	lb/mmbtu	8.40	0.40	840	27	14580	6.48E-04	0.0003	0.0047
Formaldehyde	7.89E-05	lb/mmbtu	8.40	0.40	840	27	14580	2.65E-04	0.0001	0.0019
									Total HAPs	0.0326
									(metric tons/well)	**(metric tons/yr)**
CO2	73.96	kg/mmbtu	8.40	0.40	540	27	14580		134.1930	3623.2116
CH4	0.0030	kg/mmbtu	8.40	0.40	540	27	14580		0.0054	0.1470
N2O	0.0006	kg/mmbtu	8.40	0.40	540	27	14580		0.0011	0.0294
CO2e									134.6448	3635.4099

Emission factors for CO, NOx, VOC, and PM10: Tier 2 based on Tier 2 Emissions Standards for Nonroad Engines.
SO2 emissions based on an average brake-specific fuel consumption of 7,000 Btu/hp-hr, 138,000 Btu/gal diesel fuel, 7.2 lb/gal and 15 ppm S.
Fuel Consumption 69.6 gal/hr
HAP emission factors from EPA AP-42, Volume I, Fifth Edition, October 1996, Table 3.4-3 and 3.4-4.
GHG emission factors from Tables C-1 and C-2 of 40 CFR Part 98, Mandatory Reporting of Greenhouse Gases; Final Rule.
Global warming potential for CH4 and N2O from Table A-1 of 40 CFR Part 98, Mandatory Reporting of Greenhouse Gases, Final Rule.
Calculation Details: CH4 GWP = 21
N2O GWP = 310
Heat input in mmbtu/hr based on a heat rate of 7,000 btu/hp-hr.
Coal well drilling 10 days per well, shale well drilling 35 days per well, average 22.5 days.
Hours per well is based on average drilling duration of 22.5 days x 24 hours per day
Hours per year is based on 27 wells/year developed, average of coal and shale drilling duration of 22.5 days, and 24 hours per day.
LOP drilling 150 wells = 146 oil wells plus 4 water wells. 27 wells/year first five years, 15 wells in sixth year.
One Tier 2 rig will operate year-round, two Tier 2 rigs will operate in summer season (April 1 - November 30)

Description	Total Pipeline Construction Traffic Emissions (tons per well pad)												Fugitive	
	NOx	VOC	CO	PM10	PM2.5	SO2	CO2	CH4	PM_filt	PM_cond	N2O		PM10	PM2.5
Drilling Traffic (LD)	0.0173	0.0102	0.1251	0.0006	0.0006	0.0001	4.2129	0.0005	0.0000	0.0000	0.0003		0.6625	0.0658
Drilling Traffic (HD)	0.3895	0.0358	0.2902	0.0233	0.0225	0.0015	45.6438	0.0016	0.0000	0.0000	0.0006		1.8551	0.1842
							Metric Tons	Metric Tons			Metric Tons			

Calendar Year	Pollutant	MOVES Emission Factors (g/mile)	Emissions (lb/well pad)
Light Duty	NOx	2.52	34.671
	SO2	0.01	0.198
	CO	18.19	250.196
	CO2	675.15	9288
	VOC	1.48	20.339
	PM10	0.09	1.196
	PM2.5	0.08	1.135
	PM_filt	-	0.000
	PM_cond	-	0.000
	CH4	0.08	1.169
	N2O	0.05	0.629
Heavy-Duty Truck	NOx	20.23	779.071
	SO2	0.08	3.095
	CO	15.07	580.389
	CO2	2612.44	100627.133
	VOC	1.86	71.699
	PM10	1.21	46.518
	PM2.5	1.17	45.094
	PM_filt	-	0.000
	PM_cond	-	0.000
	CH4	0.09	3.476
	N2O	0.04	1.370

Equipment Utilization

Equipment Type	Mean Vehicle Speed (mph)	Round Trip Off-Road Trip Distance (miles)	Number of Round Trips Per Pad
Light Truck	20.5	16	390
Heavy Truck	20.5	16	1,092

Fugitive Particulate Emissions

Source for Data for Constants: EPA (1995), AP-42, Section 13.2.2 Unpaved Roads (9/98). Table 13.2.2-2.

$$E\ [lb/VMT] = \frac{k(s/12)^a(S/30)d}{(M/0.5)^c} \cdot \frac{(365-P)}{365} \cdot (\text{Control Efficiency})$$

Constant	PM_{10}	$PM_{2.5}$
k	1.8	0.18
a	1.00	1.00
d	0.50	0.50
c	0.2	0.2
C	0.00047	0.00036

Variable Description	Value	Reference
E = size-specific emission factor (lb/VMT)		
s = surface material silt content (%)	5.1	EPA, *AP-42* , Volume I, Section 13.2.2 Unpaved Roads (9/98)
W = mean vehicle weight (tons)	30.5	
W = mean vehicle weight (tons)	3	
M = surface material moisture content (%)	2.4	AP-42 Table 11.9-3
Average control efficiency for watering (9 mi) and mag chloride (1 mi) (%) =	54	EPA, *Control of Open Fugitive Dust Sources*, EPA-450 / 3-88-001, Sept 1988.
P = Precipitation Days (>0.01" rainfall)	82	Precipitation days at Paonia, Colorado from NCDC climatology

Fugitive Dust Emissions

Activity	Vehicle Type	Av. Vehicle Weight (lb)	Mean vehicle speed (mph)	# of Visits per Year	Total # of Round Trips	Round Trip Distance (mi)	Total Miles Traveled	PM_{10}		$PM_{2.5}$	
								Em. Factor (lb/VMT)	Emissions (tpy/pad)	Em. Factor (lb/VMT)	Emissions (tpy/pad)
Travel to well	Light truck	6,000	20.5	390	390	16	6240	0.21	0.663	0.02	0.066
Travel to well	Heavy Truck	61,000	20.5	1,092	1,092	16	17472	0.21	1.855	0.02	0.184
							Total	**0.42**	**2.52**	**0.04**	**0.25**

Equipment Type	Engine Horesepower	Quantity	Operating Load Factor[1]	Pollutant Emission Factor (g/hp-hr)[2]					Construction Activity Duration		Pollutant Emissions (lb/pad)				
				NOx	CO	VOC	SO2	PM10	(days)	(hours/day)	NOx	CO	VOC	SO2	PM10
Backhoe	250	1	0.4	4.5	2.6	0.4	0.13	0.15	2	10	19.8	11.5	1.8	0.6	0.7
FEL	250	1	0.4	4.5	2.6	0.4	0.13	0.15	2	10	19.8	11.5	1.8	0.6	0.7
Boom/Winch	250	1	0.4	4.5	2.6	0.4	0.13	0.15	2	10	19.8	11.5	1.8	0.6	0.7
											59.5	34.4	5.3	1.7	2.0

[1] Taken from "Surface Mining" (Pfleider 1972) for average surface duty.

[2] Emission factors based on assumption that nonroad engines, on average, meet Tier 3 EPA Emission Standards.

Equipment Type	Construction Activity Duration		Average Speed (mph)	Miles Traveled	Pollutant Emission Factor (g/mile)[1]			Pollutant Emissions (tons)			Part 98 Global Warming Potential [2]		Pollutant Emissions (tons/pad)
	(days)	(hours/day)			CO2	CH4	N2O	CO2	CH4	N2O	CH4	N2O	CO2e
Backhoe	2	10	5	100	2612	0.09	0.04	0.288	9.92E-06	4.41E-06	21	310	0.29
FEL	2	10	5	100	2612	0.09	0.04	0.288	9.92E-06	4.41E-06	21	310	0.29
Boom/Winch	2	10	5	100	2612	0.09	0.04	0.288	9.92E-06	4.41E-06	21	310	0.29
											Total Emissions (tons/year/pad)		**0.87**

[1] Heavy-duty vehicle emission factors from MOVES emission model.

[2] Global warming potential for CH4 and N2O from Table A-1 of 40 CFR Part 98, Mandatory Reporting of Greenhouse Gases, Final Rule.

Calculation Details: CH4 GWP = 21
N2O GWP = 310

Bull Mountain Project
Completion Rig Emissions

Pollutant	Emission Factor	Emission Factor Units	Horsepower (hp) or Heat Input (mmbtu/hr)	Operating Load Factor	Activity Duration (hours/well)	Activity Duration (hrs/year)	Maximum Short-Term Emissions (lb/hr)	Annual Emissions (tons/well)	Annual Emissions (tons/year)
CO	2.60	g/hp-hr	500	0.40	100	2700	1.15	0.0573	1.5476
NOx	4.50	g/hp-hr	500	0.40	100	2700	1.98	0.0992	2.6786
SO2	0.01	lb/hr	500	0.40	100	2700	0.00	0.0003	0.0030
VOC	0.30	g/hp-hr	500	0.40	100	2700	0.13	0.0066	0.1786
PM10	0.15	g/hp-hr	500	0.40	100	2700	0.07	0.0033	0.0893
Benzene	7.76E-04	lb/mmbtu	3.50	0.40	100	2700	5.43E-07	5.43E-05	0.0015
Toluene	2.81E-04	lb/mmbtu	3.50	0.40	100	2700	1.97E-05	1.97E-05	0.0005
Xylene	1.93E-04	lb/mmbtu	3.50	0.40	100	2700	1.35E-05	1.35E-05	0.0004
Formaldehye	7.89E-05	lb/mmbtu	3.50	0.40	100	2700	5.52E-06	5.52E-06	0.0001
								Total HAPs	0.0025
								(metric tons/well)	**(metric tons/yr)**
CO2	73.96	kg/mmbtu	3.50	0.40	100	2700		10.3544	279.5688
CH4	0.0030	kg/mmbtu	3.50	0.40	100	2700		0.0004	0.0113
N2O	0.0006	kg/mmbtu	3.50	0.40	100	2700		0.0001	0.0023
CO2e								10.3893	280.5100

Emission factors for CO, NOx, VOC, and PM10 based on EPA Tier 2 Emissions Standards for Nonroad Engines.
SO2 emissions based on an average brake-specific fuel consumption of 7,000 Btu/hp-hr, 138,000 Btu/gal diesel fuel, 7.2 lb/gal and 15 ppm S.
Fuel Consumption 25.36 gal/hr
HAP emission factors from EPA AP-42, Volume I, Fifth Edition, October 1996, Table 3.4-3 and 3.4-4.
GHG emission factors from Tables C-1 and C-2 of 40 CFR Part 98, Mandatory Reporting of Greenhouse Gases; Final Rule.
Global warming potential for CH4 and N2O from Table A-1 of 40 CFR Part 98, Mandatory Reporting of Greenhouse Gases, Final Rule.
Heat input in mmbtu/hr based on a heat rate of 7,000 btu/hp-hr.

Calculation Details:	CH4	GWP =	21
	N2O	GWP =	310

Hours based on single well completion duration of 10 days, 10 hours per day.
Annual hours based on 27 wells completed per year, 100 hours per well.
Year-by-year annual emissions based on 27 wells completed in first five years, 11 completed in year six.

Emissions

Equipment Type	Pollutant	Per Well Emissions (tons per well)		Average Per Well Controlled Emissions (tons per well) (tons/year-well)	Method
		Shale Well	CBM Well		
Completion Flaring	NOx	0.0333	0.0344	0.0339	AP-42
	VOC	0.0158	0.0117	0.0138	Assumed 98% control
	CO	0.1813	0.1872	0.1843	AP-42
	PM10	0.0000	0.0000	0.0000	not applicable
	PM2.5	0.0000	0.0000	0.0000	not applicable
	SO2	0.0000	0.0000	0.0000	not applicable
	CO2	54.9384	54.9604	54.9494	Carbon balance assuming 98%destruction efficiency
	CH4	0.3690	0.3809	0.3749	Assumed 98% control
	N2O	0.0007	0.0007	0.0007	API Compendium
	Benzene	0.0007	0.0007	0.0007	Assumed 98% control
	Toluene	0.0011	0.0010	0.0010	Assumed 98% control
	Ethylbenzene	0.0000	0.0000	0.0000	Assumed 98% control
	Xylenes	0.0004	0.0004	0.0004	Assumed 98% control
	n-hexane	0.0013	0.0013	0.0013	Assumed 98% control
	formaldahyde	3.9984	4.1252	4.0618	EPA Speciate Profile 0051

Inputs

Fraction of vented gas controlled per well	98%	
Volume Flared Per Well	1,000	MCF/well
HHV of Flared Gas (Shale)	980	Btu/scf
HHV of Flared Gas (CBM)	1012	Btu/scf

Ideal Gas Law Conversions

R	0.0821	L atm / K-mol
Standard Temp	298.15	K
Standard Pressure	1	atm
L/mol	24.47	L/mol
	28.32	L/SCF
	453.5924	g/lb

Number of Wells

Shale Wells	CBM Wells	Total Wells
73	73	146

Completion Flaring Emissions

Pollutant	Emission Factor	Unit	Emissions	
			Shale Well (Tons Per Well)	CBM Well (Tons Per Well)
NO_X [1]	0.068	lb/MMBtu	0.0333	0.0344
CO [1]	0.37	lb/MMBtu	0.1813	0.1872
VOC	-	lb/MMBtu	0.0158	0.0117
CO_2 [2]	-	-	54.9384	54.9604
CH_4 [2]	-	-	0.3690	0.3809
PM	0	lb/MCF	0.0000	0.0000
SO_2	0	lb/MCF	0.0000	0.0000
N2O [3]	1.436	lb/MMCF	0.0007	0.0007

[1] Emission factors for NO_X and CO are based on AP-42, Chapter 13, Section 13.5, Table 13.5-1, dated 9/91 (reformated 1/95).

[2] The emission factors for VOC, CO_2 and CH_4 are based on the the lbs/MMscf gas composition below. The total lb CO_2/MMscf is multiplied by 98% combustion efficiency for the conversion of flare gas carbon to CO_2 (based on the API Compendium of Greenhouse Gas Emissions Methodologies for the Oil and Gas Industry, 2004). The lbs VOC and CH_4/MMscf are multiplied by 2% to represent the non-combusted portion.

[3] Emission Factor from API Compendium of greenhouse gas emissions methodologies for the oil and natural gas industry,2009 Table 4-11, GHG Emission Factors for Gas Flares in Developed Countries - Footnote C

Shale Well Gas Composition

Chemical	Mole %	Molecular Weight (g/mol)[1]	Weight %	lb/ MCF	lb CO_2/MCF	HHV (Btu/scf)[1]	CO2 emission potential of gas sample species (tons/well)	UNCONTROLLED - VOC emission potential of gas sample species (tons/well)	CONTROLLED - VOC emission potential of gas sample species (tons/well)	UNCONTROLLED - Emission potential of gas sample species (tons/well)	CONTROLLED - Emission potential of gas sample species (tons/well)
Carbon Dioxide	6.6600%	44.010	15.7195%	7.48	7.33		3.66			3.74	0.0748
Nitrogen	0.1600%	28.010	0.2404%	0.11			0.00			0.06	0.0011
Methane	90.1500%	16.040	77.5503%	36.90	99.21	1010	49.61			18.45	0.3690
Ethane	1.9600%	30.070	3.1608%	1.50	2.16	1769.7	1.08			0.75	0.0150
Propane	0.5200%	44.100	1.2299%	0.59	0.57	2516.2	0.29	0.29	0.0059	0.29	0.0059
Isobutane	0.1200%	58.120	0.3740%	0.18	0.13	3252	0.07	0.09	0.0018	0.09	0.0018
n-Butane	0.1000%	58.120	0.3117%	0.15	0.11	3262.4	0.06	0.07	0.0015	0.07	0.0015
Isopentane	0.0600%	72.150	0.2322%	0.11	0.07	4000.9	0.03	0.06	0.0011	0.06	0.0011
n-Pentane	0.0300%	72.150	0.1161%	0.06	0.03	4008.7	0.02	0.03	0.0006	0.03	0.0006
Helium	0.0100%	4.003	0.0021%	0.00	0.01	4756	0.01			0.00	0.0000
Hexane+	0.2300%	86.180	1.0630%	0.51	0.25	4481.6	0.13	0.25	0.0051	0.25	0.0051
Total	**100.0000%**	**18.65**	**100.0000%**	**47.58**	**109.88**	**979.83659**	**54.94**	**0.79**	**0.0158**	**23.79**	**0.4758**
Total NMHC	**3.0300%**		**6.4899%**	**3.09**							
Total VOC	**1.0700%**		**3.3290%**	**1.58**							
Total TOG	**93.1700%**		**84.0380%**	**39.98**							

[1] The molecular weights and the higher heating values are from GSPA Engineering Data Book, 12th Edition.

CBM Well Gas Composition

Chemical	Mole %	Molecular Weight (g/mol)[1]	Weight %	lb/ MCF	lb CO_2/MCF	HHV (Btu/scf)[1]	CO2 emission potential of gas sample species (tons/well)	UNCONTROLLED - VOC emission potential of gas sample species (tons/well)	CONTROLLED - VOC emission potential of gas sample species (tons/well)	UNCONTROLLED - Emission potential of gas sample species (tons/well)	CONTROLLED - Emission potential of gas sample species (tons/well)
Carbon Dioxide	3.3300%	44.010	8.2956%	3.74	3.66		1.83			1.87	0.0374
Nitrogen	0.1200%	28.010	0.1903%	0.09			0.00			0.04	0.0009
Methane	93.0600%	16.040	84.4928%	38.09	102.42	1010	51.21			19.04	0.3809
Ethane	2.6000%	30.070	4.4255%	1.99	2.86	1769.7	1.43			1.00	0.0199
Propane	0.5600%	44.100	1.3979%	0.63	0.62	2516.2	0.31	0.32	0.0063	0.32	0.0063
Isobutane	0.1000%	58.120	0.3290%	0.15	0.11	3252	0.06	0.07	0.0015	0.07	0.0015
n-Butane	0.1000%	58.120	0.3290%	0.15	0.11	3262.4	0.06	0.07	0.0015	0.07	0.0015
Isopentane	0.0300%	72.150	0.1225%	0.06	0.03	4000.9	0.02	0.03	0.0006	0.03	0.0006
n-Pentane	0.0300%	72.150	0.1225%	0.06	0.03	4008.7	0.02	0.03	0.0006	0.03	0.0006
Helium	0.0100%	4.003	0.0023%	0.00	0.01	4756	0.01			0.00	0.0000
Hexane+	0.0600%	86.180	0.2927%	0.13	0.07	4481.6	0.03	0.07	0.0013	0.07	0.0013
Total	**100.0000%**	**17.67**	**100.0000%**	**45.08**	**109.92**	**1012.09076**	**54.96**	**0.58**	**0.0117**	**22.54**	**0.4508**
Total NMHC	**3.4900%**		**7.0213%**	**3.17**							
Total VOC	**0.8900%**		**2.5959%**	**1.17**							
Total TOG	**96.5400%**		**91.5119%**	**41.25**							

[1] The molecular weights and the higher heating values are from GSPA Engineering Data Book, 12th Edition.

Emission Factor (lb/MMBtu)*			Fraction of THC as CH4	N2O (lb/MMSCF)[b]	VOC/THC
NOx	CO	THC			
0.068	0.37	0.14	25%	1.44	63%

*Emission Factors are from AP-42

b Emission Factor from API Compendium of greenhouse gas emissions methodologies for the oil and natural gas industry, 2009 Table 4-11, GHG Emission Factors for Gas Flares in Developed Countries - Footnote C

c EPA SPECIATE Profile 0051

	MW (lb/lb-mol)	lb/well
TOG	31.47	171.47
CO	28.01	362.54

Flaring Speciation Profile (EPA SPECIATE 0051)

Name	HC?	VOC?	WEIGHT_PER	Molecular Weight (lb/lb-mol)[2]
Ethane	Y	N	30	30.07
Formaldehyde	N	Y	20	30.03
Methane	Y	N	20	16.04
Propane	Y	Y	30	44.10
			100	

CH4 wt%	20
VOC wt%	50
THC wt%	80
VOC/THC (wt)	63%
CH4/THC (wt)	25%
HAPS/VOC (wt)	31.95%

Description	Total Construction Traffic Emissions (tons per well pad)												Fugitive	
	NOx	VOC	CO	PM10	PM2.5	SO2	CO2	CH4	PM_filt	PM_cond	N2O		PM10	PM2.5
Completion Traffic (LD)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		0.0000	0.0000
Completion Traffic (HD)	0.0214	0.0020	0.0159	0.0013	0.0012	0.0001	2.5079	0.0001	0.0000	0.0000	0.0000		0.1019	0.0101
							Metric Tons	Metric Tons			Metric Tons			

	Pollutant	MOVES Emission Factors (g/mile)	Emissions (lb/well pad)
Light Duty	NOx	2.52	0.000
	SO2	0.01	0.000
	CO	18.19	0.000
	CO2	675.15	0
	VOC	1.48	0.000
	PM10	0.09	0.000
	PM2.5	0.08	0.000
	PM_filt	-	0.000
	PM_cond	-	0.000
	CH4	0.08	0.000
	N2O	0.05	0.000
Heavy-Duty Truck	NOx	20.23	42.806
	SO2	0.08	0.170
	CO	15.07	31.890
	CO2	2612.44	5528.963
	VOC	1.86	3.940
	PM10	1.21	2.556
	PM2.5	1.17	2.478
	PM_filt	-	0.000
	PM_cond	-	0.000
	CH4	0.09	0.191
	N2O	0.04	0.075

Equipment Utilization

Equipment Type	Mean Vehicle Speed (mph)	Round Trip Off-Road Trip Distance (miles)	Number of Round Trips Per Pad
Light Truck	20.5	0	0
Heavy Truck	20.5	16	60

Fugitive Particulate Emissions

Source for Data for Constants: EPA (1995), AP-42, Section 13.2.2 Unpaved Roads (9/98). Table 13.2.2-2.

$$E\ [lb/VMT] = \frac{k(s/12)^a(S/30)d}{(M/0.5)^c} \cdot \frac{(365-P)}{365} \cdot (\text{Control Efficiency})$$

Constant	PM_{10}	$PM_{2.5}$
k	1.8	0.18
a	1.00	1.00
d	0.50	0.50
c	0.2	0.2
C	0.00047	0.00036

Variable Description	Value	Reference
E = size-specific emission factor (lb/VMT)		
s = surface material silt content (%)	5.1	EPA, *AP-42*, Volume I, Section 13.2.2 Unpaved Roads (9/98)
W = mean vehicle weight (tons)	39.25	
W = mean vehicle weight (tons)	0	
M = surface material moisture content (%)	2.4	AP-42 Table 11.9-3
Average control efficiency for watering (9 mi) and mag chloride (1 mi)	54	EPA, *Control of Open Fugitive Dust Sources,* EPA-450 / 3-88-001, Sept 1988.
P = Precipitation Days (>0.01" rainfall)	82	Precipitation days at Paonia, Colorado from NCDC climatology

Fugitive Dust Emissions

Activity	Vehicle Type	Av. Vehicle Weight (lb)	Mean vehicle speed (mph)	# of Visits per Year	Total # of Round Trips	Round Trip Distance (mi)	Total Miles Traveled	PM_{10}		$PM_{2.5}$	
								Em. Factor (lb/VMT)	Emissions (tpy/pad)	Em. Factor (lb/VMT)	Emissions (tpy/pad)
Travel to well	Light truck	0	20.5	0	0	0	0	0.21	0.000	0.02	0.000
Travel to well	Heavy Truck	78,500	20.5	60	60	16	960	0.21	0.102	0.02	0.010
							Total	**0.42**	**0.102**	**0.04**	**0.010**

Short-term emissions should be based on 12 days per completion/testing event, 10 hours per day.

Shale Wells

Pollutant	Quantity	Emission Factor	Emission Factor Units	Horsepower (hp) or Heat Input (mmbtu/hr)	Operating Load Factor	Activity Duration (hours/well)	Activity Duration (hrs/well/year)	Maximum Short-Term Emissions (lb/hr)	Annual Emissions (tons/well)	Annual Emissions (tons/year)
CO	6	2.60	g/hp-hr	2000	0.40	24	312	68.78	0.3302	4.2921
NOx	6	4.50	g/hp-hr	2000	0.40	24	312	119.05	0.5714	7.4286
SO2	6	0.02	lb/hr	2000	0.40	24	312	0.13	0.0016	0.0082
VOC	6	0.30	g/hp-hr	2000	0.40	24	312	7.94	0.0381	0.4952
PM10	6	0.15	g/hp-hr	2000	0.40	24	312	3.97	0.0190	0.2476
Benzene	6	7.76E-04	lb/mmbtu	14.00	0.40	24	312	1.30E-05	3.13E-04	0.0041
Toluene	6	2.81E-04	lb/mmbtu	14.00	0.40	24	312	4.72E-06	1.13E-04	0.0015
Xylene	6	1.93E-04	lb/mmbtu	14.00	0.40	24	312	3.24E-06	7.78E-05	0.0010
Formaldehye	6	7.89E-05	lb/mmbtu	14.00	0.40	24	312	1.33E-06	3.18E-05	0.0004
									(metric tons/well)	**(metric tons/yr)**
CO2	6	73.96	kg/mmbtu	14.00	0.40	24	312		59.6413	775.3375
CH4	6	0.0030	kg/mmbtu	14.00	0.40	24	312		0.0024	0.0314
N2O	6	0.0006	kg/mmbtu	14.00	0.40	24	312		0.0005	0.0063
CO2e									59.8421	777.9478

CBM Wells

Pollutant	Quantity	Emission Factor	Emission Factor Units	Horsepower (hp) or Heat Input (mmbtu/hr)	Operating Load Factor	Activity Duration (hours/well)	Activity Duration (hrs/year)	Maximum Short-Term Emissions (lb/hr)	Annual Emissions (tons/well)	Annual Emissions (tons/year)
CO	2	2.60	g/hp-hr	1500	0.40	24	336	6.88	0.0825	1.1556
NOx	2	4.50	g/hp-hr	1500	0.40	24	336	11.90	0.1429	2.0000
SO2	2	0.73	lb/hr	1500	0.40	24	336	1.46	0.0175	0.0982
VOC	2	0.30	g/hp-hr	1500	0.40	24	336	0.79	0.0095	0.1333
PM10	2	0.15	g/hp-hr	1500	0.40	24	336	0.40	0.0048	0.0667
Benzene	2	7.76E-04	lb/mmbtu	10.50	0.40	24	336	3.26E-06	7.82E-05	0.0011
Toluene	2	2.81E-04	lb/mmbtu	10.50	0.40	24	336	1.18E-06	2.83E-05	0.0004
Xylene	2	1.93E-04	lb/mmbtu	10.50	0.40	24	336	8.11E-07	1.95E-05	0.0003
Formaldehye	2	7.89E-05	lb/mmbtu	10.50	0.40	24	336	3.31E-07	7.95E-06	0.0001
									(metric tons/well)	**(metric tons/yr)**
CO2	2	73.96	kg/mmbtu	10.50	0.40	24	336		14.9103	208.7447
CH4	2	0.0030	kg/mmbtu	10.50	0.40	24	336		0.0006	0.0085
N2O	2	0.0006	kg/mmbtu	10.50	0.40	24	336		0.0001	0.0017
CO2e									14.9605	209.4475

Emission factors for CO, NOx, VOC, and PM10 based on EPA Tier 2 Emissions Standards for Nonroad Engines.
SO2 emissions based on an average brake-specific fuel consumption of 7,000 Btu/hp-hr, 138,000 Btu/gal diesel fuel, 7.2 lb/gal and 15 ppm S.
Fuel Consumption 101.45 gal/hr
HAP emission factors from EPA AP-42, Volume I, Fifth Edition, October 1996, Table 3.4-3 and 3.4-4.
GHG emission factors from Tables C-1 and C-2 of 40 CFR Part 98, Mandatory Reporting of Greenhouse Gases; Final Rule.
Global warming potential for CH4 and N2O from Table A-1 of 40 CFR Part 98, Mandatory Reporting of Greenhouse Gases, Final Rule.
Heat input in mmbtu/hr based on a heat rate of 7,000 btu/hp-hr.

Calculation Details:			
	CH4	GWP =	21
	N2O	GWP =	310

Hours based on duration of 24 hours per well fracturing event, 27 wells completed per year total, 13 shale wells and 14 CBM wells.
Average tons per well calculated as (shale tons/well + CBM tons/well) / 2.
Year-by-year annual emissions based on 27 wells fractured in first five years, 11 fractured in year six.

Pollutant	Emission Factor	Emission Factor Units	Horsepower (hp) or Heat Input (mmbtu/hr)	Operating Load Factor	Activity Duration (hours/well)	Activity Duration (hrs/year)	Maximum Short-Term Emissions (lb/hr)	Annual Emissions (tons/well)	Annual Emissions (tons/year)
CO	2.60	g/hp-hr	500	0.40	70	4690	1.15	0.0401	2.6883
NOx	4.50	g/hp-hr	500	0.40	70	4690	1.98	0.0694	4.6528
SO2	0.01	lb/hr	500	0.40	70	4690	0.01	0.0002	0.0051
VOC	0.30	g/hp-hr	500	0.40	70	4690	0.13	0.0046	0.3102
PM10	0.15	g/hp-hr	500	0.40	70	4690	0.07	0.0023	0.1551
Benzene	7.76E-04	lb/mmbtu	3.50	0.40	70	4690	5.43E-07	3.80E-05	0.0025
Toluene	2.81E-04	lb/mmbtu	3.50	0.40	70	4690	1.38E-05	1.38E-05	0.0009
Xylene	1.93E-04	lb/mmbtu	3.50	0.40	70	4690	9.46E-06	9.46E-06	0.0006
Formaldehye	7.89E-05	lb/mmbtu	3.50	0.40	70	4690	3.87E-06	3.87E-06	0.0003
								Total HAPs	0.0044
								(metric tons/well)	**(metric tons/yr)**
CO2	73.96	kg/mmbtu	3.50	0.40	70	4690		7.2481	485.6214
CH4	0.0030	kg/mmbtu	3.50	0.40	70	4690		0.0003	0.0197
N2O	0.0006	kg/mmbtu	3.50	0.40	70	4690		0.0001	0.0039
CO2e								7.2725	487.2563

Emission factors for CO, NOx, VOC, and PM10 based on EPA Tier 2 Emissions Standards for Nonroad Engines.
SO2 emissions based on an average brake-specific fuel consumption of 7,000 Btu/hp-hr, 138,000 Btu/gal diesel fuel, 7.2 lb/gal and 15 ppm S.
Fuel Consumption 25.36 gal/hr
HAP emission factors from EPA AP-42, Volume I, Fifth Edition, October 1996, Table 3.4-3 and 3.4-4.
GHG emission factors from Tables C-1 and C-2 of 40 CFR Part 98, Mandatory Reporting of Greenhouse Gases; Final Rule.
Global warming potential for CH4 and N2O from Table A-1 of 40 CFR Part 98, Mandatory Reporting of Greenhouse Gases, Final Rule.
Heat input in mmbtu/hr based on a heat rate of 7,000 btu/hp-hr.

Calculation Details:	CH4	GWP =	21
	N2O	GWP =	310

Total project emissions based on 67 workovers per year (occurring once all wells have been developed).

Description	Total Construction Traffic Emissions (tons per well pad per year)												Fugitive	
	NOx	VOC	CO	PM10	PM2.5	SO2	CO2	CH4	PM_filt	PM_cond	N2O		PM10	PM2.5
Production Traffic (LD)	0.0013	0.0008	0.0096	0.0000	0.0000	0.000008	0.3241	0.0000	0.0000	0.0000	0.0000		0.0554	0.0055
Production Traffic (HD)	0.0004	0.0000	0.0003	0.0000	0.0000	0.000001	0.0418	0.0000	0.0000	0.0000	0.0000		0.0018	0.0002
							Metric Tons	Metric Tons			Metric Tons			

	Pollutant	MOVES Emission Factors (g/mile)	Emissions (lb/well pad)
Light Duty	NOx	2.52	2.667
	SO2	0.01	0.015
	CO	18.19	19.246
	CO2	675.15	714
	VOC	1.48	1.565
	PM10	0.09	0.092
	PM2.5	0.08	0.087
	PM_filt	-	0.000
	PM_cond	-	0.000
	CH4	0.08	0.090
	N2O	0.05	0.048
Heavy-Duty Truck	NOx	20.23	0.713
	SO2	0.08	0.003
	CO	15.07	0.531
	CO2	2612.44	92.149
	VOC	1.86	0.066
	PM10	1.21	0.043
	PM2.5	1.17	0.041
	PM_filt	-	0.000
	PM_cond	-	0.000
	CH4	0.09	0.003
	N2O	0.04	0.001

Equipment Utilization

Equipment Type	Mean Vehicle Speed (mph)	Round Trip Off-Road Trip Distance (miles)	Annual Number of Round Trips Per Pad
Light Truck	20.5	16	30
Heavy Truck	20.5	16	1

Fugitive Particulate Emissions

Source for Data for Constants: EPA (1995), AP-42, Section 13.2.2 Unpaved Roads (9/98). Table 13.2.2-2.

$$E\ [lb/VMT] = \frac{k(s/12)^a(S/30)d}{(M/0.5)^c} \quad \frac{*(365-P)}{365} \quad *(\text{Control Efficiency})$$

Constant	PM_{10}	$PM_{2.5}$
k	1.8	0.18
a	1.00	1.00
d	0.50	0.50
c	0.2	0.2
C	0.00047	0.00036

Variable Description	Value	Reference
E = size-specific emission factor (lb/VMT)		
s = surface material silt content (%)	5.1	EPA, *AP-42* , Volume I, Section 13.2.2 Unpaved Roads (9/98)
W = mean vehicle weight (tons)	60	
W = mean vehicle weight (tons)	4	
M = surface material moisture content (%)	2.4	AP-42 Table 11.9-3
Average control efficiency for watering (9 mi) and mag chloride (1 mi) (%) =	50	EPA, *Control of Open Fugitive Dust Sources,* EPA-450 / 3-88-001, Sept 1988.
P = Precipitation Days (>0.01" rainfall)	82	Precipitation days at Paonia, Colorado from NCDC climatology

Activity	Vehicle Type	Av. Vehicle Weight (lb)	Mean vehicle speed (mph)	# of Visits per Year	Total # of Round Trips	Round Trip Distance (mi)	Total Miles Traveled	PM_{10}		$PM_{2.5}$	
								Em. Factor (lb/VMT)	Emissions (tpy/pad)	Em. Factor (lb/VMT)	Emissions (tpy/pad)
Travel to well	Light truck	8,000	20.5	30.0	30.0	16.0	480.0	0.2308	0.0554	0.0229	0.0055
Travel to well	Heavy Truck	120,000	20.5	1.0	1.0	16.0	16.0	0.2308	0.0018	0.0229	0.0002
							Total	**0.4616**	**0.0572**	**0.0458**	**0.0057**

Bull Mountain Project
Separator Heater Emissions

1 - 0.125 mmbtu/hr separator heater per well
Operates 12 hours/day year-round

Description	Wells	Fuel	Heat Input (mmbtu/hr)	Operating Schedule (hr/yr)	Pollutant	Emission Factor (lb/mmbtu)	Maximum ST Emis Rate (lb/hr)	Emission Rate (tons/well/yr)	Emission Rate (tons/year)
Natural Gas-Fired	146	Nat Gas	0.125	4380	NOx	0.098	0.0123	0.0268	3.9168
Separator Heaters	146	Nat Gas	0.125	4380	CO	0.049	0.0061	0.0134	1.9584
	146	Nat Gas	0.125	4380	VOC	0.031	0.0039	0.0085	1.2390
						(percent of VOC)			
	146	Nat Gas	0.125	4380	Benzene	4.0%	0.0002	0.0003	0.0496
	146	Nat Gas	0.125	4380	Toluene	2.0%	0.0001	0.0002	0.0248
	146	Nat Gas	0.125	4380	Formaldehyde	8.0%	0.0003	0.0007	0.0991
								Total HAPs	0.1735
						(kg/mmbtu)		**(metric tons/well)**	**(metric tons/yr)**
	146	Nat Gas	0.125	4380	CO2	53.02		29.0285	4238.1537
	146	Nat Gas	0.125	4380	CH4	0.001		0.0005	0.0799
	146	Nat Gas	0.125	4380	N2O	0.0001		0.0001	0.0080
					CO2e			29.0569	4242.3103

Emission factors for NOx, CO, HC from AP-42, Volume I, Fifth Edition, Table 1.4-1.
Emission factors for HAPs from SPECIATE4 Profile 0003 for natural gas external combustion (boiler/heater)
Emission factors for CO2, CH4, and N2O from Tables C-1 and C-2 of 40 CFR Part 98, Mandatory Reporting of Greenhouse Gases; Final Rule.

4 - 0.25 mmbtu/hr tank heaters per well

Description	Wells	Fuel	Heat Input (mmbtu/hr)	Quantity	Operating Schedule (hr/yr)	Pollutant	Emission Factor (lb/mmbtu)	Maximum ST Emis Rate (lb/hr)	Emission Rate (tons/well/yr)	Emission Rate (tons/year)
Natural Gas-Fired	146	Nat Gas	0.25	4	730	NOx	0.098	0.098	0.0358	5.2224
Tank Heaters	146	Nat Gas	0.25	4	730	CO	0.049	0.049	0.0179	2.6112
	146	Nat Gas	0.25	4	730	VOC	0.031	0.031	0.0113	1.6520
							(percent of VOC)			
	146	Nat Gas	0.25	4	730	Benzene	4.0%	0.0012	0.0005	0.0661
	146	Nat Gas	0.25	4	730	Toluene	2.0%	0.0006	0.0002	0.0330
	146	Nat Gas	0.25	4	730	Formaldehyde	8.0%	0.0025	0.0009	0.1322
									Total HAPs	0.231
							(kg/mmbtu)		**(metric tons/well)**	**(metric tons/yr)**
	146	Nat Gas	0.25	4	730	CO2	53.02		38.7046	5650.8716
	146	Nat Gas	0.25	4	730	CH4	0.001		0.0007	0.1066
	146	Nat Gas	0.25	4	730	N2O	0.0001		0.0001	0.0107
						CO2e			38.7426	5656.4138

Emission factors for NOx, CO, HC from AP-42, Volume I, Fifth Edition, Table 1.4-1.
Emission factors for HAPs from SPECIATE4 Profile 0003 for natural gas external combustion (boiler/heater)
Emission factors for CO2, CH4, and N2O from Tables C-1 and C-2 of 40 CFR Part 98, Mandatory Reporting of Greenhouse Gases; Final Rule.
Heaters operate for two hours, twice a day, during winter months only (assumed maximum period of 6 months, Oct-Mar)

Emissions

Equipment Type	Pollutant	Per Well Emissions (lb/year-well)		Average Per Well Emissions (lb/year-well)	Average Per Well Emissions (tpy/year-well)
		Shale Well	CBM Well		
Fugitive Devices	NOx	0.0	0.0	0.00	0.00
	VOC	64.3	46.0	55.17	0.03
	CO	0.0	0.0	0.00	0.00
	PM10	0.0	0.0	0.00	0.00
	PM2.5	0.0	0.0	0.00	0.00
	SO2	0.0	0.0	0.00	0.00
	CO2	303.9	147.3	225.56	0.11
	CH4	1499.1	1499.9	1,499.46	0.75
	N2O	0.0	0.0	0.00	0.00
	Benzene	2.8	2.6	2.73	0.00
	Toluene	4.3	3.9	4.11	0.00
	Ethylbenzene	0.2	0.1	0.15	0.00
	Xylenes	1.8	1.7	1.75	0.00
	n-hexane	5.5	5.0	5.25	0.00

Number of Wells

Shale Wells	CBM Wells	Total Wells
73	73	146

Media	Type	Well Equipment		TOC Emission Factor (kg / hr / component)	TOC Emissions (lbs/yr)		VOC Emissions (lbs/yr)	
		Shale Well	CBM Well		Shale Well	CBM Well	Shale Well	CBM Well
Gas	valves	10	10	4.50E-03	869	869	34.41	24.64
	pump seals			2.40E-03	0	0	0.00	0.00
	others	4	4	8.80E-03	680	680	26.92	19.27
	connectors			2.00E-04	0	0	0.00	0.00
	flanges	10	10	3.90E-04	75	75	2.98	2.14
	open-ended lines			2.00E-03	0	0	0.00	0.00
Light Oil >20º API	valves			2.50E-03	0	0	0.00	0.00
	pump seals			1.30E-02	0	0	0.00	0.00
	others			7.50E-03	0	0	0.00	0.00
	connectors			2.10E-04	0	0	0.00	0.00
	flanges			1.10E-04	0	0	0.00	0.00
	open-ended lines			1.40E-03	0	0	0.00	0.00
Heavy Oil <20º API	valves			8.40E-06	0	0	0.00	0.00
	pump seals			3.20E-05	0	0	0.00	0.00
	others			3.20E-05	0	0	0.00	0.00
	connectors			7.50E-06	0	0	0.00	0.00
	flanges			3.90E-07	0	0	0.00	0.00
	open-ended lines			1.40E-04	0	0	0.00	0.00
Water/Oil	valves			9.80E-05	0	0	0.00	0.00
	pump seals			2.40E-05	0	0	0.00	0.00
	others			1.40E-02	0	0	0.00	0.00
	connectors			1.10E-04	0	0	0.00	0.00
	flanges			2.90E-06	0	0	0.00	0.00
	open-ended lines			2.50E-04	0	0	0.00	0.00

Annual Hours of Operat 8760

	Shale Well	CBM Well
VOC Fraction (weight)	3.33%	2.59%
CO2 Fraction (weight)	15.72%	8.30%
CH4 Fraction (weight)	77.55%	84.49%

TOC Emission Factor (kg/hr/component)

Well Equipment Component	Gas	Light Oil >20º API	Heavy Oil <20º API	Water/Oil
valves	4.50E-03	2.50E-03	8.40E-06	9.80E-05
pump seals	2.40E-03	1.30E-02	3.20E-05	2.40E-05
others	8.80E-03	7.50E-03	3.20E-05	1.40E-02
connectors	2.00E-04	2.10E-04	7.50E-06	1.10E-04
flanges	3.90E-04	1.10E-04	3.90E-07	2.90E-06
open-ended lines	2.00E-03	1.40E-03	1.40E-04	2.50E-04

Emission Factors are from EPA, 1995 -AP-42 Table 2-4. "Oil and Gas Production Operations Average Emission Factors"
Do not calculate fugitives from pipelines containing only water
"Other" category includes compressor seals, pressure relief valves, diaphragms, drains, dump arms, hatches, instruments, meters, polished rods and vents

Assumptions
Hours of operation was assumed to be year round 24-7

Equation

$$E_{fugitive} = EF_i \times N \times t_{annual} \times Y$$

where:
$E_{fugitive}$ is the fugitive VOC emissions per well [ton-VOC/yr]
EF_i is the emission factor of TOC [kg/hr/source]
N is the total number of devices
Y is the ratio of VOC to TOC in the vented gas

CH4 and CO2 emissions

Emissions.CH4 = Emission.VOC * WtFraction.CH4 / WtFraction.CO2
Emissions.CO2 = Emission.VOC * WtFraction.CO2 / WtFraction.VOC

Description	Fuel	Quantity	Engine Size (hp)	Heat Input (mmbtu/hr)	Operating Schedule (hr/yr)	Pollutant	Emission Factor (g/hp-hr)	Emission Factor (lb/mmbtu)	Emission Rate 1 Engine (tons/year)	Emission Rate 4 Engines (tons/year)
Screw Compressors	Nat Gas	4	637	--	8760	NOx	1	--	6.1509	24.6037
		4	637	--	8760	CO	2.14	--	13.1630	52.6519
		4	637	--	8760	VOC	0.41	--	2.5219	10.0875
		4	--	5.99	8760	Benzene	--	4.40E-04	0.0115	0.0462
		4	--	5.99	8760	Toluene	--	4.08E-04	0.0107	0.0428
		4	--	5.99	8760	Ethylbenzene	--	3.97E-05	0.0010	0.0042
		4	--	5.99	8760	Xylene	--	1.84E-04	0.0048	0.0193
		4	--	5.99	8760	n-hexane	--	1.11E-03	0.0291	0.1165
		4	--	5.99	8760	Formaldehyde	--	5.28E-02	1.3853	5.5411
								Total HAPs	1.9025	5.7700
							(kg/mmbtu)		**(metric tons/yr)**	**(metric tons/yr)**
	Nat Gas	4	--	5.99	8760	CO2	53.02		2782.0866	11128.3466
		4	--	5.99	8760	CH4	0.001		0.0525	0.2099
		4	--	5.99	8760	N2O	0.0001		0.0052	0.0210
						CO2e			2784.8152	11139.2609

Emission factor for NOx based on CDPHE BACT
Emission factors for CO, HC, and fuel consumption from Caterpillar G3412C specification sheet, reference data set DM8627-02-001.
Emission factors for HAPs from EPA AP-42, Volume I, Fifth Edition, October 1996, Table 3.2-2.
Emission factors for CO2, CH4, and N2O from Tables C-1 and C-2 of 40 CFR Part 98, Mandatory Reporting of Greenhouse Gases; Final Rule.
Heat input based on fuel consumption at HHV of 9398 Btu/bhp-hr: (9398 btu/bhp-hr)x(637 bhp)/1000000= 5.99 mmbtu/hr.

Bull Mountain Project
Compressor Station Separators

1 - 0.25 mmbtu/hr separator heater per compressor station
4 compressor stations in field
Operates 12 hours/day year-round

Description	Quantity	Fuel	Heat Input (mmbtu/hr)	Operating Schedule (hr/yr)	Pollutant	Emission Factor (lb/mmbtu)	Maximum ST Emis Rate (lb/hr)	Emission Rate (tons/unit/yr)	Emission Rate (tons/year)
Natural Gas-Fired	4	Nat Gas	0.25	4380	NOx	0.098	0.0245	0.0537	0.2146
Separator Heaters	4	Nat Gas	0.25	4380	CO	0.049	0.0123	0.0268	0.1073
	4	Nat Gas	0.25	4380	VOC	0.031	0.0078	0.0170	0.0679
						(percent of VOC)			
	4	Nat Gas	0.25	4380	Benzene	4.0%	0.0003	0.0007	0.0027
	4	Nat Gas	0.25	4380	Toluene	2.0%	0.0002	0.0003	0.0014
	4	Nat Gas	0.25	4380	Formaldehyde	8.0%	0.0006	0.0014	0.0054
								Total HAPs	0.0095
						(kg/mmbtu)		**(metric tons/unit)**	**(metric tons/yr)**
	4	Nat Gas	0.25	4380	CO2	53.02		58.0569	232.2276
	4	Nat Gas	0.25	4380	CH4	0.001		0.0011	0.0044
	4	Nat Gas	0.25	4380	N2O	0.0001		0.0001	0.0004
					CO2e			58.1138	232.4554

Emission factors for NOx, CO, HC from AP-42, Volume I, Fifth Edition, Table 1.4-1.
Emission factors for HAPs from SPECIATE4 Profile 0003 for natural gas external combustion (boiler/heater)
Emission factors for CO2, CH4, and N2O from Tables C-1 and C-2 of 40 CFR Part 98, Mandatory Reporting of Greenhouse Gases; Final Rule.

1 - 0.2 mmbtu/hr, 14.2 kW pump per pad

Description	Pads	Fuel	Engine Size (kW)	Heat Input (mmbtu/hr)	Quantity	Operating Schedule (hr/yr)	Pollutant	Emission Factor (g/kW-hr)	Emission Factor (lb/mmbtu)	Maximum ST Emis Rate (lb/hr/pad)	Emission Rate (tons/yr/pad)	Emission Rate (tons/year)
Natural Gas-Fired	36	Nat Gas	14.2	0.2	1	8760	NOx	10.94	--	0.3425	1.50	54.00
Water Transfer Pumps	36	Nat Gas	14.2	0.2	1	8760	CO	--	0.353	0.0706	0.31	11.13
	36	Nat Gas	14.2	0.2	1	8760	VOC	--	0.12	0.024	0.11	3.78
									(VOC %)			
	36	Nat Gas	14.2	0.2	1	8760	Benzene	--	1.18%	2.84E-04	1.24E-03	4.47E-02
	36	Nat Gas	14.2	0.2	1	8760	Toluene	--	0.04%	9.79E-06	4.29E-05	1.54E-03
	36	Nat Gas	14.2	0.2	1	8760	Ethylbenzene	--	0.11%	2.58E-05	1.13E-04	4.06E-03
	36	Nat Gas	14.2	0.2	1	8760	Xylene	--	0.43%	1.03E-04	4.52E-04	1.63E-02
	36	Nat Gas	14.2	0.2	1	8760	n-hexane	--	0.21%	5.16E-05	2.26E-04	8.13E-03
	36	Nat Gas	14.2	0.2	1	8760	Formaldehyde	--	8.70%	2.09E-03	9.15E-03	0.33
											Total HAPs	0.40
								(kg/mmbtu)			**(metric tons/yr/pad)**	**(metric tons/yr)**
	36	Nat Gas	14.2	0.2	1	8760	CO2	53.02			92.891	3344.08
	36	Nat Gas	14.2	0.2	1	8760	CH4	0.001			0.002	6.31E-02
	36	Nat Gas	14.2	0.2	1	8760	N2O	0.0001			0.000	6.31E-03
							CO2e				92.98	3347.36

Emission factors for NOx from EPA Nonroad Spark-Ignition Engines 19 kW and Below - Exhaust Emission Standards, Phase 2, Class II Engine.
Emission factors for CO and VOC from AP-42, Volume I, Fifth Edition, Table 3.2-1.
Emission factors for CO2, CH4, and N2O from Tables C-1 and C-2 of 40 CFR Part 98, Mandatory Reporting of Greenhouse Gases; Final Rule.
Emission factors for HAPs from EPA SPECIATE4, Profile 1001

1 - 0.2 mmbtu/hr, 14.2 kW pump at 73 wells

Description	Wells	Fuel	Engine Size (kW)	Heat Input (mmbtu/hr)	Quantity	Operating Schedule (hr/yr)	Pollutant	Emission Factor (g/kW-hr)	Emission Factor (lb/mmbtu)	Maximum ST Emis Rate (lb/hr/pad)	Emission Rate (tons/yr/well)	Emission Rate (tons/year)
Natural Gas-Fired	73	Nat Gas	14.2	0.2	1	8760	NOx	10.94	--	0.3425	1.50	109.50
Pumping Units	73	Nat Gas	14.2	0.2	1	8760	CO	--	0.353	0.0706	0.31	22.57
	73	Nat Gas	14.2	0.2	1	8760	VOC	--	0.12	0.024	0.11	7.67
									(VOC %)			
	73	Nat Gas	14.2	0.2	1	8760	Benzene	--	1.18%	2.84E-04	1.24E-03	9.07E-02
	73	Nat Gas	14.2	0.2	1	8760	Toluene	--	0.04%	9.79E-06	4.29E-05	3.13E-03
	73	Nat Gas	14.2	0.2	1	8760	Ethylbenzene	--	0.11%	2.58E-05	1.13E-04	8.24E-03
	73	Nat Gas	14.2	0.2	1	8760	Xylene	--	0.43%	1.03E-04	4.52E-04	3.30E-02
	73	Nat Gas	14.2	0.2	1	8760	n-hexane	--	0.21%	5.16E-05	2.26E-04	1.65E-02
	73	Nat Gas	14.2	0.2	1	8760	Formaldehyde	--	8.70%	2.09E-03	9.15E-03	0.67
											Total HAPs	0.82
								(kg/mmbtu)			**(metric tons/yr/pad)**	**(metric tons/yr)**
	73	Nat Gas	14.2	0.2	1	8760	CO2	53.02			92.891	6781.05
	73	Nat Gas	14.2	0.2	1	8760	CH4	0.001			0.002	1.28E-01
	73	Nat Gas	14.2	0.2	1	8760	N2O	0.0001			0.000	1.28E-02
							CO2e				92.98	6787.70

Emission factors for NOx from EPA Nonroad Spark-Ignition Engines 19 kW and Below - Exhaust Emission Standards, Phase 2, Class II Engine.
Emission factors for CO and VOC from AP-42, Volume I, Fifth Edition, Table 3.2-1.
Emission factors for CO2, CH4, and N2O from Tables C-1 and C-2 of 40 CFR Part 98, Mandatory Reporting of Greenhouse Gases; Final Rule.
Emission factors for HAPs from EPA SPECIATE4, Profile 1001

Natural Gas Composition Summary

Property	Shale Well Gas	CBM Well Gas
VOC Fraction (molar)	1.06%	0.88%
VOC/TOC (weight)	3.96%	2.83%
VOC MW	63.37	55.06
VOC Fraction (weight)	3.33%	2.59%
CO2 Fraction (weight)	15.72%	8.30%
CH4 Fraction (weight)	77.55%	84.49%
H2S Fraction (weight)	0.00%	0.00%
Heat Content (BTU/SCF)	986	1017
hexane+/VOC (weight)	31.95%	11.29%

Shale Well Gas

Component	Component Moles Percent	Normalized Mole	MW	Gas g/mol	% Wt	VOC species?	VOC renormalized wt%	VOC g/mol	HAPS species?
Carbon Dioxide	6.6600%	6.66%	44.0	2.9	15.7195%	N			N
Nitrogen	0.1600%	0.16%	28.0	0.0	0.2404%	N			N
Methane	90.1500%	90.15%	16.0	14.5	77.5503%	N			N
Ethane	1.9600%	1.96%	30.1	0.6	3.1608%	N			N
Propane	0.5200%	0.52%	44.1	0.2	1.2299%	Y	36.97%	16.30	N
Isobutane	0.1200%	0.12%	58.1	0.1	0.3740%	Y	11.24%	6.53	N
n-Butane	0.1000%	0.10%	58.1	0.1	0.3117%	Y	9.37%	5.45	N
Isopentane	0.0600%	0.06%	72.2	0.0	0.2322%	Y	6.98%	5.03	N
n-Pentane	0.0300%	0.03%	72.2	0.0	0.1161%	Y	3.49%	2.52	N
Helium	0.0100%	0.01%	4.0	0.0	0.0021%	N			N
Hexane+	0.2300%	0.23%	86.2	0.2	1.0630%	Y	31.95%	27.54	N
Total	**100.0000%**	**100.00%**		**18.6**	**100.00%**		**100.00%**	**63.4**	

CBM Well Gas

Component	Component Moles Percent	Normalized Mole	MW	Gas g/mol	% Wt	VOC species?	VOC renormalized wt%	VOC g/mol	HAPS species?
Carbon Dioxide	3.3300%	3.33%	44.0	1.5	8.2956%	N			N
Nitrogen	0.1200%	0.12%	28.0	0.0	0.1903%	N			N
Methane	93.0600%	93.06%	16.0	14.9	84.4928%	N			N
Ethane	2.6000%	2.60%	30.1	0.8	4.4255%	N			N
Propane	0.5600%	0.56%	44.1	0.2	1.3979%	Y	53.90%	23.77	N
Isobutane	0.1000%	0.10%	58.1	0.1	0.3290%	Y	12.68%	7.37	N
n-Butane	0.1000%	0.10%	58.1	0.1	0.3290%	Y	12.68%	7.37	N
Isopentane	0.0300%	0.03%	72.2	0.0	0.1225%	Y	4.72%	3.41	N
n-Pentane	0.0300%	0.03%	72.2	0.0	0.1225%	Y	4.72%	3.41	N
Helium	0.0100%	0.01%	4.0	0.0	0.0023%	N			N
Hexane+	0.0600%	0.06%	86.2	0.1	0.2927%	Y	11.29%	9.73	N
Total	**100.0000%**	**100.00%**		**17.7**	**100.00%**		**100.00%**	**55.1**	

BTEX	Mole %	Wt %
Benzene	0.0364%	0.1472%
Toluene	0.0465%	0.2218%
Ethylbenzene	0.0015%	0.0082%
Xylenes	0.0172%	0.0945%
n-hexane	0.0635%	0.2833%

Fraction of VOC (Wt)	Shale Well Gas	CBM Well Gas
Benzene	4.42%	5.68%
Toluene	6.67%	8.55%
Ethylbenzene	0.25%	0.32%
Xylenes	2.84%	3.64%
n-hexane	8.52%	10.92%

BTEX COMPONENTS	MOLE%	WT%
BENZENE	0.0364	0.1472
TOLUENE	0.0465	0.2218
ETHYLBENZENE	0.0015	0.0082
XYLENES	0.0172	0.0945
TOTAL BTEX	0.1016	0.4717

	BTU @	14.650	14.730
LOW	NET DRY REAL :	981.8 /scf	987.2 /scf
	NET WET REAL :	964.6 /scf	970.0 /scf
HIGH	GROSS DRY REAL :	1086.0 /scf	1091.9 /scf
	GROSS WET REAL :	1067.0 /scf	1072.9 /scf
	NET DRY REAL :	19318.5 /lb	19423.9 /lb
	GROSS DRY REAL :	21367.2 /lb	21483.9 /lb

Bull Mountain
Existing Project Emissions Inventory
Table of Contents

Page	Title
B3-1	Emissions Summary
B3-2	Workover Rig Engines
B3-3	Production Traffic
B3-4	Separator Heaters
B3-5	Tank Heaters
B3-6	Production Fugitives
B3-7	Production Fugitives
B3-8	Production Fugitives
B3-9	Water Transfer Pumps
B3-10	Pumping Units

Bull Mountain
Emissions Summary

Activity	Pollutant Emission Rate (tpy)							HAP Emission Rate (tpy)						
	PM10	PM2.5	NOx	CO	SO2	VOC	CO2e	Benzene	Toluene	Ethylbenzene	Xylene	n-hexane	Formaldehyde	Total HAPs
Existing Field Activities (18 pads, 17 wells, 1 water well)														
Workover Rig Engines	0.021	0.0208	0.6250	0.3611	0.0017	0.0417	65.4523	3.42E-04	1.24E-04	--	8.51E-05	--	3.48E-05	0.0006
Production Traffic	3.052	0.3058	0.0831	0.5279	0.0005	0.0433	19.2182	--	--	--	--	--	--	--
Separator Heaters	--	--	0.4561	0.2280	--	0.1443	493.9676	5.77E-03	2.89E-03	--	--	--	1.15E-02	0.0202
Tank Heaters	--	--	0.6439	0.3219	--	0.2037	697.3661	8.15E-03	4.07E-03	--	--	--	1.63E-02	0.0285
Production Fugitives	--	--	--	--	--	0.4736	276.8144	2.33E-02	3.50E-02	1.30E-03	1.49E-02	4.48E-02	--	0.1193
Water Transfer Pumps	--	--	27.0010	5.5661	--	1.8922	1673.6786	2.24E-02	7.72E-04	2.03E-03	8.13E-03	4.06E-03	1.65E-01	0.2020
Pumping Units	--	--	13.5005	2.7831	--	0.9461	836.8393	1.12E-02	3.86E-04	1.02E-03	4.06E-03	2.03E-03	8.23E-02	0.1010
Existing Production Emissions	3.07	0.327	42.309	9.788	0.002	3.745	4063.3	7.11E-02	4.33E-02	4.34E-03	2.72E-02	5.09E-02	0.27	0.47

Pollutant	Emission Factor	Emission Factor Units	Horsepower (hp) or Heat Input (mmbtu/hr)	Operating Load Factor	Activity Duration (hours/well)	Activity Duration (hrs/year)	Maximum Short-Term Emissions (lb/hr)	Annual Emissions (tons/well)	Annual Emissions (tons/year)
CO	2.60	g/hp-hr	500	0.40	70	630	1.15	0.0401	0.3611
NOx	4.50	g/hp-hr	500	0.40	70	630	1.98	0.0694	0.6250
SO2	0.01	lb/hr	500	0.40	70	630	0.01	0.0002	0.0007
VOC	0.30	g/hp-hr	500	0.40	70	630	0.13	0.0046	0.0417
PM10	0.15	g/hp-hr	500	0.40	70	630	0.07	0.0023	0.0208
Benzene	7.76E-04	lb/mmbtu	3.50	0.40	70	630	5.43E-07	3.80E-05	0.0003
Toluene	2.81E-04	lb/mmbtu	3.50	0.40	70	630	1.38E-05	1.38E-05	0.0001
Xylene	1.93E-04	lb/mmbtu	3.50	0.40	70	630	9.46E-06	9.46E-06	0.0001
Formaldehye	7.89E-05	lb/mmbtu	3.50	0.40	70	630	3.87E-06	3.87E-06	0.0000
								Total HAPs	0.0006
								(metric tons/well)	**(metric tons/yr)**
CO2	73.96	kg/mmbtu	3.50	0.40	70	630		7.2481	65.2327
CH4	0.0030	kg/mmbtu	3.50	0.40	70	630		0.0003	0.0026
N2O	0.0006	kg/mmbtu	3.50	0.40	70	630		0.0001	0.0005
CO2e								7.2725	65.4523

Emission factors for CO, NOx, VOC, and PM10 based on EPA Tier 2 Emissions Standards for Nonroad Engines.
SO2 emissions based on an average brake-specific fuel consumption of 7,000 Btu/hp-hr, 138,000 Btu/gal diesel fuel, 7.2 lb/gal and 15 ppm S.
Fuel Consumption 25.36 gal/hr
HAP emission factors from EPA AP-42, Volume I, Fifth Edition, October 1996, Table 3.4-3 and 3.4-4.
GHG emission factors from Tables C-1 and C-2 of 40 CFR Part 98, Mandatory Reporting of Greenhouse Gases; Final Rule.
Global warming potential for CH4 and N2O from Table A-1 of 40 CFR Part 98, Mandatory Reporting of Greenhouse Gases, Final Rule.
Heat input in mmbtu/hr based on a heat rate of 7,000 btu/hp-hr.

Calculation Details:	CH4	GWP =	21
	N2O	GWP =	310

Total project emissions based on 9 workovers per year.

Description	Total Construction Traffic Emissions (tons per well pad per year)												Fugitive	
	NOx	VOC	CO	PM10	PM2.5	SO2	CO2	CH4	PM_filt	PM_cond	N2O		PM10	PM2.5
Completion Traffic (LD)	0.0162	0.0095	0.1171	0.0006	0.0005	0.0001	3.9428	0.0005	0.0000	0.0000	0.0003		0.6740	0.0669
Completion Traffic (HD)	0.0025	0.0002	0.0019	0.0001	0.0001	0.0000	0.2926	0.0000	0.0000	0.0000	0.0000		0.0129	0.0013
							Metric Tons	Metric Tons			Metric Tons			

	Pollutant	MOVES Emission Factors (g/mile)	Emissions (lb/well pad)
Light Duty	NOx	2.52	32.449
	SO2	0.01	0.185
	CO	18.19	234.158
	CO2	675.15	8692
	VOC	1.48	19.035
	PM10	0.09	1.119
	PM2.5	0.08	1.062
	PM_filt	-	0.000
	PM_cond	-	0.000
	CH4	0.08	1.094
	N2O	0.05	0.588
Heavy-Duty Truck	NOx	20.23	4.994
	SO2	0.08	0.020
	CO	15.07	3.720
	CO2	2612.44	645.046
	VOC	1.86	0.460
	PM10	1.21	0.298
	PM2.5	1.17	0.289
	PM_filt	-	0.000
	PM_cond	-	0.000
	CH4	0.09	0.022
	N2O	0.04	0.009

Equipment Utilization

Equipment Type	Mean Vehicle Speed (mph)	Round Trip Off-Road Trip Distance (miles)	Annual Number of Round Trips Per Pad
Light Truck	20.5	16	365
Heavy Truck	20.5	16	7

Fugitive Particulate Emissions

Source for Data for Constants: EPA (1995), AP-42, Section 13.2.2 Unpaved Roads (9/98). Table 13.2.2-2.

$$E\ [lb/VMT] = \frac{k(s/12)^a(S/30)d}{(M/0.5)^c} \quad \frac{*(365-P)}{365} \quad *(\text{Control Efficiency})$$

Constant	PM_{10}	$PM_{2.5}$
k	1.8	0.18
a	1.00	1.00
d	0.50	0.50
c	0.2	0.2
C	0.00047	0.00036

Variable Description	Value	Reference
E = size-specific emission factor (lb/VMT)		
s = surface material silt content (%)	5.1	EPA, *AP-42* , Volume I, Section 13.2.2 Unpaved Roads (9/98)
W = mean vehicle weight (tons)	60	
W = mean vehicle weight (tons)	4	
M = surface material moisture content (%)	2.4	AP-42 Table 11.9-3
Average control efficiency for watering (9 mi) and mag chloride (1 mi) (%) =	50	EPA, *Control of Open Fugitive Dust Sources,* EPA-450 / 3-88-001, Sept 1988.
P = Precipitation Days (>0.01" rainfall)	82	Precipitation days at Paonia, Colorado from NCDC climatology

Activity	Vehicle Type	Av. Vehicle Weight (lb)	Mean vehicle speed (mph)	# of Visits per Year	Total # of Round Trips	Round Trip Distance (mi)	Total Miles Traveled	PM_{10}		$PM_{2.5}$	
								Em. Factor (lb/VMT)	Emissions (tpy/pad)	Em. Factor (lb/VMT)	Emissions (tpy/pad)
Travel to well	Light truck	8,000	20.5	365.0	365.0	16.0	5840.0	0.2308	0.6740	0.0229	0.0669
Travel to well	Heavy Truck	120,000	20.5	7.0	7.0	16.0	112.0	0.2308	0.0129	0.0229	0.0013
							Total	**0.4616**	**0.6869**	**0.0458**	**0.0682**

Bull Mountain Project
Separator Heater Emissions

1 - 0.125 mmbtu/hr separator heater per well
Operates 12 hours/day year-round

Description	Wells	Fuel	Heat Input (mmbtu/hr)	Operating Schedule (hr/yr)	Pollutant	Emission Factor (lb/mmbtu)	Maximum ST Emis Rate (lb/hr)	Emission Rate (tons/well/yr)	Emission Rate (tons/year)
Natural Gas-Fired	17	Nat Gas	0.125	4380	NOx	0.098	0.0123	0.0268	0.4561
Separator Heaters	17	Nat Gas	0.125	4380	CO	0.049	0.0061	0.0134	0.2280
	17	Nat Gas	0.125	4380	VOC	0.031	0.0039	0.0085	0.1443
						(percent of VOC)			
	17	Nat Gas	0.125	4380	Benzene	4.0%	0.0002	0.0003	0.0058
	17	Nat Gas	0.125	4380	Toluene	2.0%	0.0001	0.0002	0.0029
	17	Nat Gas	0.125	4380	Formaldehyde	8.0%	0.0003	0.0007	0.0115
								Total HAPs	0.0202
						(kg/mmbtu)		**(metric tons/well)**	**(metric tons/yr)**
	17	Nat Gas	0.125	4380	CO2	53.02		29.0285	493.4837
	17	Nat Gas	0.125	4380	CH4	0.001		0.0005	0.0093
	17	Nat Gas	0.125	4380	N2O	0.0001		0.0001	0.0009
					CO2e			29.0569	493.9676

Emission factors for NOx, CO, HC from AP-42, Volume I, Fifth Edition, Table 1.4-1.
Emission factors for HAPs from SPECIATE4 Profile 0003 for natural gas external combustion (boiler/heater)
Emission factors for CO2, CH4, and N2O from Tables C-1 and C-2 of 40 CFR Part 98, Mandatory Reporting of Greenhouse Gases; Final Rule.

Bull Mountain Project
Tank Heaters

4 - 0.25 mmbtu/hr tank heaters per well

Description	Wells	Fuel	Heat Input (mmbtu/hr)	Quantity	Operating Schedule (hr/yr)	Pollutant	Emission Factor (lb/mmbtu)	Maximum ST Emis Rate (lb/hr)	Emission Rate (tons/well/yr)	Emission Rate (tons/year)
Natural Gas-Fired	18	Nat Gas	0.25	4	730	NOx	0.098	0.098	0.0358	0.6439
Tank Heaters	18	Nat Gas	0.25	4	730	CO	0.049	0.049	0.0179	0.3219
	18	Nat Gas	0.25	4	730	VOC	0.031	0.031	0.0113	0.2037
							(percent of VOC)			
	18	Nat Gas	0.25	4	730	Benzene	4.0%	0.0012	0.0005	0.0081
	18	Nat Gas	0.25	4	730	Toluene	2.0%	0.0006	0.0002	0.0041
	18	Nat Gas	0.25	4	730	Formaldehyde	8.0%	0.0025	0.0009	0.0163
									Total HAPs	0.029
							(kg/mmbtu)		**(metric tons/well)**	**(metric tons/yr)**
	18	Nat Gas	0.25	4	730	CO2	53.02		38.7046	696.6828
	18	Nat Gas	0.25	4	730	CH4	0.001		0.0007	0.0131
	18	Nat Gas	0.25	4	730	N2O	0.0001		0.0001	0.0013
						CO2e			38.7426	697.3661

Emission factors for NOx, CO, HC from AP-42, Volume I, Fifth Edition, Table 1.4-1.
Emission factors for HAPs from SPECIATE4 Profile 0003 for natural gas external combustion (boiler/heater)
Emission factors for CO2, CH4, and N2O from Tables C-1 and C-2 of 40 CFR Part 98, Mandatory Reporting of Greenhouse Gases; Final Rule.
Heaters operate for two hours, twice a day, during winter months only (assumed maximum period of 6 months, Oct-Mar)

Emissions

Equipment Type	Pollutant	Per Well Emissions (lb/year-well)		Average Per Well Emissions (lb/year-well)	Average Per Well Emissions (tpy/year-well)
		Shale Well	CBM Well		
Fugitive Devices	NOx	0.0	0.0	0.00	0.00
	VOC	64.3	46.0	55.71	0.03
	CO	0.0	0.0	0.00	0.00
	PM10	0.0	0.0	0.00	0.00
	PM2.5	0.0	0.0	0.00	0.00
	SO2	0.0	0.0	0.00	0.00
	CO2	303.9	147.3	230.16	0.12
	CH4	1499.1	1499.9	1,499.43	0.75
	N2O	0.0	0.0	0.00	0.00
	Benzene	2.8	2.6	2.74	0.00
	Toluene	4.3	3.9	4.12	0.00
	Ethylbenzene	0.2	0.1	0.15	0.00
	Xylenes	1.8	1.7	1.76	0.00
	n-hexane	5.5	5.0	5.27	0.00

Number of Wells

Shale Wells	CBM Wells	Total Wells
9	8	17

Media	Type	Well Equipment		TOC Emission Factor (kg / hr / component)	TOC Emissions (lbs/yr)		VOC Emissions (lbs/yr)	
		Shale Well	CBM Well		Shale Well	CBM Well	Shale Well	CBM Well
Gas	valves	10	10	4.50E-03	869	869	34.41	24.64
	pump seals			2.40E-03	0	0	0.00	0.00
	others	4	4	8.80E-03	680	680	26.92	19.27
	connectors			2.00E-04	0	0	0.00	0.00
	flanges	10	10	3.90E-04	75	75	2.98	2.14
	open-ended lines			2.00E-03	0	0	0.00	0.00
Light Oil >20º API	valves			2.50E-03	0	0	0.00	0.00
	pump seals			1.30E-02	0	0	0.00	0.00
	others			7.50E-03	0	0	0.00	0.00
	connectors			2.10E-04	0	0	0.00	0.00
	flanges			1.10E-04	0	0	0.00	0.00
	open-ended lines			1.40E-03	0	0	0.00	0.00
Heavy Oil <20º API	valves			8.40E-06	0	0	0.00	0.00
	pump seals			3.20E-05	0	0	0.00	0.00
	others			3.20E-05	0	0	0.00	0.00
	connectors			7.50E-06	0	0	0.00	0.00
	flanges			3.90E-07	0	0	0.00	0.00
	open-ended lines			1.40E-04	0	0	0.00	0.00
Water/Oil	valves			9.80E-05	0	0	0.00	0.00
	pump seals			2.40E-05	0	0	0.00	0.00
	others			1.40E-02	0	0	0.00	0.00
	connectors			1.10E-04	0	0	0.00	0.00
	flanges			2.90E-06	0	0	0.00	0.00
	open-ended lines			2.50E-04	0	0	0.00	0.00

Annual Hours of Operat 8760

	Shale Well	CBM Well
VOC Fraction (weight)	3.33%	2.59%
CO2 Fraction (weight)	15.72%	8.30%
CH4 Fraction (weight)	77.55%	84.49%

TOC Emission Factor (kg/hr/component)

Well Equipment Component	Gas	Light Oil >20º API	Heavy Oil <20º API	Water/Oil
valves	4.50E-03	2.50E-03	8.40E-06	9.80E-05
pump seals	2.40E-03	1.30E-02	3.20E-05	2.40E-05
others	8.80E-03	7.50E-03	3.20E-05	1.40E-02
connectors	2.00E-04	2.10E-04	7.50E-06	1.10E-04
flanges	3.90E-04	1.10E-04	3.90E-07	2.90E-06
open-ended lines	2.00E-03	1.40E-03	1.40E-04	2.50E-04

Emission Factors are from EPA, 1995 -AP-42 Table 2-4. "Oil and Gas Production Operations Average Emission Factors"
Do not calculate fugitives from pipelines containing only water
"Other" category includes compressor seals, pressure relief valves, diaphragms, drains, dump arms, hatches, instruments, meters, polished rods and vents

Assumptions
Hours of operation was assumed to be year round 24-7

Equation

$$E_{fugitive} = EF_i \times N \times t_{annual} \times Y$$

where:
$E_{fugitive}$ is the fugitive VOC emissions per well [ton-VOC/yr]
EF_i is the emission factor of TOC [kg/hr/source]
N is the total number of devices
Y is the ratio of VOC to TOC in the vented gas

CH4 and CO2 emissions

Emissions.CH4 = Emission.VOC * WtFraction.CH4 / WtFraction.CO2
Emissions.CO2 = Emission.VOC * WtFraction.CO2 / WtFraction.VOC

Bull Mountain Project
Water Transfer Pumps

1 - 0.2 mmbtu/hr, 14.2 kW pump per pad

Description	Pads	Fuel	Engine Size (kW)	Heat Input (mmbtu/hr)	Quantity	Operating Schedule (hr/yr)	Pollutant	Emission Factor (g/kW-hr)	Emission Factor (lb/mmbtu)	Maximum ST Emis Rate (lb/hr/pad)	Emission Rate (tons/yr/pad)	Emission Rate (tons/year)
Natural Gas-Fired	18	Nat Gas	14.2	0.2	1	8760	NOx	10.94	--	0.3425	1.50	27.00
Water Transfer Pumps	18	Nat Gas	14.2	0.2	1	8760	CO	--	0.353	0.0706	0.31	5.57
	18	Nat Gas	14.2	0.2	1	8760	VOC	--	0.12	0.024	0.11	1.89
									(VOC %)			
	18	Nat Gas	14.2	0.2	1	8760	Benzene	--	1.18%	2.84E-04	1.24E-03	2.24E-02
	18	Nat Gas	14.2	0.2	1	8760	Toluene	--	0.04%	9.79E-06	4.29E-05	7.72E-04
	18	Nat Gas	14.2	0.2	1	8760	Ethylbenzene	--	0.11%	2.58E-05	1.13E-04	2.03E-03
	18	Nat Gas	14.2	0.2	1	8760	Xylene	--	0.43%	1.03E-04	4.52E-04	8.13E-03
	18	Nat Gas	14.2	0.2	1	8760	n-hexane	--	0.21%	5.16E-05	2.26E-04	4.06E-03
	18	Nat Gas	14.2	0.2	1	8760	Formaldehyde	--	8.70%	2.09E-03	9.15E-03	0.16
											Total HAPs	0.20
								(kg/mmbtu)			**(metric tons/yr/pad)**	**(metric tons/yr)**
	18	Nat Gas	14.2	0.2	1	8760	CO2	53.02			92.891	1672.04
	18	Nat Gas	14.2	0.2	1	8760	CH4	0.001			0.002	3.15E-02
	18	Nat Gas	14.2	0.2	1	8760	N2O	0.0001			0.000	3.15E-03
							CO2e				92.98	1673.68

Emission factors for NOx from EPA Nonroad Spark-Ignition Engines 19 kW and Below - Exhaust Emission Standards, Phase 2, Class II Engine.
Emission factors for CO, VOC and HAPs from AP-42, Volume I, Fifth Edition, Table 3.2-1.
Emission factors for CO2, CH4, and N2O from Tables C-1 and C-2 of 40 CFR Part 98, Mandatory Reporting of Greenhouse Gases; Final Rule.

Bull Mountain Project
Pumping Units

1 - 0.2 mmbtu/hr, 14.2 kW pump at 73 wells

Description	Wells	Fuel	Engine Size (kW)	Heat Input (mmbtu/hr)	Quantity	Operating Schedule (hr/yr)	Pollutant	Emission Factor (g/kW-hr)	Emission Factor (lb/mmbtu)	Maximum ST Emis Rate (lb/hr/pad)	Emission Rate (tons/yr/well)	Emission Rate (tons/year)
Natural Gas-Fired	9	Nat Gas	14.2	0.2	1	8760	NOx	10.94	--	0.3425	1.50	13.50
Pumping Units	9	Nat Gas	14.2	0.2	1	8760	CO	--	0.353	0.0706	0.31	2.78
	9	Nat Gas	14.2	0.2	1	8760	VOC	--	0.12	0.024	0.11	0.95
									(VOC %)			
	9	Nat Gas	14.2	0.2	1	8760	Benzene	--	1.18%	2.84E-04	1.24E-03	1.12E-02
	9	Nat Gas	14.2	0.2	1	8760	Toluene	--	0.04%	9.79E-06	4.29E-05	3.86E-04
	9	Nat Gas	14.2	0.2	1	8760	Ethylbenzene	--	0.11%	2.58E-05	1.13E-04	1.02E-03
	9	Nat Gas	14.2	0.2	1	8760	Xylene	--	0.43%	1.03E-04	4.52E-04	4.06E-03
	9	Nat Gas	14.2	0.2	1	8760	n-hexane	--	0.21%	5.16E-05	2.26E-04	2.03E-03
	9	Nat Gas	14.2	0.2	1	8760	Formaldehyde	--	8.70%	2.09E-03	9.15E-03	0.08
											Total HAPs	0.10
								(kg/mmbtu)			**(metric tons/yr/pad)**	**(metric tons/yr)**
	9	Nat Gas	14.2	0.2	1	8760	CO2	53.02			92.891	836.02
	9	Nat Gas	14.2	0.2	1	8760	CH4	0.001			0.002	1.58E-02
	9	Nat Gas	14.2	0.2	1	8760	N2O	0.0001			0.000	1.58E-03
							CO2e				92.98	836.84

Emission factors for NOx from EPA Nonroad Spark-Ignition Engines 19 kW and Below - Exhaust Emission Standards, Phase 2, Class II Engine.
Emission factors for CO, VOC and HAPs from AP-42, Volume I, Fifth Edition, Table 3.2-1.
Emission factors for CO2, CH4, and N2O from Tables C-1 and C-2 of 40 CFR Part 98, Mandatory Reporting of Greenhouse Gases; Final Rule.

Natural Gas Composition Summary

Property	Shale Well Gas	CBM Well Gas
VOC Fraction (molar)	1.06%	0.88%
VOC/TOC (weight)	3.96%	2.83%
VOC MW	63.37	55.06
VOC Fraction (weight)	3.33%	2.59%
CO2 Fraction (weight)	15.72%	8.30%
CH4 Fraction (weight)	77.55%	84.49%
H2S Fraction (weight)	0.00%	0.00%
Heat Content (BTU/SCF)	986	1017
hexane+/VOC (weight)	31.95%	11.29%

Shale Well Gas

Component	Component Moles Percent	Normalized Mole	MW	Gas g/mol	% Wt	VOC species?	VOC renormalized wt%	VOC g/mol	HAPS species?
Carbon Dioxide	6.6600%	6.66%	44.0	2.9	15.7195%	N			N
Nitrogen	0.1600%	0.16%	28.0	0.0	0.2404%	N			N
Methane	90.1500%	90.15%	16.0	14.5	77.5503%	N			N
Ethane	1.9600%	1.96%	30.1	0.6	3.1608%	N			N
Propane	0.5200%	0.52%	44.1	0.2	1.2299%	Y	36.97%	16.30	N
Isobutane	0.1200%	0.12%	58.1	0.1	0.3740%	Y	11.24%	6.53	N
n-Butane	0.1000%	0.10%	58.1	0.1	0.3117%	Y	9.37%	5.45	N
Isopentane	0.0600%	0.06%	72.2	0.0	0.2322%	Y	6.98%	5.03	N
n-Pentane	0.0300%	0.03%	72.2	0.0	0.1161%	Y	3.49%	2.52	N
Helium	0.0100%	0.01%	4.0	0.0	0.0021%	N			N
Hexane+	0.2300%	0.23%	86.2	0.2	1.0630%	Y	31.95%	27.54	N
Total	**100.0000%**	**100.00%**		**18.6**	**100.00%**		**100.00%**	**63.4**	

CBM Well Gas

Component	Component Moles Percent	Normalized Mole	MW	Gas g/mol	% Wt	VOC species?	VOC renormalized wt%	VOC g/mol	HAPS species?
Carbon Dioxide	3.3300%	3.33%	44.0	1.5	8.2956%	N			N
Nitrogen	0.1200%	0.12%	28.0	0.0	0.1903%	N			N
Methane	93.0600%	93.06%	16.0	14.9	84.4928%	N			N
Ethane	2.6000%	2.60%	30.1	0.8	4.4255%	N			N
Propane	0.5600%	0.56%	44.1	0.2	1.3979%	Y	53.90%	23.77	N
Isobutane	0.1000%	0.10%	58.1	0.1	0.3290%	Y	12.68%	7.37	N
n-Butane	0.1000%	0.10%	58.1	0.1	0.3290%	Y	12.68%	7.37	N
Isopentane	0.0300%	0.03%	72.2	0.0	0.1225%	Y	4.72%	3.41	N
n-Pentane	0.0300%	0.03%	72.2	0.0	0.1225%	Y	4.72%	3.41	N
Helium	0.0100%	0.01%	4.0	0.0	0.0023%	N			N
Hexane+	0.0600%	0.06%	86.2	0.1	0.2927%	Y	11.29%	9.73	N
Total	**100.0000%**	**100.00%**		**17.7**	**100.00%**		**100.00%**	**55.1**	

BTEX	Mole %	Wt %
Benzene	0.0364%	0.1472%
Toluene	0.0465%	0.2218%
Ethylbenzene	0.0015%	0.0082%
Xylenes	0.0172%	0.0945%
n-hexane	0.0635%	0.2833%

Fraction of VOC (Wt)	Shale Well Gas	CBM Well Gas
Benzene	4.42%	5.68%
Toluene	6.67%	8.55%
Ethylbenzene	0.25%	0.32%
Xylenes	2.84%	3.64%
n-hexane	8.52%	10.92%

BTEX COMPONENTS	MOLE%	WT%
BENZENE	0.0364	0.1472
TOLUENE	0.0465	0.2218
ETHYLBENZENE	0.0015	0.0082
XYLENES	0.0172	0.0945
TOTAL BTEX	0.1016	0.4717

	BTU @	14.650	14.730
LOW	NET DRY REAL :	981.8 /scf	987.2 /scf
	NET WET REAL :	964.6 /scf	970.0 /scf
HIGH	GROSS DRY REAL :	1086.0 /scf	1091.9 /scf
	GROSS WET REAL :	1067.0 /scf	1072.9 /scf
	NET DRY REAL :	19318.5 /lb	19423.9 /lb
	GROSS DRY REAL :	21367.2 /lb	21483.9 /lb

Appendix C

Bull Mountain Project – Meteorological Data Analyses

WestJumpAQMS – Meteorology Materials

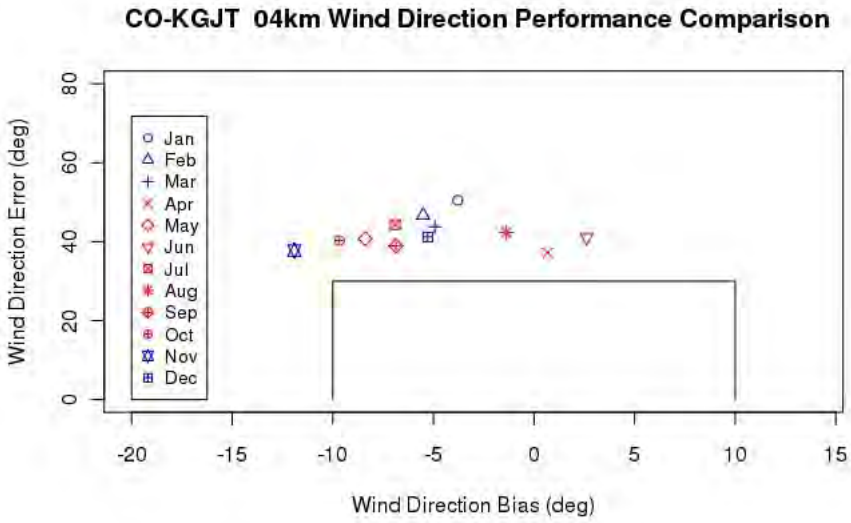
Final Report - Weather Research Forecast (WRF) Meteorological Modeling Technical Report, February 29, 2012

WRF Model Performance Evaluation products for 4km domain by site:

Grand Junction, CO Airport: KGJT

Montrose, CO Airport: KMTJ

Rifle, CO Airport: KRIL


CO-KGJT 04km Wind Direction Performance Comparison
Wind Direction Error (deg)
Wind Direction Bias (deg)
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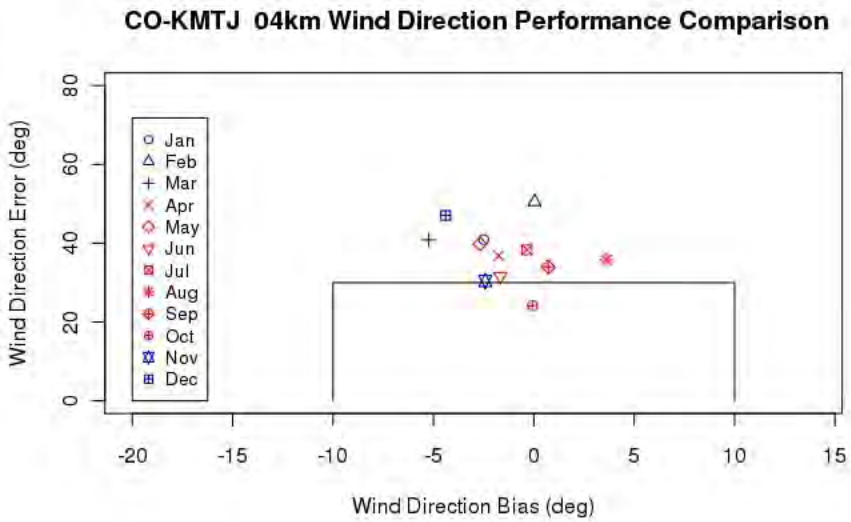
CO-KMTJ 04km Wind Direction Performance Comparison
Wind Direction Error (deg)
Wind Direction Bias (deg)
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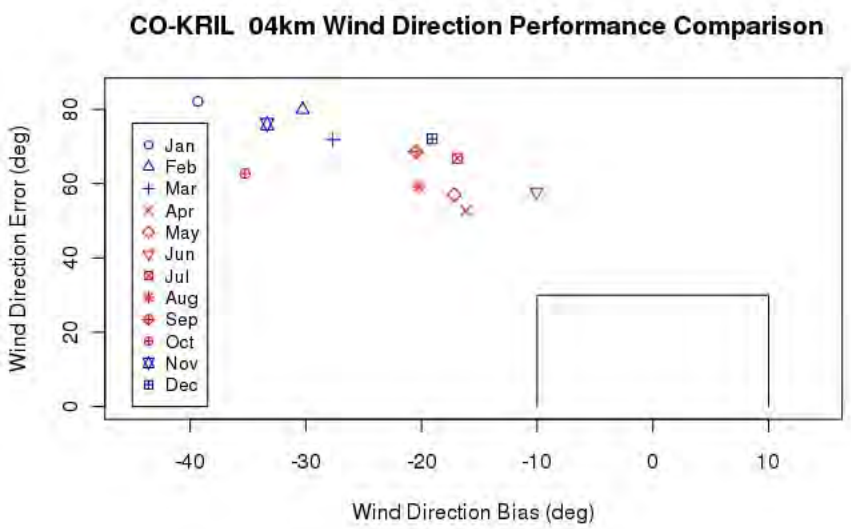
CO-KRIL 04km Wind Direction Performance Comparison
Wind Direction Error (deg)
Wind Direction Bias (deg)
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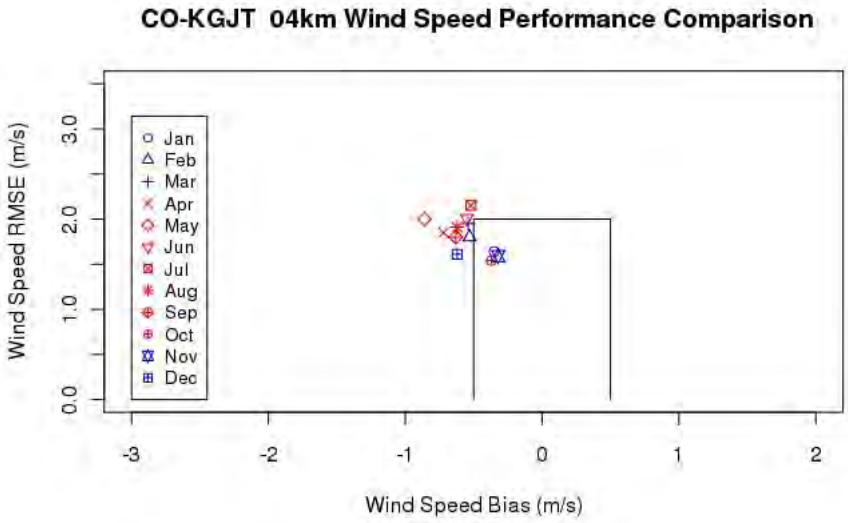
CO-KGJT 04km Wind Speed Performance Comparison
Wind Speed RMSE (m/s)
Wind Speed Bias (m/s)
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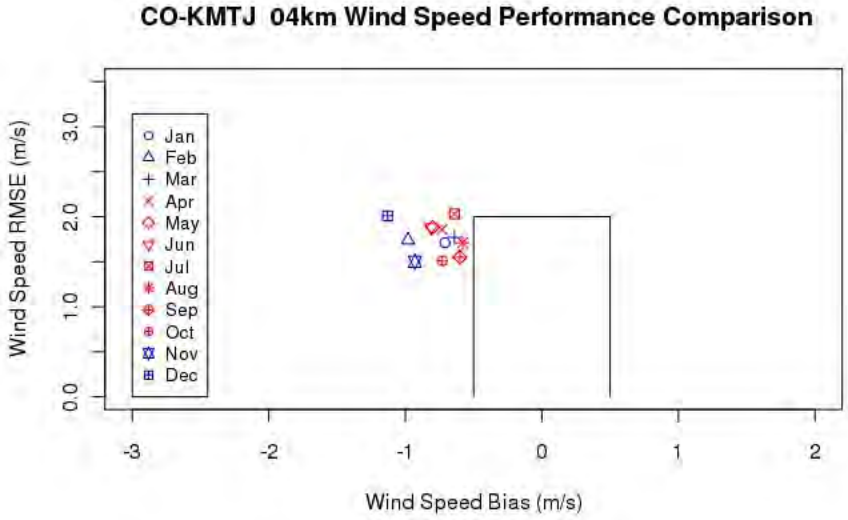
CO-KMTJ 04km Wind Speed Performance Comparison
Wind Speed RMSE (m/s)
Wind Speed Bias (m/s)
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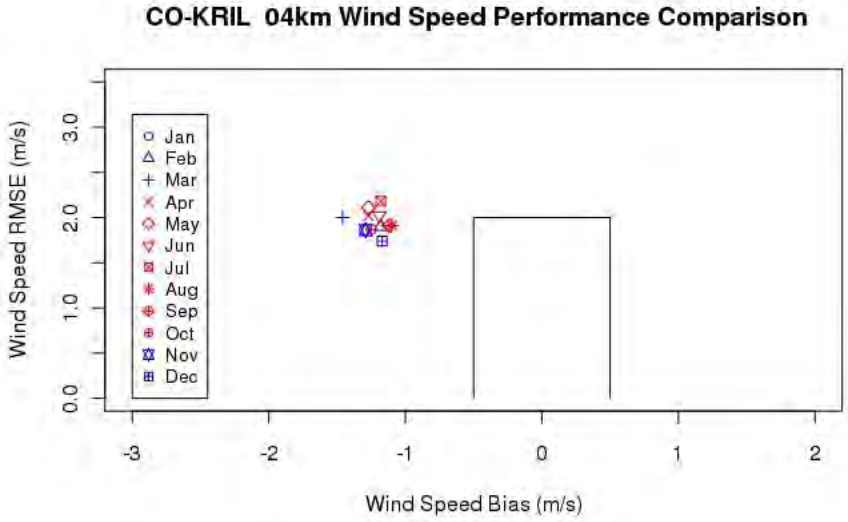
CO-KRIL 04km Wind Speed Performance Comparison
Wind Speed RMSE (m/s)
Wind Speed Bias (m/s)
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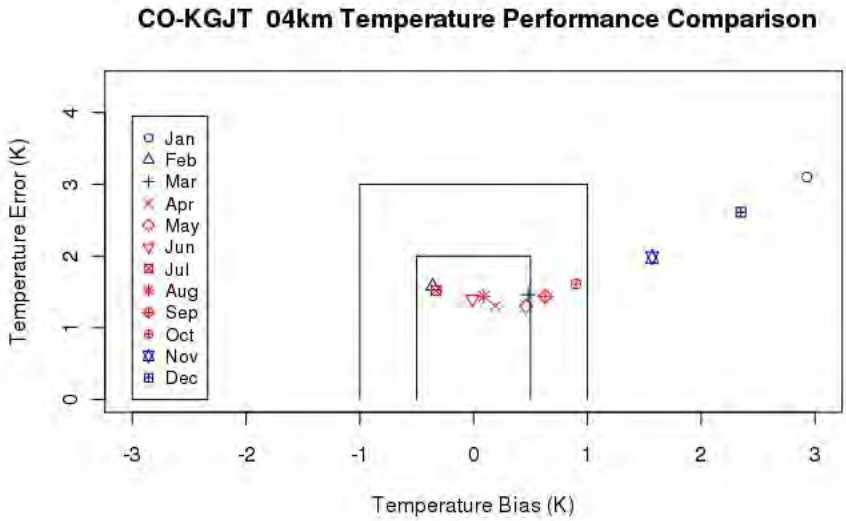
CO-KGJT 04km Temperature Performance Comparison
Temperature Error (K)
Temperature Bias (K)
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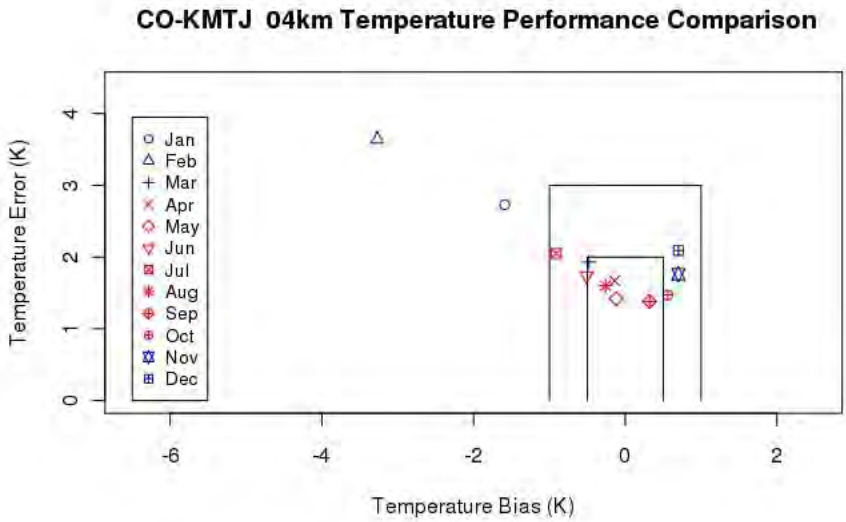
CO-KMTJ 04km Temperature Performance Comparison
Temperature Error (K)
Temperature Bias (K)
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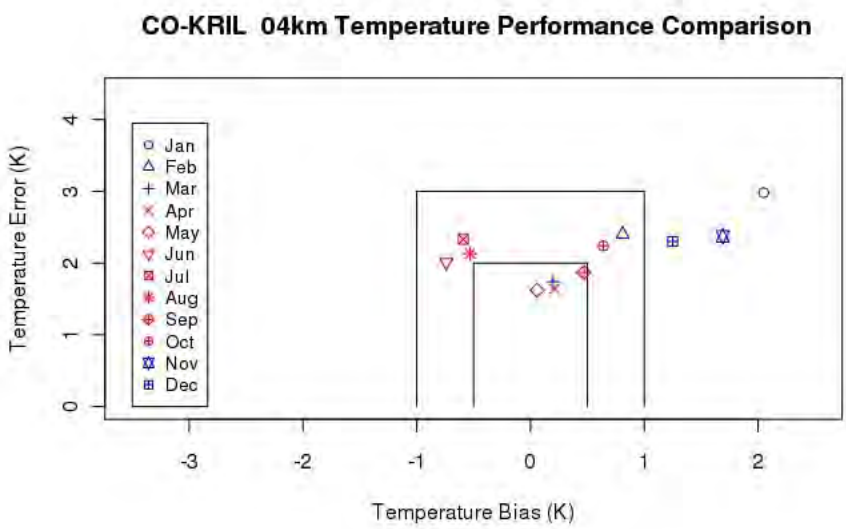
CO-KRIL 04km Temperature Performance Comparison
Temperature Error (K)
Temperature Bias (K)
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Bull Mountain Project - Comparison of 2008 WRF Model Meteorological Data at Sites within the Bull Mountain Project Area and Nearby Meteorological Station Data

MEMORANDUM

To: Chad Meister and Forrest Cook, BLM

From: Jim Zapert, Carter Lake Consulting

Date: January 15, 2014 (BLM revised June, 2014)

Subject: Bull Mountain Unit EIS Air Quality Analysis – Descriptions of the 2008 WRF Model Meteorological Data at Locations within the Bull Mountain Unit Project Area and Other Nearby Meteorological Station Data for Determining Dataset Adequacy for Near-field Modeling

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Due to the absence of any available monitored meteorology data for the Bull Mountain project area (i.e. collected within the Bull Mtn. 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) was used to generate meteorological datasets for the AERMOD modeling. To generate appropriate meteorology for input into AERMOD, the Mesoscale Model Interface Program (MMIF) was used to read and process 2008 WRF model output. MMIF converts WRF model meteorological output fields to the parameters and formats required for direct input into AERMOD.

Figure 1 (all Figures and Plots provided at the end of this Memo) shows the area surrounding the Bull Mountain Unit project area and the center points for each WRF model 4-km resolution grid cell. There are two WRF 4-km grid cells that intersect the Bull Mtn. Unit, a north site and a south site. MMIF was used to extract the WRF meteorology data for these two sites and windroses for the north and south sites are shown in Figures 2 and 3, respectively. A windrose plot for the north Bull Mtn. Unit site was included in the Bull Mountain EIS draft air quality modeling / analysis protocol. As shown in Figures 2 and 3, the sites have two distinctive and different wind flow patterns for modeling air pollutant dispersion.

In January 2012, the proposed Bull Mtn. Unit oil and gas development impact evaluation was undergoing analyses at the Environmental Assessment (EA) level and the BLM Contractor asked the CDPHE-APCD for assistance in selecting a representative meteorological dataset for conducting the AERMOD near-field modeling analysis for the EA. At that time, the 2008 WRF model data were not available to use for AERMOD modeling.

The CDPHE-APCD provided the BLM with two datasets, a Greasewood site for the 1-year period November 2009 through October 2010, and a Parachute Creek site for the 1-year period June 16, 2006 through June 15, 2007. The direction given by the CDPHE-APCD was to use the Greasewood data for modeling oil and gas emissions sources at ridge top locations and the Parachute Creek site for sources within valley locations, and to rotate the Parachute Creek wind data to orient the down slope winds to flow down the valley that the potential emissions source would be located in.

Figure 4 shows the locations of the Greasewood and Parachute Creek sites relative to the Bull Mountain Unit project area. The Parachute Creek and Greasewood sites are approximately 70 km and 105 km, respectively, northwest of the Bull Mountain Unit project area.

For purposes of comparing how well the WRF model performs for modeling meteorological conditions for the Greasewood and Parachute Creek locations, we extracted the 2008 WRF meteorology data using MMIF at the grid cells closest to the Parachute Creek and Greasewood sites, and provide windroses comparisons for the WRF data and the data collected at the two meteorological stations. The CDPHE and WRF data are different years but the 1-year annual wind roses are adequate for comparison purposes. Figures 5 and 6 show the locations of the WRF model grid nodes relative to the Greasewood and Parachute Creek meteorological stations, respectively. Figure 7 shows the comparisons of the 2008 WRF wind data with the Greasewood and Parachute Creek meteorological station wind data. Figure 8 provides a plot of the WRF model terrain in the vicinity of the Bull Mountain Unit project area and the meteorological station sites.

Overall, the WRF model and meteorological station wind data do not compare well but that is not unexpected given that 4 km resolution WRF data has one terrain value for each grid cell and therefore, would not pick up fine scale topographical influences. For the Parachute Creek site, the width of the entire valley is approximately one WRF grid cell, and is not represented well as shown in the WRF terrain plot. According to WRF, the Parachute Creek site is located in a much broader valley that opens up to the southeast and considering that specific terrain orientation, the WRF windrose looks reasonable for representing the terrain flow. At the Parachute Creek site, the valley is about 3,000 feet deep and may be deeper and narrower just to the north of the site which may be actually controlling the valley flows. The tower at the Parachute Creek site is only 10-m high, which limits its spatial representativeness. For the Greasewood site, WRF aligns better with the CDPHE Greasewood site data showing predominant southerly winds, and shows more variability than the observed CDPHE data.

Because near-field air dispersion modeling for proposed locations of oil and gas development where locations are not definite, it is reasonable to use either of the two meteorological data sets developed from the WRF 2008 data for the Bull Mountain Unit EIS AERMOD near-field modeling. In 2012, when the CDPHE provided meteorology data for the AERMOD analysis and before the WRF/MMIF data were available, the CDPHE data sets would have been the best choice for the Bull Mountain Unit EIS AERMOD analysis. Since that time, the 2008 WRF 4-km data have become available and are adequate for the Bull Mtn. EIS near-field modeling analysis and appear as representative as the data for the sites provided by the CDPHE. The WRF 2008 data may be more representative of the Bull Mtn. Unit than the Parachute Creek and Greasewood sites data due to the Greasewood and Parachute Creek sites being so far removed from the Bull Mtn. Unit. Using WRF meteorological data for both north and south Bull Mtn. Unit locations gives a 2-year variance in wind direction and meteorological conditions for AERMOD modeling. Using the same WRF/MMIF data for both near and far-field analysis also provides consistency with the near-field and far-field modeling analyses (2008 WRF data is being used for the CALPUFF and PGM modeling assessments).

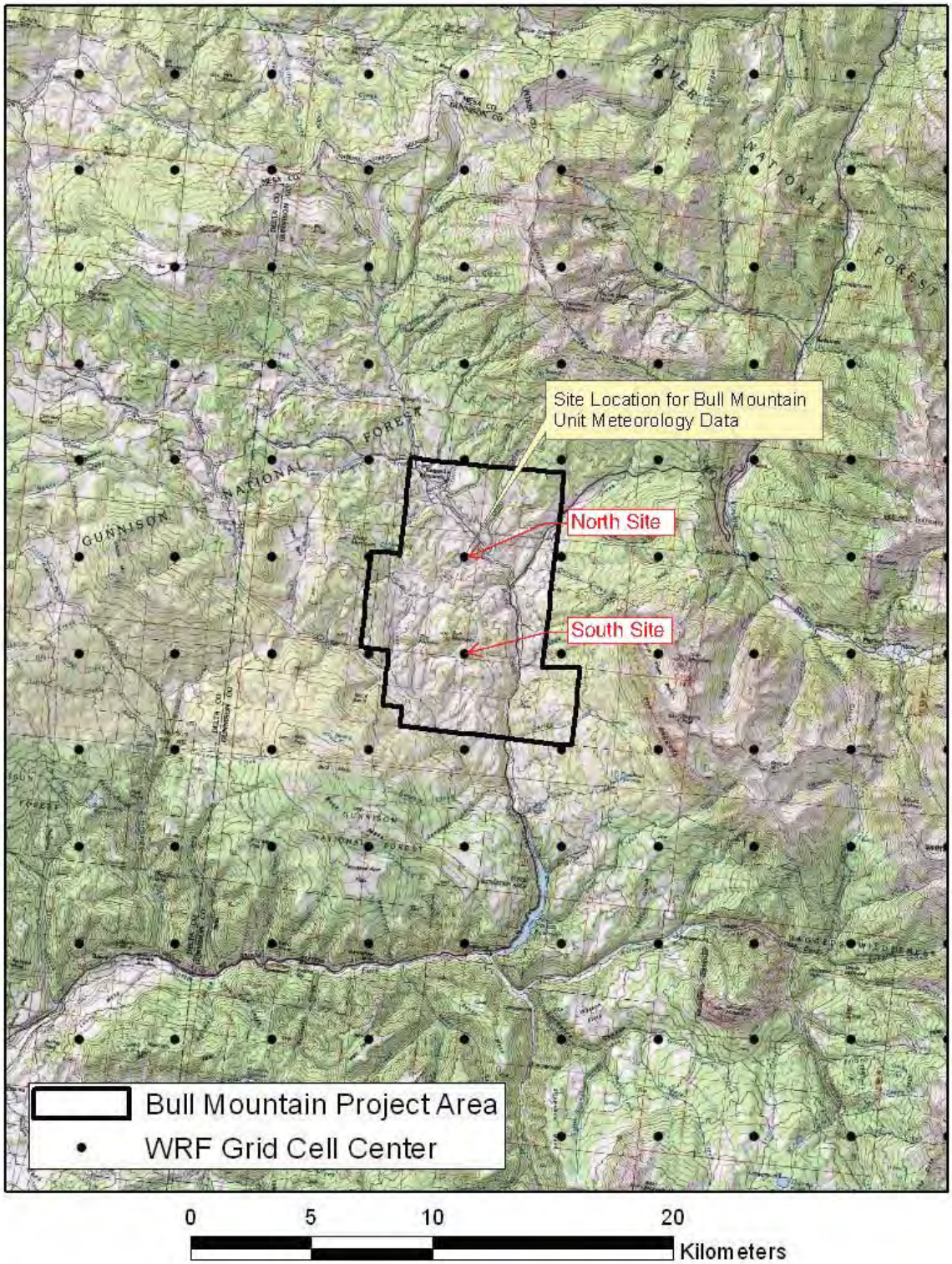


Figure 1 – WRF Model meteorological data sites within the Bull Mountain Unit Project Area

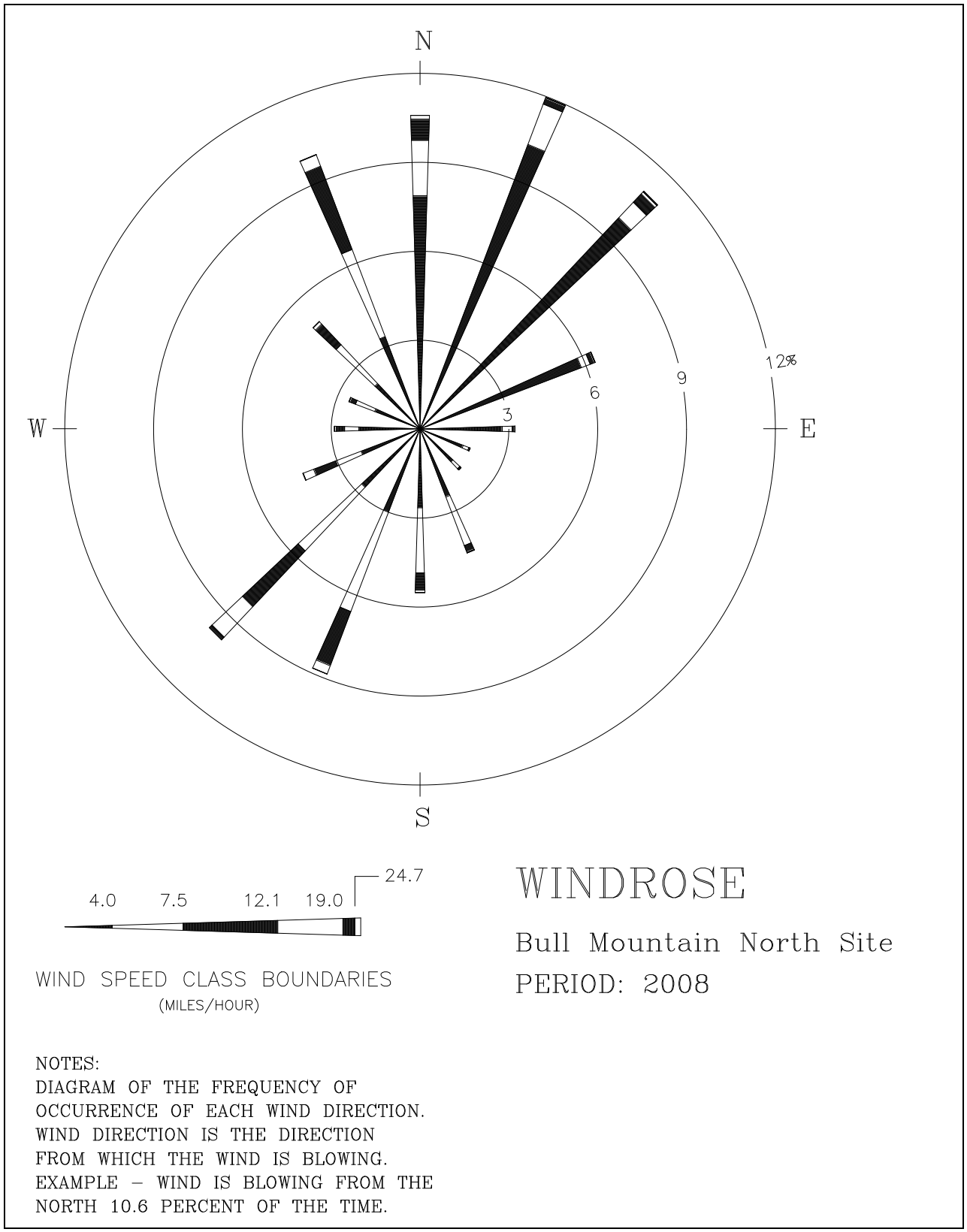


Figure 2 – WRF model 2008 meteorological data windrose for the North Site location in the Bull Mountain Project Area

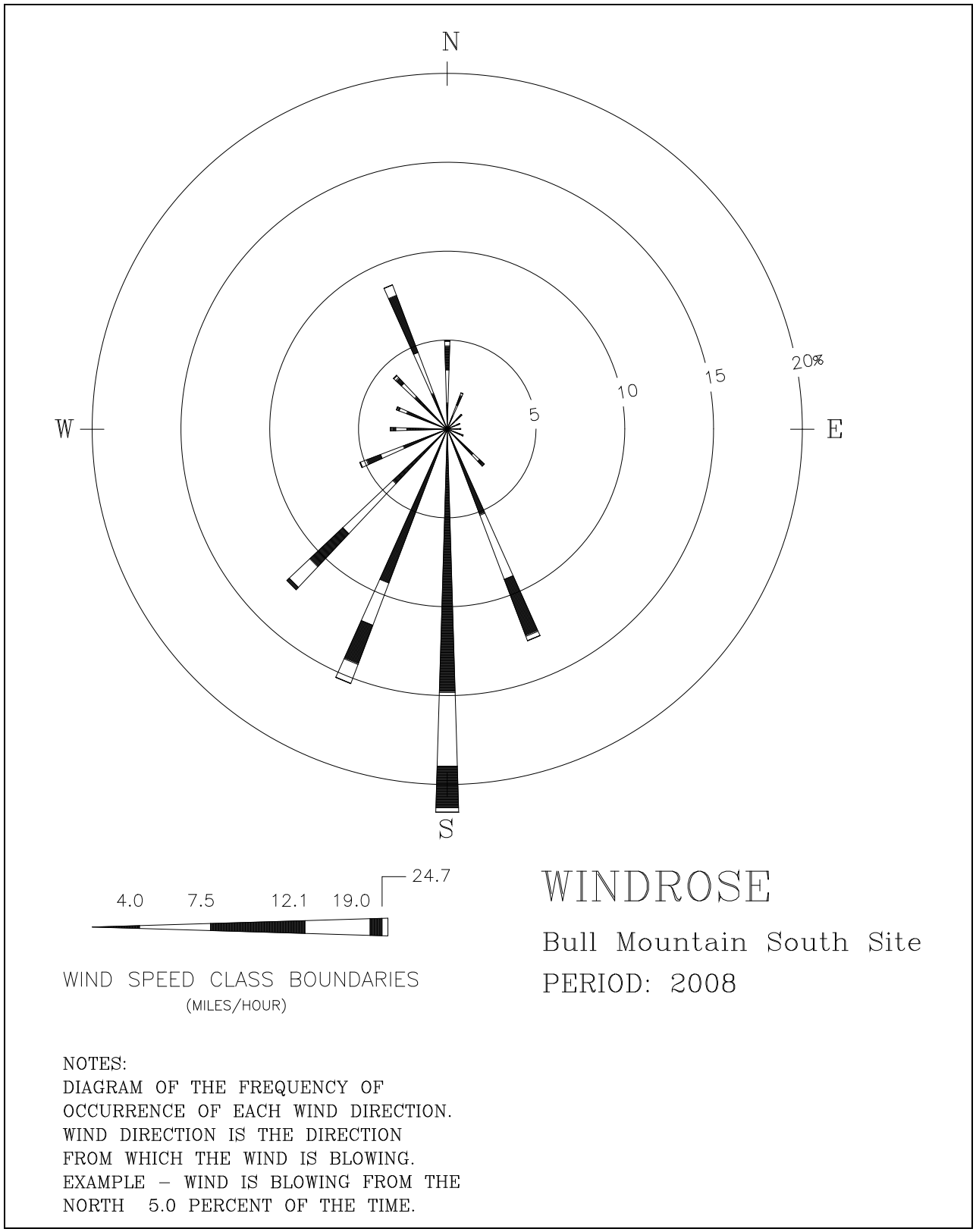


Figure 3 – WRF model 2008 meteorological data windrose for the South Site location in the Bull Mountain Project Area

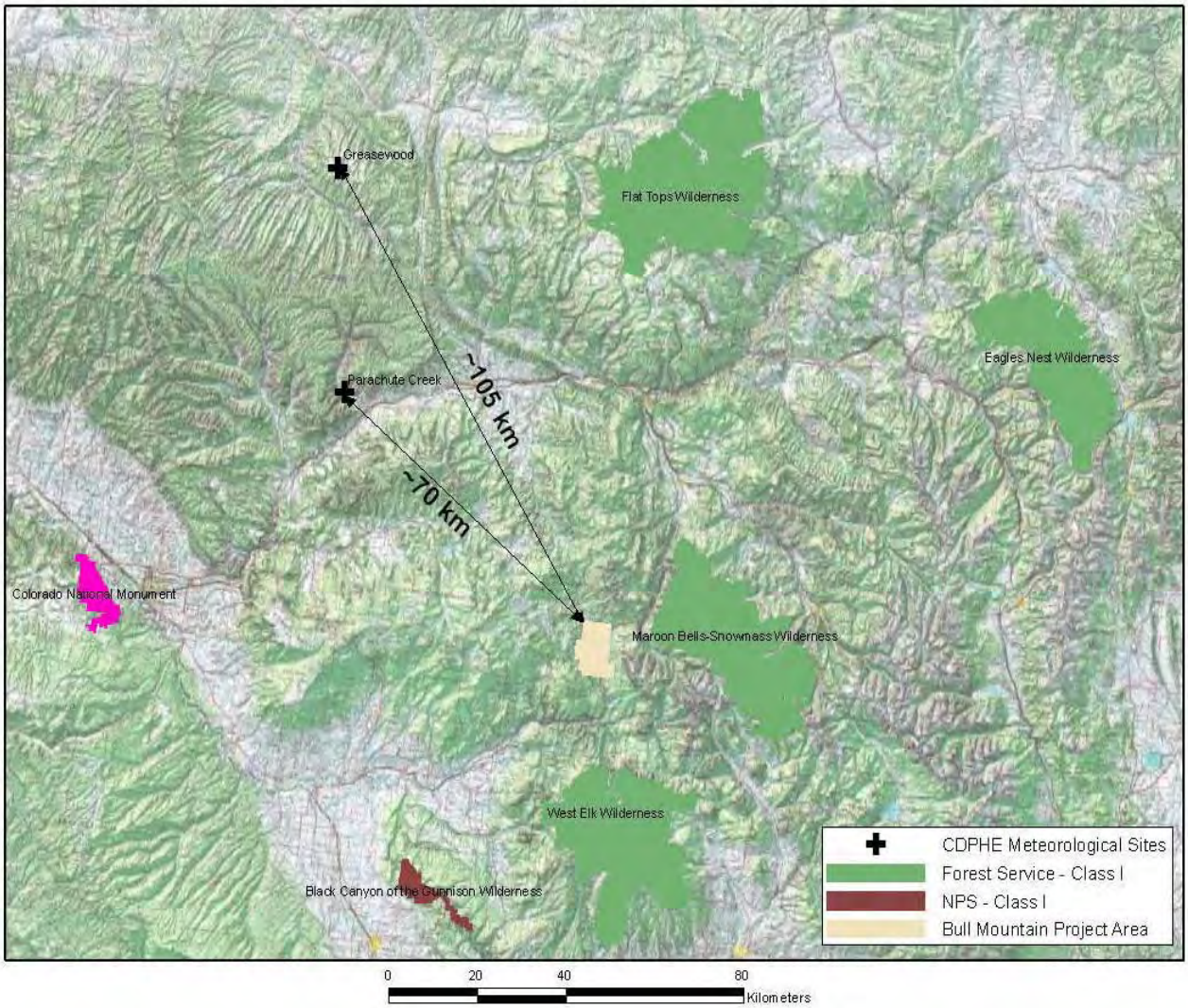


Figure 4 – Location of CDPHE meteorological sites relative to the Bull Mountain Project Area

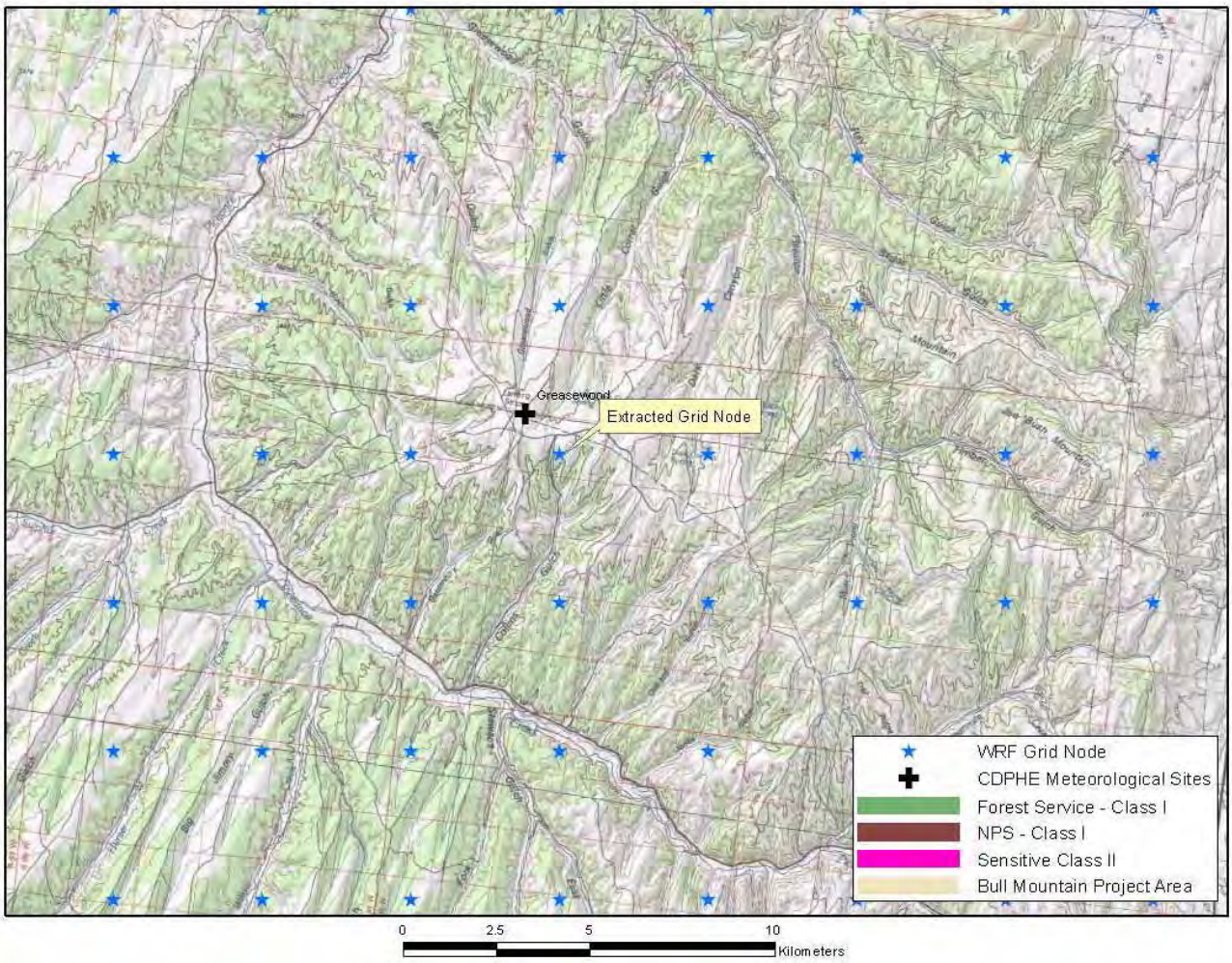


Figure 5 - WRF model grid nodes in the viciniity of the Greasewood Meterological Station

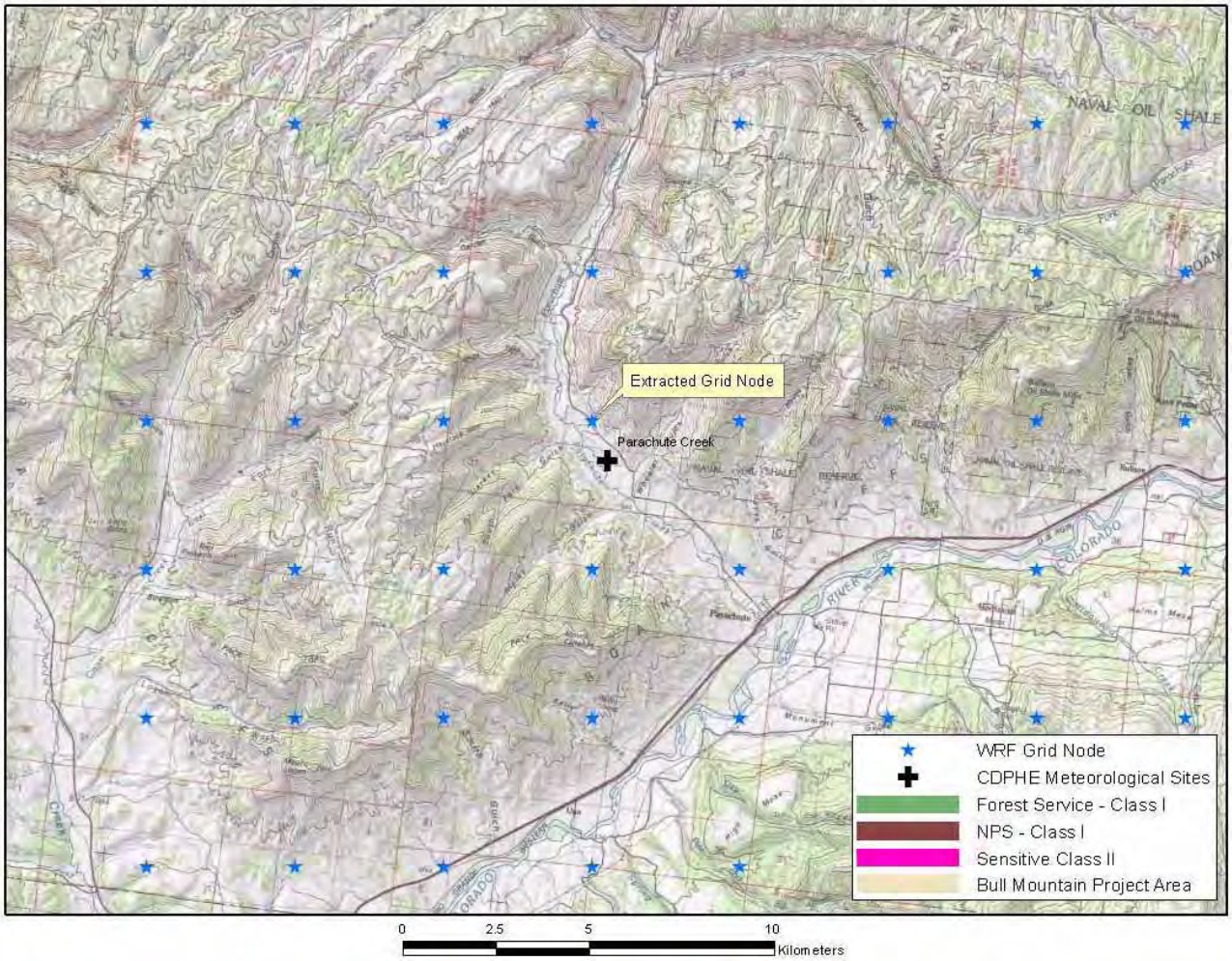
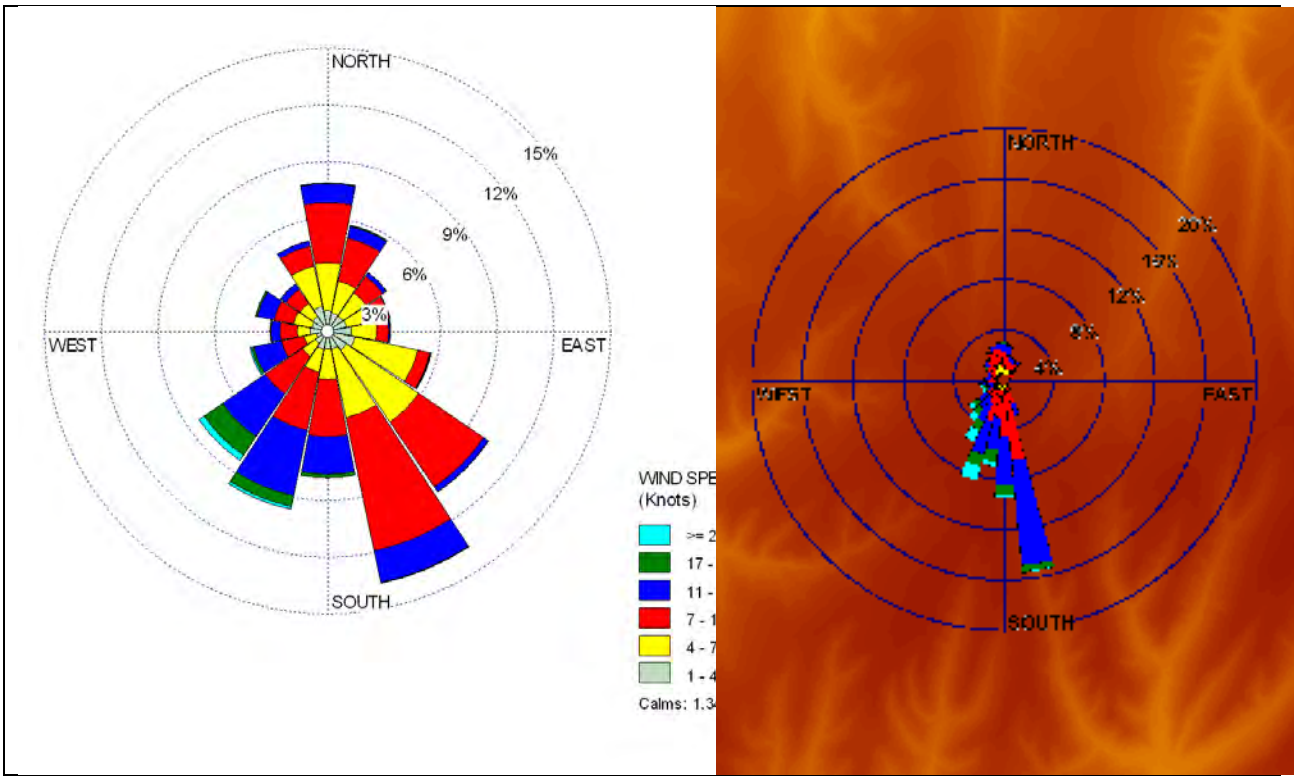
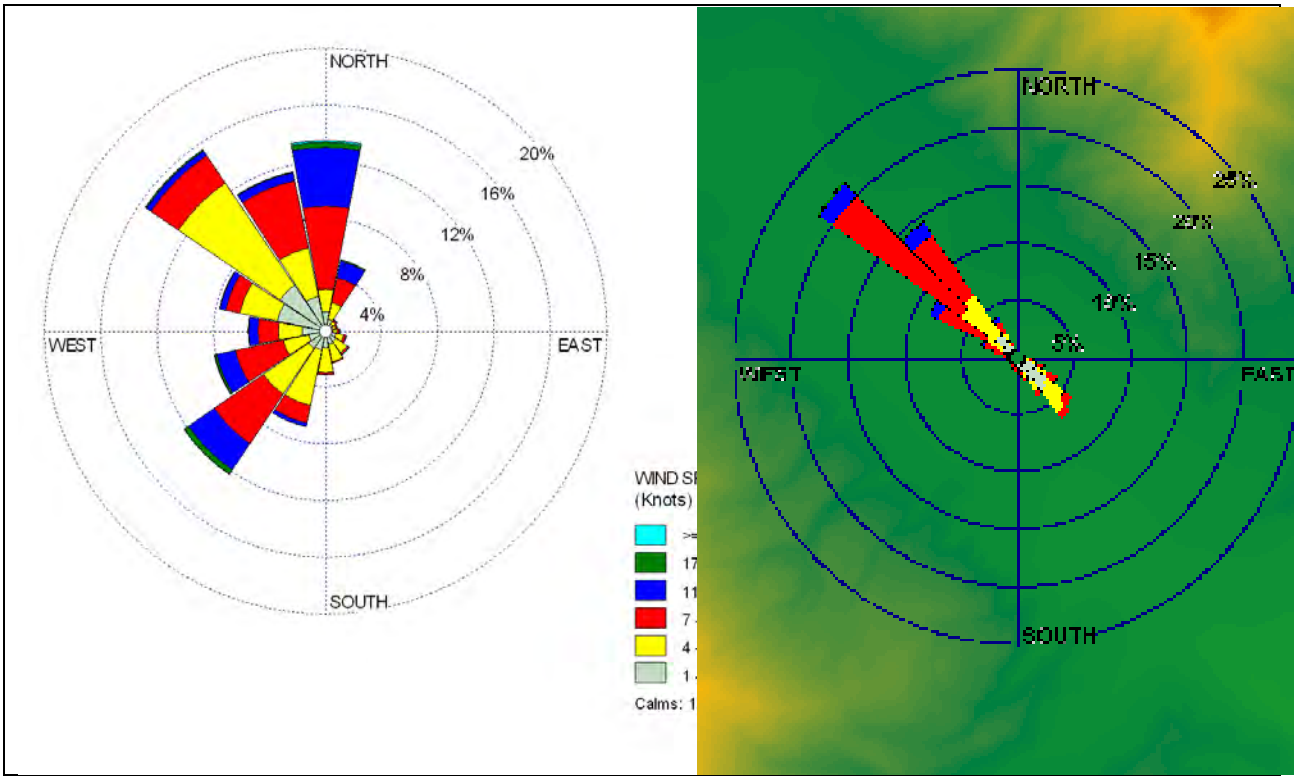


Figure 6 - WRF model grid nodes in the viciniity of the Parachute Creek Meterological Station



Greasewood 2008 WRF

Greasewood, November 2009 – October 2010 tower



Parachute Creek 2008 WRF

Parachute Creek, June 16, 2006 – June 15, 2007 tower

Figure 7 – Comparison of 2008 WRF model meteorological data with the CDPHE selected meteorology data

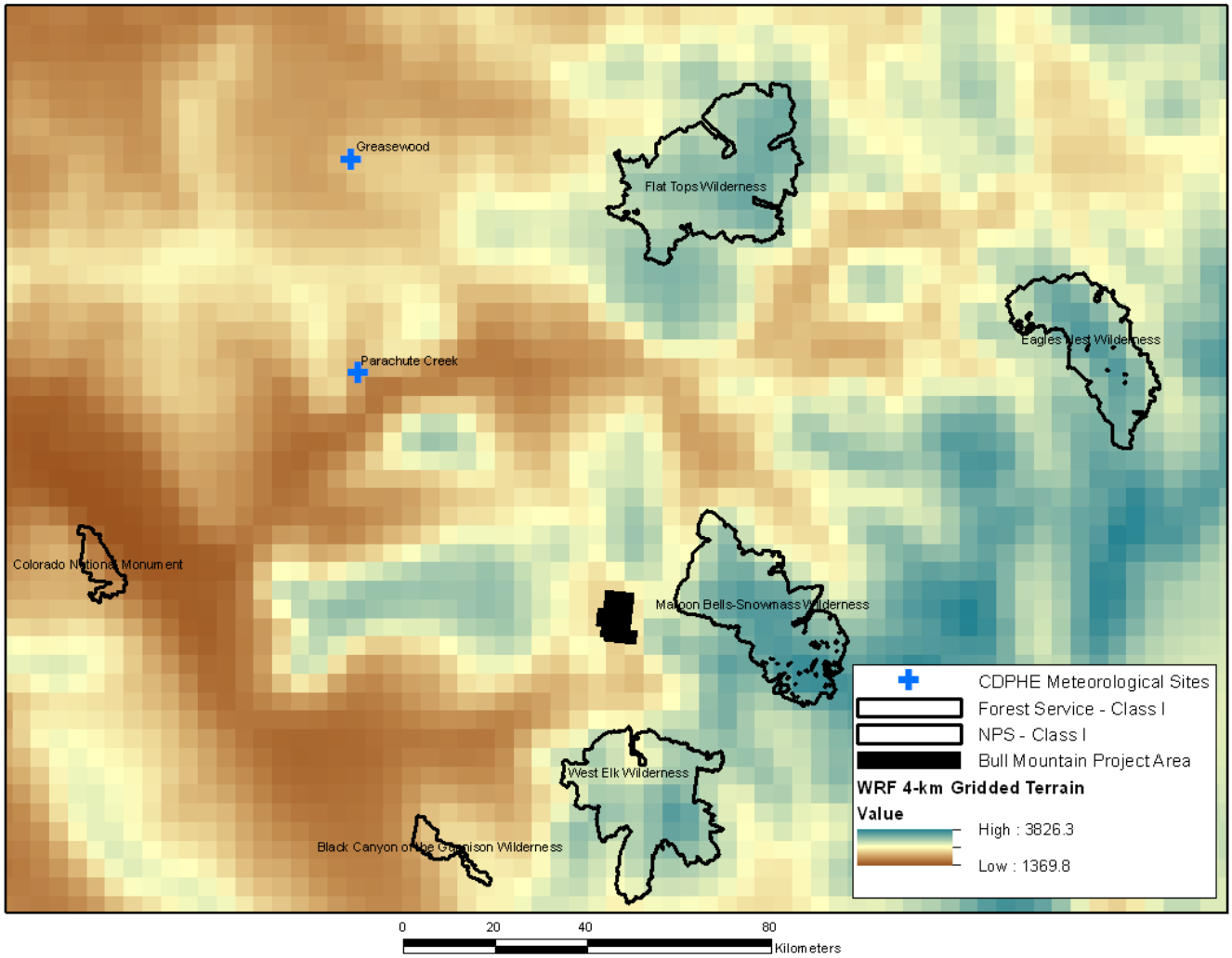


Figure 8 – 2008 WRF model terrain plot in the vicinity of the Bull Mountain project area

Appendix D

Sample AERMOD and CALPUFF Input Control Files

AERMOD Input File

```
CO STARTING
CO TITLEONE Bull Mountain Production Analysis - 2008 North Met
CO TITLETWO NO2 - 7 New Wells, 4 Existing Wells, 3 Compressor Stations, 3
drill rigs
CO MODELOPT CONC OLM ELEV
CO AVERTIME 1 ANNUAL
CO POLLUTID NO2
CO OZONEVAL 44.0 PPB
CO OZONEFIL OZONE08.DAT PPB
CO NO2STACK 0.20
CO RUNORNOT RUN
CO FINISHED
SO STARTING

SO LOCATION WELL17 VOLUME  294976.6  4326861.7  2207.8
SO LOCATION WELL18 VOLUME  293606.0  4326429.6  2326.8
SO LOCATION WELL21 VOLUME  292297.2  4327453.0  2305.3
SO LOCATION WELL25 VOLUME  292368.3  4326270.1  2380.5
SO LOCATION WELL29 VOLUME  294086.1  4325756.5  2332.4
SO LOCATION WELL37 VOLUME  294278.3  4324819.2  2256.8
SO LOCATION WELL42 VOLUME  294776.6  4324446.2  2259.9
SO LOCATION EWELL1 VOLUME  295154.0  4327933.0  2127.1
SO LOCATION EWELL2 VOLUME  292112.2  4328649.6  2236.3
SO LOCATION EWELL3 VOLUME  292938.2  4329008.1  2198.2
SO LOCATION EWELL4 VOLUME  294176.5  4329271.8  2165.1
** Traffic
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SO LOCATION TWELL18 VOLUME  293606.0  4326429.6  2326.8
SO LOCATION TWELL21 VOLUME  292297.2  4327453.0  2305.3
SO LOCATION TWELL22 VOLUME  292877.8  4327921.3  2279.2
SO LOCATION TWELL25 VOLUME  292368.3  4326270.1  2380.5
SO LOCATION TWELL29 VOLUME  294086.1  4325756.5  2332.4
SO LOCATION TWELL37 VOLUME  294278.3  4324819.2  2256.8
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SO LOCATION TEWELL3 VOLUME  292938.2  4329008.1  2198.2
SO LOCATION TEWELL4 VOLUME  294176.5  4329271.8  2165.1

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SO LOCATION DRIL40 POINT  293400.9  4327068.3  2230.5


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SO LOCATION HTR37 POINT  294278.3  4324819.2  2256.8
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SO EMISFACT DRIL40  MONTH 3*0.0 8*1.0 1*0.0

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SO XBADJ    HTR18     -0.17   -0.34   -0.50   -0.64   -0.77   -0.87
SO XBADJ    HTR18     -0.94   -0.98   -1.00   -1.51   -1.97   -2.37
SO XBADJ    HTR18     -2.69   -2.94   -3.10   -3.16   -3.13   -3.00
SO XBADJ    HTR18     -3.13   -3.16   -3.10   -2.94   -2.69   -2.37
SO XBADJ    HTR18     -1.97   -1.51   -1.00   -0.98   -0.94   -0.87
SO XBADJ    HTR18     -0.77   -0.64   -0.50   -0.34   -0.17    0.00
SO YBADJ    HTR18      0.26    0.51    0.75    0.96    1.15    1.30
SO YBADJ    HTR18      1.41    1.48    1.50    1.48    1.41    1.30
SO YBADJ    HTR18      1.15    0.96    0.75    0.51    0.26    0.00
SO YBADJ    HTR18     -0.26   -0.51   -0.75   -0.96   -1.15   -1.30
SO YBADJ    HTR18     -1.41   -1.48   -1.50   -1.48   -1.41   -1.30
SO YBADJ    HTR18     -1.15   -0.96   -0.75   -0.51   -0.26    0.00

SO BUILDHGT HTR21      2.20    2.20    2.20    2.20    2.20    2.20
SO BUILDHGT HTR21      2.20    2.20    2.20    2.20    2.20    2.20
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SO BUILDHGT HTR21      2.20    2.20    2.20    2.20    2.20    2.20
SO BUILDHGT HTR21      2.20    2.20    2.20    2.20    2.20    2.20
SO BUILDHGT HTR21      2.20    2.20    2.20    2.20    2.20    2.20
SO BUILDHGT HTR21      2.20    2.20    2.20    2.20    2.20    2.20
SO BUILDWID HTR21      2.49    2.91    3.23    3.46    3.58    3.60
SO BUILDWID HTR21      3.50    3.30    3.00    3.30    3.50    3.60
SO BUILDWID HTR21      3.58    3.46    3.23    2.91    2.49    2.00
SO BUILDWID HTR21      2.49    2.91    3.23    3.46    3.58    3.60
SO BUILDWID HTR21      3.50    3.30    3.00    3.30    3.50    3.60
SO BUILDWID HTR21      3.58    3.46    3.23    2.91    2.49    2.00
SO BUILDLEN HTR21      3.30    3.50    3.60    3.58    3.46    3.23
SO BUILDLEN HTR21      2.91    2.49    2.00    2.49    2.91    3.23
SO BUILDLEN HTR21      3.46    3.58    3.60    3.50    3.30    3.00
SO BUILDLEN HTR21      3.30    3.50    3.60    3.58    3.46    3.23
SO BUILDLEN HTR21      2.91    2.49    2.00    2.49    2.91    3.23
SO BUILDLEN HTR21      3.46    3.58    3.60    3.50    3.30    3.00
SO XBADJ    HTR21     -0.17   -0.34   -0.50   -0.64   -0.77   -0.87
SO XBADJ    HTR21     -0.94   -0.98   -1.00   -1.51   -1.97   -2.37
SO XBADJ    HTR21     -2.69   -2.94   -3.10   -3.16   -3.13   -3.00
SO XBADJ    HTR21     -3.13   -3.16   -3.10   -2.94   -2.69   -2.37
SO XBADJ    HTR21     -1.97   -1.51   -1.00   -0.98   -0.94   -0.87
SO XBADJ    HTR21     -0.77   -0.64   -0.50   -0.34   -0.17    0.00
SO YBADJ    HTR21      0.26    0.51    0.75    0.96    1.15    1.30
SO YBADJ    HTR21      1.41    1.48    1.50    1.48    1.41    1.30
SO YBADJ    HTR21      1.15    0.96    0.75    0.51    0.26    0.00
SO YBADJ    HTR21     -0.26   -0.51   -0.75   -0.96   -1.15   -1.30
SO YBADJ    HTR21     -1.41   -1.48   -1.50   -1.48   -1.41   -1.30
SO YBADJ    HTR21     -1.15   -0.96   -0.75   -0.51   -0.26    0.00

SO BUILDHGT HTR25      2.20    2.20    2.20    2.20    2.20    2.20
SO BUILDHGT HTR25      2.20    2.20    2.20    2.20    2.20    2.20
SO BUILDHGT HTR25      2.20    2.20    2.20    2.20    2.20    2.20
SO BUILDHGT HTR25      2.20    2.20    2.20    2.20    2.20    2.20
SO BUILDHGT HTR25      2.20    2.20    2.20    2.20    2.20    2.20
SO BUILDHGT HTR25      2.20    2.20    2.20    2.20    2.20    2.20
SO BUILDWID HTR25      2.49    2.91    3.23    3.46    3.58    3.60
SO BUILDWID HTR25      3.50    3.30    3.00    3.30    3.50    3.60
SO BUILDWID HTR25      3.58    3.46    3.23    2.91    2.49    2.00
SO BUILDWID HTR25      2.49    2.91    3.23    3.46    3.58    3.60
SO BUILDWID HTR25      3.50    3.30    3.00    3.30    3.50    3.60
SO BUILDWID HTR25      3.58    3.46    3.23    2.91    2.49    2.00
SO BUILDLEN HTR25      3.30    3.50    3.60    3.58    3.46    3.23
SO BUILDLEN HTR25      2.91    2.49    2.00    2.49    2.91    3.23
SO BUILDLEN HTR25      3.46    3.58    3.60    3.50    3.30    3.00
SO BUILDLEN HTR25      3.30    3.50    3.60    3.58    3.46    3.23
SO BUILDLEN HTR25      2.91    2.49    2.00    2.49    2.91    3.23
SO BUILDLEN HTR25      3.46    3.58    3.60    3.50    3.30    3.00
SO XBADJ    HTR25     -0.17   -0.34   -0.50   -0.64   -0.77   -0.87
SO XBADJ    HTR25     -0.94   -0.98   -1.00   -1.51   -1.97   -2.37
SO XBADJ    HTR25     -2.69   -2.94   -3.10   -3.16   -3.13   -3.00
SO XBADJ    HTR25     -3.13   -3.16   -3.10   -2.94   -2.69   -2.37
SO XBADJ    HTR25     -1.97   -1.51   -1.00   -0.98   -0.94   -0.87
SO XBADJ    HTR25     -0.77   -0.64   -0.50   -0.34   -0.17    0.00
SO YBADJ    HTR25      0.26    0.51    0.75    0.96    1.15    1.30
SO YBADJ    HTR25      1.41    1.48    1.50    1.48    1.41    1.30
SO YBADJ    HTR25      1.15    0.96    0.75    0.51    0.26    0.00
SO YBADJ    HTR25     -0.26   -0.51   -0.75   -0.96   -1.15   -1.30
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SO	YBADJ	HTR25	-1.41	-1.48	-1.50	-1.48	-1.41	-1.30
SO	YBADJ	HTR25	-1.15	-0.96	-0.75	-0.51	-0.26	0.00
SO	BUILDHGT	HTR29	2.20	2.20	2.20	2.20	2.20	2.20
SO	BUILDHGT	HTR29	2.20	2.20	2.20	2.20	2.20	2.20
SO	BUILDHGT	HTR29	2.20	2.20	2.20	2.20	2.20	2.20
SO	BUILDHGT	HTR29	2.20	2.20	2.20	2.20	2.20	2.20
SO	BUILDHGT	HTR29	2.20	2.20	2.20	2.20	2.20	2.20
SO	BUILDHGT	HTR29	2.20	2.20	2.20	2.20	2.20	2.20
SO	BUILDWID	HTR29	2.49	2.91	3.23	3.46	3.58	3.60
SO	BUILDWID	HTR29	3.50	3.30	3.00	3.30	3.50	3.60
SO	BUILDWID	HTR29	3.58	3.46	3.23	2.91	2.49	2.00
SO	BUILDWID	HTR29	2.49	2.91	3.23	3.46	3.58	3.60
SO	BUILDWID	HTR29	3.50	3.30	3.00	3.30	3.50	3.60
SO	BUILDWID	HTR29	3.58	3.46	3.23	2.91	2.49	2.00
SO	BUILDLEN	HTR29	3.30	3.50	3.60	3.58	3.46	3.23
SO	BUILDLEN	HTR29	2.91	2.49	2.00	2.49	2.91	3.23
SO	BUILDLEN	HTR29	3.46	3.58	3.60	3.50	3.30	3.00
SO	BUILDLEN	HTR29	3.30	3.50	3.60	3.58	3.46	3.23
SO	BUILDLEN	HTR29	2.91	2.49	2.00	2.49	2.91	3.23
SO	BUILDLEN	HTR29	3.46	3.58	3.60	3.50	3.30	3.00
SO	XBADJ	HTR29	-0.17	-0.34	-0.50	-0.64	-0.77	-0.87
SO	XBADJ	HTR29	-0.94	-0.98	-1.00	-1.51	-1.97	-2.37
SO	XBADJ	HTR29	-2.69	-2.94	-3.10	-3.16	-3.13	-3.00
SO	XBADJ	HTR29	-3.13	-3.16	-3.10	-2.94	-2.69	-2.37
SO	XBADJ	HTR29	-1.97	-1.51	-1.00	-0.98	-0.94	-0.87
SO	XBADJ	HTR29	-0.77	-0.64	-0.50	-0.34	-0.17	0.00
SO	YBADJ	HTR29	0.26	0.51	0.75	0.96	1.15	1.30
SO	YBADJ	HTR29	1.41	1.48	1.50	1.48	1.41	1.30
SO	YBADJ	HTR29	1.15	0.96	0.75	0.51	0.26	0.00
SO	YBADJ	HTR29	-0.26	-0.51	-0.75	-0.96	-1.15	-1.30
SO	YBADJ	HTR29	-1.41	-1.48	-1.50	-1.48	-1.41	-1.30
SO	YBADJ	HTR29	-1.15	-0.96	-0.75	-0.51	-0.26	0.00
SO	BUILDHGT	HTR37	2.20	2.20	2.20	2.20	2.20	2.20
SO	BUILDHGT	HTR37	2.20	2.20	2.20	2.20	2.20	2.20
SO	BUILDHGT	HTR37	2.20	2.20	2.20	2.20	2.20	2.20
SO	BUILDHGT	HTR37	2.20	2.20	2.20	2.20	2.20	2.20
SO	BUILDHGT	HTR37	2.20	2.20	2.20	2.20	2.20	2.20
SO	BUILDHGT	HTR37	2.20	2.20	2.20	2.20	2.20	2.20
SO	BUILDWID	HTR37	2.49	2.91	3.23	3.46	3.58	3.60
SO	BUILDWID	HTR37	3.50	3.30	3.00	3.30	3.50	3.60
SO	BUILDWID	HTR37	3.58	3.46	3.23	2.91	2.49	2.00
SO	BUILDWID	HTR37	2.49	2.91	3.23	3.46	3.58	3.60
SO	BUILDWID	HTR37	3.50	3.30	3.00	3.30	3.50	3.60
SO	BUILDWID	HTR37	3.58	3.46	3.23	2.91	2.49	2.00
SO	BUILDLEN	HTR37	3.30	3.50	3.60	3.58	3.46	3.23
SO	BUILDLEN	HTR37	2.91	2.49	2.00	2.49	2.91	3.23
SO	BUILDLEN	HTR37	3.46	3.58	3.60	3.50	3.30	3.00
SO	BUILDLEN	HTR37	3.30	3.50	3.60	3.58	3.46	3.23
SO	BUILDLEN	HTR37	2.91	2.49	2.00	2.49	2.91	3.23
SO	BUILDLEN	HTR37	3.46	3.58	3.60	3.50	3.30	3.00
SO	XBADJ	HTR37	-0.17	-0.34	-0.50	-0.64	-0.77	-0.87
SO	XBADJ	HTR37	-0.94	-0.98	-1.00	-1.51	-1.97	-2.37
SO	XBADJ	HTR37	-2.69	-2.94	-3.10	-3.16	-3.13	-3.00
SO	XBADJ	HTR37	-3.13	-3.16	-3.10	-2.94	-2.69	-2.37
SO	XBADJ	HTR37	-1.97	-1.51	-1.00	-0.98	-0.94	-0.87

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SO XBADJ    HTR37     -0.77   -0.64   -0.50   -0.34   -0.17    0.00
SO YBADJ    HTR37      0.26    0.51    0.75    0.96    1.15    1.30
SO YBADJ    HTR37      1.41    1.48    1.50    1.48    1.41    1.30
SO YBADJ    HTR37      1.15    0.96    0.75    0.51    0.26    0.00
SO YBADJ    HTR37     -0.26   -0.51   -0.75   -0.96   -1.15   -1.30
SO YBADJ    HTR37     -1.41   -1.48   -1.50   -1.48   -1.41   -1.30
SO YBADJ    HTR37     -1.15   -0.96   -0.75   -0.51   -0.26    0.00

SO BUILDHGT HTR42      2.20    2.20    2.20    2.20    2.20    2.20
SO BUILDHGT HTR42      2.20    2.20    2.20    2.20    2.20    2.20
SO BUILDHGT HTR42      2.20    2.20    2.20    2.20    2.20    2.20
SO BUILDHGT HTR42      2.20    2.20    2.20    2.20    2.20    2.20
SO BUILDHGT HTR42      2.20    2.20    2.20    2.20    2.20    2.20
SO BUILDHGT HTR42      2.20    2.20    2.20    2.20    2.20    2.20
SO BUILDWID HTR42      2.49    2.91    3.23    3.46    3.58    3.60
SO BUILDWID HTR42      3.50    3.30    3.00    3.30    3.50    3.60
SO BUILDWID HTR42      3.58    3.46    3.23    2.91    2.49    2.00
SO BUILDWID HTR42      2.49    2.91    3.23    3.46    3.58    3.60
SO BUILDWID HTR42      3.50    3.30    3.00    3.30    3.50    3.60
SO BUILDWID HTR42      3.58    3.46    3.23    2.91    2.49    2.00
SO BUILDLEN HTR42      3.30    3.50    3.60    3.58    3.46    3.23
SO BUILDLEN HTR42      2.91    2.49    2.00    2.49    2.91    3.23
SO BUILDLEN HTR42      3.46    3.58    3.60    3.50    3.30    3.00
SO BUILDLEN HTR42      3.30    3.50    3.60    3.58    3.46    3.23
SO BUILDLEN HTR42      2.91    2.49    2.00    2.49    2.91    3.23
SO BUILDLEN HTR42      3.46    3.58    3.60    3.50    3.30    3.00
SO XBADJ    HTR42     -0.17   -0.34   -0.50   -0.64   -0.77   -0.87
SO XBADJ    HTR42     -0.94   -0.98   -1.00   -1.51   -1.97   -2.37
SO XBADJ    HTR42     -2.69   -2.94   -3.10   -3.16   -3.13   -3.00
SO XBADJ    HTR42     -3.13   -3.16   -3.10   -2.94   -2.69   -2.37
SO XBADJ    HTR42     -1.97   -1.51   -1.00   -0.98   -0.94   -0.87
SO XBADJ    HTR42     -0.77   -0.64   -0.50   -0.34   -0.17    0.00
SO YBADJ    HTR42      0.26    0.51    0.75    0.96    1.15    1.30
SO YBADJ    HTR42      1.41    1.48    1.50    1.48    1.41    1.30
SO YBADJ    HTR42      1.15    0.96    0.75    0.51    0.26    0.00
SO YBADJ    HTR42     -0.26   -0.51   -0.75   -0.96   -1.15   -1.30
SO YBADJ    HTR42     -1.41   -1.48   -1.50   -1.48   -1.41   -1.30
SO YBADJ    HTR42     -1.15   -0.96   -0.75   -0.51   -0.26    0.00

SO BUILDHGT HTRE1      2.20    2.20    2.20    2.20    2.20    2.20
SO BUILDHGT HTRE1      2.20    2.20    2.20    2.20    2.20    2.20
SO BUILDHGT HTRE1      2.20    2.20    2.20    2.20    2.20    2.20
SO BUILDHGT HTRE1      2.20    2.20    2.20    2.20    2.20    2.20
SO BUILDHGT HTRE1      2.20    2.20    2.20    2.20    2.20    2.20
SO BUILDHGT HTRE1      2.20    2.20    2.20    2.20    2.20    2.20
SO BUILDWID HTRE1      2.49    2.91    3.23    3.46    3.58    3.60
SO BUILDWID HTRE1      3.50    3.30    3.00    3.30    3.50    3.60
SO BUILDWID HTRE1      3.58    3.46    3.23    2.91    2.49    2.00
SO BUILDWID HTRE1      2.49    2.91    3.23    3.46    3.58    3.60
SO BUILDWID HTRE1      3.50    3.30    3.00    3.30    3.50    3.60
SO BUILDWID HTRE1      3.58    3.46    3.23    2.91    2.49    2.00
SO BUILDLEN HTRE1      3.30    3.50    3.60    3.58    3.46    3.23
SO BUILDLEN HTRE1      2.91    2.49    2.00    2.49    2.91    3.23
SO BUILDLEN HTRE1      3.46    3.58    3.60    3.50    3.30    3.00
SO BUILDLEN HTRE1      3.30    3.50    3.60    3.58    3.46    3.23
SO BUILDLEN HTRE1      2.91    2.49    2.00    2.49    2.91    3.23
SO BUILDLEN HTRE1      3.46    3.58    3.60    3.50    3.30    3.00
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SO XBADJ    HTRE1     -0.17   -0.34   -0.50   -0.64   -0.77   -0.87
SO XBADJ    HTRE1     -0.94   -0.98   -1.00   -1.51   -1.97   -2.37
SO XBADJ    HTRE1     -2.69   -2.94   -3.10   -3.16   -3.13   -3.00
SO XBADJ    HTRE1     -3.13   -3.16   -3.10   -2.94   -2.69   -2.37
SO XBADJ    HTRE1     -1.97   -1.51   -1.00   -0.98   -0.94   -0.87
SO XBADJ    HTRE1     -0.77   -0.64   -0.50   -0.34   -0.17    0.00
SO YBADJ    HTRE1      0.26    0.51    0.75    0.96    1.15    1.30
SO YBADJ    HTRE1      1.41    1.48    1.50    1.48    1.41    1.30
SO YBADJ    HTRE1      1.15    0.96    0.75    0.51    0.26    0.00
SO YBADJ    HTRE1     -0.26   -0.51   -0.75   -0.96   -1.15   -1.30
SO YBADJ    HTRE1     -1.41   -1.48   -1.50   -1.48   -1.41   -1.30
SO YBADJ    HTRE1     -1.15   -0.96   -0.75   -0.51   -0.26    0.00

SO BUILDHGT HTRE2      2.20    2.20    2.20    2.20    2.20    2.20
SO BUILDHGT HTRE2      2.20    2.20    2.20    2.20    2.20    2.20
SO BUILDHGT HTRE2      2.20    2.20    2.20    2.20    2.20    2.20
SO BUILDHGT HTRE2      2.20    2.20    2.20    2.20    2.20    2.20
SO BUILDHGT HTRE2      2.20    2.20    2.20    2.20    2.20    2.20
SO BUILDHGT HTRE2      2.20    2.20    2.20    2.20    2.20    2.20
SO BUILDWID HTRE2      2.49    2.91    3.23    3.46    3.58    3.60
SO BUILDWID HTRE2      3.50    3.30    3.00    3.30    3.50    3.60
SO BUILDWID HTRE2      3.58    3.46    3.23    2.91    2.49    2.00
SO BUILDWID HTRE2      2.49    2.91    3.23    3.46    3.58    3.60
SO BUILDWID HTRE2      3.50    3.30    3.00    3.30    3.50    3.60
SO BUILDWID HTRE2      3.58    3.46    3.23    2.91    2.49    2.00
SO BUILDLEN HTRE2      3.30    3.50    3.60    3.58    3.46    3.23
SO BUILDLEN HTRE2      2.91    2.49    2.00    2.49    2.91    3.23
SO BUILDLEN HTRE2      3.46    3.58    3.60    3.50    3.30    3.00
SO BUILDLEN HTRE2      3.30    3.50    3.60    3.58    3.46    3.23
SO BUILDLEN HTRE2      2.91    2.49    2.00    2.49    2.91    3.23
SO BUILDLEN HTRE2      3.46    3.58    3.60    3.50    3.30    3.00
SO XBADJ    HTRE2     -0.17   -0.34   -0.50   -0.64   -0.77   -0.87
SO XBADJ    HTRE2     -0.94   -0.98   -1.00   -1.51   -1.97   -2.37
SO XBADJ    HTRE2     -2.69   -2.94   -3.10   -3.16   -3.13   -3.00
SO XBADJ    HTRE2     -3.13   -3.16   -3.10   -2.94   -2.69   -2.37
SO XBADJ    HTRE2     -1.97   -1.51   -1.00   -0.98   -0.94   -0.87
SO XBADJ    HTRE2     -0.77   -0.64   -0.50   -0.34   -0.17    0.00
SO YBADJ    HTRE2      0.26    0.51    0.75    0.96    1.15    1.30
SO YBADJ    HTRE2      1.41    1.48    1.50    1.48    1.41    1.30
SO YBADJ    HTRE2      1.15    0.96    0.75    0.51    0.26    0.00
SO YBADJ    HTRE2     -0.26   -0.51   -0.75   -0.96   -1.15   -1.30
SO YBADJ    HTRE2     -1.41   -1.48   -1.50   -1.48   -1.41   -1.30
SO YBADJ    HTRE2     -1.15   -0.96   -0.75   -0.51   -0.26    0.00

SO BUILDHGT HTRE3      2.20    2.20    2.20    2.20    2.20    2.20
SO BUILDHGT HTRE3      2.20    2.20    2.20    2.20    2.20    2.20
SO BUILDHGT HTRE3      2.20    2.20    2.20    2.20    2.20    2.20
SO BUILDHGT HTRE3      2.20    2.20    2.20    2.20    2.20    2.20
SO BUILDHGT HTRE3      2.20    2.20    2.20    2.20    2.20    2.20
SO BUILDHGT HTRE3      2.20    2.20    2.20    2.20    2.20    2.20
SO BUILDWID HTRE3      2.49    2.91    3.23    3.46    3.58    3.60
SO BUILDWID HTRE3      3.50    3.30    3.00    3.30    3.50    3.60
SO BUILDWID HTRE3      3.58    3.46    3.23    2.91    2.49    2.00
SO BUILDWID HTRE3      2.49    2.91    3.23    3.46    3.58    3.60
SO BUILDWID HTRE3      3.50    3.30    3.00    3.30    3.50    3.60
SO BUILDWID HTRE3      3.58    3.46    3.23    2.91    2.49    2.00
SO BUILDLEN HTRE3      3.30    3.50    3.60    3.58    3.46    3.23
```

```
SO BUILDLEN HTRE3      2.91    2.49    2.00    2.49    2.91    3.23
SO BUILDLEN HTRE3      3.46    3.58    3.60    3.50    3.30    3.00
SO BUILDLEN HTRE3      3.30    3.50    3.60    3.58    3.46    3.23
SO BUILDLEN HTRE3      2.91    2.49    2.00    2.49    2.91    3.23
SO BUILDLEN HTRE3      3.46    3.58    3.60    3.50    3.30    3.00
SO XBADJ    HTRE3     -0.17   -0.34   -0.50   -0.64   -0.77   -0.87
SO XBADJ    HTRE3     -0.94   -0.98   -1.00   -1.51   -1.97   -2.37
SO XBADJ    HTRE3     -2.69   -2.94   -3.10   -3.16   -3.13   -3.00
SO XBADJ    HTRE3     -3.13   -3.16   -3.10   -2.94   -2.69   -2.37
SO XBADJ    HTRE3     -1.97   -1.51   -1.00   -0.98   -0.94   -0.87
SO XBADJ    HTRE3     -0.77   -0.64   -0.50   -0.34   -0.17    0.00
SO YBADJ    HTRE3      0.26    0.51    0.75    0.96    1.15    1.30
SO YBADJ    HTRE3      1.41    1.48    1.50    1.48    1.41    1.30
SO YBADJ    HTRE3      1.15    0.96    0.75    0.51    0.26    0.00
SO YBADJ    HTRE3     -0.26   -0.51   -0.75   -0.96   -1.15   -1.30
SO YBADJ    HTRE3     -1.41   -1.48   -1.50   -1.48   -1.41   -1.30
SO YBADJ    HTRE3     -1.15   -0.96   -0.75   -0.51   -0.26    0.00

SO BUILDHGT HTRE4      2.20    2.20    2.20    2.20    2.20    2.20
SO BUILDHGT HTRE4      2.20    2.20    2.20    2.20    2.20    2.20
SO BUILDHGT HTRE4      2.20    2.20    2.20    2.20    2.20    2.20
SO BUILDHGT HTRE4      2.20    2.20    2.20    2.20    2.20    2.20
SO BUILDHGT HTRE4      2.20    2.20    2.20    2.20    2.20    2.20
SO BUILDHGT HTRE4      2.20    2.20    2.20    2.20    2.20    2.20
SO BUILDWID HTRE4      2.49    2.91    3.23    3.46    3.58    3.60
SO BUILDWID HTRE4      3.50    3.30    3.00    3.30    3.50    3.60
SO BUILDWID HTRE4      3.58    3.46    3.23    2.91    2.49    2.00
SO BUILDWID HTRE4      2.49    2.91    3.23    3.46    3.58    3.60
SO BUILDWID HTRE4      3.50    3.30    3.00    3.30    3.50    3.60
SO BUILDWID HTRE4      3.58    3.46    3.23    2.91    2.49    2.00
SO BUILDLEN HTRE4      3.30    3.50    3.60    3.58    3.46    3.23
SO BUILDLEN HTRE4      2.91    2.49    2.00    2.49    2.91    3.23
SO BUILDLEN HTRE4      3.46    3.58    3.60    3.50    3.30    3.00
SO BUILDLEN HTRE4      3.30    3.50    3.60    3.58    3.46    3.23
SO BUILDLEN HTRE4      2.91    2.49    2.00    2.49    2.91    3.23
SO BUILDLEN HTRE4      3.46    3.58    3.60    3.50    3.30    3.00
SO XBADJ    HTRE4     -0.17   -0.34   -0.50   -0.64   -0.77   -0.87
SO XBADJ    HTRE4     -0.94   -0.98   -1.00   -1.51   -1.97   -2.37
SO XBADJ    HTRE4     -2.69   -2.94   -3.10   -3.16   -3.13   -3.00
SO XBADJ    HTRE4     -3.13   -3.16   -3.10   -2.94   -2.69   -2.37
SO XBADJ    HTRE4     -1.97   -1.51   -1.00   -0.98   -0.94   -0.87
SO XBADJ    HTRE4     -0.77   -0.64   -0.50   -0.34   -0.17    0.00
SO YBADJ    HTRE4      0.26    0.51    0.75    0.96    1.15    1.30
SO YBADJ    HTRE4      1.41    1.48    1.50    1.48    1.41    1.30
SO YBADJ    HTRE4      1.15    0.96    0.75    0.51    0.26    0.00
SO YBADJ    HTRE4     -0.26   -0.51   -0.75   -0.96   -1.15   -1.30
SO YBADJ    HTRE4     -1.41   -1.48   -1.50   -1.48   -1.41   -1.30
SO YBADJ    HTRE4     -1.15   -0.96   -0.75   -0.51   -0.26    0.00


SO BUILDHGT COMPH1      2.20    2.20    2.20    2.20    2.20    2.20
SO BUILDHGT COMPH1      2.20    2.20    2.20    2.20    2.20    2.20
SO BUILDHGT COMPH1      2.20    2.20    2.20    2.20    2.20    2.20
SO BUILDHGT COMPH1      2.20    2.20    2.20    2.20    2.20    2.20
SO BUILDHGT COMPH1      2.20    2.20    2.20    2.20    2.20    2.20
SO BUILDHGT COMPH1      2.20    2.20    2.20    2.20    2.20    2.20
SO BUILDWID COMPH1      2.49    2.91    3.23    3.46    3.58    3.60
```

```
SO BUILDWID COMPH1      3.50    3.30    3.00    3.30    3.50    3.60
SO BUILDWID COMPH1      3.58    3.46    3.23    2.91    2.49    2.00
SO BUILDWID COMPH1      2.49    2.91    3.23    3.46    3.58    3.60
SO BUILDWID COMPH1      3.50    3.30    3.00    3.30    3.50    3.60
SO BUILDWID COMPH1      3.58    3.46    3.23    2.91    2.49    2.00
SO BUILDLEN COMPH1      3.30    3.50    3.60    3.58    3.46    3.23
SO BUILDLEN COMPH1      2.91    2.49    2.00    2.49    2.91    3.23
SO BUILDLEN COMPH1      3.46    3.58    3.60    3.50    3.30    3.00
SO BUILDLEN COMPH1      3.30    3.50    3.60    3.58    3.46    3.23
SO BUILDLEN COMPH1      2.91    2.49    2.00    2.49    2.91    3.23
SO BUILDLEN COMPH1      3.46    3.58    3.60    3.50    3.30    3.00
SO XBADJ    COMPH1     -0.17   -0.34   -0.50   -0.64   -0.77   -0.87
SO XBADJ    COMPH1     -0.94   -0.98   -1.00   -1.51   -1.97   -2.37
SO XBADJ    COMPH1     -2.69   -2.94   -3.10   -3.16   -3.13   -3.00
SO XBADJ    COMPH1     -3.13   -3.16   -3.10   -2.94   -2.69   -2.37
SO XBADJ    COMPH1     -1.97   -1.51   -1.00   -0.98   -0.94   -0.87
SO XBADJ    COMPH1     -0.77   -0.64   -0.50   -0.34   -0.17    0.00
SO YBADJ    COMPH1      0.26    0.51    0.75    0.96    1.15    1.30
SO YBADJ    COMPH1      1.41    1.48    1.50    1.48    1.41    1.30
SO YBADJ    COMPH1      1.15    0.96    0.75    0.51    0.26    0.00
SO YBADJ    COMPH1     -0.26   -0.51   -0.75   -0.96   -1.15   -1.30
SO YBADJ    COMPH1     -1.41   -1.48   -1.50   -1.48   -1.41   -1.30
SO YBADJ    COMPH1     -1.15   -0.96   -0.75   -0.51   -0.26    0.00

SO BUILDHGT COMPH2      2.20    2.20    2.20    2.20    2.20    2.20
SO BUILDHGT COMPH2      2.20    2.20    2.20    2.20    2.20    2.20
SO BUILDHGT COMPH2      2.20    2.20    2.20    2.20    2.20    2.20
SO BUILDHGT COMPH2      2.20    2.20    2.20    2.20    2.20    2.20
SO BUILDHGT COMPH2      2.20    2.20    2.20    2.20    2.20    2.20
SO BUILDHGT COMPH2      2.20    2.20    2.20    2.20    2.20    2.20
SO BUILDWID COMPH2      2.49    2.91    3.23    3.46    3.58    3.60
SO BUILDWID COMPH2      3.50    3.30    3.00    3.30    3.50    3.60
SO BUILDWID COMPH2      3.58    3.46    3.23    2.91    2.49    2.00
SO BUILDWID COMPH2      2.49    2.91    3.23    3.46    3.58    3.60
SO BUILDWID COMPH2      3.50    3.30    3.00    3.30    3.50    3.60
SO BUILDWID COMPH2      3.58    3.46    3.23    2.91    2.49    2.00
SO BUILDLEN COMPH2      3.30    3.50    3.60    3.58    3.46    3.23
SO BUILDLEN COMPH2      2.91    2.49    2.00    2.49    2.91    3.23
SO BUILDLEN COMPH2      3.46    3.58    3.60    3.50    3.30    3.00
SO BUILDLEN COMPH2      3.30    3.50    3.60    3.58    3.46    3.23
SO BUILDLEN COMPH2      2.91    2.49    2.00    2.49    2.91    3.23
SO BUILDLEN COMPH2      3.46    3.58    3.60    3.50    3.30    3.00
SO XBADJ    COMPH2     -0.17   -0.34   -0.50   -0.64   -0.77   -0.87
SO XBADJ    COMPH2     -0.94   -0.98   -1.00   -1.51   -1.97   -2.37
SO XBADJ    COMPH2     -2.69   -2.94   -3.10   -3.16   -3.13   -3.00
SO XBADJ    COMPH2     -3.13   -3.16   -3.10   -2.94   -2.69   -2.37
SO XBADJ    COMPH2     -1.97   -1.51   -1.00   -0.98   -0.94   -0.87
SO XBADJ    COMPH2     -0.77   -0.64   -0.50   -0.34   -0.17    0.00
SO YBADJ    COMPH2      0.26    0.51    0.75    0.96    1.15    1.30
SO YBADJ    COMPH2      1.41    1.48    1.50    1.48    1.41    1.30
SO YBADJ    COMPH2      1.15    0.96    0.75    0.51    0.26    0.00
SO YBADJ    COMPH2     -0.26   -0.51   -0.75   -0.96   -1.15   -1.30
SO YBADJ    COMPH2     -1.41   -1.48   -1.50   -1.48   -1.41   -1.30
SO YBADJ    COMPH2     -1.15   -0.96   -0.75   -0.51   -0.26    0.00

SO BUILDHGT COMPH3      2.20    2.20    2.20    2.20    2.20    2.20
SO BUILDHGT COMPH3      2.20    2.20    2.20    2.20    2.20    2.20
```

```
SO BUILDHGT COMPH3      2.20    2.20    2.20    2.20    2.20    2.20
SO BUILDHGT COMPH3      2.20    2.20    2.20    2.20    2.20    2.20
SO BUILDHGT COMPH3      2.20    2.20    2.20    2.20    2.20    2.20
SO BUILDHGT COMPH3      2.20    2.20    2.20    2.20    2.20    2.20
SO BUILDWID COMPH3      2.49    2.91    3.23    3.46    3.58    3.60
SO BUILDWID COMPH3      3.50    3.30    3.00    3.30    3.50    3.60
SO BUILDWID COMPH3      3.58    3.46    3.23    2.91    2.49    2.00
SO BUILDWID COMPH3      2.49    2.91    3.23    3.46    3.58    3.60
SO BUILDWID COMPH3      3.50    3.30    3.00    3.30    3.50    3.60
SO BUILDWID COMPH3      3.58    3.46    3.23    2.91    2.49    2.00
SO BUILDLEN COMPH3      3.30    3.50    3.60    3.58    3.46    3.23
SO BUILDLEN COMPH3      2.91    2.49    2.00    2.49    2.91    3.23
SO BUILDLEN COMPH3      3.46    3.58    3.60    3.50    3.30    3.00
SO BUILDLEN COMPH3      3.30    3.50    3.60    3.58    3.46    3.23
SO BUILDLEN COMPH3      2.91    2.49    2.00    2.49    2.91    3.23
SO BUILDLEN COMPH3      3.46    3.58    3.60    3.50    3.30    3.00
SO XBADJ    COMPH3     -0.17   -0.34   -0.50   -0.64   -0.77   -0.87
SO XBADJ    COMPH3     -0.94   -0.98   -1.00   -1.51   -1.97   -2.37
SO XBADJ    COMPH3     -2.69   -2.94   -3.10   -3.16   -3.13   -3.00
SO XBADJ    COMPH3     -3.13   -3.16   -3.10   -2.94   -2.69   -2.37
SO XBADJ    COMPH3     -1.97   -1.51   -1.00   -0.98   -0.94   -0.87
SO XBADJ    COMPH3     -0.77   -0.64   -0.50   -0.34   -0.17    0.00
SO YBADJ    COMPH3      0.26    0.51    0.75    0.96    1.15    1.30
SO YBADJ    COMPH3      1.41    1.48    1.50    1.48    1.41    1.30
SO YBADJ    COMPH3      1.15    0.96    0.75    0.51    0.26    0.00
SO YBADJ    COMPH3     -0.26   -0.51   -0.75   -0.96   -1.15   -1.30
SO YBADJ    COMPH3     -1.41   -1.48   -1.50   -1.48   -1.41   -1.30
SO YBADJ    COMPH3     -1.15   -0.96   -0.75   -0.51   -0.26    0.00

SO OLMGROUP ALL
SO SRCGROUP ALL

SO FINISHED
RE STARTING
RE INCLUDED const.rec
RE FINISHED
ME STARTING
ME SURFFILE bmtn2008n.sfc
ME PROFFILE bmtn2008n.pfl
ME SURFDATA 99999 2008
ME UAIRDATA 99999 2008
ME PROFBASE 2231.0 METERS
ME FINISHED
OU STARTING
OU RECTABLE 1 8
OU PLOTFILE 1 ALL 8 drill08n1hrno2c1.plt
OU FINISHED
```

CALPUFF Input File

```
Bull Mountain Project - EIS
Title 2
Title 2

Revision History:
  1/30/2014  DR  Created


---------------- Run title (3 lines) ----------------------------------------

                     CALPUFF MODEL CONTROL FILE
                     --------------------------

------------------------------------------------------------------------------

INPUT GROUP: 0 -- Input and Output File Names

--------------
Default Name  Type          File Name
------------  ----          ---------
CALMET.DAT    input    * METDAT =             *
    or
ISCMET.DAT    input    * ISCDAT =             *
    or
PLMMET.DAT    input    * PLMDAT =             *
    or
PROFILE.DAT   input    * PRFDAT =             *
SURFACE.DAT   input    * SFCDAT =             *
RESTARTB.DAT  input    * RSTARTB=             *
------------------------------------------------------------------------------
CALPUFF.LST   output   ! PUFLST = ./output/rigs_yr.lst !
CONC.DAT      output   ! CONDAT = ./output/rigs_yr_conc.dat !
DFLX.DAT      output   ! DFDAT = ./output/rigs_yr_dflx.dat !
WFLX.DAT      output   ! WFDAT = ./output/rigs_yr_wflx.dat !

VISB.DAT      output   ! VISDAT = ./output/rigs_yr_vis.dat !
TK2D.DAT      output   * T2DDAT =             *
RHO2D.DAT     output   * RHODAT =             *
RESTARTE.DAT  output   * RSTARTE=             *
------------------------------------------------------------------------------
Emission Files
--------------
PTEMARB.DAT   input    * PTDAT  =             *
VOLEMARB.DAT  input    * VOLDAT =             *
BAEMARB.DAT   input    * ARDAT  =             *
LNEMARB.DAT   input    * LNDAT  =             *
------------------------------------------------------------------------------
Other Files
-----------
OZONE.DAT     input    ! OZDAT = /aqm4/projects/bull_mountain/calpuff_EIS/ozone/ozone_1-29-
14.csv!
VD.DAT        input    * VDDAT  =             *
CHEM.DAT      input    * CHEMDAT=             *
H2O2.DAT      input    * H2O2DAT=             *
HILL.DAT      input    * HILDAT=             *
HILLRCT.DAT   input    * RCTDAT=             *
COASTLN.DAT   input    * CSTDAT=             *
FLUXBDY.DAT   input    * BDYDAT=             *
BCON.DAT      input    * BCNDAT=             *
DEBUG.DAT     output   * DEBUG =             *
MASSFLX.DAT   output   * FLXDAT=             *
MASSBAL.DAT   output   * BALDAT=             *
FOG.DAT       output   * FOGDAT=             *
------------------------------------------------------------------------------
All file names will be converted to lower case if LCFILES = T
Otherwise, if LCFILES = F, file names will be converted to UPPER CASE
```

```
         T = lower case      ! LCFILES = T !
         F = UPPER CASE
NOTE: (1) file/path names can be up to 70 characters in length


Provision for multiple input files
----------------------------------

     Number of CALMET.DAT files for run (NMETDAT)
                                    Default: 1       ! NMETDAT =   12   !

     Number of PTEMARB.DAT files for run (NPTDAT)
                                    Default: 0       ! NPTDAT =  0  !

     Number of BAEMARB.DAT files for run (NARDAT)
                                    Default: 0       ! NARDAT =  0  !

     Number of VOLEMARB.DAT files for run (NVOLDAT)
                                    Default: 0       ! NVOLDAT =  0  !

!END!

-------------
Subgroup (0a)
-------------

  The following CALMET.DAT filenames are processed in sequence if NMETDAT>1

Default Name  Type          File Name
------------  ----          ---------
none  input  ! METDAT=
/nas102/projects/Bull_Mountain/MMIF/eis/CDPHE_guidance/01_2008/mmif_met.met ! !END!
none  input  ! METDAT=
/nas102/projects/Bull_Mountain/MMIF/eis/CDPHE_guidance/02_2008/mmif_met.met ! !END!
none  input  ! METDAT=
/nas102/projects/Bull_Mountain/MMIF/eis/CDPHE_guidance/03_2008/mmif_met.met ! !END!
none  input  ! METDAT=
/nas102/projects/Bull_Mountain/MMIF/eis/CDPHE_guidance/04_2008/mmif_met.met ! !END!
none  input  ! METDAT=
/nas102/projects/Bull_Mountain/MMIF/eis/CDPHE_guidance/05_2008/mmif_met.met ! !END!
none  input  ! METDAT=
/nas102/projects/Bull_Mountain/MMIF/eis/CDPHE_guidance/06_2008/mmif_met.met ! !END!
none  input  ! METDAT=
/nas102/projects/Bull_Mountain/MMIF/eis/CDPHE_guidance/07_2008/mmif_met.met ! !END!
none  input  ! METDAT=
/nas102/projects/Bull_Mountain/MMIF/eis/CDPHE_guidance/08_2008/mmif_met.met ! !END!
none  input  ! METDAT=
/nas102/projects/Bull_Mountain/MMIF/eis/CDPHE_guidance/09_2008/mmif_met.met ! !END!
none  input  ! METDAT=
/nas102/projects/Bull_Mountain/MMIF/eis/CDPHE_guidance/10_2008/mmif_met.met ! !END!
none  input  ! METDAT=
/nas102/projects/Bull_Mountain/MMIF/eis/CDPHE_guidance/11_2008/mmif_met.met ! !END!
none  input  ! METDAT=
/nas102/projects/Bull_Mountain/MMIF/eis/CDPHE_guidance/12_2008/mmif_met.met ! !END!


-------------------------------------------------------------------------------

INPUT GROUP: 1 -- General run control parameters
--------------

    Option to run all periods found
    in the met. file     (METRUN)   Default: 0       ! METRUN =   0  !

         METRUN = 0 - Run period explicitly defined below
         METRUN = 1 - Run all periods in met. file

     Starting date:   Year (IBYR) -- No default       ! IBYR =  2008  !
     (used only if   Month (IBMO) -- No default       ! IBMO =  01 !
      METRUN = 0)      Day (IBDY) -- No default       ! IBDY =  01 !
                      Hour (IBHR) -- No default       ! IBHR =  01 !
```

```
     Base time zone        (XBTZ) -- No default       ! XBTZ = 7.0  !
        PST = 8., MST = 7.
        CST = 6., EST = 5.

     Length of run (hours) (IRLG) -- No default       ! IRLG =  8784 !  8784

     Number of chemical species (NSPEC)
                                   Default: 5       ! NSPEC =  7   !

     Number of chemical species
     to be emitted  (NSE)          Default: 3       ! NSE =  4   !

     Flag to stop run after
     SETUP phase (ITEST)           Default: 2       ! ITEST =  2   !
     (Used to allow checking
     of the model inputs, files, etc.)
           ITEST = 1 - STOPS program after SETUP phase
           ITEST = 2 - Continues with execution of program
                       after SETUP

     Restart Configuration:

        Control flag (MRESTART)      Default: 0       ! MRESTART =  0   !

           0 = Do not read or write a restart file
           1 = Read a restart file at the beginning of
               the run
           2 = Write a restart file during run
           3 = Read a restart file at beginning of run
               and write a restart file during run

        Number of periods in Restart
        output cycle (NRESPD)        Default: 0       ! NRESPD =  0   !

           0 = File written only at last period
          >0 = File updated every NRESPD periods

     Meteorological Data Format (METFM)
                                   Default: 1       ! METFM =  1   !

           METFM = 1 - CALMET binary file (CALMET.MET)
           METFM = 2 - ISC ASCII file (ISCMET.MET)
           METFM = 3 - AUSPLUME ASCII file (PLMMET.MET)
           METFM = 4 - CTDM plus tower file (PROFILE.DAT) and
                       surface parameters file (SURFACE.DAT)
           METFM = 5 - AERMET tower file (PROFILE.DAT) and
                       surface parameters file (SURFACE.DAT)

     Meteorological Profile Data Format (MPRFFM)
            (used only for METFM = 1, 2, 3)
                                   Default: 1       ! MPRFFM =  1   !

           MPRFFM = 1 - CTDM plus tower file (PROFILE.DAT)
           MPRFFM = 2 - AERMET tower file (PROFILE.DAT)

     PG sigma-y is adjusted by the factor (AVET/PGTIME)**0.2
     Averaging Time (minutes) (AVET)
                                   Default: 60.0    ! AVET = 60. !
     PG Averaging Time (minutes) (PGTIME)
                                   Default: 60.0    ! PGTIME = 60. !

!END!


------------------------------------------------------------------------------

INPUT GROUP: 2 -- Technical options
--------------
```

```
Vertical distribution used in the
near field (MGAUSS)                  Default: 1     ! MGAUSS =  1   !
   0 = uniform
   1 = Gaussian

Terrain adjustment method
(MCTADJ)                             Default: 3     ! MCTADJ =  3   !
   0 = no adjustment
   1 = ISC-type of terrain adjustment
   2 = simple, CALPUFF-type of terrain
       adjustment
   3 = partial plume path adjustment

Subgrid-scale complex terrain
flag (MCTSG)                         Default: 0     ! MCTSG =  0   !
   0 = not modeled
   1 = modeled

Near-field puffs modeled as
elongated slugs? (MSLUG)             Default: 0     ! MSLUG =  0   !
   0 = no
   1 = yes (slug model used)

Transitional plume rise modeled?
(MTRANS)                             Default: 1     ! MTRANS =  1   !
   0 = no  (i.e., final rise only)
   1 = yes (i.e., transitional rise computed)

Stack tip downwash? (MTIP)           Default: 1     ! MTIP =  1  !
   0 = no  (i.e., no stack tip downwash)
   1 = yes (i.e., use stack tip downwash)

Method used to simulate building
downwash? (MBDW)                     Default: 1     ! MBDW =   1  !
   1 = ISC method
   2 = PRIME method

Vertical wind shear modeled above
stack top? (MSHEAR)                  Default: 0     ! MSHEAR =  0  !
   0 = no  (i.e., vertical wind shear not modeled)
   1 = yes (i.e., vertical wind shear modeled)

Puff splitting allowed? (MSPLIT)     Default: 0     ! MSPLIT =  0  !
   0 = no (i.e., puffs not split)
   1 = yes (i.e., puffs are split)

Chemical mechanism flag (MCHEM)      Default: 1     ! MCHEM =  1   !
   0 = chemical transformation not
       modeled
   1 = transformation rates computed
       internally (MESOPUFF II scheme)
   2 = user-specified transformation
       rates used
   3 = transformation rates computed
       internally (RIVAD/ARM3 scheme)
   4 = secondary organic aerosol formation
       computed (MESOPUFF II scheme for OH)

Aqueous phase transformation flag (MAQCHEM)
(Used only if MCHEM = 1, or 3)       Default: 0     ! MAQCHEM =  0   !
   0 = aqueous phase transformation
       not modeled
   1 = transformation rates adjusted
       for aqueous phase reactions

Wet removal modeled ? (MWET)         Default: 1     ! MWET =  1   !
   0 = no
   1 = yes

Dry deposition modeled ? (MDRY)      Default: 1     ! MDRY =  1   !
   0 = no
```

```
   1 = yes
   (dry deposition method specified
    for each species in Input Group 3)


Gravitational settling (plume tilt)
modeled ? (MTILT)                    Default: 0     ! MTILT =  0   !
   0 = no
   1 = yes
   (puff center falls at the gravitational
    settling velocity for 1 particle species)

Restrictions:
    - MDRY  = 1
    - NSPEC = 1  (must be particle species as well)
    - sg    = 0  GEOMETRIC STANDARD DEVIATION in Group 8 is
                 set to zero for a single particle diameter

Method used to compute dispersion
coefficients (MDISP)                 Default: 3     ! MDISP =  3   !

   1 = dispersion coefficients computed from measured values
       of turbulence, sigma v, sigma w
   2 = dispersion coefficients from internally calculated
       sigma v, sigma w using micrometeorological variables
       (u*, w*, L, etc.)
   3 = PG dispersion coefficients for RURAL areas (computed using
       the ISCST multi-segment approximation) and MP coefficients in
       urban areas
   4 = same as 3 except PG coefficients computed using
       the MESOPUFF II eqns.
   5 = CTDM sigmas used for stable and neutral conditions.
       For unstable conditions, sigmas are computed as in
       MDISP = 3, described above.  MDISP = 5 assumes that
       measured values are read

Sigma-v/sigma-theta, sigma-w measurements used? (MTURBVW)
(Used only if MDISP = 1 or 5)        Default: 3     ! MTURBVW =  3  !
   1 = use sigma-v or sigma-theta measurements
       from PROFILE.DAT to compute sigma-y
       (valid for METFM = 1, 2, 3, 4, 5)
   2 = use sigma-w measurements
       from PROFILE.DAT to compute sigma-z
       (valid for METFM = 1, 2, 3, 4, 5)
   3 = use both sigma-(v/theta) and sigma-w
       from PROFILE.DAT to compute sigma-y and sigma-z
       (valid for METFM = 1, 2, 3, 4, 5)
   4 = use sigma-theta measurements
       from PLMMET.DAT to compute sigma-y
       (valid only if METFM = 3)

Back-up method used to compute dispersion
when measured turbulence data are
missing (MDISP2)                     Default: 3     ! MDISP2 =  3  !
(used only if MDISP = 1 or 5)
   2 = dispersion coefficients from internally calculated
       sigma v, sigma w using micrometeorological variables
       (u*, w*, L, etc.)
   3 = PG dispersion coefficients for RURAL areas (computed using
       the ISCST multi-segment approximation) and MP coefficients in
       urban areas
   4 = same as 3 except PG coefficients computed using
       the MESOPUFF II eqns.

[DIAGNOSTIC FEATURE]
Method used for Lagrangian timescale for Sigma-y
(used only if MDISP=1,2 or MDISP2=1,2)
(MTAULY)                             Default: 0     ! MTAULY =  0  !
   0 = Draxler default 617.284 (s)
   1 = Computed as Lag. Length / (.75 q) -- after SCIPUFF
  10 < Direct user input (s)             -- e.g., 306.9
```

```
[DIAGNOSTIC FEATURE]
Method used for Advective-Decay timescale for Turbulence
(used only if MDISP=2 or MDISP2=2)
(MTAUADV)                             Default: 0     ! MTAUADV =  0  !
   0 = No turbulence advection
   1 = Computed (OPTION NOT IMPLEMENTED)
  10 < Direct user input (s)   -- e.g., 300


Method used to compute turbulence sigma-v &
sigma-w using micrometeorological variables
(Used only if MDISP = 2 or MDISP2 = 2)
(MCTURB)                              Default: 1     ! MCTURB =  1  !
   1 = Standard CALPUFF subroutines
   2 = AERMOD subroutines

PG sigma-y,z adj. for roughness?      Default: 0     ! MROUGH =  0  !
(MROUGH)
   0 = no
   1 = yes

Partial plume penetration of          Default: 1     ! MPARTL =  1  !
elevated inversion?
(MPARTL)
   0 = no
   1 = yes

Strength of temperature inversion     Default: 0     ! MTINV =  0  !
provided in PROFILE.DAT extended records?
(MTINV)
   0 = no (computed from measured/default gradients)
   1 = yes

PDF used for dispersion under convective conditions?
                                      Default: 0     ! MPDF =  0  !
(MPDF)
   0 = no
   1 = yes

Sub-Grid TIBL module used for shore line?
                                      Default: 0     ! MSGTIBL = 0  !
(MSGTIBL)
   0 = no
   1 = yes

Boundary conditions (concentration) modeled?
                                      Default: 0     ! MBCON = 0  !
(MBCON)
   0 = no
   1 = yes, using formatted BCON.DAT file
   2 = yes, using unformatted CONC.DAT file

Note:  MBCON > 0 requires that the last species modeled
       be 'BCON'.  Mass is placed in species BCON when
       generating boundary condition puffs so that clean
       air entering the modeling domain can be simulated
       in the same way as polluted air.  Specify zero
       emission of species BCON for all regular sources.

Individual source contributions saved?
                                      Default: 0     ! MSOURCE = 0  !
(MSOURCE)
   0 = no
   1 = yes


Analyses of fogging and icing impacts due to emissions from
arrays of mechanically-forced cooling towers can be performed
using CALPUFF in conjunction with a cooling tower emissions
```

```
     processor (CTEMISS) and its associated postprocessors.  Hourly
     emissions of water vapor and temperature from each cooling tower
     cell are computed for the current cell configuration and ambient
     conditions by CTEMISS. CALPUFF models the dispersion of these
     emissions and provides cloud information in a specialized format
     for further analysis. Output to FOG.DAT is provided in either
     'plume mode' or 'receptor mode' format.

     Configure for FOG Model output?
                                          Default: 0     ! MFOG =  0   !
     (MFOG)
        0 = no
        1 = yes  - report results in PLUME Mode format
        2 = yes  - report results in RECEPTOR Mode format


     Test options specified to see if
     they conform to regulatory
     values? (MREG)                       Default: 1     ! MREG =  1   !

        0 = NO checks are made
        1 = Technical options must conform to USEPA
            Long Range Transport (LRT) guidance
                       METFM    1 or 2
                       AVET     60. (min)
                       PGTIME   60. (min)
                       MGAUSS   1
                       MCTADJ   3
                       MTRANS   1
                       MTIP     1
                       MCHEM    1 or 3 (if modeling SOx, NOx)
                       MWET     1
                       MDRY     1
                       MDISP    2 or 3
                       MPDF     0 if MDISP=3
                                1 if MDISP=2
                       MROUGH   0
                       MPARTL   1
                       SYTDEP   550. (m)
                       MHFTSZ   0
                       SVMIN    0.5 (m/s)

!END!

-------------------------------------------------------------------------------

INPUT GROUP: 3a, 3b -- Species list
-------------------

------------
Subgroup (3a)
------------

  The following species are modeled:

! CSPEC =          SO2 !         !END!
! CSPEC =          SO4 !         !END!
! CSPEC =          NOX !         !END!
! CSPEC =         HNO3 !         !END!
! CSPEC =          NO3 !         !END!
! CSPEC =         PM10 !         !END!
! CSPEC =         PM25 !         !END!

                                                     Dry                OUTPUT GROUP
    SPECIES          MODELED          EMITTED       DEPOSITED              NUMBER
     NAME         (0=NO, 1=YES)    (0=NO, 1=YES)    (0=NO,                (0=NONE,
   (Limit: 12                                        1=COMPUTED-GAS        1=1st CGRUP,
    Characters                                       2=COMPUTED-PARTICLE   2=2nd CGRUP,
    in length)                                       3=USER-SPECIFIED)     3= etc.)

!          SO2  =         1,               1,           1,                 0   !
```

```
!          SO4  =         1,               0,           2,                 0   !
!          NOX  =         1,               1,           1,                 0   !
!         HNO3  =         1,               0,           1,                 0   !
!          NO3  =         1,               0,           2,                 0   !
!         PM10  =         1,               1,           2,                 0   !
!         PM25  =         1,               1,           2,                 0   !

!END!

  Note:  The last species in (3a) must be 'BCON' when using the
         boundary condition option (MBCON > 0).  Species BCON should
         typically be modeled as inert (no chem transformation or
         removal).


-------------
Subgroup (3b)
-------------
  The following names are used for Species-Groups in which results
  for certain species are combined (added) prior to output.  The
  CGRUP name will be used as the species name in output files.
  Use this feature to model specific particle-size distributions
  by treating each size-range as a separate species.
  Order must be consistent with 3(a) above.


-------------------------------------------------------------------------------


INPUT GROUP: 4 -- Map Projection and Grid control parameters
--------------

     Projection for all (X,Y):
     -------------------------

     Map projection
     (PMAP)                     Default: UTM    ! PMAP = LCC  !

         UTM :  Universal Transverse Mercator
         TTM :  Tangential Transverse Mercator
         LCC :  Lambert Conformal Conic
          PS :  Polar Stereographic
          EM :  Equatorial Mercator
        LAZA :  Lambert Azimuthal Equal Area

     False Easting and Northing (km) at the projection origin
     (Used only if PMAP= TTM, LCC, or LAZA)
     (FEAST)                    Default=0.0     ! FEAST  = 0.000  !
     (FNORTH)                   Default=0.0     ! FNORTH = 0.000  !

     UTM zone (1 to 60)
     (Used only if PMAP=UTM)
     (IUTMZN)                   No Default      ! IUTMZN =  0   !

     Hemisphere for UTM projection?
     (Used only if PMAP=UTM)
     (UTMHEM)                   Default: N      ! UTMHEM = N  !
         N   :  Northern hemisphere projection
         S   :  Southern hemisphere projection

     Latitude and Longitude (decimal degrees) of projection origin
     (Used only if PMAP= TTM, LCC, PS, EM, or LAZA)
     (RLAT0)                    No Default      ! RLAT0 = 40N  !
     (RLON0)                    No Default      ! RLON0 = 97W  !

         TTM :  RLON0 identifies central (true N/S) meridian of projection
                RLAT0 selected for convenience
         LCC :  RLON0 identifies central (true N/S) meridian of projection
                RLAT0 selected for convenience
         PS  :  RLON0 identifies central (grid N/S) meridian of projection
                RLAT0 selected for convenience
```

```
        EM  :  RLON0 identifies central meridian of projection
               RLAT0 is REPLACED by 0.0N (Equator)
        LAZA:  RLON0 identifies longitude of tangent-point of mapping plane
               RLAT0 identifies latitude of tangent-point of mapping plane

    Matching parallel(s) of latitude (decimal degrees) for projection
    (Used only if PMAP= LCC or PS)
    (XLAT1)                    No Default      ! XLAT1 = 33N  !
    (XLAT2)                    No Default      ! XLAT2 = 45N  !

        LCC :  Projection cone slices through Earth's surface at XLAT1 and XLAT2
        PS  :  Projection plane slices through Earth at XLAT1
               (XLAT2 is not used)

    ----------
    Note:  Latitudes and longitudes should be positive, and include a
           letter N,S,E, or W indicating north or south latitude, and
           east or west longitude.  For example,
           35.9  N Latitude  =  35.9N
           118.7 E Longitude = 118.7E


    Datum-region
    ------------

    The Datum-Region for the coordinates is identified by a character
    string.  Many mapping products currently available use the model of the
    Earth known as the World Geodetic System 1984 (WGS-84).  Other local
    models may be in use, and their selection in CALMET will make its output
    consistent with local mapping products.  The list of Datum-Regions with
    official transformation parameters is provided by the National Imagery and
    Mapping Agency (NIMA).

    NIMA Datum - Regions(Examples)
    ------------------------------------------------------------------------------
    WGS-84    WGS-84 Reference Ellipsoid and Geoid, Global coverage (WGS84)
    NAS-C     NORTH AMERICAN 1927 Clarke 1866 Spheroid, MEAN FOR CONUS (NAD27)
    NAR-C     NORTH AMERICAN 1983 GRS 80 Spheroid, MEAN FOR CONUS (NAD83)
    NWS-84    NWS 6370KM Radius, Sphere
    ESR-S     ESRI REFERENCE 6371KM Radius, Sphere

    Datum-region for output coordinates
    (DATUM)                    Default: WGS-84    ! DATUM = NWS-84  !


METEOROLOGICAL Grid:

    Rectangular grid defined for projection PMAP,
    with X the Easting and Y the Northing coordinate

           No. X grid cells (NX)      No default     ! NX =  175   !
           No. Y grid cells (NY)      No default     ! NY =  184   !
        No. vertical layers (NZ)      No default     ! NZ =  11   !

          Grid spacing (DGRIDKM)      No default     ! DGRIDKM = 4.0 !
                                      Units: km

               Cell face heights
                   (ZFACE(nz+1))      No defaults
                                      Units: m
  ! ZFACE = .0, 20.0, 40.0, 80.0, 160.0, 320.0, 640.0, 1200.0, 2000.0, 3000.0,
            4000.0, 5000.0 !

           Reference Coordinates
          of SOUTHWEST corner of
                grid cell(1, 1):

           X coordinate (XORIGKM)     No default     ! XORIGKM = -1248 !
           Y coordinate (YORIGKM)     No default     ! YORIGKM = -412.0 !
                                     Units: km
```

```
COMPUTATIONAL Grid:

     The computational grid is identical to or a subset of the MET. grid.
     The lower left (LL) corner of the computational grid is at grid point
     (IBCOMP, JBCOMP) of the MET. grid.  The upper right (UR) corner of the
     computational grid is at grid point (IECOMP, JECOMP) of the MET. grid.
     The grid spacing of the computational grid is the same as the MET. grid.

        X index of LL corner (IBCOMP)      No default     ! IBCOMP = 25  !
                  (1 <= IBCOMP <= NX)

        Y index of LL corner (JBCOMP)      No default     ! JBCOMP = 25   !
                  (1 <= JBCOMP <= NY)


        X index of UR corner (IECOMP)      No default     ! IECOMP =  150   !
                  (1 <= IECOMP <= NX)

        Y index of UR corner (JECOMP)      No default     ! JECOMP =  159   !
                  (1 <= JECOMP <= NY)


SAMPLING Grid (GRIDDED RECEPTORS):

     The lower left (LL) corner of the sampling grid is at grid point
     (IBSAMP, JBSAMP) of the MET. grid.  The upper right (UR) corner of the
     sampling grid is at grid point (IESAMP, JESAMP) of the MET. grid.
     The sampling grid must be identical to or a subset of the computational
     grid.  It may be a nested grid inside the computational grid.
     The grid spacing of the sampling grid is DGRIDKM/MESHDN.

        Logical flag indicating if gridded
        receptors are used (LSAMP)         Default: T     ! LSAMP = F !
        (T=yes, F=no)

        X index of LL corner (IBSAMP)      No default     ! IBSAMP =  0   !
         (IBCOMP <= IBSAMP <= IECOMP)

        Y index of LL corner (JBSAMP)      No default     ! JBSAMP =  0   !
         (JBCOMP <= JBSAMP <= JECOMP)


        X index of UR corner (IESAMP)      No default     ! IESAMP =  0   !
         (IBCOMP <= IESAMP <= IECOMP)

        Y index of UR corner (JESAMP)      No default     ! JESAMP =  0   !
         (JBCOMP <= JESAMP <= JECOMP)


       Nesting factor of the sampling
        grid (MESHDN)                      Default: 1     ! MESHDN =  1  !
        (MESHDN is an integer >= 1)

!END!


-------------------------------------------------------------------------------


INPUT GROUP: 5 -- Output Options
--------------
                                          *                          *
     FILE                        DEFAULT VALUE             VALUE THIS RUN
     ----                        -------------             --------------

   Concentrations (ICON)               1                   !  ICON =  1   !
   Dry Fluxes (IDRY)                   1                   !  IDRY =  1   !
   Wet Fluxes (IWET)                   1                   !  IWET =  1   !
   2D Temperature (IT2D)               0                   !  IT2D =  0   !
   2D Density (IRHO)                   0                   !  IRHO =  0   !
   Relative Humidity (IVIS)            1                   !  IVIS =  0   !
```

```
 (relative humidity file is
  required for visibility
  analysis)
Use data compression option in output file?
(LCOMPRS)                          Default: T         ! LCOMPRS = T !

*
 0 = Do not create file, 1 = create file


 QA PLOT FILE OUTPUT OPTION:

    Create a standard series of output files (e.g.
    locations of sources, receptors, grids ...)
    suitable for plotting?
    (IQAPLOT)                      Default: 1         !  IQAPLOT =  1   !
      0 = no
      1 = yes

 DIAGNOSTIC MASS FLUX OUTPUT OPTIONS:

    Mass flux across specified boundaries
    for selected species reported hourly?
    (IMFLX)                        Default: 0         ! IMFLX =  0  !
      0 = no
      1 = yes (FLUXBDY.DAT and MASSFLX.DAT filenames
               are specified in Input Group 0)

    Mass balance for each species
    reported hourly?
    (IMBAL)                        Default: 0         ! IMBAL =  0  !
      0 = no
      1 = yes (MASSBAL.DAT filename is
           specified in Input Group 0)


 LINE PRINTER OUTPUT OPTIONS:

    Print concentrations (ICPRT)   Default: 0         ! ICPRT =  0   !
    Print dry fluxes (IDPRT)       Default: 0         ! IDPRT =  0   !
    Print wet fluxes (IWPRT)       Default: 0         ! IWPRT =  0   !
    (0 = Do not print, 1 = Print)

    Concentration print interval
    (ICFRQ) in hours               Default: 1         ! ICFRQ =  1   !
    Dry flux print interval
    (IDFRQ) in hours               Default: 1         ! IDFRQ =  1   !
    Wet flux print interval
    (IWFRQ) in hours               Default: 1         ! IWFRQ =  1   !

    Units for Line Printer Output
    (IPRTU)                        Default: 1         ! IPRTU =  3   !
                    for            for
                Concentration    Deposition
        1 =       g/m**3          g/m**2/s
        2 =      mg/m**3         mg/m**2/s
        3 =      ug/m**3         ug/m**2/s
        4 =      ng/m**3         ng/m**2/s
        5 =     Odour Units

    Messages tracking progress of run
    written to the screen ?
    (IMESG)                        Default: 2         ! IMESG =  2   !
      0 = no
      1 = yes (advection step, puff ID)
      2 = yes (YYYYJJJHH, # old puffs, # emitted puffs)


  SPECIES (or GROUP for combined species) LIST FOR OUTPUT OPTIONS
```

```
                 ---- CONCENTRATIONS ----   ------ DRY FLUXES ------   ------ WET FLUXES ------
-- MASS FLUX --
   SPECIES
   /GROUP        PRINTED?  SAVED ON DISK?   PRINTED?  SAVED ON DISK?   PRINTED?  SAVED ON DISK?
SAVED ON DISK?
   -------       ------------------------   ------------------------   ------------------------
!          SO2 =     0,           1,           0,           1,           0,           1,
0   !
!          SO4 =     0,           1,           0,           1,           0,           1,
0   !
!          NOX =     0,           1,           0,           1,           0,           1,
0   !
!         HNO3 =     0,           1,           0,           1,           0,           1,
0   !
!          NO3 =     0,           1,           0,           1,           0,           1,
0   !
!         PM10 =     0,           1,           0,           1,           0,           1,
0   !
!         PM25 =     0,           1,           0,           1,           0,           1,
0   !

  Note:  Species BCON (for MBCON > 0) does not need to be saved on disk.


     OPTIONS FOR PRINTING "DEBUG" QUANTITIES (much output)

       Logical for debug output
       (LDEBUG)                                Default: F     ! LDEBUG = F !

       First puff to track
       (IPFDEB)                                Default: 1     ! IPFDEB =  1  !

       Number of puffs to track
       (NPFDEB)                                Default: 1     ! NPFDEB =  1  !

       Met. period to start output
       (NN1)                                   Default: 1     ! NN1 =  1  !

       Met. period to end output
       (NN2)                                   Default: 10    ! NN2 =  10 !

!END!


-------------------------------------------------------------------------------


INPUT GROUP: 6a, 6b, & 6c -- Subgrid scale complex terrain inputs
-------------------------

---------------
Subgroup (6a)
---------------
       Number of terrain features (NHILL)      Default: 0     ! NHILL =  0   !

       Number of special complex terrain
       receptors  (NCTREC)                     Default: 0     ! NCTREC =  0   !

       Terrain and CTSG Receptor data for
       CTSG hills input in CTDM format ?
       (MHILL)                                 No Default     ! MHILL =  0   !
       1 = Hill and Receptor data created
           by CTDM processors & read from
           HILL.DAT and HILLRCT.DAT files
       2 = Hill data created by OPTHILL &
           input below in Subgroup (6b);
           Receptor data in Subgroup (6c)

       Factor to convert horizontal dimensions  Default: 1.0   ! XHILL2M = 1.0 !
       to meters (MHILL=1)
```

```
       Factor to convert vertical dimensions    Default: 1.0   ! ZHILL2M = 1.0 !
       to meters (MHILL=1)

       X-origin of CTDM system relative to      No Default     ! XCTDMKM = 0 !
       CALPUFF coordinate system, in Kilometers (MHILL=1)

       Y-origin of CTDM system relative to      No Default     ! YCTDMKM = 0 !
       CALPUFF coordinate system, in Kilometers (MHILL=1)

! END !

---------------
Subgroup (6b)
---------------

                      1 **
     HILL information


HILL           XC        YC       THETAH  ZGRID  RELIEF    EXPO 1    EXPO 2   SCALE 1    SCALE 2
AMAX1     AMAX2
 NO.          (km)      (km)      (deg.)   (m)     (m)      (m)       (m)       (m)        (m)
(m)       (m)
----          ----      ----      ------  -----  ------    ------    ------   -------    --------
---     -----

---------------
Subgroup (6c)
---------------

    COMPLEX TERRAIN RECEPTOR INFORMATION

                      XRCT         YRCT        ZRCT          XHH
                      (km)         (km)         (m)
                     ------        -----      ------         ----


-------------------
1
     Description of Complex Terrain Variables:
          XC, YC  = Coordinates of center of hill
          THETAH  = Orientation of major axis of hill (clockwise from
                    North)
          ZGRID   = Height of the  0  of the grid above mean sea
                    level
          RELIEF  = Height of the crest of the hill above the grid elevation
          EXPO 1  = Hill-shape exponent for the major axis
          EXPO 2  = Hill-shape exponent for the major axis
          SCALE 1 = Horizontal length scale along the major axis
          SCALE 2 = Horizontal length scale along the minor axis
          AMAX    = Maximum allowed axis length for the major axis
          BMAX    = Maximum allowed axis length for the major axis

          XRCT, YRCT = Coordinates of the complex terrain receptors
          ZRCT    = Height of the ground (MSL) at the complex terrain
                    Receptor
          XHH     = Hill number associated with each complex terrain receptor
                    (NOTE: MUST BE ENTERED AS A REAL NUMBER)

   **
     NOTE: DATA for each hill and CTSG receptor are treated as a separate
           input subgroup and therefore must end with an input group terminator.

-------------------------------------------------------------------------------


INPUT GROUP: 7 -- Chemical parameters for dry deposition of gases
--------------

      SPECIES     DIFFUSIVITY      ALPHA STAR      REACTIVITY    MESOPHYLL RESISTANCE     HENRY'S
LAW COEFFICIENT
```

```
       NAME        (cm**2/s)                                          (s/cm)
(dimensionless)
      -------     -----------      ----------      ----------    --------------------     -------
----------------

!          SO2 =      .1509,        1000.0,           8.0,                .0,
.04 !
!          NOX =      .1656,           1.0,           8.0,               5.0,
3.5 !
!         HNO3 =      .1628,           1.0,          18.0,                .0,                 8E-
08 !

!END!


-------------------------------------------------------------------------------


INPUT GROUP: 8 -- Size parameters for dry deposition of particles
--------------

     For SINGLE SPECIES, the mean and standard deviation are used to
     compute a deposition velocity for NINT (see group 9) size-ranges,
     and these are then averaged to obtain a mean deposition velocity.

     For GROUPED SPECIES, the size distribution should be explicitly
     specified (by the 'species' in the group), and the standard deviation
     for each should be entered as 0.  The model will then use the
     deposition velocity for the stated mean diameter.

      SPECIES      GEOMETRIC MASS MEAN        GEOMETRIC STANDARD
       NAME             DIAMETER                 DEVIATION
                        (microns)                (microns)
      -------      -------------------        ------------------
!          SO4 =           .48,                     2.0   !
!          NO3 =           .48,                     2.0   !
!         PM10 =           .48,                     2.0   !
!         PM25 =           .48,                     2.0   !

!END!


-------------------------------------------------------------------------------


INPUT GROUP: 9 -- Miscellaneous dry deposition parameters
--------------

     Reference cuticle resistance (s/cm)
     (RCUTR)                          Default: 30    !  RCUTR = 30.0 !
     Reference ground resistance  (s/cm)
     (RGR)                            Default: 10    !    RGR = 10.0 !
     Reference pollutant reactivity
     (REACTR)                         Default: 8     ! REACTR = 8.0 !

     Number of particle-size intervals used to
     evaluate effective particle deposition velocity
     (NINT)                           Default: 9     !   NINT =  9  !

     Vegetation state in unirrigated areas
     (IVEG)                           Default: 1     !   IVEG =  1   !
        IVEG=1 for active and unstressed vegetation
        IVEG=2 for active and stressed vegetation
        IVEG=3 for inactive vegetation

!END!


-------------------------------------------------------------------------------
```

```
INPUT GROUP: 10 -- Wet Deposition Parameters
---------------


                      Scavenging Coefficient -- Units: (sec)**(-1)

       Pollutant      Liquid Precip.       Frozen Precip.
       ---------      --------------       --------------
!          SO2 =          3.0E-05,             0.0E00 !
!          SO4 =          1.0E-04,             3.0E-05!
!         HNO3 =          6.0E-05,             0.0E00 !
!          NO3 =          1.0E-04,             3.0E-05!
!         PM10 =          1.0E-04,             3.0E-05!
!         PM25 =          1.0E-04,             3.0E-05!

!END!


-------------------------------------------------------------------------------


INPUT GROUP: 11 -- Chemistry Parameters
---------------

     Ozone data input option (MOZ)     Default: 1            ! MOZ =  1   !
     (Used only if MCHEM = 1, 3, or 4)
        0 = use a monthly background ozone value
        1 = read hourly ozone concentrations from
            the OZONE.DAT data file

     Monthly ozone concentrations
     (Used only if MCHEM = 1, 3, or 4 and
      MOZ = 0 or MOZ = 1 and all hourly O3 data missing)
     (BCKO3) in ppb                    Default: 12*80.
     !  BCKO3 = 80.00, 80.00, 80.00, 80.00, 80.00, 80.00, 80.00, 80.00, 80.00, 80.00, 80.00,
80.00 !

     Monthly ammonia concentrations
     (Used only if MCHEM = 1, or 3)
     (BCKNH3) in ppb                   Default: 12*10.
     !  BCKNH3 =  1.00,  1.00,  1.00,  1.00,  1.00,  1.00,  1.00,  1.00,  1.00,  1.00,  1.00,
1.00 ! Use value for arid land per FLAG (2010)

     Nighttime SO2 loss rate (RNITE1)
     in percent/hour                   Default: 0.2          ! RNITE1 = .2 !

     Nighttime NOx loss rate (RNITE2)
     in percent/hour                   Default: 2.0          ! RNITE2 = 2.0 !

     Nighttime HNO3 formation rate (RNITE3)
     in percent/hour                   Default: 2.0          ! RNITE3 = 2.0 !

     H2O2 data input option (MH2O2)    Default: 1            ! MH2O2 =  1   !
     (Used only if MAQCHEM = 1)
        0 = use a monthly background H2O2 value
        1 = read hourly H2O2 concentrations from
            the H2O2.DAT data file

     Monthly H2O2 concentrations
     (Used only if MQACHEM = 1 and
      MH2O2 = 0 or MH2O2 = 1 and all hourly H2O2 data missing)
     (BCKH2O2) in ppb                  Default: 12*1.
     !  BCKH2O2 = 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00 !


 --- Data for SECONDARY ORGANIC AEROSOL (SOA) Option
     (used only if MCHEM = 4)

     The SOA module uses monthly values of:
          Fine particulate concentration in ug/m^3 (BCKPMF)
          Organic fraction of fine particulate     (OFRAC)
```

```
     VOC / NOX ratio (after reaction)         (VCNX)
     to characterize the air mass when computing
     the formation of SOA from VOC emissions.
     Typical values for several distinct air mass types are:

        Month    1    2    3    4    5    6    7    8    9   10   11   12
                Jan  Feb  Mar  Apr  May  Jun  Jul  Aug  Sep  Oct  Nov  Dec

     Clean Continental
        BCKPMF   1.   1.   1.   1.   1.   1.   1.   1.   1.   1.   1.   1.
        OFRAC  .15  .15  .20  .20  .20  .20  .20  .20  .20  .20  .20  .15
        VCNX    50.  50.  50.  50.  50.  50.  50.  50.  50.  50.  50.  50.

     Clean Marine (surface)
        BCKPMF  .5   .5   .5   .5   .5   .5   .5   .5   .5   .5   .5   .5
        OFRAC  .25  .25  .30  .30  .30  .30  .30  .30  .30  .30  .30  .25
        VCNX    50.  50.  50.  50.  50.  50.  50.  50.  50.  50.  50.  50.

     Urban - low biogenic (controls present)
        BCKPMF  30.  30.  30.  30.  30.  30.  30.  30.  30.  30.  30.  30.
        OFRAC  .20  .20  .25  .25  .25  .25  .25  .25  .20  .20  .20  .20
        VCNX     4.   4.   4.   4.   4.   4.   4.   4.   4.   4.   4.   4.

     Urban - high biogenic (controls present)
        BCKPMF  60.  60.  60.  60.  60.  60.  60.  60.  60.  60.  60.  60.
        OFRAC  .25  .25  .30  .30  .30  .55  .55  .55  .35  .35  .35  .25
        VCNX    15.  15.  15.  15.  15.  15.  15.  15.  15.  15.  15.  15.

     Regional Plume
        BCKPMF  20.  20.  20.  20.  20.  20.  20.  20.  20.  20.  20.  20.
        OFRAC  .20  .20  .25  .35  .25  .40  .40  .40  .30  .30  .30  .20
        VCNX    15.  15.  15.  15.  15.  15.  15.  15.  15.  15.  15.  15.

     Urban - no controls present
        BCKPMF 100. 100. 100. 100. 100. 100. 100. 100. 100. 100. 100. 100.
        OFRAC  .30  .30  .35  .35  .35  .55  .55  .55  .35  .35  .35  .30
        VCNX     2.   2.   2.   2.   2.   2.   2.   2.   2.   2.   2.   2.

     Default: Clean Continental
     !  BCKPMF = 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00 !
     !  OFRAC  = 0.15, 0.15, 0.20, 0.20, 0.20, 0.20, 0.20, 0.20, 0.20, 0.20, 0.20, 0.15 !
     !  VCNX   = 50.00, 50.00, 50.00, 50.00, 50.00, 50.00, 50.00, 50.00, 50.00, 50.00, 50.00,
50.00 !


!END!


-------------------------------------------------------------------------------


INPUT GROUP: 12 -- Misc. Dispersion and Computational Parameters
---------------

     Horizontal size of puff (m) beyond which
     time-dependent dispersion equations (Heffter)
     are used to determine sigma-y and
     sigma-z (SYTDEP)                          Default: 550.   ! SYTDEP = 5.5E02 !

     Switch for using Heffter equation for sigma z
     as above (0 = Not use Heffter; 1 = use Heffter
     (MHFTSZ)                                  Default: 0      ! MHFTSZ =  0   !

     Stability class used to determine plume
     growth rates for puffs above the boundary
     layer (JSUP)                              Default: 5      ! JSUP =  5   !

     Vertical dispersion constant for stable
     conditions (k1 in Eqn. 2.7-3)  (CONK1)    Default: 0.01   ! CONK1 = .01 !

     Vertical dispersion constant for neutral/
```

```
unstable conditions (k2 in Eqn. 2.7-4)
(CONK2)                                     Default: 0.1    ! CONK2 = .1 !

Factor for determining Transition-point from
Schulman-Scire to Huber-Snyder Building Downwash
scheme (SS used for Hs < Hb + TBD * HL)
(TBD)                                       Default: 0.5    ! TBD = .5 !
   TBD < 0   ==> always use Huber-Snyder
   TBD = 1.5 ==> always use Schulman-Scire
   TBD = 0.5 ==> ISC Transition-point

Range of land use categories for which
urban dispersion is assumed
(IURB1, IURB2)                              Default: 10     ! IURB1 =  10  !
                                                     19     ! IURB2 =  19  !

Site characterization parameters for single-point Met data files ---------
(needed for METFM = 2,3,4,5)

   Land use category for modeling domain
   (ILANDUIN)                               Default: 20     ! ILANDUIN =  20  !

   Roughness length (m) for modeling domain
   (Z0IN)                                   Default: 0.25   ! Z0IN = .25 !

   Leaf area index for modeling domain
   (XLAIIN)                                 Default: 3.0    ! XLAIIN = 3.0 !

   Elevation above sea level (m)
   (ELEVIN)                                 Default: 0.0    ! ELEVIN = .0 !

   Latitude (degrees) for met location
   (XLATIN)                                 Default: -999.  ! XLATIN = -999.0 !

   Longitude (degrees) for met location
   (XLONIN)                                 Default: -999.  ! XLONIN = -999.0 !

Specialized information for interpreting single-point Met data files -----

   Anemometer height (m) (Used only if METFM = 2,3)
   (ANEMHT)                                 Default: 10.    ! ANEMHT = 10.0 !

   Form of lateral turbulance data in PROFILE.DAT file
   (Used only if METFM = 4,5 or MTURBVW = 1 or 3)
   (ISIGMAV)                                Default: 1      ! ISIGMAV =  1  !
       0 = read sigma-theta
       1 = read sigma-v

   Choice of mixing heights (Used only if METFM = 4)
   (IMIXCTDM)                               Default: 0      ! IMIXCTDM =  0  !
       0 = read PREDICTED mixing heights
       1 = read OBSERVED mixing heights

Maximum length of a slug (met. grid units)
(XMXLEN)                                    Default: 1.0    ! XMXLEN = 1.0 !

Maximum travel distance of a puff/slug (in
grid units) during one sampling step
(XSAMLEN)                                   Default: 1.0    ! XSAMLEN = 1.0 !

Maximum Number of slugs/puffs release from
one source during one time step
(MXNEW)                                     Default: 99     ! MXNEW =  99   !

Maximum Number of sampling steps for
one puff/slug during one time step
(MXSAM)                                     Default: 99     ! MXSAM =  99   !

Number of iterations used when computing
the transport wind for a sampling step
that includes gradual rise (for CALMET
```

```
and PROFILE winds)
(NCOUNT)                                    Default: 2      ! NCOUNT =  2   !

Minimum sigma y for a new puff/slug (m)
(SYMIN)                                     Default: 1.0    ! SYMIN = 1.0  !

Minimum sigma z for a new puff/slug (m)
(SZMIN)                                     Default: 1.0    ! SZMIN = 1.0  !

Default minimum turbulence velocities sigma-v and sigma-w
for each stability class over land and over water (m/s)
(SVMIN(12) and SWMIN(12))

                ----------  LAND  ----------       ---------  WATER  ----------
   Stab Class :  A    B    C    D    E    F         A    B    C    D    E    F
                ---  ---  ---  ---  ---  ---       ---  ---  ---  ---  ---  ---
Default SVMIN : .50, .50, .50, .50, .50, .50,      .37, .37, .37, .37, .37, .37
Default SWMIN : .20, .12, .08, .06, .03, .016,     .20, .12, .08, .06, .03, .016

      ! SVMIN = 0.500, 0.500, 0.500, 0.500, 0.500, 0.500, 0.500, 0.500, 0.500, 0.500, 0.500,
0.500!
      ! SWMIN = 0.200, 0.120, 0.080, 0.060, 0.030, 0.016, 0.200, 0.120, 0.080, 0.060, 0.030,
0.016!

Divergence criterion for dw/dz across puff
used to initiate adjustment for horizontal
convergence (1/s)
Partial adjustment starts at CDIV(1), and
full adjustment is reached at CDIV(2)
(CDIV(2))                                   Default: 0.0,0.0  ! CDIV = .0, .0 !

Minimum wind speed (m/s) allowed for
non-calm conditions. Also used as minimum
speed returned when using power-law
extrapolation toward surface
(WSCALM)                                    Default: 0.5    ! WSCALM = .5 !

Maximum mixing height (m)
(XMAXZI)                                    Default: 3000.  ! XMAXZI = 3000.0 !

Minimum mixing height (m)
(XMINZI)                                    Default: 50.    ! XMINZI = 50.0 !

Default wind speed classes --
5 upper bounds (m/s) are entered;
the 6th class has no upper limit
(WSCAT(5))                        Default   :
                                  ISC RURAL : 1.54, 3.09, 5.14, 8.23, 10.8 (10.8+)

                           Wind Speed Class :  1     2     3     4     5
                                               ---   ---   ---   ---   ---
                                     ! WSCAT = 1.54, 3.09, 5.14, 8.23, 10.80 !

Default wind speed profile power-law
exponents for stabilities 1-6
(PLX0(6))                         Default   : ISC RURAL values
                                  ISC RURAL : .07, .07, .10, .15, .35, .55
                                  ISC URBAN : .15, .15, .20, .25, .30, .30

                            Stability Class :  A     B     C     D     E     F
                                               ---   ---   ---   ---   ---   ---
                                        ! PLX0 = 0.07, 0.07, 0.10, 0.15, 0.35, 0.55 !

Default potential temperature gradient
for stable classes E, F (degK/m)
(PTG0(2))                         Default: 0.020, 0.035
                                     ! PTG0 = 0.020,   0.035 !

Default plume path coefficients for
each stability class (used when option
for partial plume height terrain adjustment
```

```
is selected -- MCTADJ=3)
(PPC(6))                  Stability Class :  A     B     C     D     E     F
                             Default  PPC : .50,  .50,  .50,  .50,  .35,  .35
                                            ---   ---   ---   ---   ---   ---
                                   !  PPC = 0.50, 0.50, 0.50, 0.50, 0.35, 0.35 !

Slug-to-puff transition criterion factor
equal to sigma-y/length of slug
(SL2PF)                                Default: 10.        ! SL2PF = 10.0 !

Puff-splitting control variables ------------------------

  VERTICAL SPLIT
  --------------

  Number of puffs that result every time a puff
  is split - nsplit=2 means that 1 puff splits
  into 2
  (NSPLIT)                             Default:   3        ! NSPLIT =  3  !

  Time(s) of a day when split puffs are eligible to
  be split once again; this is typically set once
  per day, around sunset before nocturnal shear develops.
  24 values: 0 is midnight (00:00) and 23 is 11 PM (23:00)
  0=do not re-split    1=eligible for re-split
  (IRESPLIT(24))                       Default:  Hour 17 = 1
  !  IRESPLIT = 0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,1,0,0,0,0,0,0 !

  Split is allowed only if last hour's mixing
  height (m) exceeds a minimum value
  (ZISPLIT)                            Default: 100.       ! ZISPLIT = 100.0 !

  Split is allowed only if ratio of last hour's
  mixing ht to the maximum mixing ht experienced
  by the puff is less than a maximum value (this
  postpones a split until a nocturnal layer develops)
  (ROLDMAX)                            Default: 0.25       ! ROLDMAX = 0.25 !


  HORIZONTAL SPLIT
  ----------------

  Number of puffs that result every time a puff
  is split - nsplith=5 means that 1 puff splits
  into 5
  (NSPLITH)                            Default:   5        ! NSPLITH =  5  !

  Minimum sigma-y (Grid Cells Units) of puff
  before it may be split
  (SYSPLITH)                           Default:  1.0       ! SYSPLITH = 1.0 !

  Minimum puff elongation rate (SYSPLITH/hr) due to
  wind shear, before it may be split
  (SHSPLITH)                           Default:  2.        ! SHSPLITH = 2.0 !

  Minimum concentration (g/m^3) of each
  species in puff before it may be split
  Enter array of NSPEC values; if a single value is
  entered, it will be used for ALL species
  (CNSPLITH)                           Default:  1.0E-07   ! CNSPLITH = 1.0E-07 !

Integration control variables ------------------------

  Fractional convergence criterion for numerical SLUG
  sampling integration
  (EPSSLUG)                            Default:   1.0e-04  ! EPSSLUG = 1.0E-04 !

  Fractional convergence criterion for numerical AREA
  source integration
  (EPSAREA)                            Default:   1.0e-06  ! EPSAREA = 1.0E-06 !
```

```
       Trajectory step-length (m) used for numerical rise
       integration
       (DSRISE)                          Default:   1.0      ! DSRISE = 1.0 !

       Boundary Condition (BC) Puff control variables ------------------------

       Minimum height (m) to which BC puffs are mixed as they are emitted
       (MBCON=2 ONLY).  Actual height is reset to the current mixing height
       at the release point if greater than this minimum.
       (HTMINBC)                         Default:   500.     ! HTMINBC = 500.0 !

       Search radius (km) about a receptor for sampling nearest BC puff.
       BC puffs are typically emitted with a spacing of one grid cell
       length, so the search radius should be greater than DGRIDKM.
       (RSAMPBC)                         Default:   10.      ! RSAMPBC = 10.0 !

       Near-Surface depletion adjustment to concentration profile used when
       sampling BC puffs?
       (MDEPBC)                          Default:   1        ! MDEPBC =  1  !
          0 = Concentration is NOT adjusted for depletion
          1 = Adjust Concentration for depletion

!END!


--------------------------------------------------------------------------------


INPUT GROUPS: 13a, 13b, 13c, 13d -- Point source parameters
--------------------------------

---------------
Subgroup (13a)
---------------

     Number of point sources with
     parameters provided below      (NPT1)  No default  ! NPT1 = 4 !

     Units used for point source
     emissions below                (IPTU)  Default: 1  !  IPTU =   1  !
           1 =        g/s
           2 =       kg/hr
           3 =       lb/hr
           4 =     tons/yr
           5 =     Odour Unit * m**3/s  (vol. flux of odour compound)
           6 =     Odour Unit * m**3/min
           7 =     metric tons/yr

     Number of source-species
     combinations with variable
     emissions scaling factors
     provided below in (13d)        (NSPT1) Default: 0  ! NSPT1 = 15 !

     Number of point sources with
     variable emission parameters
     provided in external file      (NPT2)  No default  !  NPT2 =  0  !

     (If NPT2 > 0, these point
     source emissions are read from
     the file: PTEMARB.DAT)

!END!

---------------
Subgroup (13b)
---------------
                                    a
          POINT SOURCE: CONSTANT DATA
          ----------------------------
                                                                          b          c
  Source       X         Y       Stack    Base     Stack    Exit  Exit    Bldg.  Emission
```

```
   No.     Coordinate Coordinate Height Elevation Diameter  Vel.  Temp.   Dwash   Rates
              (km)      (km)       (m)      (m)       (m)  (m/s) (deg. K)
  ------   ---------- ---------- ------  ------   -------- ----- -------- ----- --------



                                                                    Erates
          LCC_X   LCC_Y     Hs  Elev.   Ds    Vs     Ts Dwash     SO2      SO4      NOX     HNO3
NO3     PM10     PM25

           (km)    (km)    (m)    (m)  (m) (m/s)    (K)         (g/s)    (g/s)    (g/s)    (g/s)
(g/s)    (g/s)    (g/s)
1! SRCNAM = DR_365 !
! X = -887.374, -51.59, 4.6, 2426, 0.2, 50, 700, 0,
6.68149E-02, 0.00000E+00, 5.99990E-01, 0.00000E+00, 0.00000E+00, 1.99997E-02, 1.99997E-02 !

! END !

2! SRCNAM = DR_SMR1 !
! X = -888.026, -48.002, 4.6, 2231, 0.2, 50, 700, 0,
6.68149E-02, 0.00000E+00, 5.99990E-01, 0.00000E+00, 0.00000E+00, 1.99997E-02, 1.99997E-02 !

! END !

3! SRCNAM = DR_SMR2 !
! X = -887.462, -54.888, 4.6, 2489, 0.2, 50, 700, 0,
6.68149E-02, 0.00000E+00, 5.99990E-01, 0.00000E+00, 0.00000E+00, 1.99997E-02, 1.99997E-02 !

! END !

4! SRCNAM = CR1 !
! X = -888.026, -48.002, 4.6, 2231, 0.2, 40, 600, 0,
2.30083E-02, 0.00000E+00, 2.49996E-01, 0.00000E+00, 0.00000E+00, 8.33319E-03, 8.33319E-03 !

! END !



--------

    a
     Data for each source are treated as a separate input subgroup
     and therefore must end with an input group terminator.

     SRCNAM  is a 12-character name for a source
             (No default)
     X       is an array holding the source data listed by the column headings
             (No default)
     SIGYZI  is an array holding the initial sigma-y and sigma-z (m)
             (Default: 0.,0.)
     ZPLTFM  is the platform height (m) for sources influenced by an isolated
             structure that has a significant open area between the surface
             and the bulk of the structure, such as an offshore oil platform.
             The Base Elevation is that of the surface (ground or ocean),
             and the Stack Height is the release height above the Base (not
             above the platform).  Building heights entered in Subgroup 13c
             must be those of the buildings on the platform, measured from
             the platform deck.  ZPLTFM is used only with MBDW=1 (ISC
             downwash method) for sources with building downwash.
             (Default: 0.0)
     FMFAC   is a vertical momentum flux factor (0. or 1.0) used to represent
             the effect of rain-caps or other physical configurations that
             reduce momentum rise associated with the actual exit velocity.
             (Default: 1.0  -- full momentum used)

    b
     0. = No building downwash modeled
     1. = Downwash modeled for buildings resting on the surface
     2. = Downwash modeled for buildings raised above the surface (ZPLTFM > 0.)
     NOTE: must be entered as a REAL number (i.e., with decimal point)
```

```
    c
     An emission rate must be entered for every pollutant modeled.
     Enter emission rate of zero for secondary pollutants that are
     modeled, but not emitted.  Units are specified by IPTU
     (e.g. 1 for g/s).

---------------
Subgroup (13c)
---------------

           BUILDING DIMENSION DATA FOR SOURCES SUBJECT TO DOWNWASH
           -------------------------------------------------------
Source                                                                  a
 No.       Effective building height, width, length and X/Y offset (in meters)
           every 10 degrees.  LENGTH, XBADJ, and YBADJ are only needed for
           MBDW=2 (PRIME downwash option)
------     ---------------------------------------------------------------


--------

    a
     Building height, width, length, and X/Y offset from the source are treated
     as a separate input subgroup for each source and therefore must end with
     an input group terminator.  The X/Y offset is the position, relative to the
     stack, of the center of the upwind face of the projected building, with the
     x-axis pointing along the flow direction.

---------------
Subgroup (13d)
---------------
                                                  a
          POINT SOURCE: VARIABLE EMISSIONS DATA
          -------------------------------------

     Use this subgroup to describe temporal variations in the emission
     rates given in 13b.  Factors entered multiply the rates in 13b.
     Skip sources here that have constant emissions.  For more elaborate
     variation in source parameters, use PTEMARB.DAT and NPT2 > 0.

     IVARY determines the type of variation, and is source-specific:
     (IVARY)                                Default: 0
           0 =       Constant
           1 =       Diurnal cycle (24 scaling factors: hours 1-24)
           2 =       Monthly cycle (12 scaling factors: months 1-12)
           3 =       Hour & Season (4 groups of 24 hourly scaling factors,
                                    where first group is DEC-JAN-FEB)
           4 =       Speed & Stab. (6 groups of 6 scaling factors, where
                                    first group is Stability Class A,
                                    and the speed classes have upper
                                    bounds (m/s) defined in Group 12
           5 =       Temperature   (12 scaling factors, where temperature
                                    classes have upper bounds (C) of:
                                    0, 5, 10, 15, 20, 25, 30, 35, 40,
                                    45, 50, 50+)

1 2-1 ! SRCNAM = DR_SMR1 !
! IVARY=  2 !
! SO2 = 0,0,0,1,1,1,1,1,1,1,1,0 !
! END !

2 2-2 ! SRCNAM = DR_SMR1 !
! IVARY=  2 !
! SO4 = 0,0,0,1,1,1,1,1,1,1,1,0 !
! END !

3 2-3 ! SRCNAM = DR_SMR1 !
! IVARY=  2 !
! NOX = 0,0,0,1,1,1,1,1,1,1,1,0 !
! END !
```

```
4 2-4 ! SRCNAM = DR_SMR1 !
! IVARY=  2 !
! PM10 = 0,0,0,1,1,1,1,1,1,1,1,0 !
! END !

5 2-5 ! SRCNAM = DR_SMR1 !
! IVARY=  2 !
! PM25 = 0,0,0,1,1,1,1,1,1,1,1,0 !
! END !

6 3-1 ! SRCNAM = DR_SMR2 !
! IVARY=  2 !
! SO2 = 0,0,0,1,1,1,1,1,1,1,1,0 !
! END !

7 3-2 ! SRCNAM = DR_SMR2 !
! IVARY=  2 !
! SO4 = 0,0,0,1,1,1,1,1,1,1,1,0 !
! END !

8 3-3 ! SRCNAM = DR_SMR2 !
! IVARY=  2 !
! NOX = 0,0,0,1,1,1,1,1,1,1,1,0 !
! END !

9 3-4 ! SRCNAM = DR_SMR2 !
! IVARY=  2 !
! PM10 = 0,0,0,1,1,1,1,1,1,1,1,0 !
! END !

10 3-5 ! SRCNAM = DR_SMR2 !
! IVARY=  2 !
! PM25 = 0,0,0,1,1,1,1,1,1,1,1,0 !
! END !

11 4-1 ! SRCNAM = CR1 !
! IVARY=  1 !
! SO2= 0,0,0,0,0,0,0,1,1,1,1,1,1,1,1,1,1,0,0,0,0,0,0,0 !
! END !

12 4-2 ! SRCNAM = CR1 !
! IVARY=  1 !
! SO4= 0,0,0,0,0,0,0,1,1,1,1,1,1,1,1,1,1,0,0,0,0,0,0,0 !
! END !

13 4-3 ! SRCNAM = CR1 !
! IVARY=  1 !
! NOX= 0,0,0,0,0,0,0,1,1,1,1,1,1,1,1,1,1,0,0,0,0,0,0,0 !
! END !

14 4-4 ! SRCNAM = CR1 !
! IVARY=  1 !
! PM10= 0,0,0,0,0,0,0,1,1,1,1,1,1,1,1,1,1,0,0,0,0,0,0,0 !
! END !

15 4-5 ! SRCNAM = CR1 !
! IVARY=  1 !
! PM25= 0,0,0,0,0,0,0,1,1,1,1,1,1,1,1,1,1,0,0,0,0,0,0,0 !
! END !
```

---

a Data for each species are treated as a separate input subgroup and therefore must end with an input group terminator.

```
INPUT GROUPS: 14a, 14b, 14c, 14d -- Area source parameters
---------------------------------

---------------
Subgroup (14a)
---------------

     Number of polygon area sources with
     parameters specified below (NAR1)       No default  ! NAR1 = 0 !

     Units used for area source
     emissions below           (IARU)       Default: 1  !  IARU =   1  !
           1 =        g/m**2/s
           2 =       kg/m**2/hr
           3 =       lb/m**2/hr
           4 =     tons/m**2/yr
           5 =     Odour Unit * m/s  (vol. flux/m**2 of odour compound)
           6 =     Odour Unit * m/min
           7 =     metric tons/m**2/yr

     Number of source-species
     combinations with variable
     emissions scaling factors
     provided below in (14d)        (NSAR1) Default: 0  ! NSAR1 = 0 !

     Number of buoyant polygon area sources
     with variable location and emission
     parameters (NAR2)                      No default  !  NAR2 =  0   !
     (If NAR2 > 0, ALL parameter data for
     these sources are read from the file: BAEMARB.DAT)

!END!

---------------
Subgroup (14b)
---------------
                                      a
          AREA SOURCE: CONSTANT DATA
          ----------------------------
                                                          b
Source           Effect.    Base      Initial    Emission
 No.             Height   Elevation   Sigma z     Rates
                   (m)       (m)        (m)
-------          ------    ------     --------   ---------


--------
    a
     Data for each source are treated as a separate input subgroup
     and therefore must end with an input group terminator.
    b
     An emission rate must be entered for every pollutant modeled.
     Enter emission rate of zero for secondary pollutants that are
     modeled, but not emitted.  Units are specified by IARU
     (e.g. 1 for g/m**2/s).

---------------
Subgroup (14c)
---------------

           COORDINATES (km) FOR EACH VERTEX(4) OF EACH POLYGON
           ---------------------------------------------------------
Source                                                                a
 No.       Ordered list of X followed by list of Y, grouped by source
------     ------------------------------------------------------------


--------
    a
     Data for each source are treated as a separate input subgroup
```

and therefore must end with an input group terminator.

Subgroup (14d)

AREA SOURCE: VARIABLE EMISSIONS DATA[a]

Use this subgroup to describe temporal variations in the emission rates given in 14b. Factors entered multiply the rates in 14b. Skip sources here that have constant emissions. For more elaborate variation in source parameters, use BAEMARB.DAT and NAR2 > 0.

IVARY determines the type of variation, and is source-specific:
(IVARY) Default: 0

```
      0 =       Constant
      1 =       Diurnal cycle (24 scaling factors: hours 1-24)
      2 =       Monthly cycle (12 scaling factors: months 1-12)
      3 =       Hour & Season (4 groups of 24 hourly scaling factors,
                               where first group is DEC-JAN-FEB)
      4 =       Speed & Stab. (6 groups of 6 scaling factors, where
                               first group is Stability Class A,
                               and the speed classes have upper
                               bounds (m/s) defined in Group 12
      5 =       Temperature   (12 scaling factors, where temperature
                               classes have upper bounds (C) of:
                               0, 5, 10, 15, 20, 25, 30, 35, 40,
                               45, 50, 50+)
```

---

[a] Data for each species are treated as a separate input subgroup and therefore must end with an input group terminator.

INPUT GROUPS: 15a, 15b, 15c -- Line source parameters

Subgroup (15a)

Number of buoyant line sources with variable location and emission parameters (NLN2) No default ! NLN2 = 0 !

(If NLN2 > 0, ALL parameter data for these sources are read from the file: LNEMARB.DAT)

Number of buoyant line sources (NLINES) No default ! NLINES = 0 !

Units used for line source emissions below (ILNU) Default: 1 ! ILNU = 1 !

```
      1 =        g/s
      2 =       kg/hr
      3 =       lb/hr
      4 =     tons/yr
      5 =     Odour Unit * m**3/s  (vol. flux of odour compound)
      6 =     Odour Unit * m**3/min
      7 =     metric tons/yr
```

Number of source-species combinations with variable emissions scaling factors provided below in (15c) (NSLN1) Default: 0 ! NSLN1 = 0 !

```
     Maximum number of segments used to model
     each line (MXNSEG)                            Default: 7   ! MXNSEG =  7  !

     The following variables are required only if NLINES > 0.  They are
     used in the buoyant line source plume rise calculations.

        Number of distances at which               Default: 6   ! NLRISE =  6  !
        transitional rise is computed

        Average building length (XL)               No default   ! XL = .0 !
                                                   (in meters)

        Average building height (HBL)              No default   ! HBL = .0 !
                                                   (in meters)

        Average building width (WBL)               No default   ! WBL = .0 !
                                                   (in meters)

        Average line source width (WML)            No default   ! WML = .0 !
                                                   (in meters)

        Average separation between buildings (DXL) No default   ! DXL = .0 !
                                                   (in meters)

        Average buoyancy parameter (FPRIMEL)       No default   ! FPRIMEL = .0 !
                                                   (in m**4/s**3)

!END!

---------------
Subgroup (15b)
---------------

          BUOYANT LINE SOURCE: CONSTANT DATA
          ----------------------------------
                                                                                a
Source     Beg. X      Beg. Y      End. X    End. Y     Release    Base        Emission
 No.     Coordinate  Coordinate  Coordinate Coordinate  Height    Elevation      Rates
            (km)        (km)        (km)       (km)       (m)       (m)
------   ----------  ----------  ---------  ----------  -------   ---------    ---------

--------

    a
     Data for each source are treated as a separate input subgroup
     and therefore must end with an input group terminator.

    b
     An emission rate must be entered for every pollutant modeled.
     Enter emission rate of zero for secondary pollutants that are
     modeled, but not emitted.  Units are specified by ILNTU
     (e.g. 1 for g/s).

---------------
Subgroup (15c)
---------------
                                                        a
          BUOYANT LINE SOURCE: VARIABLE EMISSIONS DATA
          --------------------------------------------

     Use this subgroup to describe temporal variations in the emission
     rates given in 15b.  Factors entered multiply the rates in 15b.
     Skip sources here that have constant emissions.

     IVARY determines the type of variation, and is source-specific:
     (IVARY)                                Default: 0
           0 =       Constant
           1 =       Diurnal cycle (24 scaling factors: hours 1-24)
           2 =       Monthly cycle (12 scaling factors: months 1-12)
           3 =       Hour & Season (4 groups of 24 hourly scaling factors,
```

```
                                  where first group is DEC-JAN-FEB)
           4 =       Speed & Stab. (6 groups of 6 scaling factors, where
                                  first group is Stability Class A,
                                  and the speed classes have upper
                                  bounds (m/s) defined in Group 12
           5 =       Temperature   (12 scaling factors, where temperature
                                  classes have upper bounds (C) of:
                                  0, 5, 10, 15, 20, 25, 30, 35, 40,
                                  45, 50, 50+)

--------
    a
     Data for each species are treated as a separate input subgroup
     and therefore must end with an input group terminator.


-------------------------------------------------------------------------------


INPUT GROUPS: 16a, 16b, 16c -- Volume source parameters
---------------------------

---------------
Subgroup (16a)
---------------

     Number of volume sources with
     parameters provided in 16b,c (NVL1)     No default  ! NVL1= 0 !
          Units used for volume source
     emissions below in 16b       (IVLU)     Default: 1  ! IVLU = 1 !
           1 =        g/s
           2 =       kg/hr
           3 =       lb/hr
           4 =     tons/yr
           5 =     Odour Unit * m**3/s  (vol. flux of odour compound)
           6 =     Odour Unit * m**3/min
           7 =     metric tons/yr

     Number of source-species
     combinations with variable
     emissions scaling factors
     provided below in (16c)      (NSVL1)    Default: 0  ! NSVL1= 0 !

     Number of volume sources with
     variable location and emission
     parameters                   (NVL2)     No default  !  NVL2 =   0   !

     (If NVL2 > 0, ALL parameter data for
      these sources are read from the VOLEMARB.DAT file(s) )

!END!

---------------
Subgroup (16b)
---------------
                                       a
           VOLUME SOURCE: CONSTANT DATA
           ----------------------------
                                                                        b
         X           Y        Effect.    Base     Initial    Initial    Emission
     Coordinate  Coordinate   Height   Elevation  Sigma y    Sigma z     Rates
        (km)       (km)        (m)       (m)        (m)       (m)
     ----------  ----------   ------    ------    --------   --------   ---------
    a
     Data for each source are treated as a separate input subgroup
     and therefore must end with an input group terminator.

    b
     An emission rate must be entered for every pollutant modeled.
     Enter emission rate of zero for secondary pollutants that are
     modeled, but not emitted.  Units are specified by IVLU
```

(e.g. 1 for g/s).

Subgroup (16c)

VOLUME SOURCE: VARIABLE EMISSIONS DATA[a]

Use this subgroup to describe temporal variations in the emission rates given in 16b. Factors entered multiply the rates in 16b. Skip sources here that have constant emissions. For more elaborate variation in source parameters, use VOLEMARB.DAT and NVL2 > 0.

IVARY determines the type of variation, and is source-specific:
(IVARY) Default: 0

```
      0 =       Constant
      1 =       Diurnal cycle (24 scaling factors: hours 1-24)
      2 =       Monthly cycle (12 scaling factors: months 1-12)
      3 =       Hour & Season (4 groups of 24 hourly scaling factors,
                                where first group is DEC-JAN-FEB)
      4 =       Speed & Stab. (6 groups of 6 scaling factors, where
                                first group is Stability Class A,
                                and the speed classes have upper
                                bounds (m/s) defined in Group 12
      5 =       Temperature   (12 scaling factors, where temperature
                                classes have upper bounds (C) of:
                                0, 5, 10, 15, 20, 25, 30, 35, 40,
                                45, 50, 50+)
```

---
[a] Data for each species are treated as a separate input subgroup and therefore must end with an input group terminator.

INPUT GROUPS: 17a & 17b -- Non-gridded (discrete) receptor information
---

Subgroup (17a)

Number of non-gridded receptors (NREC) No default ! NREC = 3385 !

!END!

Subgroup (17b)

NON-GRIDDED (DISCRETE) RECEPTOR DATA[a]

```
                  LCC_X       LCC_Y      Ground    Height   b
Receptor      Coordinate  Coordinate   Elevation  Above Ground
   No.             (km)        (km)         (m)           (m)
--------      ----------  ----------   ---------  ------------
00001   !X =   -1085.499,    -78.020,     1328.0,          0.0 ! !END!   Arches_001
```

---
[a] Data for each receptor are treated as a separate input subgroup and therefore must end with an input group terminator.

[b] Receptor height above ground is optional. If no value is entered, the receptor is placed on the ground.

CALPUFF INPUT FILE EXCERPT - COMPRESSOR STATIONS

```
---------------
Subgroup (13b)
---------------
                                    a
          POINT SOURCE: CONSTANT DATA
          ----------------------------
                                                                                b          c
  Source       X         Y       Stack    Base     Stack    Exit  Exit    Bldg.  Emission
   No.     Coordinate Coordinate Height Elevation Diameter  Vel.  Temp.   Dwash   Rates
              (km)      (km)       (m)      (m)       (m)  (m/s) (deg. K)
  ------   ---------- ---------- ------  ------   -------- ----- -------- ----- --------



                                                                  Erates
          LCC_X   LCC_Y     Hs  Elev.   Ds    Vs     Ts Dwash     SO2      SO4      NOX     HNO3
NO3     PM10     PM25

           (km)    (km)    (m)    (m)  (m) (m/s)    (K)         (g/s)    (g/s)    (g/s)    (g/s)
(g/s)    (g/s)    (g/s)
1! SRCNAM = CS1 !
! X = -890.25, -50.061, 3.7, 2231, 0.2, 46, 689, 0,
0.00000E+00, 0.00000E+00, 1.76941E-01, 0.00000E+00, 0.00000E+00, 0.00000E+00, 0.00000E+00 !

! END !

2! SRCNAM = CS2 !
! X = -893.032, -46.441, 3.7, 2346, 0.2, 46, 689, 0,
0.00000E+00, 0.00000E+00, 1.76941E-01, 0.00000E+00, 0.00000E+00, 0.00000E+00, 0.00000E+00 !

! END !

3! SRCNAM = CS3 !
! X = -889.831, -50.311, 3.7, 2231, 0.2, 46, 689, 0,
0.00000E+00, 0.00000E+00, 1.76941E-01, 0.00000E+00, 0.00000E+00, 0.00000E+00, 0.00000E+00 !

! END !

4! SRCNAM = CS4 !
! X = -890.297, -54.293, 3.7, 2214, 0.2, 46, 689, 0,
0.00000E+00, 0.00000E+00, 1.76941E-01, 0.00000E+00, 0.00000E+00, 0.00000E+00, 0.00000E+00 !

! END !



--------
```

CALPUFF INPUT FILE EXCERPT - VOLUME SOURCES USED FOR PUMPING ENGINES

```
INPUT GROUPS: 16a, 16b, 16c -- Volume source parameters
---------------------------

---------------
Subgroup (16a)
---------------

     Number of volume sources with
     parameters provided in 16b,c (NVL1)     No default  ! NVL1= 47 !
          Units used for volume source
     emissions below in 16b       (IVLU)     Default: 1  ! IVLU = 1 !
           1 =        g/s
           2 =       kg/hr
           3 =       lb/hr
           4 =     tons/yr
           5 =     Odour Unit * m**3/s  (vol. flux of odour compound)
           6 =     Odour Unit * m**3/min
           7 =     metric tons/yr

     Number of source-species
     combinations with variable
     emissions scaling factors
     provided below in (16c)      (NSVL1)    Default: 0  ! NSVL1= 0 !

     Number of volume sources with
     variable location and emission
     parameters                   (NVL2)     No default  !  NVL2 =   0   !

     (If NVL2 > 0, ALL parameter data for
      these sources are read from the VOLEMARB.DAT file(s) )

!END!

---------------
Subgroup (16b)
---------------
                                        a
           VOLUME SOURCE: CONSTANT DATA
           ----------------------------
                                                                          b
         X           Y        Effect.    Base     Initial    Initial    Emission
     Coordinate  Coordinate   Height   Elevation  Sigma y    Sigma z     Rates
        (km)       (km)         (m)       (m)        (m)       (m)
     ----------  ----------   ------    ------    --------   --------   --------

****** SAMPLE FOR PUMPING ENGINE (47 TOTAL INCLUDED IN INPUT FILE)


1! SRCNAM = Prod_L5 !
! X = -887.98, -46.654, 5, 2558, 20.9, 4.7,
1.95815E-04, 0.00000E+00, 9.75E-02,0.00000E+00, 0.00000E+00, 1.77E-04, 1.77302E-04 !

! END !


--------
    a
```

CALPUFF FILE EXCERPT - TANK HEATERS AND TRAFFIC VOLUME SOURCES

```
INPUT GROUPS: 16a, 16b, 16c -- Volume source parameters
---------------------------

---------------
Subgroup (16a)
---------------

     Number of volume sources with
     parameters provided in 16b,c (NVL1)     No default  ! NVL1= 101 !
          Units used for volume source
     emissions below in 16b       (IVLU)     Default: 1  ! IVLU = 1 !
           1 =        g/s
           2 =       kg/hr
           3 =       lb/hr
           4 =     tons/yr
           5 =     Odour Unit * m**3/s  (vol. flux of odour compound)
           6 =     Odour Unit * m**3/min
           7 =     metric tons/yr

     Number of source-species
     combinations with variable
     emissions scaling factors
     provided below in (16c)      (NSVL1)    Default: 0  ! NSVL1= 470 !

     Number of volume sources with
     variable location and emission
     parameters                   (NVL2)     No default  !  NVL2 =   0   !

     (If NVL2 > 0, ALL parameter data for
      these sources are read from the VOLEMARB.DAT file(s) )

!END!

---------------
Subgroup (16b)
---------------
                                        a
           VOLUME SOURCE: CONSTANT DATA
           ----------------------------
                                                                        b
         X           Y        Effect.    Base     Initial    Initial    Emission
     Coordinate  Coordinate   Height   Elevation  Sigma y    Sigma z     Rates
        (km)       (km)        (m)       (m)        (m)       (m)
     ----------  ----------   ------    ------    --------   --------   --------


**** TANK HEATERS EXAMPLE (47 TOTAL IN INPUT FILE)

1! SRCNAM = TankHeat_L5 !
! X = -887.98, -46.654, 5, 2558, 20.9, 4.7,
0.00000E+00, 0.00000E+00, 2.95559E-03,0.00000E+00, 0.00000E+00, 0.00000E+00, 0.00000E+00 !

! END !


**** COMPRESSOR STATION TANK HEATERS EXAMPLE (4 TOTAL IN INPUT FILE)

48! SRCNAM = CShtr1_L1 !
! X = -890.25, -50.061, 5, 2231, 20.9, 4.7,
0.00000E+00, 0.00000E+00, 1.54347E-03,0.00000E+00, 0.00000E+00, 0.00000E+00, 0.00000E+00 !

! END !


**** TRAFFIC EMISSIONS (47 TOTAL IN INPUT FILE)

52! SRCNAM = CPT_L5 !
! X = -887.98, -46.654, 2.5, 2558, 20.9, 2.3,
```

```
1.70757E-03, 0.00000E+00, 4.75905E-02,0.00000E+00, 0.00000E+00, 4.44E-02, 6.19561E-03 !

**** DRILLING TRAFFIC EMISSIONS (3 TOTAL IN INPUT FILE)



99! SRCNAM = DT1_L14 !
! X = -887.374, -51.59, 2.5, 2426, 20.9, 2.3,
9.52161E-03, 0.00000E+00, 4.34554E-01,0.00000E+00, 0.00000E+00, 8.54132E-08, 1.73506E-02 !

! END !



--------
    a
     Data for each source are treated as a separate input subgroup
     and therefore must end with an input group terminator.

    b
     An emission rate must be entered for every pollutant modeled.
     Enter emission rate of zero for secondary pollutants that are
     modeled, but not emitted.  Units are specified by IVLU
     (e.g. 1 for g/s).



---------------
Subgroup (16c)
---------------
                                                a
          VOLUME SOURCE: VARIABLE EMISSIONS DATA
          --------------------------------------

     Use this subgroup to describe temporal variations in the emission
     rates given in 16b.  Factors entered multiply the rates in 16b.
     Skip sources here that have constant emissions.  For more elaborate
     variation in source parameters, use VOLEMARB.DAT and NVL2 > 0.

     IVARY determines the type of variation, and is source-specific:
     (IVARY)                                Default: 0
           0 =       Constant
           1 =       Diurnal cycle (24 scaling factors: hours 1-24)
           2 =       Monthly cycle (12 scaling factors: months 1-12)
           3 =       Hour & Season (4 groups of 24 hourly scaling factors,
                                    where first group is DEC-JAN-FEB)
           4 =       Speed & Stab. (6 groups of 6 scaling factors, where
                                    first group is Stability Class A,
                                    and the speed classes have upper
                                    bounds (m/s) defined in Group 12
           5 =       Temperature   (12 scaling factors, where temperature
                                    classes have upper bounds (C) of:
                                    0, 5, 10, 15, 20, 25, 30, 35, 40,
                                    45, 50, 50+)
```

***** TANK HEATERS SCALARS EXAMPLE

```
1 1-1 ! SRCNAM = TankHeat_L5 !
! IVARY=  2 !
! SO2 = 1,1,1,0,0,0,0,0,0,1,1,1 !
! END !

2 1-2 ! SRCNAM = TankHeat_L5 !
! IVARY=  2 !
! SO4 = 1,1,1,0,0,0,0,0,0,1,1,1 !
! END !

3 1-3 ! SRCNAM = TankHeat_L5 !
```

```
! IVARY=  2 !
! NOX = 1,1,1,0,0,0,0,0,0,1,1,1 !
! END !

4 1-4 ! SRCNAM = TankHeat_L5 !
! IVARY=  2 !
! PM10 = 1,1,1,0,0,0,0,0,0,1,1,1 !
! END !

5 1-5 ! SRCNAM = TankHeat_L5 !
! IVARY=  2 !
! PM25 = 1,1,1,0,0,0,0,0,0,1,1,1 !
! END !
```

***** PRODUCTION TRAFFIC SCALARS EXAMPLE

```
236 52-1 ! SRCNAM = CPT_L5 !
! IVARY=  1 !
! SO2= 0,0,0,0,0,0,0,1,1,1,1,1,1,1,1,1,1,0,0,0,0,0,0,0 !
! END !

237 52-2 ! SRCNAM = CPT_L5 !
! IVARY=  1 !
! SO4= 0,0,0,0,0,0,0,1,1,1,1,1,1,1,1,1,1,0,0,0,0,0,0,0 !
! END !

238 52-3 ! SRCNAM = CPT_L5 !
! IVARY=  1 !
! NOX= 0,0,0,0,0,0,0,1,1,1,1,1,1,1,1,1,1,0,0,0,0,0,0,0 !
! END !

239 52-4 ! SRCNAM = CPT_L5 !
! IVARY=  1 !
! PM10= 0,0,0,0,0,0,0,1,1,1,1,1,1,1,1,1,1,0,0,0,0,0,0,0 !
! END !

240 52-5 ! SRCNAM = CPT_L5 !
! IVARY=  1 !
! PM25= 0,0,0,0,0,0,0,1,1,1,1,1,1,1,1,1,1,0,0,0,0,0,0,0 !
! END !


--------
```

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Appendix K

Economic Impact Analysis Methodology – Technical Report

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 $1.5 million per coal well $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 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 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	**Production 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 - 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. Rural Households Are Statistically Unaffected By The Density Of Hydraulic Fracturing In Their Immediate Area. 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 District Court
Water Division 4

JUL 0 6 2009

DISTRICT COURT, WATER DIVISION NO. 4 **STATE OF COLORADO** 1200 North Grand Ave., Bin A Montrose, CO 81401-3146	Filed in the District Court Water Division 4 JUN 1 1 2009
CONCERNING THE APPLICATION FOR WATER RIGHTS OF: **SG INTERESTS I, Ltd,** **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

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.

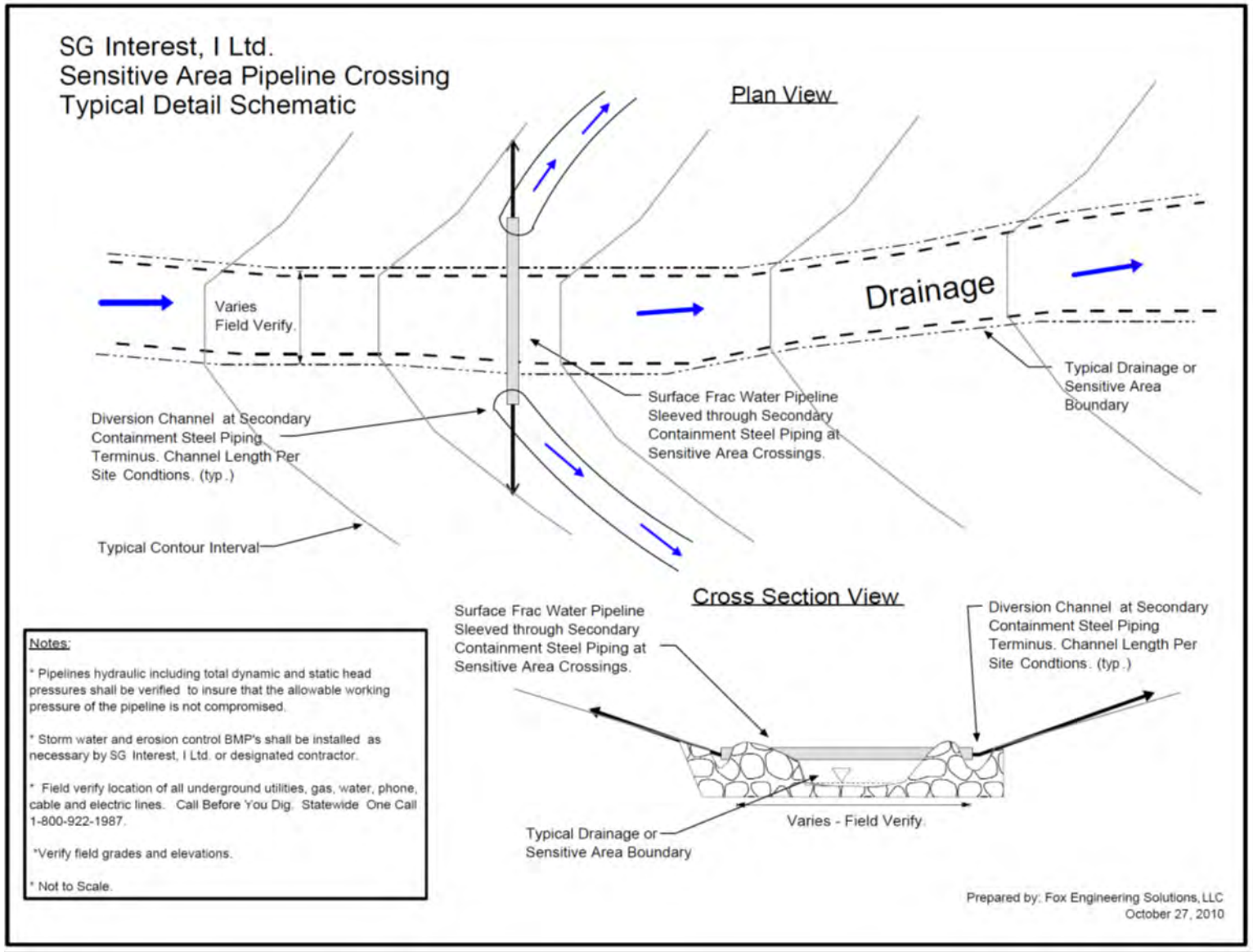
Poly pipelines are constructed between the pits and the well location generally by fusing the first several joints of pipe together end to end. The fuses are created by heating facing ends of pipe until they have melted and can then be cooled and fused together. The resulting fuse is as strong as the 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.

Appendix N

Response to Comments on the Draft EIS

APPENDIX N
RESPONSE TO COMMENTS ON THE BULL MOUNTAIN UNIT MASTER DEVELOPMENT PLAN DRAFT EIS

Introduction

After publishing the Draft Environmental Impact Statement (EIS), the Bureau of Land Management (BLM) held a 90-day public comment period to receive comments on it. The BLM received written comments by mail, e-mail, and submissions and oral comments at the public meetings, which were transcribed. Comments covered a wide spectrum of thoughts, opinions, ideas, and concerns. The BLM recognizes that commenters invested considerable time and effort to submit comments on the Draft EIS and so developed a comment analysis method to ensure that all comments were considered, as directed by National Environmental Policy Act (NEPA) regulations.

According to NEPA, the BLM is required to identify and formally respond to all substantive public comments. It developed a systematic process to ensure that all substantive comments were tracked and considered. Upon receipt, each comment letter was assigned an identification number and logged into the BLM's comment analysis database, CommentWorks, which allowed the BLM to organize, categorize, and respond to comments. Substantive comments from each letter were coded to appropriate categories based on the content of the comment, retaining the link to the commenter. The categories generally follow the sections presented in the Draft EIS, though some relate to the NEPA process or editorial concerns.

Comments similar to each other were grouped under a topic heading, and the BLM drafted a statement summarizing the issues and themes contained in the comments. The responses were crafted to respond to the comments, and, if warranted, a change to the EIS was made.

Although the BLM diligently considered each comment, the comment analysis process involved determining whether a comment was substantive or nonsubstantive. In performing this analysis, the BLM relied on the Council on Environmental Quality's regulations to determine what constituted a substantive comment.

A substantive comment does one or more of the following:

- Questions, with a reasonable basis, the accuracy of the information or analysis in the Draft EIS
- Questions, with a reasonable basis, the adequacy of the information or analysis in the Draft EIS
- Presents reasonable alternatives other than those presented in the Draft EIS that meet the purpose and need of the proposed action and addresses significant issues
- Questions, with a reasonable basis, the merits of an alternative or alternatives
- Causes changes in or revisions to the proposed action
- Questions, with a reasonable basis, the adequacy of the planning process itself

Additionally, the BLM's NEPA Handbook (H-1790-1) identifies the following types of substantive comments:

- Comments on the Adequacy of the Analysis—Comments that express a professional disagreement with the conclusions of the analysis or assert that the analysis is inadequate are substantive but may or may not lead to changes in the Proposed Final EIS. Interpretations of analyses should be based on professional expertise. Where there is disagreement within a professional discipline, a careful review of the various interpretations is warranted. In some cases, public comments may necessitate a reevaluation of analytical conclusions. If, after reevaluation, the manager responsible for preparing the EIS (Authorized Officer) does not think that a change is warranted, his or her response should provide the rationale for that conclusion.
- Comments that Identify New Impacts, Alternatives, or Mitigation Measures—Public comments on a Draft EIS that identify impacts, alternatives, or mitigation measures that were not addressed in the draft are substantive. This type of comment requires the Authorized Officer to determine whether it warrants further consideration. If it does, the Authorized Officer must determine whether the new impacts, new alternatives, or new mitigation measures should be analyzed in the Final EIS, a supplement to the Draft EIS, or a completely revised and recirculated Draft EIS.
- Disagreements with Significance Determinations—Comments that directly or indirectly question, with a reasonable basis, determinations regarding the significance or severity of impacts are substantive. A reevaluation of these determinations may be warranted and may lead to changes in the Final EIS. If, after reevaluation, the Authorized Officer does not think that a change is warranted, his or her response should provide the rationale for that conclusion.

Comments that failed to meet the above descriptions were considered nonsubstantive. Many comments received throughout the process expressed personal opinions or preferences, had little relevance to the adequacy or accuracy of the Draft EIS, represented commentary regarding resource management or impacts without any real connection to the document being reviewed, or were considered out of scope because they dealt with existing law, rule, regulation, or policy. These comments did not provide specific information to assist the interdisciplinary team in making changes to the alternatives or impact analysis in the Draft EIS and were not addressed further in this document.

Examples of nonsubstantive comments are the following:

- The best of the alternatives is Alternative A (or B or C).
- The BLM has yet to show land stewardship above their current level.
- The MDP does not reflect balanced land management.
- You cannot let the project proceed.
- You should not allow leasing in this area.

Opinions, feelings, and preferences for one element or one alternative over another and comments of a personal or philosophical nature were all read, analyzed, and considered; however, because such comments are not substantive, the BLM did not respond to them.

It is also important to note that while all comments were reviewed and considered, comments were not counted as "votes." The NEPA public comment period is neither an election nor does it result in a representative sampling of the population. Therefore, public comments are not appropriate to be used as a democratic decision-making tool or as a scientific sampling mechanism.

Comments citing editorial changes to the document were reviewed and incorporated. The Final EIS has been extensively technically edited and revised to fix typos, missing references, definitions, and acronyms and other clarifications as needed.

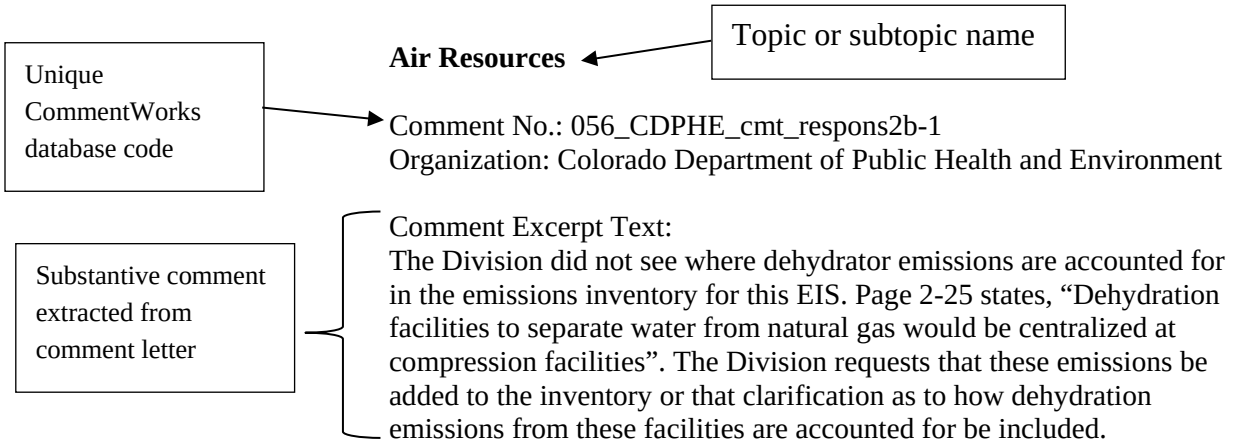
Copies of all comment documents received on the Draft EIS are available by request from the BLM Uncompahgre Field Office. Comments received by mail, e-mail, and at meetings or delivered orally during the public meetings are tracked by commenter name and submission number.

Campaign Letters

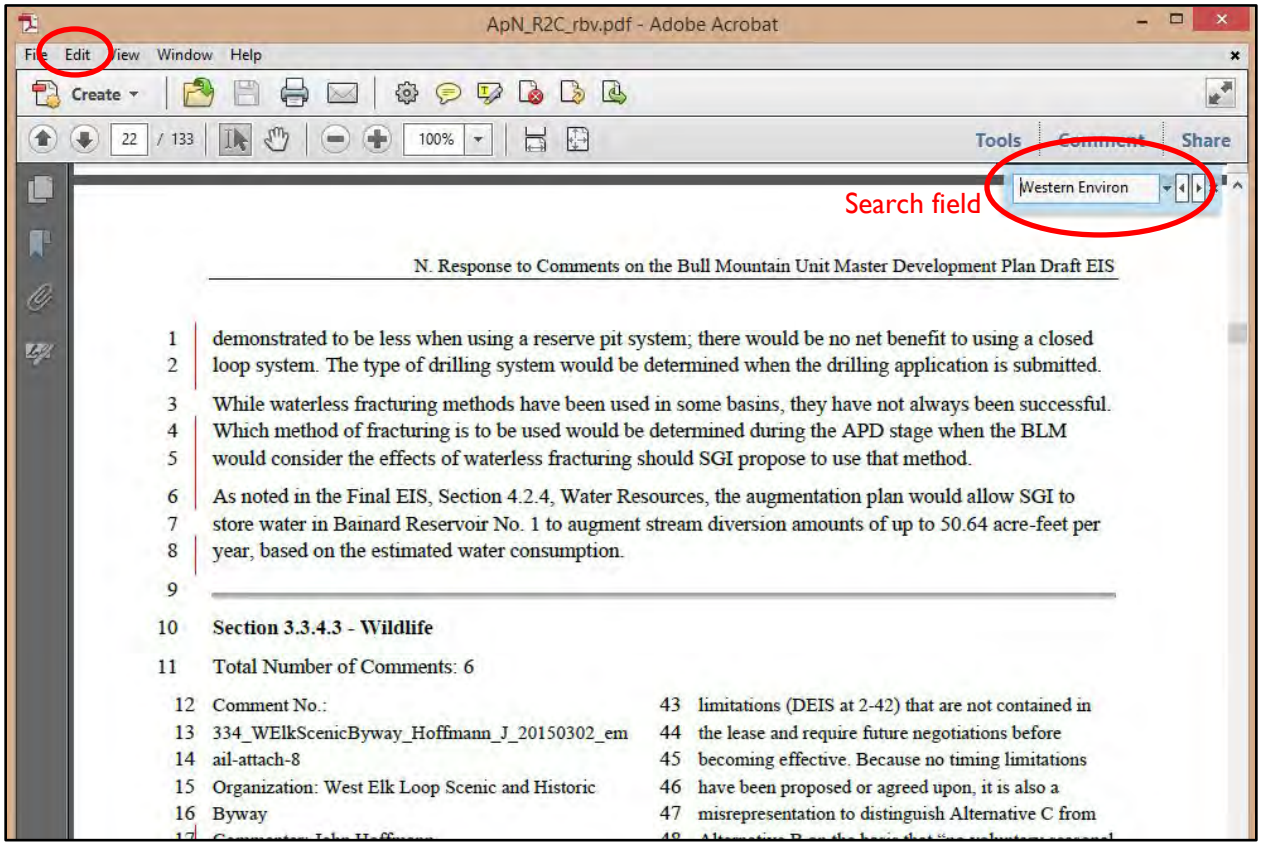
In addition to the unique submissions, 83 form letters were submitted during the public comment period. Form letters are exact or very close copies of a letter that are submitted multiple times by different individuals; individuals may add additional language to the letter, but this usually does not substantially change the content of the letter. Often, form letters are created by an organization and sent to their members, who in turn submit one or more copies during the public comment period. For the Bull Mountain Unit MDP EIS, there was only one type of form letter master submitted. While all content in the letter was identical or nearly so with additional text, there was no indication as to which group generated the master content. One copy of the letter was included in the comment analysis process as a master form letter, and it was reviewed for substantive content. All substantive comments were included in the comment analysis process. For the form letters that contained additional unique content, the comments were reviewed for substantive content; when found, the comments were parsed and analyzed.

How This Report Is Organized

This report is organized by the primary topic and then by specific issue subtopics that relate to an aspect of NEPA. For example, all substantive comments that relate to the baseline information for the air quality analysis fall under **"Impact Analysis: Air Resources"**. Each topic or subtopic contains the substantive comments identified for that topic area. See the sample below.



The report can also be searched by name, organization, and/or key word. To search in the PDF, bring up the search field by either pressing the Ctrl + "F" or use the "Find" command under the "Edit" tab in the top left of the screen. Once the search field appears, type in the word or name to search for, and press "Enter." See below for an example.



Section 1 – Bonding requirements

Total Number of Comments: 14

Comment No.: 071_Coleman_F_21050407_email-8
Commenter: Frank M. Coleman

Comment Excerpt Text:
In view of the likelihood of impacts to air and water described above it is recommended that an independent bonding agent be appointed by BLM. The details of the bonding agreement should be publicly disclosed to all members of the North Fork and Delta communities.

Comment No.: 188_McGuire_E_20150415_email-8
Organization: Desert Weyr, LLC
Commenter: Eugenie McGuire

Comment Excerpt Text:
The Draft EIS does not provide for sufficient bonds to cover the costs of the potential for permanent damage to our farms and livelihoods through accidents or spills. Without any additional measures in place by the BLM we would be forced to accept the risks of development while not enjoying any benefits of that development. Delta county will not receive any income from severance taxes because the wells are in Gunnison County yet we have all risks. Our business will not benefit from the oil and gas but we will lose business because of this development.

Comment No.: 189_Mcguire_K_20150415_email-5
Organization: Weyr Associates, LLC
Commenter: Kenyon McGuirer

Comment Excerpt Text:
The Draft EIS does not provide for sufficient bonds to cover the costs of the potential for permanent damage to our livelihood through accidents or spills. Without any additional measures in place by the BLM we would be forced to accept the risks of development while not enjoying any benefits of that development. Delta county will not receive any income from severance taxes because the wells are in Gunnison County yet we have all risks.

Comment No.: 207_Nagel_C_20150404_email-attach-2
Commenter: Clinton Nagel

Comment Excerpt Text:
A big debate here is to make sure that corporations have increased financing (i.e. bonding) to cover cleanup and remediation in case of accidents and to ensure complete reclamation after the project's completion. This needs to be incorporated into the EIS.

Comment No.: 292_Soule_J_20150414_email-attach-2
Commenter: Joli Soule

Comment Excerpt Text:
• On p. 2-28 of the EIS, addressing Final Reclamation and Abandonment, you note the project could have a 50 year life span. A recent article in the Denver Post stated that 70% of post-production wells in Colorado were either abandoned by producers or in violation of reclamation requirements. Because any number of circumstances could render SGI bankrupt in the coming 50 years, you must immediately require them to post bond sufficient to cover reclamation costs.

Comment No.: 292_Soule_J_20150414_email-attach-3
Commenter: Joli Soule

Comment Excerpt Text:
• On p.3-44 of the EIS, you mention that "the project could lead to erosion and faster sedimentation of (Paonia) Reservoir". The development will denude significant drainages in the watershed that feeds the

reservoir, making it likely that increased sedimentation will occur. I believe it behooves you to monitor the affected sections of the Muddy for increased sediment, and quantify the cumulative effects on Paonia's reservoir. Should this development bring the reservoir to the end of its useful lifespan more quickly, SGI must be required to pay its share of the repairs needed. Require SGI to post bond in an amount sufficient to cover the cost of repairs.

Comment No.: 292_Soule_J_20150414_email-attach-4
Commenter: Joli Soule

Comment Excerpt Text:
• On p. 3-51: "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." Development of the Unit could lead to more rock-fall on Hwy 133, adding to the existing dangers. Landslides brought on by development could rupture pipelines and lead to spills into Paonia Reservoir, the North Fork of the Gunnison, the Gunnison, and the Colorado River. The possibilities are many, and have not been fully considered by the EIS. It is the responsibility of BLM to require SGI to post bond sufficient to remediate such catastrophic accidents that are likely to occur in the terrain of Bull Mountain.

Comment No.: 498_VanDusen_P_20150415_hard-4
Organization: Delta County Commissioners CHC
Commenter: Paul Van Dusen

Comment Excerpt Text:
Financial essurances (bonding and penalties) should be in place to assure compliance end to guard against the exorbitant costs of cleaning-up and remediation of any catastrophic accident thet may occur, and complete reclamation at the completion or the abandonment of the Project.

Comment No.:
503_WELC_King_L_20150416_email-attach-110
Organization: Western Environmental Law Center
Commenter: Laura King

Comment Excerpt Text:
The DEIS makes no mention of required bonding (i.e. financial assurance). A recent Government Accountability Office ("GAO") report found that BLM's bond holdings are "based on regulatory minimums and not on full reclamation costs" (U.S. Government Accountability Office. Bonding Requirements and BLM Expenditures to Reclaim Orphaned Wells. Report # GAO-10-245 (Jan. 2010) at 10, available at:
http://www.gao.gov/assets/310/300218.pdf
(Highlights page attached as Exhibit 140).) and further, that despite bonding requirements, "not all operators perform reclamation." (Id. at Highlights Page.)

Comment No.:
503_WELC_King_L_20150416_email-attach-111
Commenter: Laura King
Organization: Western Environmental Law Center

Comment Excerpt Text:
The BLM is authorized to require additional bonding when "the total cost of plugging existing wells and reclaiming lands exceeds the present bond amount based on BLM estimates." (Id at 16.) In light of the many likely and potential significant impacts discussed herein, the BLM should require enhanced bonding before development is allowed to proceed in order to ensure full compliance with rules and law as well as final reclamation. At the very least, however, BLM must consider and analyze how bonding requirements, or the insufficiency thereof, bear on the agency's assumptions regarding the mitigation and remediation of impacts to specific resource values, as discussed above.

Comment No.:
504_WestSlopeConsCtr_Sauter_S_21050416_email-attach-4
Commenter: Sarah Sauter
Organization: Western Slope Conservation Center

Comment Excerpt Text:
The BLM has not addressed bonding. The DEIS fails to mention required bonding. BLM regulations require lessees to purchase a bond in the amount of at least $10,000 before surface disturbing activities can begin. The BLM also has the authority to require additional bonding when the cost of reclamation exceeds the present bond amount. We encourage the BLM to evaluate bonding amounts on a case-by-case basis, similarly to the way that Colorado Division of Mining, Reclamation and Safety (DRMS) evaluates bonding for coal mines, which is based upon estimates as to the cost of reclamation.

Comment No.:
548_BlackCanRegLandTrust_Puckett_J_20150415-2
Organization: Black Canyon Regional Land Trust
Commenter: Jeremy Puckett

Comment Excerpt Text:
bonding and reclamation standards for conserved property should be enhanced to ensure timely and effective recovery of conserved lands to pre-disturbance conditions.

Comment No.: 572_Peters_A_20150415_hard-2
Commenter: Anthony Peters

Comment Excerpt Text:
My third concern is the small amount of bonding money that is required of the developers in relation to the cost of reclamation at the completion of the project and the cost of cleanup and remediation in the event of a catastrophe or accident not to mention settlements to land owners who lost their livelihoods or substantially diminished their property values as a result. I would like to see the the BLM require bond money that is adequate to deal with these issues

Comment No.: Form_CHC-5

Comment Excerpt Text:
Finally, BLM should require increased financial assurance (i.e. bonding) of an amount adequate to cover cleanup and remediation of a catastrophic accident and to ensure a thorough reclamation at the project's completion

Summary

The BLM should apply additional bonding requirements beyond current required amounts before development is allowed to proceed. Additionally, the EIS needs to address bonding in the impact analysis.

Response

Bonding requirements are enacted at the application for permit to drill (APD) stage of permitting before any APDs are approved and before any drilling of federal mineral estate. On split estate land, if there is a current surface use access agreement between the landowner and the operator, then surface protection bonding is not necessary. The BLM's surface owner protection bond requirements would apply only if SGI cannot come to an agreement with the landowner. The BLM's general bond requirements described in its regulations would still apply, and would govern the amount of bond and any bond increase (43 CFR Part 3104).

Section 2 - Jurisdiction/Authority (BLM vs. COGCC)

Total Number of Comments: 2

Comment No.: 038_Breitnauer_B_20150410_hard-1
Commenter: Barb Breitnauer

Comment Excerpt Text:
The additional restrictions imposed by Alternative C, for example, are in strict violation of the rights of those surface owners to utilize their property. Many of those additional restrictions are simply not within the power and authority of the government, at either federal or state level, to impose.

Comment No.: 206_Myers_N_20150320_hard-1
Commenter: Nellie Myers

Comment Excerpt Text:
The other Alternatives fail to meet the requirements of the Purpose and Need Statement; Alternative A, of course, would result in no action being taken, and the vast majority of the resource being left undeveloped. Similarly, the modified weighting factors for site selections contained in Alternative C would violate the P&N statement by leaving large amounts of resource untapped.
Perhaps more seriously, those site selection limits would violate the property rights of surface owners on the Unit. While the federal government owns about 65% of the subsurface mineral rights on the unit, necessitating the NEPA analysis, 98% of the surface is privately owned, and the 2% that is BLM managed will not be touched by this development. The BLM simply lacks the authority to place such stipulations on private land holders.

Summary

Commenters state that Alternative C restrictions are in violation of surface owner's property rights and the federal or state governments do not have the right to impose them.

Response

Onshore Order 1 addresses BLM responsibilities on federal leases overlain by private surface (split-estate). It states that NEPA, the Endangered Species Act (ESA), and the National Historic Preservation Act (NHPA) require the BLM to regulate exploration, development, and abandonment on federal leases on split-estate lands in essentially the same manner as a lease overlain by federal surface. While private owners' wishes should be considered in decisions, they do not overrule requirements of these statutes and their implementing regulations.

Section 3 - Range of Alternatives

Total Number of Comments: 5

Comment No.: 139_Hilberman_M_20150328_email-1
Commenter: Mark Hilberman

Comment Excerpt Text:
However, it is disturbing that while Figure 2-1 p. 2-9 shows no development on Federal Land in Alt A In Table 4-1 p. 4-6ff – specifically lists 36 new well pads on Federal Land for this option!!

Comment No.: 188_McGuire_E_20150415_email-1
Organization: Desert Weyr, LLC
Commenter: Eugenie McGuire

Comment Excerpt Text:
Specifically we are concerned that the EIS does not provide any reasonable alternatives other than full development. In the EIS the BLM has failed to consider all potential impacts of this development on our valley and our region.

Comment No.: 503_WELC_King_L_20150416_email-attach-112
Organization: Western Environmental Law Center
Commenter: Laura King

Comment Excerpt Text:
The determination to adopt SG Interests proposal without considering alternatives the conserve and protect competing resources is arbitrary and capricious, and fails to protect water, air, and wilderness resources. The BLM cannot reasonably choose to prioritize oil and gas development in this way, nor is doing so consistent with its mandate to manage public lands for the sustained yield of its resources.

Comment No.: 503_WELC_King_L_20150416_email-attach-113
Organization: Western Environmental Law Center
Commenter: Laura King

Comment Excerpt Text:
As a threshold issue, the BLM has muddied the alternatives by not including the “baseline” of Alternative A in Alternatives B and C, thereby making the environmental impacts under Alternatives B and C look better, by reference to the “baseline” of Alternative A, than they actually are. Alternative A considers development on private land. Alternatives B and C do not include the “baseline” of private development considered in Alternative A; instead, they consider development only on federal lands. See ES-9; 2-33; 2-42. This is despite the fact that “[i]f Alternative B or C is approved, the operations and development of private minerals described in Alternative A would likely continue to be implemented.” DEIS 2-55 n. 4. Either Alternatives B and C should include private development, or Alternative A should be restricted to federal development, so that there is a fair comparison between the “baseline” and Alternatives B and C.

Comment No.: 573_Phillips_M_20150415_hard-1
Commenter: Margaret Phillips

Comment Excerpt Text:
lf the BLM were to adopt Alternative C, the restrictions imposed, and the modified weighing factors, would violate both the Purpose and Need statement (“to increase the orderly development of domestic natural gas reserves”) because the well location restrictions would leave resources untapped within the unit, and the private property rights of the surface owners.

Summary

Commenters state that the Draft EIS alternatives do not have a sufficient range to protect resources such as water, air, or wilderness; that Alternative A is not an adequate baseline and Alternatives B and C are not comparable to it; and that Alternative C does not address the purpose and need.

Response

CEQ regulations direct that an EIS "… shall briefly specify the underlying purpose of and need for action to which the agency is responding in proposing the alternatives including the proposed action" (40 CFR, Part 1502.13). Also under the CEQ regulations, the BLM is required to "study, develop, and describe appropriate alternatives to recommended courses of action in any proposal which involves unresolved conflicts concerning alternative uses of available resources as provided by section 102(2)(E) of the Act [NEPA]" (40 CFR, Part 1501.2[c]). The breadth or narrowness of the purpose of and need for action statement has a substantial influence on the scope of the subsequent analysis. The purpose of and need for action statement provides a framework for issue identification and will inform the rationale for alternatives selection.

The alternatives developed meet the purpose of and need for action, address the issue, and provide a basis for eventual selection of an alternative in a decision (BLM NEPA Handbook). As stated in the Draft EIS, **Section 1.2**, Purpose of and Need, the BLM's purpose is to consider the proponent's request for a Master Development Plan (MDP) to increase the orderly development of natural gas resources consistent with the Energy Policy Acts of 2001 and 2005 and to better facilitate the planning of infrastructure. It takes into account field development as a whole rather than as individual actions.

As described in the Draft EIS, **Section 2.2.1**, Alternatives 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, Parts 1500.1, 1501.7, and 1502.1). 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 from public comments submitted on the Bull Mountain Unit MDP EA; they are presented in **Section 1.8**, Key Issues Addressed in this EIS. The action alternatives (Alternative B [the Proposed Action] and Alternative C [the Modified Action]) offer a range of possible management approaches for responding to the issues, increase the orderly development of natural gas resources, and better facilitate the planning of infrastructure.

Meaningful differences between the alternatives include finding alternate locations for well pads that take into account different resource emphasis (erosive soils being weighted more under one alternative versus another alternative) and application of wildlife, water, and air resource design features and mitigation measures.

Alternative A, as the No Action Alternative, is the only alternative that does not meet the purpose and need; this is because it would not respond to the issues, increase the orderly development of natural gas resources, or better facilitate the planning of infrastructure. The intent of the No Action Alternative is to provide a scenario illustrating what would happen should the BLM reject the MDP. Under Alternative A, SGI would continue to develop the private mineral estate, but the federal mineral estate could be developed through multiple individual authorizations. As such, the BLM assumed that federal mineral development would occur later in time and would take much longer, making it better suited for

consideration under cumulative effects. The combined actions of Alternative A private mineral development plus the federal mineral development in Alternatives B and C is addressed in **Section 4.1.3**, Cumulative Effects. By reducing the number of wells, pads, and facilities/infrastructure in Alternative A allowed for determining a lower end of impacts, as demonstrated in the air quality analysis. Having the lower limit shown in the analysis provided a baseline to compare full federal development under the MDP.

Alternatives B, C, and D only describe decisions that BLM has jurisdiction over; the BLM cannot approve applications for permits to drill (APDs) for wells on private mineral estate. Development on private mineral estate falls within the jurisdiction of the Colorado Oil and Gas Conservation Commission (COGCC). This distinction is noted in Chapter 2, Alternatives, under the detailed explanation of each action alternative; see the Final EIS at **Section 2.2.7**, Alternative B Proposed Action, **Section 2.2.8**, Alternative C Modified Action, and **Section 2.2.9**, BLM's Preferred Alternative.

Section 3.1 - Alternatives assumptions

Total Number of Comments: 7

Comment No.: 071_Coleman_F_21050407_email-10
Commenter: Frank M. Coleman

Comment Excerpt Text:
Since fracking profits have crashed on account of Saudi intervention in the market, escalating production costs, and the expense of compliance with progressive regulations, it is recommended that BLM take a close look at whether SGI can and will be able to carry this project through to completion. Known and stipulated environmental costs will not be forgiven at a later point.

Comment No.: 387_DeltaCoComms_20150416_hard-2
Organization: Delta Board of County Commissioners
Commenter: Mark Roeber

Comment Excerpt Text:
The reliance on site specific permitting by all regulatory bodies within the constraints of Alternative B would help provide consistent and effective conditions of approval of activities in the entire BMU.

Comment No.: 407_GunnisonEnergy_Fyock_L_20150415_email-attach-3
Organization: Gunnison Energy LLC
Commenter: Lee Fyock

Comment Excerpt Text:
3. In the Vegetation section, Table 4-39/Alternative A shows effects on federal lands, which is an error if the No Action Alternative only affects private lands. If there are effects to federal lands, they become 'connected actions' and should be included in the Proposed Action. BLM should determine if there are federal lands affected by the No Action Alternative and revise the alternatives accordingly or remove effects to federal lands under the No Action Alternative in the Vegetation impact section.

Comment No.: 482_SGI_Gordy_S_20150416_email-attach-7
Organization: SG Interests I, Ltd.
Commenter: Shaun Gordy

Comment Excerpt Text:
The DEIS should state explicitly that if the MDP is not approved, SG will still have the ability to submit:

(i) individual APDs on a well-by-well basis; (ii) requests for access across federal lands for oil and gas development; and (iii) request for authorization of other production-related activities. BLM recognizes that, even without an approved MDP, "federal mineral estate development is a reasonably foreseeable action." DEIS at ES-6. In fact, SG intends to develop the federal leases in the Bull Mountain Unit through the permitting of individual wells in a similar manner as proposed under Alternative B if the No Action Alternative is selected.

Comment No.: 482_SGI_Gordy_S_20150416_email-attach-8
Organization: SG Interests I, Ltd.
Commenter: Shaun Gordy

Comment Excerpt Text:
Because federal mineral development is possible under the status quo, and thus not precluded under Alternative A, the following statements in the DEIS should be amended:

Representation that drilling duration would be less under Alternative A than Alternatives B or C. DEIS at 4-6. Because Alternative A would require SG and BLM to proceed without the benefit of comprehensive master planning, it is possible, because of time associated with well-by-well NEPA analysis, that the duration of active drilling periods will be longer under Alternative A than under other alternatives.

Statement that Alternative A would consist only of eleven new pads on private lands. DEIS at 4-98. SG intends to develop its federal mineral leases under Alternative A. The DEIS should clarify that this does not represent an actual development scenario.

Statement that under Alternative A, "some new development could occur on private and state lands with non-federal minerals." DEIS at 4-165. All sections of DEIS should emphasize that development of federal minerals will occur under any selected alternative.

Statement that wildlife habitat fragmentation is more likely under Alternatives B and C because there would be limited development on federal land under Alternative A. DEIS at 4-165. The same degree of development of federal minerals is contemplated under all alternatives. Because the scope of development is the same under all alternatives, there is no evidence to support this conclusion. SG notes, however, that the MDP provides the best way to analyze regional development impacts such as habitat fragmentation.

Determination that a lesser number of vehicles would enter and exit via Highway 133 to the north under Alternative A. DEIS at 4-174. Because the scope of development is the same under all alternatives, there is no evidence to support this conclusion.

Under Alternative A, "the extent of land uses displaced by oil and gas facilities would be mostly on private lands." DEIS at 4-169. Because the scope of development is the same under all alternatives, there is no evidence to support this conclusion.

Conclusion that less development is expected under Alternative A. DEIS at 4-183. Because the scope of development is the same under all alternatives, there is no evidence to support this conclusion.

Statement that "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." DEIS at 4-193. The same degree of development of federal minerals is contemplated under all alternatives. Because the scope of development is the same under all alternatives, there is no evidence to support this conclusion.

Statement that previously approved federal action would be the limit of future development on federal land. DEIS at 4-173. SG has existing leases that allow it to develop federal minerals and SG intends to develop those leases.

Comment No.: 482_SGI_Gordy_S_20150416_email-attach-81

Organization: SG Interests I, Ltd.
Commenter: Shaun Gordy

Comment Excerpt Text:
There is no support for the conclusion that impacts to land health are less under Alternative C as compared to Alternative B. DEIS at 4-104. As explained above, Alternative B is well-tailored to minimize environmental disturbance and carefully balances BLM's statutory mandate to ensure efficient production of the federal mineral estate with the agency's commitment to environmental values. As proposed, Alternative C contemplates a similar level of development as Alternative B while concomitantly limiting the operational flexibility that SG and BLM need -- and that Alternative B provides -- to minimize the operational footprint of oil and gas development.

Comment No.: 482_SGI_Gordy_S_20150416_email-attach-9

Organization: SG Interests I, Ltd.
Commenter: Shaun Gordy

Comment Excerpt Text:
Although the DEIS does account for development of private minerals under Alternative A, it is unclear whether the DEIS fully accounts for when and how that development will take place. The DEIS posits, for example, that development of private minerals would continue for three years under Alternative A. See DEIS at 2-8 ("BLM estimates that drilling activities would occur for approximately 3 years"), 4-63 (listing development over 3 years). But there is no three year restriction on SG's rights to develop private minerals. So long as SG is compliant with the terms of its private leases, SG could choose to develop these interests indefinitely. These errors should be corrected to ensure that the DEIS adequately accounts for baseline conditions.

Summary

The Draft EIS has numerous assumptions in the alternatives and impacts analysis that need to be clarified or corrected, including the assumed drilling rate (27 wells per year) and the drilling horizons under each alternative (3 years versus 6 years). Commenters requested that the Final EIS clarify that federal mineral development would be permitted under Alternative A and clarify the terms of development without an MDP and statements that drilling would be less under Alternative A than the other alternatives.

Commenters also stated that the BLM should consider the feasibility of the project, given current market conditions.

Response

The estimate of 27 wells per year drilled within the Unit is based on SGI's action proposed to the BLM and on its plan to use three drilling rigs for three seasons of the year and each rig drilling three wells per season. Doing the math results in 3 rigs x 3 seasons x 3 wells per rig = 27 wells per year. Based on the estimate of up to 27 wells per year, the BLM calculated the timeframe of the drilling horizon based on simple division. For alternative A, as the drilling estimate is for 55 wells, the BLM divided 55 wells by the 27 wells/year assumption, then rounded up to 3 years based on an understanding that delays may result in extending the time frame. For Alternatives B and C, the BLM divided the 146 wells by 27 wells/year, then rounded up to 6 years, with the same understanding that delays may occur. The BLM understands that meeting these targets depends on several factors outside of SGI's control, such as availability of enough rigs and no delays when drilling starts. However, for the purposes of NEPA analysis, the assumption of 27 wells per year and a 3- or 6-year drilling horizon provides a bounded

estimate of anticipated development. Should SGI fall below these rates, the BLM would still rely on the NEPA analysis in this EIS in addition to any new information when considering individual APDs.

Commenters are correct in noting that Alternative A, No Action, does not mean that SGI would not drill; instead, as noted in the CEQ's 40 Questions, specifically Question #3, the No Action Alternative is to describe what would happen if the BLM made no change to current management or actions. In this case, the No Action Alternative would mean that the BLM rejected the MDP and would continue to consider APDs on a case-by-case basis; SGI would continue to develop the private mineral estate regardless of the BLM's decision. SGI's proposed drilling plan of 146 gas wells and 4 water wells would still occur but would be spaced over a longer period, would not have the benefit of orderly, structured development planning, and would not have the benefit of tiering to an overarching NEPA analysis. Because BLM-approved drilling under Alternative A would occur over an extended period, these wells were considered reasonably foreseeable future actions and were analyzed under the cumulative effects analysis.

Section 3.2 - Siting Model

Total Number of Comments: 5

Comment No.: 482_SGI_Gordy_S_20150416_email-attach-10
Organization: SG Interests I, Ltd.
Commenter: Shaun Gordy

Comment Excerpt Text:
BLM indicates that it developed Alternative C by applying "different weighting factors in the site selection model" from those used in Alternative B. DEIS at ES-9. BLM also represents that it removed one well pad on account of "verified elk critical winter range data," but failed to cite this data or explain its relevance. DEIS at ES-9. This revised modeling and reconfiguration leads to a development plan that makes little economic sense and cannot be reconciled with the public, private, and statutory duties to prevent waste. See 30 U.S.C. § 187 (identifying "the prevention of undue waste" as an obligation in oil and gas leasing decisions); Colo. Rev. Stat. § 34-60- 102(1)(a)(ii) (declaring it "to be in the public interest to . . . [p]rotect the public and private interests against waste in the production and utilization of oil and gas.").

Comment No.: 482_SGI_Gordy_S_20150416_email-attach-12
Organization: SG Interests I, Ltd.
Commenter: Shaun Gordy

Comment Excerpt Text:
The clumping of well locations in Alternative C would also lead to inefficient spacing and would likely preclude SG from drilling an adequate number of wells to maximize the recovery of federal and private minerals within the Bull Mountain Unit. DEIS at 2-42. BLM recognized this as an issue when it rejected other alternatives as not meeting the purpose and need of the proposal. See DEIS at 2-53 (rejecting alternative where "well pad locations produced from the modified model were not uniformly distributed throughout the Unit" as "not consistent with the existing Unit agreement to efficiently develop the federal mineral resources"). Though BLM suggests that SG could overcome spacing issues by developing the resources horizontally (DEIS at 4-163), this is impractical given spacing requirements for injection wells and may limit coalbed methane and sandstone development.

Comment No.: 482_SGI_Gordy_S_20150416_email-attach-13
Organization: SG Interests I, Ltd.
Commenter: Shaun Gordy

Comment Excerpt Text:
Alternative C represents an unrealistic development scenario because the terrain in some of the proposed locations is not conducive to well pad development. Some of the specified locations overlap with closed elk habitat, reducing the available places that a well pad could be constructed. Given that steep and other unfavorable terrain exists in the same areas -- Alternative C considered slope as less of a factor in site selection than Alternative B -- SG would be incapable of constructing a well pad within certain designated locations. This effectively reduces the total wells that can be developed and would not allow for the efficient development of federal mineral resources. The ultimate result of this approach would be to frustrate SG's ability to maximize resource recovery and to minimize revenues that would otherwise be payable to governments and private mineral holders. See DEIS at 4-203.

Comment No.: 482_SGI_Gordy_S_20150416_email-attach-14
Organization: SG Interests I, Ltd.
Commenter: Shaun Gordy

Comment Excerpt Text:
Alternative C does not account for surface use agreements that SG has executed with private surface owners, or private landholders' preferences for where wells should be located on private property. Placing well pads in "clumps" as Alternative C suggests unduly burdens certain surface owners and may violate existing contractual surface use agreements.

Comment No.: 574_Phillips_T_20150415_hard-1
Commenter: Troy Phillips

Comment Excerpt Text:
[The Proposed MDP] recognizes private property rights by honoring Surface Use Agreements previously entered into with the land owners. Alternative C would violate these rights by imposing land use restrictions superseding the SUA's regardless of the wishes of the landowners.

Summary

Use of the reweighted amounts in the siting model to create Alternative C results in infeasible locations because of more difficult terrain due to slope, causes more burdens on a few landowners, and does not allow for the retrieval of all resources. Additionally, the removal of one well pad in Alternative C within elk habitat should be explained in more detail.

Response

In the 2012 EA for the project, BLM went through a process to explore trade-offs in resource use and impacts by increasing and reducing different weighting factors to show how well pads would change under each alternative. Factors BLM wanted to consider were reducing the amount of disturbance from new roads and new pipelines which was spatially analyzed using the distance a pad would be from pipelines and existing roads, as well as reducing effects from erosion by placing more weight on erodible soils. The results of adding weight to these factors was to move development closer to roads and on to soils that were more stable. The trade-off of increasing these weighting factors was to reduce the weight on slopes and wetland areas. In other words, development could occur on steeper slopes and closer to wetlands. The percentage of reweighting is shown in Table 2-11 in Chapter 2 and Table A-1 in Appendix A, Well Pad Site Suitability Models and Methodology.

The different weighting factors also allowed the BLM to see differences in development distribution for drilling in the Unit. However, the distribution of well pads were not weighted as strongly as the wildlife, soils, and water resource factors. Additionally, the BLM did not account for burdens on landowners in weighting the GIS model factors. The impacts from Alternative C on economic viability and any potential burdens that a clustered development pattern may cause are discussed in the Final EIS in Chapter 4, Environmental Consequences, **Section 4.4.2**, Socioeconomics.

A well pad analysis area was removed from Alternative C because, after verified elk habitat was removed, the area was less than 10 acres. When considering Alternative D, the BLM did not run a new site analysis model, but selected well pads from Alternative B and Alternative C based on the analyzed impacts in Chapter 4. This resulted in selecting 31 pads from Alternative B, elimination of five pads from Alternative B, and inclusion of 2 pads from Alternative C.

Section 3.3 - Changes to current range of alternatives

Section 3.3.1 - Construction

Total Number of Comments: 8

Comment No.: 124_Goldstein_E_20150408_Hard-4
Commenter: Elena M.

Comment Excerpt Text:
4. lnspectors be required to be on site during the construction stages as well as the drilling stages.

Comment No.: 334_WElkScenicByway_Hoffmann_J_20150302_email-attach-6
Organization: West Elk Loop Scenic and Historic Byway
Commenter: John Hoffmann

Comment Excerpt Text:
In Best Management Practices (page 594), it is stated that impacts of power lines, PIPELINES and roads should be reduced where possible. Yet a proposal on page 116 would allow reopening smaller pipeline cuts that appear to be healing. Given the extent of the increase in wells and the quality of habitat being disturbed a larger pipe would be better situated as shown on pages 569-70 along the haul roads recently put in place (as represented on Google Earth 2012 photos). This would also facilitate future pipeline maintenance.

Comment No.: 334_WElkScenicByway_Hoffmann_J_20150302_email-attach-7
Organization: West Elk Loop Scenic and Historic Byway
Commenter: John Hoffmann

Comment Excerpt Text:
The installation of shortest distance ELECTRIC LINES allowed (page 67) in Alternative A would be inappropriate. Best Practices should have them run along the haul roads to reduce impacts to habitat.

Comment No.: 482_SGI_Gordy_S_20150416_email-attach-16
Organization: SG Interests I, Ltd.
Commenter: Shaun Gordy

Comment Excerpt Text:
The DEIS incorporates certain measures into Alternative C that are not practical or have no real environmental benefit. It is not practical for pipelines to be located within existing road networks. DEIS at 2-45. Nor is it practical to rely upon timing limitations (DEIS at 2-42) that are not contained in

the lease and require future negotiations before becoming effective. Because no timing limitations have been proposed or agreed upon, it is also a misrepresentation to distinguish Alternative C from Alternative B on the basis that "no voluntary seasonal timing limitations have been proposed under Alternative B." DEIS at 4-139. No voluntary seasonal timing limitations have been proposed under any alternative.

Comment No.: 482_SGI_Gordy_S_20150416_email-attach-3
Organization: SG Interests I, Ltd.
Commenter: Shaun Gordy

Comment Excerpt Text:
The assumptions regarding the miles of roads to be used and constructed under Alternative B, for example, overestimate the actual roads that will need to be developed or maintained to conduct operations under Alternative B. The map depicting the road network development on page 2-34 and Table 2-9 on page 2-55 suggest that numerous redundant, dead-end, and unnecessary roads will be upgraded and used if Alternative B is selected. See also DEIS at 4-6, 4-9, 4-106, 4-169, 4-173. In developing oil and gas resources, SG would upgrade the least amount of roads necessary to efficiently access well-sites and would refrain from using duplicative roadways or roadways that, as the picture on page 2-34 depicts, result in dead-ends or that are unconnected to proposed well-sites. BLM's apparent inaccurate calculation of the miles of roads to be developed skews the number of acres of land that would be disturbed under Alternative B.

Comment No.: 482_SGI_Gordy_S_20150416_email-attach-87
Organization: SG Interests I, Ltd.
Commenter: Shaun Gordy

Comment Excerpt Text:
Several assumptions related to well construction and operations should also be refined. The DEIS states facilities on a well pad would occupy less than 1 acre and assumes that a well pad would occupy less than 1.4 acres. DEIS at 2-26. But the size of the well pad depends on production, and could be greater or smaller than the size estimated in the DEIS. The DEIS represents that dust abatement measures would include the application of magnesium chloride, (DEIS at 2-28), but does not note that water is often used as a substitute dust suppressant. BLM assumes that SG would apply a top dressing of 3-inch road base around tank batteries or facilities (DEIS at 2-11), but offers no authority or basis for this approach. The DEIS discussion of well head densities is also confusing and requires clarification, as it is unclear whether the DEIS is representing that much is unknown about the number of wells needed to develop each formation. See DEIS at 2-4 (fourth bullet).

Comment No.: 482_SGI_Gordy_S_20150416_email-attach-88
Organization: SG Interests I, Ltd.
Commenter: Shaun Gordy

Comment Excerpt Text:
Other operational features are impractical. Because of shallow rocks present in the soil within the Bull Mountain Unit, the use of rotary trenching for pipeline construction (DEIS at 2-12), is not a viable option. When constructing or maintaining infrastructure, SG will continue to comply with all regulatory requirements for x-ray inspection of pipeline welds consistent with Department of Transportation regulations and all other applicable laws. There is also no basis for requiring a third party compliance contractor to insure adherence to mitigation requirements. DEIS at 2-48. SG is already legally required to adhere to all applicable legal and regulatory provisions as well as all permit conditions; SG voluntary conducts all operations in a manner consistent with the highest standards of industry best practices; and both the BLM and the COGCC already have the right to inspect oil and gas operations at any time.

Comment No.:
495_TownofHotchkiss_Koontz_W_20150414_hard-2
Organization: Town of Hotchkiss
Commenter: Wendell Koontz

Comment Excerpt Text:
2. Access road and drill pad construction. All construction should follow the Best Management Practices as utilized elsewhere in both oil and gas and solid mineral exploration for control of surface water runoff, soil erosion, and dust. Berms, straw bales, silt fences, gravel surfacing, etc. should be employed and maintained to protect
the culinary and irrigation water for the community.

Summary

There are various elements of the construction section of the alternatives that need to be corrected or clarified, including methods of construction, road and pipeline locations and alignments, wellhead densities, the inclusion of voluntary timing limitations, the use of third-party compliance monitors, the number of roads assumed to be needed for access and to be built, and the average acreage used in the disturbance calculations.

Response

The Final EIS has been revised to correct and clarify construction details. Road and pipeline alignments and mileage were updated based on revised data sets received from SGI. The road data layer used in the GIS maps and calculations has eliminated redundant routes and dead ends. See **Section 1.9.1**, Updates to Geographic Information Systems Information, **Section 2.2.3**, Elements Common to All Alternatives, and **Section 2.2.7**, Alternative D (the BLM's Preferred Alternative) in the Final EIS for changes made.

Methods of construction were updated based on input from SGI and the text in Chapter 2 of the Final EIS has been revised with SGI's clarifications.

Wellhead density was noted as varying from one well up to 12 per pad; for analysis purposes, the BLM estimated an average of 4 to 6 wellheads per pad but noted that there could be variations across the field, depending on the results of exploratory drilling.

The timing limitations under Alternative C have been corrected to indicate that under this alternative the timing limitations stipulated in the lease terms would be required. Under Alternatives B and D, the timing limitations are described as voluntary as they were included in SGI's Wildlife Habitat Plan. The requirement for third-party compliance monitors was deleted from the alternatives.

As the exact locations, number of wells, and well pad dimensions were unknown, it was important for BLM to make assumptions for acreage disturbance that could be used in impact analysis. It's recognized that well pads may be larger or smaller depending on the number of wells and facilities included, but the five acres of short-term disturbance and two acres of long-term disturbance assumptions are reasonable estimates based on past experience and professional judgement.

Section 3.3.2 - Drilling

Total Number of Comments: 6

Comment No.: 124_Goldstein_E_20150408_Hard-1
Commenter: Elena M.

Comment Excerpt Text:
The instability of the land proposed for the drilling of 146 wells is significant. The DEIS report acknowledges that and mentions the need for mitigations. I ask that before things proceed any further.
1. The Colorado Geological Survey geologists be consulted as to the safety of the project.

Comment No.: 275_Shishim_M_20150414_email-attach-2
Commenter: Margaret Shishim

Comment Excerpt Text:
The BLM acknowledges in the above EIS statement, that the area proposed for drilling is geologically unsafe and unstable. The fact that there is a “high potential for landslide activity”, “surface equipment including tanks and pipelines could be damaged in a landslide, potentially resulting in releases or safety hazards”, and “slope failure would be a significant impact” is proof that this area should not have drilling activity.

Comment No.: 334_WElkScenicByway_Hoffmann_J_20150302_email-attach-2
Organization: West Elk Loop Scenic and Historic Byway
Commenter: John Hoffmann

Comment Excerpt Text:
Page 187 speaks about the MUD FLOWS that are frequent within the Alluvial Terraces on the North side of the MDP. There is one well shown on the Alternative C map (page 95) that appears to be situated on an unstable Alluvial Terrace (page 185). Given the anticipated 40 year life of these wells, this location is unadvisable due to the instability of the area. The wells shown on Alluvial Terrace (page 61, Alternative A) should definitely not be developed.

Comment No.: 334_WElkScenicByway_Hoffmann_J_20150302_email-attach-3
Organization: West Elk Loop Scenic and Historic Byway
Commenter: John Hoffmann

Comment Excerpt Text:
Also in the southeast corner of the MDP is an area of Colluvial Deposit (page 185) that is historically unstable. Given the proposed 40 year well life, this area should also be accessed by placing the pad on more stable ground. The guidance provided by the document (pages 582, 584 and 585) should disallow wells on unstable grounds.

Comment No.: 334_WElkScenicByway_Hoffmann_J_20150302_email-attach-4
Organization: West Elk Loop Scenic and Historic Byway
Commenter: John Hoffmann

Comment Excerpt Text:
Locating wells on the unstable Alluvial Terraces and Colluvial Deposits locations may be exacerbated by the proposed waste water injection wells (4 requested). Injection wells have been proven to lubricate and pressurize strata and initiate earth temblors up to magnitude 5.7. See studies from Rocky Mountain Arsenal (1962-1966) and Chevron’s Colorado Oil Fields experiments (1967-69) where intensity and frequency of quakes can increase from the pressure and frequency of such injections. There are a variety of examples including:
(1) Raton Basin 2001-present, magnitude 5.3 in

August 2011;
(2) Dallas-Fort Worth October 2008-May 2009, several magnitude 3.3 quakes;
(3) Prague Oklahoma, November 6 2011, magnitude 5.7 destroying 14 homes;
(4) Youngstown Ohio, December 31, their first recorded quake at magnitude 4.0; and
(5) Cogdell Oil Field, Snyder Texas, 2006-2011, a series of 90 quakes, one at magnitude 4.4, two years after starting CO2 injections.

Summary

The geology of the area, especially the alluvial terraces and colluvial deposits, is unstable and prone to earthquakes, and wastewater injection wells would increase the risk of earthquakes; five examples of earthquakes were provided.

Response

The Draft EIS acknowledges the potential for geologic instability in the area (Section 4.2.5, Geology); COAs and mitigation measures included in Alternatives B and C would minimize this potential. Suggested literature related to geologic instability was reviewed and references have been updated. Additionally, geologic hazard mitigation measures that the BLM considered under ***Effects Common to All*** in Section 4.2.5 have been incorporated as design features under Alternative D, the Preferred Alternative, for application as needed during future APD analysis and consideration.

These new measures are similar to what the BLM applies to coal leases, so they are not outside the BLM's experience for applicability.

Section 3.3.3 - Hydraulic fracturing

Total Number of Comments: 1

Comment No.: 482_SGI_Gordy_S_20150416_email-attach-33
Organization: SG Interests I, Ltd.
Commenter: Shaun Gordy

Comment Excerpt Text:
The DEIS fails to acknowledged that coalbed methane water can also be used for completions. DEIS at 2-55

Summary

The commenter states that alternatives should note that coal bed methane water can be used for completions.

Response

The BLM has updated the Final EIS to note that coal bed methane water can also be used for completions.

Section 3.3.4 – Measures to reduce weeds and traffic

Total Number of Comments: 2

Comment No.:
548_BlackCanRegLandTrust_Puckett_J_20150415-1
Organization: Black Canyon Regional Land Trust
Commenter: Jeremy Puckett

Comment Excerpt Text:
To limit the potential for spread of invasive and noxious weeds, the operator should be required to clean equipment prior to its utilization for construction related activities, thereby limiting the unintentional dispersal of unwanted seeds,etc.

Comment No.: 572_Peters_A_20150415_hard-3
Commenter: Anthony Peters

Comment Excerpt Text:
First off there needs to be a staggered timing of well drilling and location management to mitigate truck traffic and a requirement for interim reclamation. Also increased air pollution controls and enhanced 1,000 ft. setbacks from bodies of water,

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Summary

Commenters requested additional conditions of approval to be considered, including additional measures to prevent the spread of noxious and invasive weeds and measures to control traffic, such as staggering drilling and production timing.

Response

The Final EIS includes a measure to wash equipment and vehicles requested by commenters. See COA #47 in Appendix C.

Each action alternative describing the Master Development Plan (MDP) is designed to consolidate development, which allows for more productivity over a short duration, therefore extending those periods where traffic would be less intense.

Section 3.3.5 - Water

Total Number of Comments: 6

Comment No.: 026_Bishop_S_20150330_email-2
Commenter: Sara Bishop

Comment Excerpt Text:
Oil and gas development companies need to be using state of the art techniques for managing waste waters, no matter what their origin. There is a product currently being used in Ohio that neutralizes waste waters. It is called Osorb. BLM should insist that all permitees consider using Osorb at their sites. If they decide against using this product, they must justify their decision on other than strictly a cost basis.

Comment No.: 071_Coleman_F_21050407_email-5
Commenter: Frank M. Coleman

Comment Excerpt Text:
The Safe Drinking Water Act requires removal of the contaminants mentioned above from public water

supplies. To insure this is done it is recommended that the producer water used by SGI be analyzed by an independent, reputable laboratory before deposition in wastewater ponds.
The EIS makes no mention of SGI conducting such an analysis themselves, or contracting it out and so, by inference, SGI has no intention of doing so.

Comment No.: 071_Coleman_F_21050407_email-7
Commenter: Frank M. Coleman

Comment Excerpt Text:
If analysis reveals the presence of the contaminants discussed above the disposition of producer water wastes in the waste water ponds, even if buffered etc., should be prohibited.

Comment No.: 482_SGI_Gordy_S_20150416_email-attach-86
Organization: SG Interests I, Ltd.
Commenter: Shaun Gordy

Comment Excerpt Text:
SG notes that the description of certain operational parameters in the DEIS is inconsistent. With respect to water usage, for example, the DEIS does not consistently describe how water used in oil and gas operations is acquired. SG uses surface water in its operations consistent with the terms of SG's water rights and its approved water augmentation plan. But the DEIS' description of the water augmentation plan does not consistently reflect the manner in which the plan regulates SG's water usage. Compare DEIS at 2-29, with DEIS at 4-131. Because the augmentation plan speaks for itself, the DEIS should reference specific portions of the plan – and explain how those provisions support the DEIS' conclusions – when discussing the augmentation plan's applicability.

Comment No.: 494_Thompson_G_20150415_email-attach-4
Commenter: Greg Thompson

Comment Excerpt Text:
This Bull Mountain project uses far too much water, especially when the West is in a long term drought. In addition, hydraulic fracturing threatens to pollute water in place, in nearby aquifers, streams, and reservoirs. I have read about a technology being tested whereby fracking can be done without water. I believe it is appropriate to require that SGI await development of waterless fracking before they proceed. It is my belief that other federal agencies are working to conserve Colorado River water. Is BLM at cross purposes with its government partners in using an outdated policy on water usage?

Comment No.: 504_WestSlopeConsCtr_Sauter_S_21050416_email-attach-5
Organization: Western Slope Conservation Center
Commenter: Sarah Sauter

Comment Excerpt Text:
The BLM has not adequately addressed compliance monitoring. The DEIS falls short in discussing compliance monitoring of air, water, and wildlife impacts. We ask the BLM to require monitoring efforts beyond the minimum practices established by the Colorado Oil & Gas Conservation Commission. The BLM should require on-going wildlife monitoring through the life of the project, and not limit monitoring to the reclamation phase. Baseline and on-going air and water monitoring should test for chemicals related to drilling and fracking including methane, volatile organic compounds, and polycyclic aromatic hydrocarbons.

Summary

The alternatives should include additional water resource mitigation measures, such as a requirement for third-party monitoring of produced water, prohibition of sending wastewaters to the reserve pits if they contain contaminants, and consideration of no-water fracturing methods. Additionally, the alternatives need to clarify the augmentation plan's applicability.

Response

In response to public and internal comments, BLM has included a baseline water quality monitoring program in the Preferred Alternative (Alternative D). See **Section 2.2.9**, BLM's Preferred Alternative.

Under the Preferred Alternative, the standard would be for closed loop systems to be used to eliminate pits on location and the release of VOCs, unless due to resource considerations impacts can be demonstrated to be less when using a reserve pit system; there would be no net benefit to using a closed loop system. The type of drilling system would be determined when the drilling application is submitted.

While waterless fracturing methods have been used in some basins, they have not always been successful. Which method of fracturing is to be used would be determined during the APD stage when the BLM may consider the effects of waterless fracturing, if feasible for the proposed well and geologic conditions.

As noted in the Final EIS, **Section 4.2.4**, Water Resources, the augmentation plan would allow SGI to store water in Bainard Reservoir No. 1 to augment stream diversion amounts of up to 50.64 acre-feet per year, based on the estimated water consumption.

Section 3.3.6 - Wildlife

Total Number of Comments: 6

Comment No.: 334_WElkScenicByway_Hoffmann_J_20150302_email-attach-8
Organization: West Elk Loop Scenic and Historic Byway
Commenter: John Hoffmann

Comment Excerpt Text:
In the summaries of lease stipulations (page 641), the TIMING LIMITATION STIPULATION of no surface occupancy from December-May seems hollow in light of the next sentence, saying that the stipulation does not apply to Operations and Maintenance of production facilities! It is recommended that these stipulations DO apply to Operations, if not the Maintenance of production facilities and that the period be extended through November to conform with Colorado Parks and Wildlife best practices for wildlife.

Comment No.: 482_SGI_Gordy_S_20150416_email-attach-16
Organization: SG Interests I, Ltd.
Commenter: Shaun Gordy

Comment Excerpt Text:
The DEIS incorporates certain measures into Alternative C that are not practical or have no real environmental benefit. It is not practical for pipelines to be located within existing road networks. DEIS at 2-45. Nor is it practical to rely upon timing limitations (DEIS at 2-42) that are not contained in the lease and require future negotiations before becoming effective. Because no timing limitations have been proposed or agreed upon, it is also a

misrepresentation to distinguish Alternative C from Alternative B on the basis that "no voluntary seasonal timing limitations have been proposed under Alternative B." DEIS at 4-139. No voluntary seasonal timing limitations have been proposed under any alternative.

Comment No.:
503_WELC_King_L_20150416_email-attach-114
Organization: Western Environmental Law Center
Commenter: Laura King

Comment Excerpt Text:
An alternative that analyzes and applies the best available information and science through stipulations aimed to protect federally listed species and their habitats.

Comment No.:
503_WELC_King_L_20150416_email-attach-115
Organization: Western Environmental Law Center
Commenter: Laura King

Comment Excerpt Text:
BLM must rigorously explore and objectively evaluate an alternative that applies best available information and science through stipulations aimed at protecting federally listed species and their habitats.

Comment No.:
504_WestSlopeConsCtr_Sauter_S_21050416_email-attach-5
Organization: Western Slope Conservation Center
Commenter: Sarah Sauter

Comment Excerpt Text:
The BLM has not adequately addressed compliance monitoring. The DEIS falls short in discussing compliance monitoring of air, water, and wildlife impacts. We ask the BLM to require monitoring efforts beyond the minimum practices established by the Colorado Oil & Gas Conservation Commission. The BLM should require on-going wildlife monitoring through the life of the project, and not limit monitoring to the reclamation phase. Baseline and on-going air and water monitoring should test for chemicals related to drilling and fracking including methane, volatile organic compounds, and polycyclic aromatic hydrocarbons.

Comment No.: Form_CHC-3

Comment Excerpt Text:
BLM should require extra mitigation measures to prevent harm to big game animals—which would also harm the local hunting economy—such as timing limitation stipulations during certain seasons on operations and maintenance activities, and big game monitoring throughout the life of the project.

Summary

The BLM should require protections to wildlife, such as timing limitations and wildlife monitoring. The BLM should consider an alternative that has stipulations to protect federally listed species and their habitats.

The Draft EIS contains wildlife protections that are not practical or have no environmental benefits. The timing limitations that are not noted on the lease should not be used to distinguish between Alternatives B and C.

Response

Timing limitation stipulations are applied on several of the leases in the Unit (Appendix F of the Final EIS). The wildlife habitat plan was developed in coordination with CPW and contains seasonal closures to avoid or minimize impacts on wintering big game. Measures in Alternative C are feasible, and the BLM feels that collocating pipelines with roads would reduce environmental impacts on habitat, such as fragmentation. The Final EIS has been revised to remove reference to voluntary seasonal timing limitations in Alternative C.

Section 3.3.7 - Plans

Total Number of Comments: 1

Comment No.: 482_SGI_Gordy_S_20150416_email-attach-26
Organization: SG Interests I, Ltd.
Commenter: Shaun Gordy

Comment Excerpt Text:
Surface Use Plan of Operations does not apply to fee-fee leases and the lease stipulations listed do not apply to every lease. DEIS at 2-33

Summary

The surface use plan of operations does not apply to fee/fee leases. The lease stipulations listed on page 2-33 do not apply to every lease.

Response

The commenter is correct in the case when production is not coming from federal minerals; if production were to come from federal minerals, the company would still be required to submit a complete federal APD package that includes a Surface Use Plan of Operations (SUPO). The SUPO would be reviewed for cumulative impacts at the time of the APD review, and federal oversight applies to all downhole operations. Also, in cases where Federal development would be considered from private land/private mineral locations, operations would require a Federal APD per the additional requirements found in BLM Instruction Memorandum 2009-078.

Section 3.3.8 – Additional stipulations BLM should consider

Total Number of Comments: 3

Comment No.: 026_Bishop_S_20150330_email-3
Commenter: Sara Bishop

Comment Excerpt Text:
At a minimum, the company or companies that will benefit from developing the resource should be tasked with making the highway compatible with their operations. What needs to be done: Widen and harden State Highway 133 from Rogers Mesa at least to the turnoff(s) to the Bull Mountain drill sites,

similar to the highway improvements done to the west of Rogers Mesa.

Comment No.: 071_Coleman_F_21050407_email-9
Commenter: Frank M. Coleman

Comment Excerpt Text:
Noise Pollution It is certain that the pneumatic drills used in fracking will impact on the peace and quiet of wildlife and residents of nearby communities. Therefore, it is recommended that all possible means be employed to deter overwhelming, continuing, racket. This includes restrictions on hours of drilling and the required use of pneumatic drills with no bleed devices.

Comment No.: 482_SGI_Gordy_S_20150416_email-attach-89
Organization: SG Interests I, Ltd.
Commenter: Shaun Gordy

Comment Excerpt Text:
There are also several components of operations that appear to be misstated or misunderstood in the DEIS. When SG re-seeds private surface land, for example, it is often required to use seed based on the landowner's preference. SG cannot re-seed private land based on BLM's preferred method (see e.g., DEIS at 2-23, 4-102) if it conflicts with the preference of the landowner. The timing of reclamation activities is also unclear in the DEIS. Well pad reclamation occurs when no more wells are anticipated, not simply when existing wells are "not productive" as stated in the DEIS. DEIS at 2-23. These reclamation activities are conducted consistent with the terms of the approved Surface Use Plan of Operations and COGCC rules.

Summary

The BLM should have additional mitigation measures in the alternatives, including a requirement to improve State Highway 133 to accommodate the anticipated increase in traffic, measures to address noise impacts, and clarification of how and when SGI will conduct reclamation activities.

Response

The noise, state highway, and reclamation measures noted by commenters are included in the Final EIS. The noise COAs are found in Appendix C and in Section 4.2.2, Noise, in the Final EIS. Improvements to and maintenance of State Highway 133 are under the authority of the Colorado Department of Transportation. Reclamation activities and requirements are found under all alternatives and in Appendix C; as noted on page 1-6, Section 1.3.2 in the Final EIS, "The seed mix will be chosen by the landowner, stipulated in permit conditions of approval, or dictated by the surface management agency." Additionally, the SGI Wildlife Habitat Plan includes measures for working with landowners on seed mixes for revegetation and reclamation activities, "SGI will use a CPW-recommended wildlife friendly seed mix for interim and final reclamation where approved by the surface owner. The CPW-recommended wildlife friendly seed mixes for the BMU are found in Appendix A [of the Wildlife Habitat Plan]."

Section 3.3.9 – Requiring Remote Telemetry

Total Number of Comments: 1

Comment No.: 482_SGI_Gordy_S_20150416_email-attach-17
Organization: SG Interests I, Ltd.
Commenter: Shaun Gordy

Comment Excerpt Text:
Requiring remote telemetry (DEIS at 2-48), presumably to reduce monitoring trips to each individual well site, would increase the risk of non-detection of any on-going release or a spill. Irrespective whether remote telemetry is installed on a well, regular and frequent monitoring trips to a well site are an essential part of preventing and remedying operational and maintenance incidents. The environmental benefits of utilizing a centralized production facility are likewise inconclusive. DEIS at 2-48. The DEIS assumes that such a facility would reduce traffic to certain areas; but the DEIS does not account for the disturbed acreage that this facility would create and any potential impact associated with the construction and operation of the facility.

Summary

The BLM needs to further explain why it is requiring remote telemetry under Alternative C. It is not explained how this would meet the goals of this alternative.

Response

Remote telemetry has become a standard operating procedure for many fields that can result in better monitoring and less frequent trips to facilities, although it cannot be a replacement for human inspections. Alternative B has been revised to include remote telemetry based on the information provided in SGI's Wildlife Habitat Plan. Under the plan, SGI agrees to remotely monitor specific aspects of well production. This remote monitoring is proposed as a way to provide monitoring between the daily site inspections by SGI personnel. Additionally, this proposed remote monitoring will be conducted at all fee and federal well pad locations as proposed in SGI's Proposed Action under Alternative A and Alternative B. These measures were also included into Alternative D. See Appendix C, Wildlife Habitat Plan for additional details.

Section 3.4 - New actions for consideration in range of alternatives

Section 3.4.1 – Conservation Alternative

Total Number of Comments: 39

Comment No.: 071_Coleman_F_21050407_email-4
Commenter: Frank M. Coleman

Comment Excerpt Text:
A baseline study of water quality prior to development must be conducted. The purpose of the study is to identify possible contamination of surface and groundwater before and after start up of fracking activity.

Comment No.: 096_Edson-Simmons_20150408_email-1
Commenter: Jan Simmons

Comment Excerpt Text:
include a conservation alternative within the scope of alternatives. This option should include phased development that would control the timing, pace, and location of new development and require interim reclamation, enhanced 1,000-foot setbacks for new well locations from water bodies, increased air pollution controls (e.g. no-bleed and low-bleed pneumatic devices, green completions and closed-loop drilling systems)

Comment No.: 188_McGuire_E_20150415_email-5
Organization: Desert Weyr, LLC
Commenter: Eugenie McGuire

Comment Excerpt Text:
In addition to baseline data collection and ongoing monitoring the BLM must provide an alternative that requires the companies involved to mitigate those emissions by installing closed loop and no bleed systems and other measures to prevent any outflow of any contaminant into the surrounding air.

Comment No.: 188_McGuire_E_20150415_email-6
Organization: Desert Weyr, LLC
Commenter: Eugenie McGuire

Comment Excerpt Text:
The BLM has not considered the full impacts of those trips and is ignoring how it will impact the scenic views that our valley is known for. The BLM must provide a conservation alternative that reduces the number of trips required and also provides for the companies involved to be required to improve the roads and take on all the additional costs of the road maintenance that their increased traffic will require.

Comment No.: 189_Mcguire_K_20150415_email-3
Organization: Weyr Associates, LLC
Commenter: Kenyon McGuirer

Comment Excerpt Text:
The BLM must provide a conservation alternative that reduces the number of trips required and also provides for the companies involved to be required to improve the roads and take on all the additional costs of the road maintenance that their increased traffic will require.

Comment No.: 207_Nagel_C_20150404_email-attach-1
Commenter: Clinton Nagel

Comment Excerpt Text:
As I was studying the different alternatives of the draft, I was waiting to see one which proposed a more conservative approach. I did not see one. There needs to be a conservation-oriented alternative, one with additional mitigation measures. Serious consideration must be given to number, spacing and timing of wells.

Comment No.: 219_Overton_L_20150410_hard-1
Commenter: Lee S. Overton

Comment Excerpt Text:
The BLM should require mandatory baseline suface water sampling and ongoing monitoring and collection of baseline air samples prior to development, and ongoing air monitoring to test for chemicals related to drilling and fracking operations such as VOCs and PAHs. ln addition, the North Fork Valley has become an important center for organic wine, fruit and other edible food production and is vulnerable to any soil, water or air contamination from hazardous pollutants.

Comment No.: 220_Paladino_P_20150403_email-1
Commenter: Paul Paladino

Comment Excerpt Text:
BLM should consider additional mitigation measures, such as “phased development” that would control the timing, pace, and location of new development and require interim reclamation, enhanced 1,000-foot setbacks for new well locations from water bodies, increased air pollution controls (e.g. no-bleed and low-bleed pneumatic devices, green completions and closed-loop drilling systems).

Comment No.: 224_Peters-Wicks_20150415_email-attach-1
Commenter: Nancy Wicks

Comment Excerpt Text:
Therefore I think the BLM should require mandatory baseline surface water sampling and ongoing air monitoring to test for chemicals related to drilling and fracking operations, like methane, volatile organic compounds (VOC’s), and polycyclic aromatic hydrocarbons (PAH’s).

Comment No.: 281_Singleton_R_20150415_email-1
Commenter: Ron Singleton

Comment Excerpt Text:
This letter is to suggest the following changes to BLM’s draft EIS for the Bull Mountain Master Development Plan: Consider adding a fourth alternative that addresses the conservation and safety issues absent in the first three alternatives:

1. A phased development approach that would control the pace of drilling, limiting the number of drill rigs in operation and including timing stipulations that minimize the impact on big game and other wildlife. One drilling rig at a time would be optimal.

2. Require baseline air and surface water quality sampling prior to development and ongoing monitoring of both during drilling and fracking operations.

3. Require bonding adequate for a catastrophic accident and to ensure complete reclamation at project completion.

4. Require 1000-foot setbacks from water bodies for new well locations.

5. Include a cost analysis in determining the economic impact of this project, examining costs to existing agricultural, tourist and real estate industries from increased heavy truck traffic, water diversion, the intrusion of industrial development onto public lands, and the threat of accidental or operational air and water pollution.

Comment No.: 298_Stone_M_20150415_email-attach-1
Commenter: Marilyn Stone

Comment Excerpt Text:
I request that you consider a conservation-oriented alternative and additional mitigation measures. These would include phased-in development to reduce the impact citizens and wildlife experience at any one time. Impacts include traffic and human disturbance,

degradation of air quality, traffic which is hazardous to tourists, locals and wildlife; reduced demands on our limited water resources during a drought, possibly severe drought.

Comment No.:
303_Swackhammer_P_20150414_email-attach-1
Commenter: Phyllis Swackhamer

Comment Excerpt Text:
Air and water monitoring: I believe there should be mandatory third party baseline air and water samples prior to development, as well as ongoing sampling of air and water for chemicals used in and produced by drilling and fracking. In this day closed-loop should be required.

Comment No.: 331_Webb_P_20150413_hard-1
Commenter: Patrick Webb

Comment Excerpt Text:
In addition Ms. Jones in your management of this project I would think that you would
require mandatory baseline surface water sampling and of course, ON- GOING monitoring, collection of baseline air samples prior to development, and ongoing air monitoring to test for chemicals related to drilling and franking operations, like methane, volatile organic compounds (VOC's), and polycyclic aromatic hydrocarbons (PAH's).

Comment No.:
334_WElkScenicByway_Hoffmann_J_20150302_email-attach-1
Organization: West Elk Loop Scenic and Historic Byway
Commenter: John Hoffmann

Comment Excerpt Text:
The capabilities of MODERN DRILLING RIGS enable a single rig pad to drill up to 20 wells, 2 miles deep reaching out another two miles horizontally. This would enable the driller to reach the 5 X 7 mile perimeter of the proposed Bull Mountain MDP area with as few as 7 pads with 20 wells each to achieve the 146 well scope the applicant desires. This is an advantage compared to the 35 well pads that would be allowed by Alternative C (page 94). We recommend that development be limited to the 11 recently developed pads already in the area.

Comment No.: 389_Deva_A_20150415_email-2
Commenter: Arlyn Alderdice

Comment Excerpt Text:
At the very least, I urge the BLM to require mandatory baseline surface water sampling and ongoing
monitoring, collection of baseline air samples prior to development, and ongoing air monitoring to test for chemicals related to drilling and fracking operations, like methane, volatile organic compounds (VOCs), and polycyclic aromatic hydrocarbons (PAHs).

Comment No.: 389_Deva_A_20150415_email-4
Commenter: Arlyn Alderdice

Comment Excerpt Text:
So far, the BLM has failed to consider a conservation alternative within its scope of alternatives. I
urge you to implement a conservation-oriented alternative and additional mitigation measures, such as "phased development" that would control the timing, pace, and location of new development and require interim reclamation, enhanced 1,000-foot setbacks for new well locations from water bodies, and increased air pollution controls (e.g. no-bleed and low-bleed pneumatic devices, green completions and closed-loop drilling systems).

Comment No.: 406_Gulick_S_20150416_email-attach-1
Commenter: Stephen Gulick

Comment Excerpt Text:
1) Lack of Alternatives. The BLM has not provided

sufficiently varied alternatives to choose from. Alternative A has no MDP, and Alternatives B and C are almost the same. There are no real choices here.

Comment No.: 413_Helleckson_B_20150416_email-3
Commenter: Brent Helleckson

Comment Excerpt Text:
Uneven Treatment of Extrapolation and Projection of Positive and Negative Impacts Inadequate Breadth of Alternatives The alternatives presented are essentially "No MDP" (Alternative A) and "Do Essentially what SG Interests Suggests" (Alternatives B and C). There is no alternative that examines the relative merit of the imposition of requirements for phased development, active sound suppression, hooded lighting, limitation of activity to weekday daylight hour operations, areas of no surface disturbance, limitation of visual disturbance, etc. The examination of such andalternative more equitably explores the costs and benefits of the proposed MDP. The DEIS, as it exists, does not bother to explore beyond what SG Interests proposes and even seem to alter its analyses to support their Proposed Alternative. By way of example, several instances of the importance of the rural character of life and scenic resources are are identified (DEIS at 3102, DEIS at 4189, etc.) The impact to these resources are admitted (DEIS at 4199, etc.) However, no alternative is presented wherein these impacts are avoided or even minimized. To avoid the burden of even a cursory examination of the issue, the DEIS citing the outdated Resource Management Plan currently under revision, even arbitrarily reclassifies the visual resources associated with the Unit, from Class II To Class III (DEIS at 3102).

Comment No.: 413_Helleckson_B_20150416_email-5
Commenter: Brent Helleckson

Comment Excerpt Text:
The Preferred Alternative consents to the transfer of business cost and risk from those who stand to gain economically from the activity (e.g., SG Interests, the Federal, State and Local Governments) to those who do not (e.g the residents of the North Fork Valley, those dependent upon unfouled irrigation and domestic water, those businesses dependent on recreational and visual resources, etc.) An alternative that examines the methods (i.e. avoidance of the impacts, mitigation of the impacts, insurance or other indemnification for the risks associated the the activity, etc.) by which these costs can be properly absorbed by the entities that stand to benefit is necessary to adequately address NEPA requirements and to properly allow decisionmaking to occur.

Comment No.: 424_Kolbenschlag_P_20150416_email-attach-5
Commenter: Pete Kolbenschlag

Comment Excerpt Text:
There is no conservation alternative. There is no reasonable range at all. There is No Action, and there is Alt. BC: the industry proposal and the industry proposal ever-so-slightly modified. This slight tweak between the two is already accounted for within the narrow sub-range of alternatives, that is it is already within the range considered by the No Action and the unmodified SGI proposal; thus the modified SGI proposal is not really a distinct alternative, for practicable or NEPA purposes, at all.

Comment No.: 431_Leger_N_20150416_email-attach-5
Commenter: Natasha Leger

Comment Excerpt Text:
10. BLM failed to consider a conservation alternative within its scope of alternatives. BLM needs to consider a conservation-oriented alternative and additional mitigation measures, such as "phased development" that would control the timing, pace, and location of new development and require interim reclamation, enhanced 1,000-foot setbacks for new well locations from water bodies, increased air

pollution controls (e.g. no-bleed and low-bleed pneumatic devices, green completions and closed-loop drilling systems).

Comment No.: 488_Stone_V_20150416_email-1
Organization: Round Earth Farm
Commenter: Valerie Stone

Comment Excerpt Text:
I urge you to consider a conservation oriented alternative that includes significant mitigation measures such as: phased development, interim reclamation, setbacks for new wells from water and private residences and pollution controls. The BLM should require mandatory baseline surface water and air sampling and ongoing monitoring to test for chemicals associated with hydraulic fracturing. Considerations for the impacts on hunting and wildlife and the associated cost of carbon emissions should also be included for the Master Development Plan to be a thorough analysis of the costs and benefit of the Bull Mountain MDP.

Comment No.: 494_Thompson_G_20150415_email-attach-3
Commenter: Greg Thompson

Comment Excerpt Text:
Adequacy of proposed alternatives. I find the alternatives to be inadequate. B and C are very similar which means the choices are really just two. I would like to see two additional alternatives: the preferred alternative (and one that BLM needs to consider) would be a “conservation-oriented” alternative that allows for “phased development” while emphasizing resource protection. The second, although less desirable alternative, would spread development over a greater number of years, instead of just six years. It seems that it would be reasonable to add an alternative that stretches out development. A 12 year well development plan would be an improvement over six years in that the development impact would not be so concentrated. In the alternatives, BLM needs to consider requiring additional mitigation measures (including the use of air quality controls, such as no-bleed and low-bleed pneumatic devices, green completions and closed-loop drilling systems). A more drawn out timeframe would also mean that should fracking technologies improve environmentally over the intermediate term, those improvements could be incorporated into the operations at Bull Mountain. Contrarily, should more negative impacts from fracking reveal themselves over a more drawn out development timeframe, then detrimental environmental impacts could perhaps be minimized or avoided altogether. A more phased development would also facilitate required interim reclamation.

Comment No.: 496_TroutUnltd_Cross_S_20150416_email-attach-6
Organization: Trout Unlimited
Commenter: Shane Cross

Comment Excerpt Text:
4. The BLM should Select an Alternative that Contains, at minimum, all of the Fish and Wildlife and Water Resource Protections Contained in Alternative C should it Decide to Approve the BMDP.

Comment No.: 498_VanDusen_P_20150415_hard-2
Organization: Delta County Commissioners CHC
Commenter: Paul Van Dusen

Comment Excerpt Text:
A reasonably long timeline should be developed to control the timing, pace, and location of disruption by drilling, such as interim reclamation and wide (=>1000 foot) setbacks for new well locations from sources of water (3-27). These should also maximize air pollution controls usíng no-bleed and low-bleed pneumatic devices and closed-loop drilling methods (3-4).

Comment No.: 498_VanDusen_P_20150415_hard-3
Organization: Delta County Commissioners CHC

Commenter: Paul Van Dusen

Comment Excerpt Text:
To level the playing field both for human residents and the finned and four-footed ones (3-57) BLM should require mandatory baseline surface water and air samples prior to development (4-1) and on-going monitoring to test for chemicals (e.g. methane, volatile organic compounds and polycyclic aromatic hydrocarbons) related to drilling and hydraulic fracturing operations (3-120).

Comment No.:
503_WELC_King_L_20150416_email-attach-117
Organization: Western Environmental Law Center
Commenter: Laura King

Comment Excerpt Text:
BLM must rigorously explore and objectively evaluate an alternative that requires the implementation of these 10 technologies through stipulations that attach to all APDs within the Bull Mountain Unit

Comment No.: 497_Van-West_R_20150416_email-5
Commenter: Rein Van West

Comment Excerpt Text:
So why, then, isn't there a more appropriate alternative than the ones proposed by the BLM? I'm aware Alternative C is the one supported by the BLM, but it does not offer enough conservation measures to mitigate the resource damage that will be done. I'm asking that the BLM consider proposing another alternative that addresses deeply-held conservation concerns related to the sensitivity of the resources within the Bull Mountain drilling area. True, the BLM has taken a number of conservation middle-ground considerations into account with its Alternative C, but more can and should be done.

Comment No.:
503_WELC_King_L_20150416_email-attach-118
Organization: Western Environmental Law Center
Commenter: Laura King

Comment Excerpt Text:
BLM's NEPA process should further include analysis of an alternative that applies existing and new BMPs as mandatory stipulations applied to all oil and gas development proposed within the Bull Mountain Unit. For example, The Intermountain Oil and Gas BMP Project, which is maintained by the Natural Resources Law Center at the University of Colorado Law School, provides supplemental information, including construction specifications, illustrations, pictures, maps, monitoring reports, and evaluations of the potential of the practice for mitigating impacts of development.

Comment No.:
503_WELC_King_L_20150416_email-attach-120
Organization: Western Environmental Law Center
Commenter: Laura King

Comment Excerpt Text:
the BLM should consider an alternative that requires a 1,000-foot corridor between drilling activities and the outermost limit of riparian zones. Such a corridor is imperative to minimize the risk of migration or spill of contaminants such as benzene, toluene, ethylbenzene, and xylene to waterbodies. BLM considered and eliminated a 500-foot setback alternative during initial EA scoping on the basis that it would require 5.6 miles of additional roads and 8.3 acres of additional surface disturbance. See EIS at 2-53. Given the importance of setbacks to protecting waterbodies, however, the BLM has a duty to weigh this option against the potential risks from additional roads and disturbance.

Comment No.:
503_WELC_King_L_20150416_email-attach-121
Organization: Western Environmental Law Center
Commenter: Laura King

Comment Excerpt Text:

To mitigate impacts from heavy truck traffic, reduce the potential for water contamination, minimize air and noise pollution, and protect wildlife, we recommend a phased development alternative.

Staged or phased development clusters drilling geographically to maintain open areas; i.e., concentrated development that proceeds in stages in smaller areas rather than all at once. Such an alternative could include limitations on the number of drilling rigs operating in the Project Area at any one time, as well as interim surface reclamation measures to restore each site "to a pastoral landscape" before drilling a new site.

Comment No.:
503_WELC_King_L_20150416_email-attach-122
Organization: Western Environmental Law Center
Commenter: Laura King

Comment Excerpt Text:
Operators would be allowed to develop production in one geographic area at a time and, when complete, be permitted to move on to another area. W. Org. of Res. Councils v. Bureau of Land Mgmt., 591 F. Supp. 2d 1206, 1288 (D. Wyo. 2008). In certain instances, corridors could be left undeveloped to allow for wildlife management.

Comment No.:
503_WELC_King_L_20150416_email-attach-123
Organization: Western Environmental Law Center
Commenter: Laura King

Comment Excerpt Text:
Phasing in development could limit new well drilling and fracking to a rate similar to the historical rate for the area. According to Colorado Oil & Gas Conservation Commission data, Gunnison County has seen an average of two new wells drilled per year from 1997 to 2014. Colorado Oil & Gas Conservation Commission, Jan. 2015 Staff Report. By phasing in development, the BLM could require that only one drilling and fracturing job occur at any given time. Instead of operating numerous drilling rigs and numerous fracking operations, the BLM can require interim surface reclamation before an operator proceeds with developing new well pad sites. This will help reduce pollution and traffic, while preserving open space for wildlife.

Comment No.:
503_WELC_King_L_20150416_email-attach-33
Organization: Western Environmental Law Center
Commenter: Laura King

Comment Excerpt Text:
a Report released by NRDC identified that "[c]apturing currently wasted methane for sale could reduce pollution, enhance air quality, improve human health, conserve energy resources, and bring in more than $2 billion of additional revenue each year."(Susan Harvey, et al., Leaking Profits: The U.S. Oil and Gas Industry Can Reduce Pollution, Conserve Resources, and Make Money by Preventing Methane Waste (March 2012) (attached as Exhibit 47).) Moreover, the Report further identified ten technically proven, commercially available, and profitable methane emission control technologies that together can capture more than 80 percent of the methane currently going to waste. Id. Such technologies must also be considered in BLM's alternatives analysis.

Comment No.:
503_WELC_King_L_20150416_email-attach-38
Organization: Western Environmental Law Center
Commenter: Laura King

Comment Excerpt Text:
Convincing evidence also exists to support the consideration of alternatives that would attach meaningful stipulations to areas open to oil and gas leasing, above and beyond the steps taken by the agency, here. As a prime contributor to short-term climate change over the next few decades, methane is a prime target for near-term GHG reductions. In fact, there are many proven technologies and practices

already available to reduce significantly the methane emissions from oil and gas operations, further detailed below. These technologies also offer opportunities for significant cost-savings from recovered methane gas.

Comment No.:
503_WELC_King_L_20150416_email-attach-39
Organization: Western Environmental Law Center
Commenter: Laura King

Comment Excerpt Text:
BLM should evaluate these technologies, analyzing the benefits of technological implementation versus current agency requirements

Comment No.: 572_Peters_A_20150415_hard-1
Commenter: Anthony Peters

Comment Excerpt Text:
I would like to see the BLM require this baseline and ongoing testing to insure that the air and water in our valley is is not being compromised due to these extraction activities.

Comment No.: Form_CHC-1

Comment Excerpt Text:
BLM's proposed alternatives do not include a conservation-minded alternative. I believe that BLM needs to consider a separate alternative that includes critical mitigation measures such as "phased development" (controlling the timing, pace, and location of new development and requiring interim reclamation), enhanced 1,000-foot setbacks for new well locations from water bodies, and increased air pollution controls (e.g. no-bleed and low-bleed pneumatic devices, green completions, and closed-loop drilling systems).

Comment No.: Form_CHC-2

Comment Excerpt Text:
BLM should require mandatory baseline surface water sampling and ongoing monitoring, collection of baseline air samples prior to development, and ongoing air monitoring to test for chemicals related to drilling and fracking operations, like methane, volatile organic compounds (VOCs), and polycyclic aromatic hydrocarbons (PAHs).

Summary

The DEIS should include a conservation alternative, which would include many of the following:

- Phasing development through geographic locations, meaning developing in one geographic area within the Bull Mountain Unit, finishing, and then moving development into another area in the Unit
- Phasing development through timing beyond the proposed six-year development timeframe
- Limit the number of drilling and fracturing jobs to one at any given time
- Installing enhanced 1,000-foot setbacks from water bodies, and reconsidering, not eliminating, a 500-foot setback
- Requiring air pollution controls, such as non-bleed pneumatic devices, green completion, and closed-loop drilling systems, and methane emission control measures
- Reducing the number of truck trips
- Making road improvements paid for by SGI
- Conducting baseline air and water sampling
- Requiring higher bonding
- Limiting water use
- Including all of Alternative C's fish and wildlife and water protections

Commenters also requested additional changes to consider including limiting development to the 11 recently developed pads already in the area.

Response

The BLM has addressed many elements of the commenters' "Conservation Alternative" in other sections of this report: the setback requirement is addressed in **Section 8.2**, Water, of this Response to Comments; baseline air monitoring is addressed in **Section 8.1,** baseline water quality in **Section 8.2**; bonding in **Section 1**, and the socioeconomic effects analysis in **Section 5.14**.

Some measures have been included in the Alternative D, the Preferred Alternative, such as the additional air quality measures (including green completion, closed-loop drilling, etc.), remote monitoring requirements to reduce truck traffic to, from, and in the Unit, additional wildlife protections, and additional timing limitations; see Appendix C and the wildlife habitat plan for details.

Highway improvements are outside the scope of this document because they are under the authority of the responsible state or county highway department.

Considering additional phasing time frames to extend the drilling horizon past the estimated six-year window was considered and eliminated; see **Section 2.3.2** of the Final EIS. Limiting the number of drilling jobs to one at any given time would extend the drilling in the project area to 16 – 18 years, well beyond the estimated 6 years. Phasing development through geographic locations was considered in Alternative C and the analysis for such movements are presented in Chapter 4, Environmental Consequences. There are also requirements for BLM and SGI to meet on an annual basis to discuss the results of monitoring and development activities which is an opportunity to plan for the next year's operations and any new or additional reclamation actions needed to mitigate impacts seen from the year's previous activities.

Limited water use through waterless fracturing is discussed in **Section 4.2.4**, Water Resources.

Limiting all 146 gas wells and four water wells to the existing 11 pads is economically unfeasible and would not allow SGI adequate distribution across the geologic resource to fully develop their leases.

Section 3.4.3 – Alternative that does not include Landslide Risk

Total Number of Comments: 1

Comment No.:	Comment Excerpt Text:
503_WELC_King_L_20150416_email-attach-55 Organization: Western Environmental Law Center Commenter: Laura King	Third, the BLM entirely ignores the possibility of an alternative that does not involve high landslide risk (e.g. a sensible alternative that avoids siting well pads on old landslides).

Summary

The Draft EIS should have an alternative that does not include a high risk of landslides.

Response

The Draft EIS Section 4.2.5, Geology, is an analysis of mitigation measures that would be used to monitor and address impacts and risks associated with geological hazard areas. These measures were incorporated into Alternative D, the Preferred Alternative. When an APD is submitted for a specific well site, the BLM reviews it for many factors, including the location's position in or near areas of geologic hazard. At the time of the on-site inspection, if the BLM determines that the area is a high risk landslide zone, then it may require SGI to mitigate the risks and impacts.

Section 4 - Best available information and/or Baseline Data

Section 4.1 - Air resources

Total Number of Comments: 9

Comment No.: 056_CDPHE_cmt_respons2b-1
Organization: Colorado Department of Public Health and Environment

Comment Excerpt Text:
The Division did not see where dehydrator emissions are accounted for in the emissions inventory for this EIS. Page 2-25 states, "Dehydration facilities to separate water from natural gas would be centralized at compression facilities". The Division requests that these emissions be added to the inventory or that clarification as to how dehydration emissions from these facilities are accounted for be included.

Comment No.: 071_Coleman_F_21050407_email-1
Commenter: Frank M. Coleman

Comment Excerpt Text:
The SGI project is located in proximity to a number of officially designated wilderness areas (Black Canyon of the Gunnison, West Elk, Snowmass, Maroon Bells, Dominguez Canyon, Gunnison Gorge). Therefore, a baseline study of air quality must be made in advance of the actual conduct of fracking activities. This should be followed up by a regular, systematic study of contaminants identified by the Clean Air Act (CAA). Among these contaminants are, at a minimum, S02, N0x, PM10, VOC's, PAH's

Comment No.: 139_Hilberman_M_20150328_email-2
Organization:
Commenter: Mark Hilberman

Comment Excerpt Text:
The impact of methane leakage is mysteriously not considered in section 3.2.1 on Air Resources which is an outdated listing of air quality issues in light of climate change. On page 3-18 the atmospheric lifetime of methane (decades) and carbon dioxide (centuries) are misstated as "years".

Comment No.: 188_McGuire_E_20150415_email-3
Organization: Desert Weyr, LLC
Commenter: Eugenie McGuire

Comment Excerpt Text:
VOCs and PAHs
There are no baseline measurements and information about the current level of volatile organic compounds in the air and water. The draft EIS does not require mandatory baseline surface and underground water sampling and ongoing monitoring. The chemicals used in the drilling and fracking operations, like methane, volatile organic compounds (VOCs), and polycyclic aromatic hydrocarbons (PAHs) are known to cause significant harm to humans, plants and animals.

Comment No.: 293_Soule_M_20150413_hard-1
Commenter: Michael Soule

Comment Excerpt Text:
Accomplish new and review past baseline environmental studies and surveys to document past and present conditions of all potentially affected habitats and environments, surface and sub-surface. Notably, please plan for preventing and mitigating the potential atmospheric impacts of the MDP that could or should be mitigated, particularly those development related impacts that would exacerbate emissions of greenhouse gases such as carbon dioxide and methane

Comment No.:
503_WELC_King_L_20150416_email-attach-10
Organization: Western Environmental Law Center
Commenter: Laura King

Comment Excerpt Text:
The DEIS's analysis of ozone fails to meet the most basic threshold of rational analysis by omitting the most recent air-quality data. The MDP DEIS presents a background concentration for ozone of 141 micrograms per cubic meter, or 72 ppb. See DEIS at Table 3-3. However, more recent data from ozone monitors in the region indicate that ozone levels are already exceeding the NAAQS of 75 ppb. See Appendix A at 7. Recent monitored concentrations closest to the proposed development (in Rifle and Gothic) are especially concerning, as they are significantly above the level of NAAQS. See id. at 7-8.

Comment No.:
503_WELC_King_L_20150416_email-attach-11
Organization: Western Environmental Law Center
Commenter: Laura King

Comment Excerpt Text:
EPA's proposal to revise ozone standards, as well as the science supporting the revision, must be considered by BLM in its preparation of the EIS for the Bull Mountain MDP. As noted above, existing ozone concentrations in the project area would not meet the proposed standards of 65-70 ppb even assuming the outdated monitoring data provided in the DEIS. See DEIS at Table 3-3 (reporting background concentration of 72 ppb). Moreover, recent monitoring shows ozone concentrations in the region that significantly exceed the higher end of the range of the proposed standards. See Appendix A at 7. Monitors in Rifle and Gothic, closest to the proposed development, have recorded ozone levels significantly above the level of the NAAQS. See id. (reporting background concentrations of 107 and 81, respectively). Additionally, recently recorded maximum 8-hour average ozone concentrations at three monitors in the air quality study area exceed 100 ppb. The DEIS fails to account for the EPA's proposed revision of ozone standards, fails to consider the most recent relevant air quality data, and neglects to address and consider that the impacts of climate change will worsen ozone pollution.

Comment No.:
503_WELC_King_L_20150416_email-attach-12
Organization: Western Environmental Law Center
Commenter: Laura King

Comment Excerpt Text:
the CARPP framework should be used as a tool by the agency for its consideration in the Bull Mountain MDP. Evaluation of the overarching purpose, scope and responsibilities under the CARPP (Section I) requires analysis of how the CARPP relates to the Bull Mountain MDP and the BLM's authority under NEPA, which UFO failed to provide.

Comment No.:
503_WELC_King_L_20150416_email-attach-24
Organization: Western Environmental Law Center
Commenter: Laura King

Comment Excerpt Text:
the BLM includes no estimate of the projected methane emission rates from drilling and production activities authorized by the proposed action and no analysis of measures employed to mitigate such emissions. The BLM merely notes that methane emissions from drilling and production activities were inventoried, but does not disclose the inventory. DEIS at 4-17; J-2-1.

Summary

- The BLM should include dehydrator emissions in emissions inventory or explain how they were accounted for.

- The BLM needs to have baseline study of air quality completed before development.
- The BLM needs to show current baseline conditions and to cite relevant and credible studies for baseline conditions.
- The BLM needs to consider methane leaks in affected environment.
- The BLM needs to use more recent baseline ozone monitoring data.
- The BLM needs to consider the EPA's proposed ozone standards changes in the Final EIS.
- The BLM needs to address the CARPP and how it can be used in the EIS analysis.
- The BLM needs to disclose the methane emission inventory data in the EIS.

Response

There are no well site or centralized facility dehydrators proposed in any of the alternatives at this time. However, the air analyses performed for the Final EIS are adequate in disclosing the maximum pollutant impacts from the Bull Mountain project even if the operator proposed dehydration facilities in the field at a later date. The emissions of concern from dehydration facilities would be primarily volatile organic compound (VOC) and hazardous air pollutant (HAP) emissions, with minor combustion emissions (nitrous oxide [NOx] and carbon dioxide [CO)] from dehydrator heaters. The CARMMS project results were used to disclose potential regional ozone formation for the project. Regional VOC emissions modeled for the CARMMS project in the vicinity of the Bull Mountain project area are much larger than the project field-wide and other nearby project VOC emissions; therefore the predicted impacts on potential ozone formation in the area are conservatively disclosed. The primary HAP of concern determined for the project is formaldehyde, and the maximum impacts occur from compressor stations. Potential NOx emissions occurring from dehydrator heaters would be minimal. Analysis indicates that any increase in overall field-wide emissions would be controlled by the air quality conditions of approval that are listed in the EIS.

VOC and HAPs concentrations are currently monitored in an area of Garfield County, Colorado that has much higher oil and gas operations than currently exists in the Bull Mtn. Unit project area. These Garfield County values can be used to assess "existing conditions" for areas of western Colorado oil and gas operations or future conditions for areas that are not currently developed for oil and gas. These VOC / HAPs monitored concentrations for recent years 2013-2014 show concentrations below acceptable thresholds (RELs, RfCs) and within acceptable cancer risk ranges. Adding these existing conditions to modeled values for future Bull Mtn. Unit oil and gas development also result in acceptable concentrations. For the BLM CARMMS, baseline and future year modeling was conducted for oil and gas growth in the region to describe potential air quality changes. As shown in the EIS and CARMMS report, overall air quality conditions (urban ozone, visibility, etc.) are expected to improve from baseline conditions; these findings are also consistent with other regional modeling studies. As part of the CARPP and briefly described in the EA for the proposed action, the BLM continuously monitors / evaluates oil and gas development in the region to verify whether actual current and future oil and gas development and cumulative emissions rates are consistent with the annual emissions rates modeled in studies and analyses (CARMMS, etc.). The CDPHE, having the regulatory authority, sets additional Colorado-specific oil and gas regulations / requirements beyond federal mandated regulations; any new future Bull Mtn. Unit oil and gas development / operations would be subject to the new CDPHE requirements that focus on controlling VOC, HAPs and methane emissions. The EIS provides CARMMS results for the maximum impact source apportionment contributions (for PM2.5, ozone, etc.) for new UFO federal oil and gas (oil and gas developed year 2012 - 2021) and these information is relevant regardless of the

standard levels and attainment designation for the area; it is fair to say that future UFO federal oil and gas contribution (~ 0.8 ppb) is small compared to current ozone standard range (60-70 ppb). The CARMMS analysis for the EIS is based on the current ozone standard. Future authorization of Bull Mtn. Unit oil and gas will rely on the air quality impacts analysis completed for the EIS and will consider future changes in ozone air quality standards at that time.

Current baseline air quality data (background data) for criteria pollutants (CO, NOx, sulfur dioxide [SO2], PM_{10} and $PM_{2.5}$)[1] used in the air analyses were determined by the CDPHE and disclose baseline conditions for the project.

Methane leaks were accounted for in the project emissions inventory. See the detailed emissions inventory provided in the Air Quality Technical Support Document (Appendix J); these emissions are included as "well production fugitive emissions."

The monitored background ozone data provide in the EIS was provided by the CDPHE and disclose the ozone concentrations in the vicinity of the project. Since release of the Draft EIS, the EPA has released new ozone National Ambient Air Quality Standards (NAAQS); BLM has reviewed and updated the information in Chapter 3, Affected Environment, and Chapter 4, Environmental Consequences, to address this new standard and discuss what it means in the Bull Mountain project analysis. See **Section 4.2.1**, Air Resources, in the Final EIS.

The CARPP is a protocol document that provides information and description of the tools, datasets and analyses that are used for conducting BLM Colorado air quality assessments. The CARPP's components include the CARMMS and the development of project-specific emissions inventories for air quality impacts analyses. For the Bull Mtn. EIS, project-specific emissions inventories were developed for each project-level air quality impacts analysis (near-field and far-field) and the CARMMS was used to assess potential cumulative air quality impacts. The CARPP also describes that potential air quality mitigation could be imposed on project-specific sources / actions should project-specific air quality impacts analysis suggest the need for additional mitigation (beyond State and Federal regulations).

As shown in the EIS, additional mitigation measures are being considered by the BLM to protect air quality/air quality related values. The additional AQRV mitigation measure (unit-wide NOx emissions limit) was developed using the CALPUFF modeling results for low and high NOx emissions scenarios for the Alternatives (No-Action and Proposed-Action). For the high emissions scenario, the Forest Service found the NOx impacts to nitrogen deposition to be unacceptable as compared to USFS project-level threshold; however, they found the low emissions scenario acceptable. Therefore, the unit-wide NOx emissions limit to mitigate nitrogen deposition impacts was set to the low NOx emissions scenario value for the Unit. Operation under the low Unit-wide NOx emissions limit could reduce potential for local ozone formation and would also reduce NOx contribution to visibility degradation for the nearby Class I / sensitive Class II areas.

The methane emissions inventory is disclosed in detail in the AQTSD. Project-wide methane emissions are included in the total carbon dioxide equivalent (CO_{2e}) emissions that are reported in the greenhouse gas (GHG) sections of the EIS. Current EPA guidance advises that GHG emissions be reported as CO_{2e}.

[1] PM_{10} and $PM_{2.5}$ refer to particulate matter that is 10 microns and 2.5 microns or smaller in diameter.

Section 4.2 - Water

Total Number of Comments: 4

Comment No.: 482_SGI_Gordy_S_20150416_email-attach-36
Organization: SG Interests I, Ltd.
Commenter: Shaun Gordy

Comment Excerpt Text:
The methodology BLM employed to calculate concentrations of chemicals in water is inaccurate because it appears to have excluded samples where no chemicals were detected. DEIS at 3-42. This understates SG's water quality tracking program. The DEIS should be revised to include all samples to more accurately depict water quality, and SG's commitment to monitor and protect water quality, within the Bull Mountain Unit.

Comment No.: 482_SGI_Gordy_S_20150416_email-attach-63
Organization: SG Interests I, Ltd.
Commenter: Shaun Gordy

Comment Excerpt Text:
The DEIS should also clarify the specific source of sedimentation in the Paonia Reservoir. This is a potentially material fact omitted from discussion of sedimentation issues with the Muddy Creek. DEIS at 3-30.

Comment No.: 482_SGI_Gordy_S_20150416_email-attach-64
Organization: SG Interests I, Ltd.
Commenter: Shaun Gordy

Comment Excerpt Text:
The DEIS also includes a discussion of impacts to water-related resources that does not reference any scientific literature. The DEIS should clarify the sources relied upon to make the following statements:

Alluvial aquifers 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. DEIS at 3-35.

Fractures in rocks might be capable of conducting fresh water to greater depths. DEIS at 3-36.

The quality of produced water wells and the amount of produced water and drilling fluids that remains underground after completion is relevant to assessing health impacts. DEIS at 4-179.

There is some evidence that sedimentation rates have accelerated over the years. DEIS at 3-26.

Comment No.: 554_EPA_Strobel_P_20150415_hard-3
Organization: EPA
Commenter: Philip S. Strobel

Comment Excerpt Text:
The EPA asks that the BLM reference and base analysis on the latest available information, which would be the 2012 CDPHE 303(d) Impaired Waters List. It appears that some new waterbody segments within the 3 analysis area are either on the 2012 Monitoring & Evaluation List or are on the 303(d) list. Additionally, EPA requests that BLM list out the specific waterbody segments using CDPHE's unique ID numbers, which will easily cross-reference the CDPHE 2012 303(d) list. If the 2012 list identifies impaired waters not identified by the 2010 list, we recommend a minimum of a 7 50-foot no surface occupancy (NSO) setback for those impaired stream segments.

Summary

The BLM should update the baseline information presented in the Affected Environment by more accurately describing the current baseline water monitoring program and data, why BLM did not include the non-detection data in the analysis, identifying the source for Paonia Reservoir sedimentation, providing citations for the sources that several statements are based on, and updating the listed impaired waters with more recent datasets.

Response

The BLM used water monitoring data provided by SGI which included over 70 files indicating water quality testing results and test points throughout the project area. All of this information was analyzed and presented the information in Chapter 3. BLM obtained analytical results of baseline water quality monitoring conducted to date. However, although many of the data are in digital form, many of the results have not yet been entered into the electronic database. This makes it difficult to perform statistical analyses, to make comparisons among samples, or to evaluate termporal or spatial relationships. Until the data are compiled into an electronic database, it will be difficult to describe and interpret the data. Furthermore, the purpose of the particular analytical suites that have been run in the past was not clear; therefore, BLM was unable to definitely state why non-detection data did or did not appear in the datasets.

No new data were provided in public comments or by SGI during review of the Draft EIS, and the BLM reviewed other sources of potential data (such as US Geological Survey [USGS] and COGCC records); to date, none of the sources have provided better or more complete data than what was used in the Draft EIS. Therefore, the BLM determined that these data are the best available at this time. If new or additional baseline data are provided at a later date, then the BLM would consider it in future NEPA analysis for this project (i.e., when reviewing APDs submitted for Bull Mountain Unit wells).

Section 3.2.4, Water Resources, under *Trends* identifies the source of sedimentation into Paonia Reservoir from the high erosion rates along the west slope of the Raggeds and transported by Muddy Creek.

The Final EIS was updated to reflect the 2012 stream segments data.

The Final EIS was updated to include appropriate citations to statements in the affected environment.

Section 4.3 - Geology

Total Number of Comments: 3

Comment No.: 025_Berry_K_20140319_email-1
Organization: Member of Citizens for a Healthy Community
Commenter: Elena Goldstein

Comment Excerpt Text:
I am writing to you as a member of the board of Citizens for a Healthy Community, based in Paonia. Jim Ramey, our Executive Director, has been in touch with you in the past.
CHC is currently concerned about a proposed fracking project at Bull Mountain north of Paonia, off Highway 133. The unstable geology of the area has been brought to our attention by Mr. Shawn LaBounty at a BLM hearing and in the letter I have included below.

Would you advise us on what action we might take to bring in some experts on this matter?

Comment No.: 123_Goldstein_E_20150402-1
Organization:
Commenter: Elena Goldstein

Comment Excerpt Text:
I have been in touch with Karen Berry, the State Geologist and Director of the Colorado Geological Survey who has suggested I check in with you to make sure you are aware of their hazard and landslide maps of the Bull Mountain area.
Here's the link.
http://cgsmaps.state.co.us/colorado_landslide_inventory/
I would appreciate acknowledgement that you have received this email.

Comment No.: 334_WElkScenicByway_Hoffmann_J_20150302_email-attach-4
Organization: West Elk Loop Scenic and Historic Byway
Commenter: John Hoffmann

Comment Excerpt Text:
Locating wells on the unstable Alluvial Terraces and Colluvial Deposits locations may be exacerbated by the proposed waste water injection wells (4 requested). Injection wells have been proven to lubricate and pressurize strata and initiate earth temblors up to magnitude 5.7. See studies from Rocky Mountain Arsenal (1962-1966) and Chevron's Colorado Oil Fields experiments (1967-69) where intensity and frequency of quakes can increase from the pressure and frequency of such injections. There are a variety of examples including:
(1) Raton Basin 2001-present, magnitude 5.3 in August 2011;
(2) Dallas-Fort Worth October 2008-May 2009, several magnitude 3.3 quakes;
(3) Prague Oklahoma, November 6 2011, magnitude 5.7 destroying 14 homes;
(4) Youngstown Ohio, December 31, their first recorded quake at magnitude 4.0; and
(5) Cogdell Oil Field, Snyder Texas, 2006-2011, a series of 90 quakes, one at magnitude 4.4, two years after starting CO2 injections.

Summary

The Colorado Geological Survey has hazard and landslide maps of the Bull Mountain area, and the maps and unstable geology in general should be considered. Unstable geology, combined with injections wells, can lead to earthquakes; five examples were given.

Response

The Colorado Geological Survey does not have maps, as described in the comment. All available information from the Geological Society and BLM experts has been used in the Final EIS. Geologic mapping has been done outside the area of the Bull Mountain Unit, but no geologic hazard mapping of the Unit was available for inclusion in the affected environment of this EIS.

Site-specific geological engineering will be done for each APD and pad location when the permit is submitted to the BLM. The BLM will review and analyze the information at that time and apply appropriate conditions of approval to minimize hazards.

Section 4.4 - Vegetation

Total Number of Comments: 1

Comment No.: 482_SGI_Gordy_S_20150416_email-attach-71
Organization: SG Interests I, Ltd.
Commenter: Shaun Gordy

Comment Excerpt Text:
The DEIS should likewise eliminate the confusing reference to the Colorado Natural Heritage Program Natural Communities. DEIS at 3-55. The DEIS acknowledges that there are no natural communities considered to be rare or pristine associations within the Bull Mountain Unit and that the closest community is 4 miles away. The DEIS should clearly indicate that there is no potential impact to these natural communities or remove the discussion entirely.

Summary

The Bull Mountain Unit does not have any Colorado Natural Heritage Program natural communities considered to be rare or pristine associations; the affected environment should be updated to reflect this.

Response

The BLM agrees that the section was unnecessary and therefore deleted it from the Final EIS.

Section 4.5 - Special status species

Total Number of Comments: 1

Comment No.: 482_SGI_Gordy_S_20150416_email-attach-39
Organization: SG Interests I, Ltd.
Commenter: Shaun Gordy

Comment Excerpt Text:
The DEIS provides a discussion of the canyon treefrog. DEIS at 3-87. BLM should clarify that the project area is out of range of this species or provide evidence of its occurrence.

Summary

The Bull Mountain Unit does not have any occurrences of the canyon tree frog; the affected environment should be updated to reflect this.

Response

The list Table 3-33 includes all species found on the BLM special status species list, but also noted is that many of the species in the list are not found in the project area; therefore, no change was made to the Final EIS.

Section 4.6 - Visual resources

Total Number of Comments: 1

Comment No.: 482_SGI_Gordy_S_20150416_email-attach-55
Organization: SG Interests I, Ltd.
Commenter: Shaun Gordy

Comment Excerpt Text:
The DEIS represents that BLM possesses legal authority to manage visual resources private surface estates that overlie federal minerals. DEIS at 3-101. No legal citation was provided with this statement and SG seeks clarification on this point.

Summary

The Draft EIS implies that the BLM has authority over visual resources on non-BLM surfaces. Please provide a reference.

Response

As noted previously under Section 2, Jurisdiction and Authority, Onshore Order 1 addresses the BLM's responsibilities on federal leases overlain by private surface (split-estate). The BLM regulates exploration, development, and abandonment on federal leases on split-estate lands in essentially the same manner as a lease overlain by federal surface. While a private landowner's wishes should be considered in decisions, BLM must follow applicable statutory requirements.

Section 4.7 - GIS data and analysis

Total Number of Comments: 2

Comment No.: 482_SGI_Gordy_S_20150416_email-attach-22
Organization: SG Interests I, Ltd.
Commenter: Shaun Gordy

Comment Excerpt Text:
The map on page 4-97 is missing the Jacobs and Borich wells.

Comment No.: 482_SGI_Gordy_S_20150416_email-attach-24
Organization: SG Interests I, Ltd.
Commenter: Shaun Gordy

Comment Excerpt Text:
The calculation of roads used in Alternative B, depicted in the map on 3-118, is incorrect. The map shows redundant and dead-end routes and it identifies non-existent roads (e.g., County Road 77 does not exist in section 8 and the road past Hughes 26-2 does not currently exist).

Summary

The map on page 4-97 is missing the Jacobs and Borich wells. The calculation for road miles is incorrect, including many redundant roads, dead-end roads, and roads that do not exist.

Response

Jacobs 29-1 is displayed on Chapter 3, Affected Environment, on the Existing Infrastructure figure. Borich 11-89-32-1 is displayed as proposed on Chapter 2, Alternatives, on the Alternative A figure. Both are displayed on Chapter 4, Environmental Consequences, cumulative impacts figures.

Based on revised road data provided by SGI, the maps and calculations have been updated to better reflect current existing infrastructure and proposed access routes into well pads.

Section 5 - Direct - Indirect Impacts

Section 5.1 - General methodology, assumptions (not related to a specific resource)

Total Number of Comments: 3

Comment No.: 482_SGI_Gordy_S_20150416_email-attach-45
Organization: SG Interests I, Ltd.
Commenter: Shaun Gordy

Comment Excerpt Text:
The DEIS states that development of Alternative A would take place over approximately three years. DEIS at 4-63. BLM should clarify how it made that determination. As discussed in detail, the scope of development under Alternative A is consistent with development contemplated under Alternative B. Development under Alternative A would continue indefinitely consistent with SG's rights under valid, existing leases.

Comment No.: 482_SGI_Gordy_S_20150416_email-attach-6
Organization: SG Interests I, Ltd.
Commenter: Shaun Gordy

Comment Excerpt Text:
In portions of the analysis, the DEIS correctly acknowledges that under the status quo, SG would submit application for permits to drill ("APDs") and BLM would review and analyze each APD individually (without the ability to tier to a programmatic NEPA analysis). In other portions of the analysis, particularly Chapter 4, the DEIS implies that selection of Alternative A would preclude development of federal leases and SG would develop only non-federal mineral rights. That implication is incorrect. The DEIS should clarify that selection of the no action alternative does not preclude SG from developing federal mineral rights.

Comment No.: 482_SGI_Gordy_S_20150416_email-attach-76
Organization: SG Interests I, Ltd.
Commenter: Shaun Gordy

Comment Excerpt Text:
The DEIS advances a number of operational assumptions that are unsupported or not explained in the record. Among other provisions, the record lacks any discussion providing scientific and objective support for each of the following statements:

Waterless fracturing is a viable technology for development of wells within the Bull Mountain Unit. DEIS at 4-84. Waterless fracturing has been

unsuccessful in practice in many basins (SG has tried this method in the past) and the company that pioneered the technology has gone bankrupt.

Use of a centralized facility outside of Reduced Winter Activity Areas would reduce wildlife impacts. DEIS at 4-118. The DEIS does not include any discussion of which species would benefit from centralized production facilities or how such facilities would benefit those species. A centralized production facility, whose size and impacts are unspecified, could easily cause as many impacts as it is designed to reduce.

A closed loop system greatly reduces water use. DEIS at 4-86. An efficiently managed conventional drilling system can operate using similar quantities of water as a closed loop version.

Assumption that water for operations would be obtained between April and July. DEIS at 4-86. SG's ability to obtain water will be impacted by the provisions in the Augmentation Plan.

Injected fluids have the potential to migrate to shallow ground water. DEIS at 4-181. There is no peer-reviewed scientific support for concluding that injected fluids can migrate to shallow ground water.

Produced water injected into underground control wells will contain soil, grease, inorganic and organic additives. DEIS at 4-180. Produced water does not contain grease or inorganic and organic additives.

The severity of operational impacts would vary depending on surface ownership. DEIS at 4-167.

SG would focus on private development if BLM rejects the MDP, causing a greater development of private wells. DEIS at 4-160 to 162. As explained above, although adopting Alternative A will have little or no effect on the scope of mineral development that takes place, it will have important consequences for BLM's ability to ensure meaningful environmental review.

Summary

The Draft EIS has numerous analysis assumptions that need to be clarified or substantiated with citations.

Response

The explanation for the assumption of 27 wells per year and the average of years assumed under each alternative and the note that federal mineral development would continue under Alternative A is provided in Section 3.1 of this Response to Comments. The remaining assumptions have been clarified and are explained in Section 5.17 of this report.

Section 5.2 - Air resources

Total Number of Comments: 26

Comment No.: 189_Mcguire_K_20150415_email-2
Organization: Weyr Associates, LLC
Commenter: Kenyon McGuirer

Comment Excerpt Text:
The EIS indicates that over 43,000 truck trips will be required by this project. This huge increase in traffic will discourage visitors from coming to our valley and directly affect our income. In addition these trucks will be spewing exhaust and fumes that will impact the air quality. The BLM has not considered the full impacts of those trips and is ignoring how it will impact the scenic views that our valley is known for.

Comment No.:
213_NPS_McCoy_C_20150303_email-attach-1
Organization: National Park Service
Commenter: Mike George

Comment Excerpt Text:
We believe it is imperative that the air quality Conditions of Approval (COAs) upon which the air analysis assumptions are predicated, listed on pages 4-60 and 4-61 of Section 4.2.1, Air Quality, are incorporated into Appendix C along with the other COAs for this proposal. We note that they currently are not incorporated in the list of COAs in Appendix C.

Comment No.:
213_NPS_McCoy_C_20150303_email-attach-2
Organization: National Park Service
Commenter: Mike George

Comment Excerpt Text:
However, we are concerned that the air quality COAs are not reflected elsewhere in the document. Table 2-10 summarizes the COAs to be implemented by Alternative. This table states that all COAs incorporated into Appendix C, Best Management Practices and Conditions of Approval, are to be Implemented under both action Alternatives (Alternatives B and C). The air quality COAs listed in the Environmental Consequences section on pages 4-60 and 4-61 of Section 4.2.1, Air Quality are not included in Appendix C.
To ensure these measures are incorporated into the final Record of Decision, and eventually implemented in APDs, Appendix C needs to be revised to include the air quality COAs. If this issue is rectified, we believe the COAs are appropriate to mitigate air resource issues and concerns.

Comment No.:
213_NPS_McCoy_C_20150303_email-attach-3
Organization: National Park Service
Commenter: Mike George

Comment Excerpt Text:
The air quality mitigation measures listed in the Environmental Consequences section on pages 4-60 and 4-61 of Section 4.2.1, Air Quality require the operator to submit a detailed Unit-wide Equipment Configuration Plan and a Well-pad Development Phase Emission Inventory. These two plans should be reflected in the “Plans and Strategy Documents” section of Table 2-10, Stipulations and Conditions of Approval by Alternative.

Comment No.:
213_NPS_McCoy_C_20150303_email-attach-4
Organization: National Park Service
Commenter: Mike George

Comment Excerpt Text:
We recommend that the language is clarified in the following air quality COAs:
• The third COA listed, last sentence states “The goal of the requirement is for development (drill / completion / fracturing) related engines to emit no more than 1 gram per second of NOx total at anyone time (total of all engines operating concurrently), unless another NOx emissions rate can be demonstrated to achieve compliance with the N02I-hour NAAQS.” We recommend this statement is moved to the beginning of the COA language, as it summarizes the overall requirement. We also recommend that the term goal (in bold) is replaced with the term purpose, as this is a requirement, not a goal.

Comment No.:
213_NPS_McCoy_C_20150303_email-attach-5
Organization: National Park Service
Commenter: Mike George

Comment Excerpt Text:
The last COA states “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 kglha-yrJ 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 emissionsfit into the overall Unit-wide production phase (post construction and development) NOx emissions budget (approximately 143 tpy of NO x). " The meaning of the text in bold is unclear. As it appears this is the calculation method for determining compliance with the NOx emission cap, we recommend this statement is clarified.

Comment No.: 396_Frank_C_20150416_email-1
Commenter: Christine Frank

Comment Excerpt Text:
Natural gas consists mostly of methane, which is chemically reactive in the atmosphere and contributes to an increase in tropospheric ozone and stratospheric water vapor, which is itself a greenhouse gas. By changing the oxidizing capacity of the atmosphere, methane affects its own lifetime there. It also impacts the presence of sulfur dioxide and nitrous oxides, which influence aerosol formation and aerosol-cloud interactions. These factors affect Earth's albedo and the hydrological cycle in terms of the formation of water droplets and precipitation. Methane's impacts on the climate are huge and far reaching.
Airborne methane remains aloft for 12 years before being scrubbed out by atmospheric chemistry, reacting with hydroxyl molecules to form CO2 or water, whereas, carbon dioxide remains 30 to 95 years. Because of methane's tenfold shorter residence time in the atmosphere, its effect on global heating attenuates more rapidly. That is why it is given a specific time horizon in relation to its global warming effects. Over a 100-year timeframe, CH4 is 34 times as potent as CO2, but over 20 years it's 86 times more potent! Of all the anthropogenic greenhouse gases, methane contributes 40% of all radiative forcing. It's a big deal.

Comment No.:
400_GMUGNF_Armentrout_20150416_email-attach-1
Organization: USDA United States Department of Agriculture
Commenter: Scott Armentrout

Comment Excerpt Text:
• Tier 2 drill rigs and other mitigations listed on 4-60 should be included in Appendix C. Please address the effectiveness of these mitigations in reducing impacts on air. Also we understand that emissions limits have been developed, this should be included as part of the proposed action.

Comment No.:
424_Kolbenschlag_P_20150416_email-attach-2
Commenter: Pete Kolbenschlag

Comment Excerpt Text:
New data just keep piling up, like evidence of radon spikes in fracking zones—a matter the EIS neglected to consider, let alone take the requisite "hard look" at in a county with a known incidence of high radon levels. That seems problematic.

Comment No.: 482_SGI_Gordy_S_20150416_email-attach-82
Organization: SG Interests I, Ltd.
Commenter: Shaun Gordy

Comment Excerpt Text:
There is no data or analysis that would support a conclusion that nitrogen deposition impacts will be lower under Alternative C because the same number of engines would be used under Alternative C as under Alternative B. DEIS at 2-63.

Comment No.:
503_WELC_King_L_20150416_email-attach-135
Organization: Western Environmental Law Center
Commenter: Laura King

Comment Excerpt Text:
The MDP DEIS does not adequately analyze the air quality impacts that could occur as a result of the actions authorized under the MDP DEIS, therefore, failing to comply with the National Environmental Policy Act (NEPA) and the Federal Land Policy and Management Act (FLPMA). The air analyses included in the DEIS are not a comprehensive assessment of the environmental and public health impacts resulting from an increase in air pollution in an area already heavily impacted by the adverse effects of increasing development. Without such an analysis, the BLM cannot know what the impacts of the activities proposed in the MDP DEIS will be on air quality, human health and the natural environment or whether the BLM will prevent significant deterioration in air quality, as required by the Clean Air Act.

Comment No.:
503_WELC_King_L_20150416_email-attach-14
Organization: Western Environmental Law Center
Commenter: Laura King

Comment Excerpt Text:
To suggest that the agency does not, here, have to account for GHG pollution from oil and gas development authorized by the MDP, would be to suggest that the 13,340 acres of federal subsurface mineral estate in the Bull Mountain Unit is not relevant to protecting against climate change. This sort of flawed, reductive thinking would be problematic, and is contradicted by the agency's very management framework that provides a place-based lens to account for specific pollution sources to ensure that the broader public interest is protected. In discussing the project's climate change impacts, it is insufficient for the BLM to only frame the problem in global terms

Comment No.:
503_WELC_King_L_20150416_email-attach-17
Organization: Western Environmental Law Center
Commenter: Laura King

Comment Excerpt Text:
Second, the BLM may not decline to analyze the project's impacts on climate change merely because they are small in comparison to global emissions. As explained by the Council on Environmental Quality, in Revised Draft Guidance for Greenhouse Gas Emissions and Climate Change Impacts (See CEQ Draft Guidance.) at 9:

This approach [framing a project's emissions in global terms] does not reveal anything beyond the nature of the climate challenge itself: the fact that diverse individual sources of emissions each make relatively small additions to global atmospheric GHG concentrations that collectively have huge impact.

Accordingly, comparison of a project's emissions to global emissions "is not an appropriate basis for deciding whether to consider climate impacts under NEPA." Id.

Comment No.:
503_WELC_King_L_20150416_email-attach-18
Organization: Western Environmental Law Center
Commenter: Laura King

Comment Excerpt Text:
Third, it is ironic that BLM compares the project's emissions to the emissions from coalfired power plants since, in calculating the project's emissions, the BLM only considered construction and production emissions, but ignored combustion emissions (like those emitted from power plants).

Comment No.:
503_WELC_King_L_20150416_email-attach-19
Organization: Western Environmental Law Center
Commenter: Laura King

Comment Excerpt Text:

The BLM has effectively assumed a price of carbon that is $0 by failing to consider the social, economic, and environmental costs of leasing and development altogether. Failure to take these impacts into account violates NEPA by relying on a partially disclosed amount of GHG pollution from foreseeable oil and gas development, and fails to take the essential next step required for a hard look: disclosing the impacts that such pollution would have.

Comment No.:
503_WELC_King_L_20150416_email-attach-20
Organization: Western Environmental Law Center
Commenter: Laura King

Comment Excerpt Text:
the BLM fails to consider the indirect impacts of combustion, as NEPA and CEQ's climate guidance demands. This is a significant oversight, as the potential GHG emission impacts associated with the combustion of the produced natural gas appears to be substantial. The BLM does not disclose the amount of gas that is estimated to be produced (although this estimate is in the project record), incorrectly deeming this information proprietary. See DEIS at K-7.

Comment No.:
503_WELC_King_L_20150416_email-attach-21
Organization: Western Environmental Law Center
Commenter: Laura King

Comment Excerpt Text:
However, by taking the amount of natural gas produced within the Unit in 2012 from 9 wells (95,299,000 cubic feet), see DEIS at 2-25, extrapolating this figure to the 146 wells contemplated by the Bull Mountain MDP (amounting to 15,459,615,555 cubic feet), and using the emission factor for natural gas provided by the EPA,(U.S. Environmental Protection Agency, Clean Energy, Calculations and References, http://www.epa.gov/cleanenergy/energy-resources/refs.html. For natural gas, the EPA estimates carbon emissions to average 0.00536 metric tons per therm. One therm of natural gas equals approximately 100 cubic feet, thus carbon emissions would average 0.0000536 metric tons per cubic foot of natural gas combusted.) it appears that greenhouse gas emissions may approach 828,790 metric tons or more under the proposed action. See Table below. This is a large amount of GHG emissions that the DEIS does not analyze or assess. Moreover, the BLM does not consider other hydrocarbons that may be produced, nor take into account gas that is flared, vented, or leaked. Direct methane emissions released to the atmosphere are much more powerful than CO2 in terms of their warming effect on the atmosphere, see infra at B.4.b.

Comment No.:
503_WELC_King_L_20150416_email-attach-23
Organization: Western Environmental Law Center
Commenter: Laura King

Comment Excerpt Text:
The agency must take a hard look, and meaningful action, to address the serious issue of methane ("CH4") emissions and waste in the oil and gas production process. Such action must include an estimate of the projected methane emission rates from drilling and production activities authorized by the proposed action, as well as detailed analysis of measures employed to mitigate such emissions.

Comment No.:
503_WELC_King_L_20150416_email-attach-24
Organization: Western Environmental Law Center
Commenter: Laura King

Comment Excerpt Text:
the BLM includes no estimate of the projected methane emission rates from drilling and production activities authorized by the proposed action and no analysis of measures employed to mitigate such emissions. The BLM merely notes that methane emissions from drilling and production activities were inventoried, but does not disclose the inventory. DEIS at 4-17; J-2-1.

Comment No.:
503_WELC_King_L_20150416_email-attach-28
Organization: Western Environmental Law Center
Commenter: Laura King

Comment Excerpt Text:
Moreover, Colorado's CARPP, is a tool that can provide an important state-of-the-art resource to guide the agency's analysis of GHG mitigation measures applicable to the Bull Mountain MDP. In particular, Table

V-I identifies Best Management Practices and Air Emission Reduction Strategies for Oil and Gas Development, which displays some emission reduction measures, their potential environmental benefits and liabilities, and feasibility. As detailed above, the UFO's failure to consider and include the CARPP in its analysis is a significant omission, which could otherwise benefit the agency's consideration of mitigation measures, as here

Comment No.:
503_WELC_King_L_20150416_email-attach-34
Organization: Western Environmental Law Center
Commenter: Laura King

Comment Excerpt Text:
The UFO fails to even identify the issue of fugitive emissions and waste, much less provide a hard look analysis or enforceable mitigation requirements.

Comment No.:
503_WELC_King_L_20150416_email-attach-35
Organization: Western Environmental Law Center
Commenter: Laura King

Comment Excerpt Text:
In light of serious controversy and uncertainties regarding GHG pollution from oil and gas development the agency's quantitative assessment should account for methane's long-term (100-year) global warming impact and, also, methane's short-term (20-year) warming impact using the latest peer-reviewed science to ensure that potentially significant impacts are not underestimated or ignored.

Comment No.:
503_WELC_King_L_20150416_email-attach-36
Organization: Western Environmental Law Center
Commenter: Laura King

Comment Excerpt Text:
However, recent peer-reviewed science demonstrates that gas-aerosol interactions amplify methane's impact such that methane is actually 105 times as potent over a twenty-year time period.(Drew Shindell et al., Improved Attribution of Climate Forcing to Emissions, SCIENCE 2009 326 (5953), p. 716, available at: www.sciencemag.org/cgi/content/abstract/326/5953/716 (attached as Exhibit 55).) This information suggests that the near-term impacts of methane emissions have been significantly underestimated. See 40 C.F.R. § 1508.27(a) (requiring consideration of short and long term effects). Further, by extension, BLM has also significantly underestimated the near-term benefits of keeping methane emissions out of the atmosphere. 40 C.F.R. §§ 1502.16(e), (f); id. at 1508.27. These estimates are important given the noted importance of near term action to ameliorate climate change – near term action that scientists say should focus, inter alia, on preventing the emission of short-lived but potent GHGs like methane while, at the same time, stemming the ongoing increase in the concentration of carbon dioxide.(See, e.g., Limiting Global Warming: Variety of Efforts Needed Ranging from 'Herculean' to the Readily Actionable, Scientists Say, SCIENCE DAILY (May 4, 2010), available at: http://www.sciencedaily.com/releases/2010/05/100503161328.htm; see also, Ramanathan, et. al., (attached above as Exhibit 12).) These uncertainties –which, here, the agency does not address – necessitate analysis in the RMP and FEIS. 40 C.F.R. §§ 1508.27(a), (b)(4)-(5).

Comment No.:
503_WELC_King_L_20150416_email-attach-37
Organization: Western Environmental Law Center
Commenter: Laura King

Comment Excerpt Text:
inefficiencies and leakage in oil and gas production results in a huge amount of avoidable waste and emissions, and, conversely, a great opportunity for the UFO to reduce GHG emissions on our public lands.

Comment No.:
554_EPA_Strobel_P_20150415_hard-1
Organization: EPA
Commenter: Philip S. Strobel

Comment Excerpt Text:
The EPA recommends the BLM consider modifying the NOx mitigation measures in the following ways to ensure that the measures result in the BLM's intended outcome of not exceeding the 1-hour N02 NAAQS.

• The mitigation measure under the second bullet on page 4-60 is intended to protect the 1-hour N02 NAAQS during long-term production by limiting NOx emissions based on a ton per year emission level. We recommend that the mitigation measure instead be based on an hourly, or shorter, emission rate (i.e. lblhr) in order to assure it will be protective of the 1-hour standard.

• The mitigation measure under the third bullet on. pages 4-60 and 4-61 is also intended to protect the 1-hour N02 NAAQS by limiting well pad combined development NOx emissions to 1 g/s or less. However, the mechanism to meet this goal is proposed to be the use of Tier 2 engines, which may not limit well pad-wide NOx emissions to less than 1 g NOxls. We note that Appendix J reports a modeled 1-hour exceedance of281.9 micrograms per cubic meter (~g/m3) under Scenario 1 that is associated with the drilling scenario utilizing Tier 2 drill rigs. We also note that Tier 2 engines for drill rigs, hydraulic fracturing and completion activities may not be able to achieve a combined emission rate of 1 g NOx/s. Based on the estimated 11.9 lb NOx/hr Tier 2 emission rate in the emission inventory, we calculate an emission rate for a single drill rig engine of 1.5 g NOx/s. We request that the BLM ensure that the actual configurations for these activities do not exceed the 1 g NOx/s emission rate committed to through additional mitigation measures for Alternative C.

• We recommend that the above recommended NOx mitigation be applied to the construction phase as well, in addition to the post-construction/production phase. The emission inventory for this project included Tier 3 compliant emissions factors for diesel construction equipment (listed at 2.8 g NOxlhp-hr). The combined emissions from heavy diesel well pad equipment would result in an emission rate of0.7 g NOx/s based on assumptions in the emissions 2 inventory, which is below the 1 g NOxls emission rate committed to through additional mitigation measures for Alternative C during well development. Because the emissions inventory assumes the use of Tier 3 equipment and the resulting emission rate approaches the BLM's target rate, we recommend requiring the use of Tier 3 construction equipment to meet the 1 g NOxls limit for combined well pad emissions. Tier 3 diesel equipment may provide co benefits of reducing actual emissions of other pollutants, including hydrocarbons and hazardous air pollutants (HAPs).

Comment No.:
554_EPA_Strobel_P_20150415_hard-5
Organization: EPA
Commenter: Philip S. Strobel

Comment Excerpt Text:
Greenhouse Gas Emissions and Climate Change
We appreciate the summary discussion of climate change in the Draft EIS Chapter 3, as well as the inclusion of the GHG inventories for each ofthe alternatives in Chapter 4. We recommend that the Final EIS analyze GHG emissions and climate change consistent with the Council on Environmental Quality's (CEQ) December 2014 Revised Draft

Guidance for Federal Agencies' Consideration of GHG Emissions and Climate Change. Therefore, we suggest the following approach to augment the work already completed on the analysis of GHG emissions and climate change in the Final EIS:

• In the summary discussion of climate change and ongoing and reasonably foreseeable climate change impacts relevant to the project, incorporate information based on U.S. Global Change Research Program1 assessments to assist with identification of potential project impacts that may be exacerbated by climate change and to inform consideration of measures to adapt to climate change impacts. The Draft EIS currently references the Intergovernmental Panel on Climate 1 http://www.globalchange.gov/

4

Change (2007). Incorporation of current information from the U.S. Global Change Research Program will add valuable information to the Final EIS.

• We recommend that you do not compare the GHG emissions to total U.S. emissions, as this approach does not provide meaningful information for a project level analysis. Consider providing a frame of reference, such as an applicable Federal, state, tribal or local goal for GHG emission reductions, and discuss whether the emissions levels are consistent with such goals.

• Utilize the estimated GHG emissions as a reasonable proxy for climate change impacts when comparing the proposal and alternatives. In disclosing the potential impacts of the proposal and alternatives, consideration should be given to whether and to what extent the impacts may be exacerbated by expected climate change in the action area, as discussed in the "affected environment" section.

• Assess and identify measures to reduce GHG emissions associated with the project, including reasonable alternatives or other practicable mitigation opportunities, and disclose the estimated GHG reductions associated with such measures. Such measures could include consideration of renewable energy resources to address energy needs for compressor stations and other facilities.

The Final EIS alternatives analysis should, as appropriate, consider practicable changes to the proposal to make it more resilient to anticipated climate change. The EPA further recommends that the Final EIS and ROD commit to implementation of reasonable mitigation measures that would reduce or eliminate project-related GHG emissions.

Summary

The EIS needs to improve the discussion of air resources impacts analysis by expanding the greenhouse gas, climate change, and methane discussions; the analysis should be revised to incorporate the CARPP and new CEQ greenhouse gas guidance; modify the mitigation measures that were included in Alternative C; include combustion engines in the calculations of impacts; and better explain how applying the mitigation measures in Alternative C would result in the stated deposition reductions and improved visibility.

Response

The Final EIS was revised to update Appendix C to better reflect that Alternatives B, C, and D includes the air mitigation measures. The COA requiring 5 TPY or less of NOx emissions at each well-pad applies to production operations (post-construction / development) and therefore, these emissions would be associated with production / operation phase activities and equipment. Most (~ 92%) of operational phase well-pad NOx emissions for the proposed action were estimated to be associated with small pumping units located at the well pad that could operate year round (5 TPY year estimate assumed that these pumps would operate 8,760 hours per year). For any operation/activity, a maximum short-term hourly

emissions rate threshold would be equivalent to an annual TPY emissions threshold for equipment operating at the same hourly emissions rate year-round (~ 8,760 hours). Therefore, the 5 TPY threshold translates to a maximum hourly emissions rate threshold for well-pad operations. As described in the EIS for air quality related mitigation, additional analysis would be needed before authorizing future oil and gas development should emissions information for operator submitted APDs (based on actual refined oil and gas design plans) suggest that actual oil and gas development and associated emissions and projected air quality impacts at sensitive receptors (residences, etc.) would be unacceptable and above what was analyzed in the EIS analyses. This approach is in-line with the adaptive management scheme as described in the BLM CARPP. The current analysis for the Bull Mtn. EIS proposed action oil and gas development is still adequate and suffice considering the level of impacts that were predicted, the additional required mitigation that is being imposed and the probable over-estimates (equipment numbers and operation probably over-estimated, impacts predicted at locations where people do not readily occupy, etc.) that were associated with the analyses.

The Final EIS also includes more recent information on climate change and GHG emissions (from the BLM's Air Resources Technical Report for Oil and Gas Development, New Mexico, Oklahoma, Texas, and Kansas), following proposed guidance from the CEQ (January 2014, Draft Guidance for Federal Departments and Agencies on Consideration of Greenhouse Gas Emissions and the Effects of Climate Change in NEPA Reviews).

The draft CEQ GHG Guidance describes that the analysis to be prepared for any proposed action should be informed by the tools and information available to conduct the analysis. Currently, there are no acceptable methods to determine the level of GHG emissions that contribute to "significant" climate change impacts. Important factors would need to be considered to determine a proposed action's significant contribution to climate change including the overall net change in cumulative (global) GHG emissions for scenarios with and without proposed project approval and whether the resource (oil and gas) would be offset by new oil and gas development or increased production elsewhere. The draft CEQ Guidance also states that it is important to consider the investment of time and resources for analysis ensuring that the level of effort is reasonably proportional to the importance of climate change related considerations. The current EIS analysis provides quantified comparison of the proposed action's GHG emissions as compared to several contexts but is not able to quantify the change in impacts as they relate to climate change effects on the environment.

Regardless of whether these tools are available, we expect that emissions comparable to those related to the proposed project would be generated even if the BLM were to deny the proposal. Federal mineral estate in areas of Colorado including the DJ Basin (northeast Colorado) and Uncompahgre Field Office (Bull Mtn. Unit) are surrounded by private mineral ownership. Most proposed projects for these areas include private oil and gas development with requests to BLM for developing / extracting adjacent Federal minerals. For most projects, the private oil and gas development portion of a proposed project would occur regardless of BLM APD / project approval. As such, Federal minerals may be "drained" through the oil and gas development on nearby private mineral ownership adjacent to Federal minerals even if Federal minerals are not directly extracted. Therefore, non-approval of Federal mineral development may result in enhanced private mineral development. This means that direct impacts would be fewer if the No Action Alternative is chosen. However, cumulative impacts would be comparable as the actions are a combination of Alternative A and one of the action alternatives, although they would be spread over a longer time frame. Second, future oil and gas production and GHG emissions associated with the proposed Bull Mtn. Unit project is very small relative to future projected U.S. oil and gas production totals, small compared to future projected Colorado oil and gas production totals and even

small compared to future projected central-western Colorado oil and gas production / GHG emissions. At this size (146 natural gas wells), it is fair to say that oil and gas production for the proposed Bull Mtn. Unit well development would not impact the overall economic supply and demand relationship for natural gas. Further, if this proposal were denied, an alternative natural gas development project likely would occur to attain future natural gas supply at a 146-well scale with a marginal increase to gas development costs—essentially, the opportunity cost to industry of denying this proposal is the increased costs of developing the next best 146 well (or equivalent natural gas production) project. Based on these factors, it is reasonable to assume that cumulative / global GHG emissions both upstream and downstream would not differ regardless of the BLM approval of developing the Bull Mtn. Unit wells for the proposed action and would not have further importance to decision making at this level.

The current EIS for the proposed action Bull Mtn. Unit natural gas well development discloses projected GHG emissions totals for the proposed action and compares the GHG estimates to GHG emissions rates for a several Colorado-based power plants and a large scale U.S. GHG emissions inventory. The EIS also provides descriptions of some of the new CDPHE regulations that require additional methane emissions controls and monitoring applicable to the proposed project emissions sources. Based on the information described above, the current level of GHG emissions and climate change impacts analysis for the EIS is adequate and “reasonably proportional” for the proposed action Bull Mtn. Unit wells potential natural gas production and GHG emissions.

Section 5.3 - Noise

Total Number of Comments: 8

Comment No.: 089_Day_B_20150408_email-attach-4
Commenter: Bill Day

Comment Excerpt Text:
Night time wind speed and direction are more important in siting compressors than daylight direction, in my opinion. Nocturnal species depend on hearing more, and compressor noise seems much louder in cooler, denser air. I can never find owls downwind of compressors, even when other species are present. Nocturnal noise is mentioned at p 4-62. Low frequency noise is mentioned at p 4-66, but there is no plan to minimize it. P 4-68 states that the noise level will be the same in all alts, but over a smaller area in alt c, which is meaningful, and another reason to eliminate alt b.

Comment No.: 400_GMUGNF_Armentrout_20150416_email-attach-4
Organization: USDA United States Department of Agriculture
Commenter: Scott Armentrout

Comment Excerpt Text:
Noise: Please consider as a cumulative effect of development in the area (proposed action and baseline) additional drill rigs would be operating or if the same number of drill rigs would operate for a longer duration and if this makes a difference in analysis.

Comment No.: 482_SGI_Gordy_S_20150416_email-attach-30
Organization: SG Interests I, Ltd.
Commenter: Shaun Gordy

Comment Excerpt Text:
Contrary to the representation in the DEIS,

construction traffic would occur during nighttime hours. DEIS at 4-64

Comment No.: 482_SGI_Gordy_S_20150416_email-attach-38
Organization: SG Interests I, Ltd.
Commenter: Shaun Gordy

Comment Excerpt Text:
The DEIS contends that electric pumps would be available for water injection wells. DEIS at 4-66. These types of pumps are unavailable to SG given both the distance between the proposed operations and a reliable electricity source and the type of work being performed.

Comment No.: 482_SGI_Gordy_S_20150416_email-attach-77
Organization: SG Interests I, Ltd.
Commenter: Shaun Gordy

Comment Excerpt Text:
There is no basis for concluding that the well pad distribution in Alternative C would produce a lower noise profile (DEIS at 4-66) or result in a reduced workforce (DEIS at 4-204). To the contrary, given the close proximity of well pads in Alternative C, development areas are likely to experience greater noise profiles than under Alternative B. And SG will require the same number of workers to develop and operate wells under Alternative C as under Alternative B. The DEIS should provide comparison data to support any conclusion to the contrary.

Comment No.:
503_WELC_King_L_20150416_email-attach-105
Organization: Western Environmental Law Center
Commenter: Laura King

Comment Excerpt Text:
the BLM fails to provide any estimates of the “actual noise” generated by the project and affecting people and wildlife in the area because, the BLM says, that would depend on the location of wells and infrastructure and the amount of development occurring. The exact location of wells and infrastructure will be determined at the APD stage. However, the BLM has already identified “well pad analysis areas” based on the “areas currently thought to be most prospective for natural gas development.” See DEIS at 2-33, 2-34 (Figure 2-2), 4-65. Additionally, the BLM knows the amount and rate of development that will occur under each alternative.

Comment No.:
503_WELC_King_L_20150416_email-attach-106
Organization: Western Environmental Law Center
Commenter: Laura King

Comment Excerpt Text:
Thus, it is reasonably foreseeable where the wells will be located and the timeline and rate of drilling. Even putting aside the question of location, the BLM can estimate the amount of noise that the project could generate, under reasonably foreseeable scenarios (i.e. vehicle traffic is likely to occur at the same time as well drilling, and will cause a predictable level of noise). This analysis is both possible and essential. If it is determined that noise will be too disruptive to people and wildlife, that will effect which alternative is selected and whether, for example, phased development is desirable.

Comment No.:
503_WELC_King_L_20150416_email-attach-107
Organization: Western Environmental Law Center
Commenter: Laura King

Comment Excerpt Text:
The BLM concludes that well pad construction and drilling are estimated to be within the maximum permissible noise levels allowed under COGCC rules: 70 decibels for light industrial or 80 decibels for industrial from 7 am to 7 pm and 65 decibels or 70 decibels from 7pm to 7am. See DEIS at 4-64 (Alternative A), 4-65 (Alternative B), 4-67 (Alternative C). But it is unclear how this could be

the case. It does not seem likely that only one discrete step will occur in isolation at a time, by that the project's steps will be overlapping and occurring simultaneously. For example, if a compressor station (42 decibels of noise at 1,000 feet) is near a well pump (41 decibels of noise at 1,000 feet), those two pieces equipment alone would generate 83 decibels at 1,000 feet. And that does not include the added noise of any other equipment, drilling, or truck traffic. The DEIS does not consider the obvious possibility of cumulative noise and should

Summary

Commenters state that analysis in the Draft EIS is inconsistent or incomplete, as follows:

- Assumption of no nighttime construction is incorrect.
- Electric pumps are not available for use due to distance between electricity source and the type of work being performed.
- Alternative C would likely produce more noise because well pads are closer together.
- The BLM should estimate actual noise generated for the project because well pad analysis areas, drilling rate, and estimated vehicle traffic are already identified.
- Noise effects may be cumulative and greater than estimated in the Draft EIS.

Response

Section 4.2.2., Noise, was updated to address many of the comments summarized above. Specifically, the analysis was reviewed for accuracy in stating that nighttime construction would occur but that vehicle traffic would be largely confined to the daytime. The analysis was also corrected to remove the mention of electric pumps. The cumulative analysis was revised to account for synergistic impacts resulting from multiple projects' noise sources.

As stated in the Draft EIS, Section 4.2.2, "…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."

The noise analysis already quantifies impacts at given distances to determine impacts on sensitive receptors and compliance with regulations. Assigning specific distances from well pads to sensitive receptors is not currently possible because the exact location of each well pad is unknown. Therefore, the programmatic analysis analyzes noise impacts at multiple distances (e.g., 50, 500, and 1,000 feet), measured from the edge of the well pad analysis areas to sensitive receptors. Specific decibel levels at each sensitive receptor will be quantifiable once site-specific plans are developed.

Section 5.4 - Soil

Total Number of Comments: 6

Comment No.:
400_GMUGNF_Armentrout_20150416_email-attach-2
Organization: USDA United States Department of Agriculture
Commenter: Scott Armentrout

Comment Excerpt Text:
Soils: Include soils analysis for proposed screw compressor outside of Bull Mountain Unit (Sections 3.2.3, 4.2.3)

Comment No.: 431_Leger_N_20150416_email-attach-2
Commenter: Natasha Leger

Comment Excerpt Text:
3. BLM did not consider the prime organic farmland downstream of the Bull Mountain Project, which has a high risk of contamination by the proposed development. In light of the drought in California and the Midwest, BLM should make protecting Colorado's food sheds, especially organic food sheds a top priority in the EIS.

Comment No.:
503_WELC_King_L_20150416_email-attach-41
Organization: Western Environmental Law Center
Commenter: Laura King

Comment Excerpt Text:
The DEIS provides some analysis of impacts to farmland, unlike the EA. However, the analysis is still insufficient under NEPA, for two reasons: First, with respect to the 1,690 acres of farmland that is prime or of statewide importance (as determined by the USDA under the Farmland Protection Policy Act), the DEIS only analyzes direct effects, e.g., direct surface-disturbance from roads and well pads, not indirect or cumulative effects, including from air pollution, water shortages, or climate change. See DEIS at 3-23 to 3-25. Second, the DEIS ignores impacts to the 2,160 acres of irrigated farmland in the Unit that have not been classified as prime, unique, or important, even though this land also contributes to the community's welfare. See id.

Comment No.:
503_WELC_King_L_20150416_email-attach-42
Organization: Western Environmental Law Center
Commenter: Laura King

Comment Excerpt Text:
The BLM must closely scrutinize any action that results in the conversion of farmland to nonagricultural uses or that that undermines a community's welfare and capacity to provide for itself, especially in the face of recognized changes to climate. Here, the preferred alternative would cause short-term impacts to 36 acres, and long-term impacts to 16 acres, of prime farmland and farmland of statewide importance. Moreover, the DEIS fails even to mention the impact (even the direct impact) of the project on unclassified farmland, or to address any indirect or cumulative effects, including deposition from air pollution, water quality and quantity impacts that will affect irrigation, or the cumulative stress of oil and gas development in combination with climate change.

Comment No.:
503_WELC_King_L_20150416_email-attach-43
Organization: Western Environmental Law Center
Commenter: Laura King

Comment Excerpt Text:
While the FPPA [Farmland Protection Policy Act] does not create a private cause of action, agencies still have the duty under NEPA to evaluate the environmental impact of actions on agricultural

lands. See Town of Norfolk v. U.S. EPA, 761 F.Supp. 867, 890 (D.Mass. 1991). Notably, this duty extends to all farmlands, not just farmlands classified as prime or unique.

Comment No.:
503_WELC_King_L_20150416_email-attach-64
Organization: Western Environmental Law Center
Commenter: Laura King

Comment Excerpt Text:
BLM must consider the total erosion picture, taking into account (1) the range of impacts from the project, including but not limited to compaction, surface-disturbance, and vegetation removal; (2) the threat of extreme weather posed by climate change; (3) the threat of injection-induced earthquakes; (4) the fact that the area is one of active erosion and unstable slopes; and (5) and SGI's plan to build on sensitive soils and old landslide deposits.

Summary

The Draft EIS didn't include sufficient analysis for soil resources and should further analyze direct and indirect impacts from erosion and infrastructure construction (including the compressor station outside the Unit), and the effects on farmlands, especially prime or irrigated farmlands and even unclassified farmlands.

Response

The Final EIS has been revised to update the soil resources effects analysis for farmlands noting that should impacts on farmlands occur, then an impact rating form would need to be submitted to the appropriate US Department of Agriculture's Natural Resources Conservation Service (NRCS) office. The other elements regarding soils analysis were reviewed for adequacy and revised to better explain the nature, types, and magnitude of impacts under each alternative and the cumulative effects.

Section 5.5 - Water

Total Number of Comments: 30

Comment No.: 188_McGuire_E_20150415_email-2
Organization: Desert Weyr, LLC
Commenter: Eugenie McGuire

Comment Excerpt Text:
As one of the options for development the BLM must require that no fresh water be used in any process related to the development of these wells. The fresh water that will be used under the scheme is enough to irrigate our farm for over 40 years! Irrigation does not use all the water resource and indeed passes it along and contributes to a healthy hydrological cycle. The BLM must consider what the loss of this much fresh water will do to our regional environment in the face of the continuing and deepening drought conditions in the west.

Comment No.: 188_McGuire_E_20150415_email-4
Organization: Desert Weyr, LLC
Commenter: Eugenie McGuire

Comment Excerpt Text:
Our flock of Black Welsh Mountain sheep has been a research flock for the USDA National Animal Germplasm program for over 10 years focused on sheep reproduction. Even trace amounts of these chemicals are likely to cause reproductive harm to

our sheep flock. Any such effects will negate years of research and eliminate our flock as a viable research flock. The cost to the government to source suitable sheep to replace our research flock is not included in the impacts of this development.

Comment No.: 189_Mcguire_K_20150415_email-1
Organization: Weyr Associates, LLC
Commenter: Kenyon McGuirer

Comment Excerpt Text:
To allow the removal of fresh water in our arid climate and then to permanently contaminate said water and inject it into a geologically unstable area shows that the BLM is not adequately considering possible impacts of development. As one of the options for development the BLM must require that no fresh water be used in any process related to the development of these wells. The BLM must consider what the loss of this much fresh water will do to our regional environment in the face of the continuing and deepening drought conditions in the west.

Comment No.: 264_Ryman_K_20150402_email-1
Organization: Great Old Broads for Wilderness
Commenter: Karen Ryman

Comment Excerpt Text:
An estimated 353.6 million gallons of fresh water will be used. A reduction of stream flow and groundwater levels.
Contamination of fresh water sources and aquifers by waste or wastewater.

Comment No.: 275_Shishim_M_20150414_email-attach-1
Commenter: Margaret Shishim

Comment Excerpt Text:
In the event of any drilling at all, the BLM should require mandatory baseline surface water sampling and ongoing monitoring, collection of baseline air samples prior to development, and ongoing air monitoring for VOCs and PAHs and require bonding of an adequate amount to cover cleanup and accident remediation and complete reclamation upon completion.

Comment No.: 292_Soule_J_20150414_email-attach-5
Commenter: Joli Soule

Comment Excerpt Text:
• On p. 2-29 "…it is assumed for purposes of analysis…that the entire depletion (of water) associated with this project would be a new depletion from the Colorado River…" Given an extreme drought situation in California, it would be prudent to assess the impacts of permanently removing a portion of Colorado River water from the hydrologic cycle by loading it with toxic chemicals and injecting it into waste wells.

Comment No.: 299_Stopher_Griffin_E_20150409_hard-1
Commenter: Emma Stopher-Griffin

Comment Excerpt Text:
This water source supplies many farmers including us and is already in high demand with
what little there is. Irresponsible development would devastate our valley and the mass amounts
of food that is grown here. This plan does not show that the oil and gas companies are moving
forward with responsible oil and gas development and below I share with you a number of ways
that I believe that it could move in the right direction.

Comment No.: 334_WElkScenicByway_Hoffmann_J_20150302_email-attach-10
Organization: West Elk Loop Scenic and Historic Byway
Commenter: John Hoffmann

Comment Excerpt Text:

even a tiny portion of the tons of FRACKING CHEMICALS (pages 648-50) were to escape into the Muddy watershed, consideration of how that would be mitigated has not been fully demonstrated. What would the impacts be to wildlife, aquatic organisms, and water quality for downstream users, as residential and agricultural downstream use are likely dependent on the Muddy aquifer. What would be the cost to develop alternative water sources, and would real estate values be impacted?

Comment No.: 376_Cheesman_D_20150416_email-1
Commenter: Debbie Cheesman

Comment Excerpt Text:
Will the BLM take the responsibility for compensation of this impact? Can the extracted water be reused in any way? Can you purify it to provide this water for some use as to conserve what is desperately needed at this critical point? How is "vital" applied when using 353.6 million gallons of water for extracting natural gas? Which is more vital?

Comment No.: 482_SGI_Gordy_S_20150416_email-attach-31
Organization: SG Interests I, Ltd.
Commenter: Shaun Gordy

Comment Excerpt Text:
Table 4-1 fails to acknowledge that Coalbed Methane Natural Gas-produced water may be used in completions and recycled before it is injected into disposal wells or disposed. DEIS at 4-7

Comment No.: 482_SGI_Gordy_S_20150416_email-attach-54
Organization: SG Interests I, Ltd.
Commenter: Shaun Gordy

Comment Excerpt Text:
In analyzing the potential impacts to water resources, the DEIS implies that "public controversy" over hydraulic fracturing represents a basis for finding impacts to water. DEIS at 4- 76. This concern has been the subject of frequent technical reports, finding not only that hydraulically stimulated fractures in deeper formations have not penetrated drinking water aquifers, but also that principles of petrophysics indicate it is highly unlikely that such fractures could ever reach aquifers. Unsubstantiated public concern cannot constitute the basis for conclusions that require technical, objective, and scientific support.

Comment No.: 482_SGI_Gordy_S_20150416_email-attach-57
Organization: SG Interests I, Ltd.
Commenter: Shaun Gordy

Comment Excerpt Text:
Portable pipelines may be vulnerable to sabotage. DEIS at 4-80. The DEIS provides no evidence that portable pipelines have been subject to sabotage.

Comment No.: 482_SGI_Gordy_S_20150416_email-attach-58
Organization: SG Interests I, Ltd.
Commenter: Shaun Gordy

Comment Excerpt Text:
A description of a contained spill from the Jacobs well. DEIS at 4-82. A narrative description of one spill is not quantitative evidence that can be used to support a conclusion of the risk of spills in the Bull Mountain Unit.

Comment No.: 482_SGI_Gordy_S_20150416_email-attach-59
Organization: SG Interests I, Ltd.
Commenter: Shaun Gordy

Comment Excerpt Text:
A higher risk exists in the Bull Mountain Unit for spills. DEIS at 4-81. There is no evidence that physical conditions within the Bull Mountain Unit

establish a risk of spills that is higher than in any other location in Colorado or elsewhere.

Comment No.: 482_SGI_Gordy_S_20150416_email-attach-64
Organization: SG Interests I, Ltd.
Commenter: Shaun Gordy

Comment Excerpt Text:
The DEIS also includes a discussion of impacts to water-related resources that does not reference any scientific literature. The DEIS should clarify the sources relied upon to make the following statements:

Alluvial aquifers 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. DEIS at 3-35.

Fractures in rocks might be capable of conducting fresh water to greater depths. DEIS at 3-36.

The quality of produced water wells and the amount of produced water and drilling fluids that remains underground after completion is relevant to assessing health impacts. DEIS at 4-179.

There is some evidence that sedimentation rates have accelerated over the years. DEIS at 3-26.

Comment No.: 482_SGI_Gordy_S_20150416_email-attach-76
Organization: SG Interests I, Ltd.
Commenter: Shaun Gordy

Comment Excerpt Text:
The DEIS advances a number of operational assumptions that are unsupported or not explained in the record. Among other provisions, the record lacks any discussion providing scientific and objective support for each of the following statements:

Waterless fracturing is a viable technology for development of wells within the Bull Mountain Unit. DEIS at 4-84. Waterless fracturing has been unsuccessful in practice in many basins (SG has tried this method in the past) and the company that pioneered the technology has gone bankrupt.

Use of a centralized facility outside of Reduced Winter Activity Areas would reduce wildlife impacts. DEIS at 4-118. The DEIS does not include any discussion of which species would benefit from centralized production facilities or how such facilities would benefit those species. A centralized production facility, whose size and impacts are unspecified, could easily cause as many impacts as it is designed to reduce.

A closed loop system greatly reduces water use. DEIS at 4-86. An efficiently managed conventional drilling system can operate using similar quantities of water as a closed loop version.

Assumption that water for operations would be obtained between April and July. DEIS at 4-86. SG's ability to obtain water will be impacted by the provisions in the Augmentation Plan.

Injected fluids have the potential to migrate to shallow ground water. DEIS at 4-181. There is no peer-reviewed scientific support for concluding that injected fluids can migrate to shallow ground water.

Produced water injected into underground control wells will contain soil, grease, inorganic and organic additives. DEIS at 4-180. Produced water does not contain grease or inorganic and organic additives.

The severity of operational impacts would vary depending on surface ownership. DEIS at 4-167.

SG would focus on private development if BLM rejects the MDP, causing a greater development of private wells. DEIS at 4-160 to 162. As explained above, although adopting Alternative A will have little or no effect on the scope of mineral development that takes place, it will have important consequences for BLM's ability to ensure meaningful environmental review.

Comment No.:
503_WELC_King_L_20150416_email-attach-44
Organization: Western Environmental Law Center
Commenter: Laura King

Comment Excerpt Text:
the BLM's confidence that fracking will not contaminate groundwater is belied by recent events and studies. For example, as discussed in more detail below, hydraulic fracturing was identified as one of several causes of methane contamination of drinking water and a subsequent explosion at a home in Bainbridge Township, Ohio. Spills of hydraulic fracturing fluid into the Acorn Fork Creek in Kentucky resulted in a fish kill including the threatened Blackside Dace. Also, one study modeled that chemically concentrated fracking fluids can migrate into groundwater aquifers within a matter of years – calling into question industry claims that rock layers separating aquifers are impervious to these pollutants.(See, Abrahm Lustgarten, New Study Predicts Frack Fluids can Migrate to Aquifers Within Years, PROPUBLICA, May 1, 2012 (attached as Exhibit 63); Josh Fox, The Sky is Pink: Annotated Documents (attached as Exhibit 64).) Claims that there has never been a documented case of groundwater contamination from fracking was challenged by EPA's research in Pavillion, Wyoming. Indeed, a second round of testing in the Pavillion area was recently performed by the U.S. Geological Survey, which supported EPA's preliminary findings that hydraulic fracturing resulted in groundwater contamination.(Peter Wright, et. al., U.S. Geological Survey, Groundwater-Quality and Quality-Control Data for Two Monitoring Wells near Pavillion, Wyoming, April and May 2012 (attached as Exhibit 65).) Even in draft form, the Pavillion Report and its troubling findings as well as incidents described above and other evidence of fracking related contamination from around the country underscore the need for thorough analysis to be performed by the UFO, which the agency failed to provide in the DEIS.

Comment No.:
503_WELC_King_L_20150416_email-attach-46
Organization: Western Environmental Law Center
Commenter: Laura King

Comment Excerpt Text:
Indeed, even an industry report prepared for Gunnison Energy Corporation – a major oil and gas developer with leases just south of the Bull Mountain MDP – has acknowledged the potential for significant impacts to water resources from fracking.(See Gunnison Energy Corporation, Analysis of Potential Impacts of Four Exploratory Natural Gas Wells to Water Resources of the South Flank of the Grand Mesa, Delta County, Colorado (March 2003) at 42, 56 (attached as Exhibit 88).) The simple fact of the matter is that natural gas development has the potential for poisoning our water with toxic, hazardous, and carcinogenic chemicals as well as naturally occurring radioactive radium, and BLM has failed to provide a thorough hard look analysis of these potentially significant impacts in its analysis for Bull Mountain MDP.

Comment No.:
503_WELC_King_L_20150416_email-attach-47
Organization: Western Environmental Law Center
Commenter: Laura King

Comment Excerpt Text:
The DEIS identifies numerous potential impacts to surface water quality, including impacts from sedimentation, salinity, and chemical contamination. See DEIS at 4-80. However, the DEIS fails to analyze the effect of these impacts on the human environment in general, or the risks these impacts pose to citizens of the North Fork area specifically. Perfunctory references to risks and impacts do not amount to the "hard look" that NEPA demands. See Natural Res. Def. Council, Inc. v. Hodel, 865 F.2d 288, 299 (D.C. Cir. 1988). Instead, an EIS must contain an analysis that would aid a decisionmaker in deciding whether, or how, to alter the proposed action to lessen environmental impacts. See id. The BLM undertakes no such analysis here.

Comment No.:
503_WELC_King_L_20150416_email-attach-48
Organization: Western Environmental Law Center

Commenter: Laura King

Comment Excerpt Text:
First, the DEIS gives short shrift to the risk of sedimentation caused by development on erodible soils, landslide deposits, and steep slopes, and the risk of releases from landslide damage to equipment. The DEIS notes that Best Management Practice 97 requires avoiding unstable slopes, old landslides, and slopes in excess of 40% unless otherwise approved by the BLM. The BLM then goes on to describe significant development under Alternatives B and C on unstable slopes, old landslides, and slopes in excess of 40%. Thus, while the BLM promises that the risk of sedimentation will be "greatly reduced" by implementation of BMPs, this promise is empty: the agency does not intend to follow even the basic protections provided by BMP 97.

Comment No.:
503_WELC_King_L_20150416_email-attach-49
Organization: Western Environmental Law Center
Commenter: Laura King

Comment Excerpt Text:
the EIS fails to address the impacts of sedimentation on saltloading and selenium contamination in the Gunnison River. The Gunnison River is already impaired for selenium under the Clean Water Act ("CWA"). See DEIS at 3-33. But the DEIS does not address the potential impact of sedimentation on selenium loading, the effect of selenium loading on the already impaired Gunnison River, the effect that selenium has on aquatic species (including ESA listed species and their habitat), or the Memorandum of Understanding ("MOU") that BLM has with the Bureau of Reclamation ("USBR") for the implementation of a Selenium Management Program, in which BLM has agreed to "[e]valuate options to conform to a goal of no net new selenium loading from land exchanges, sales, and other actions involving public lands." Lease Sale EA at 81. Nor does the DEIS address the potential impact of sedimentation on saltloading, despite acknowledging that "the North Fork Gunnison River is recognized as a major contributor of salt to the Colorado River System," and salinity has become a "major concern" in the Colorado River drainage basin. DEIS at 3-34.

Comment No.:
503_WELC_King_L_20150416_email-attach-50
Organization: Western Environmental Law Center
Commenter: Laura King

Comment Excerpt Text:
BLM attempts to ignore the sedimentation that the project will cause, noting that the streams draining the project area normally carry high sediment, and indicating that any "additional sediment loading rates could be greatly reduced by implementation of BMPs." See DEIS at 4-89. This is a far cry from the "hard look" that NEPA requires

Comment No.:
503_WELC_King_L_20150416_email-attach-51
Organization: Western Environmental Law Center
Commenter: Laura King

Comment Excerpt Text:
The DEIS also fails to address the impacts of sedimentation on the effective life of the Paonia Reservoir, despite acknowledging that the project could lead to increased erosion rates and faster sedimentation of the reservoir, thereby impacting agriculture dependent on the reservoir. See DEIS 3-44.

Comment No.:
503_WELC_King_L_20150416_email-attach-52
Organization: Western Environmental Law Center
Commenter: Laura King

Comment Excerpt Text:
BLM acknowledges that water quality could be degraded by accidental spills or releases. See DEIS at 4-80. But the BLM does not address the impact of these spills or releases on water quality. Instead, the BLM merely says that the use of BMPs, setbacks,

and spill containment structures "can" provide adequate protection to surface water. See id.

Comment No.:
503_WELC_King_L_20150416_email-attach-56
Organization: Western Environmental Law Center
Commenter: Laura King

Comment Excerpt Text:
Under a "worst case scenario," a large volume of brine could be discharged to a stream, "causing a sudden change in salinity capable of impacting riparian habitat and biota downstream of the release." See DEIS at 4-80. The BLM does not identify what events might precipitate this worst case scenario, or the likelihood of this worst case scenario. The fact that the pipes will be crossing "difficult terrain" and areas of "extensive landslide deposit" suggests, however, that there is a possibility (perhaps a likelihood) that creep or landslides could damage or destroy the poly pipes, causing brine to spill into streams and damage riparian life. The BLM fails to adequately analyze these risks; fails to impose any mitigation measures on the use of poly pipe; and fails to provide any alternative to the use of poly pipe (use of poly pipe is "common to all alternatives"). Thus, the DEIS does not provide enough information to aid a decisionmaker in deciding whether, or how, to alter the proposed action to lessen the environmental risk posed by transfer of produced water via poly pipe.

Comment No.:
503_WELC_King_L_20150416_email-attach-57
Organization: Western Environmental Law Center
Commenter: Laura King

Comment Excerpt Text:
The BLM also fails to provide any analysis of the risk of fracking on surface water, including on surface waters outside the Unit, such as the North Fork and irrigation canals serving agricultural uses of the North Fork Valley. The BLM recognizes that the project poses the risk of chemical contamination to surface water, and in particular that water quality may be degraded by spills or releases of "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." See DEIS at 4-80. But the BLM undertakes no discussion or analysis of the 980 products and 649 chemicals that energy companies inject into the ground – and can therefore be spilled and released into surface waters – in the process of extracting natural gas, many of which are harmful to human health

Comment No.:
503_WELC_King_L_20150416_email-attach-58
Organization: Western Environmental Law Center
Commenter: Laura King

Comment Excerpt Text:
While BLM's DEIS identifies numerous potential impacts to surface water quality – including impacts from sedimentation, salinity, and chemical contamination – the DEIS does not address the effect that these impacts may pose to the human environment. A catalog of impacts without analysis or quantification, along with a mere listing of uncertain mitigation measures, does not amount to the "hard look" that NEPA demands. See NRDC, 865 F.2d at 299. In order to ensure that surface water is protected from sedimentation, salinity, and chemical contamination, BLM should require mandatory baseline surface water sampling and ongoing monitoring.

Comment No.:
503_WELC_King_L_20150416_email-attach-59
Organization: Western Environmental Law Center
Commenter: Laura King

Comment Excerpt Text:
The BLM fails altogether to address how fracking and reinjection of produced water will affect groundwater quality. See DEIS at 4-90. Rather, the BLM dodges this issue, claiming that fracking "is not expected to impact potable groundwater resources"

and that impacts from reinjection of produced water are expected to be "minor" and reduced to "less than significant levels" through compliance with law. Id. Yet, this conclusion is contradicted by the BLM's own findings. The BLM notes that brines with concentrations of up to 70,000 ppm TDS may be generated in the fracking process. See DEIS at 4-84. Moreover, the BLM cites lab results that show that produced water from existing wells in the Unit contain "dissolved petroleum hydrocarbons, including the volatile constituents benzene, toluene, ethylbenzene, and xylenes, which are found in light crude oil." See DEIS at 3-38. The EIS also notes that "[t]he 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." Id. (emphasis added). Despite BLM's dismissive approach, health impacts from petroleum hydrocarbons and heavy metals are not "minor."

Comment No.:
503_WELC_King_L_20150416_email-attach-61
Organization: Western Environmental Law Center
Commenter: Laura King

Comment Excerpt Text:
Under the proposed alternative, BLM estimates that the fracking process alone will require a total of 2,370 acre-feet of water. DEIS at 4-88. This is the equivalent of nearly an hour and half of the average flow of the Colorado River, and is enough water to flood 237 football fields to the depth of 10 feet. Unlike other applications, this water must be permanently removed from the hydrologic cycle because it is mixed with chemicals. Dust suppression and drilling will require an additional 111 acre-feet of water. This combined water use will have a significant impact on both surface and groundwater, with associated effects on stream and fish health and human (including agricultural) use. These impacts should be considered together with the drought-inducing effects of climate change and the quality impacts posed by the project. The BLM fails to mention, much less analyze, these impacts.

Comment No.:
503_WELC_King_L_20150416_email-attach-63
Organization: Western Environmental Law Center
Commenter: Laura King

Comment Excerpt Text:
The BLM also fails to address the disruption of natural surface and groundwater flow patterns caused by the project's water use, an impact recognized in the EA. In the EA, the BLM noted that the significant drawdown of surface and groundwater quantities, necessary to "facilitate the natural gas recovery process," may also have a deeper impact on the area's hydrology, stating: "Construction activities may also disrupt natural surface and groundwater flow patterns. Altered flow patterns could disrupt natural surface and groundwater recharge/discharge patterns." EA at 128. In turn, these changes could have "adverse impacts on stream channel morphology, productivity of springs, riparian areas, and aquatic life." Id. However, this impact, recognized in the EA, is entirely omitted in the DEIS.

Summary

The action alternatives allow for the use of too large a quantity of water and too many impacts on water. Impacts include reduced stream and groundwater flows, water contamination (with fracking chemicals or otherwise), salt loading, selenium contamination, sedimentation, impacts on wildlife, impacts on farmers and their livestock, impacts on Paonia Reservoir, and water impacts on humans and the human environment. Impacts may occur from spills too. Water sampling, including baseline sampling, should be required. If water sources are contaminated then an alternative water source would be needed for water users and the Draft EIS does not account for this. The Draft EIS does not recommend how to lessen the

impacts on water; just saying there are BMPs to lessen water impacts is not enough, and NEPA requires more.

The Draft EIS relies on public opinion or one spill to analyze water impacts rather than technical reports or petro physics. The Draft EIS needs to provide scientific evidence and sources for many described water impacts.

Response

Baseline Water Monitoring Program: The BLM has included an expanded baseline water quality monitoring program in Alternative D, the Preferred Alternative. See Appendix C for the additional measures (COA #57) and Chapter 4, **Section 4.2.4**, Water Resources, for analysis of the measures.

The impact analysis acknowledges that there are risks that could affect water resources when developing oil and gas resources. Application of the COAs, baseline water monitoring, and other design features may not avoid all impacts, but including baseline water quality monitoring would help identify the extent of the impacts. If spill or leak incidents were to occur, baseline and ongoing monitoring would help BLM to identify the source and extent of the contamination and to remedy it.

Water quantity analysis is provided in **Section 4.2.4**, Water Resources under Short-term Effects, under each alternative heading "Water Quantity," and in Cumulative Effects.

Further, water depletions are analyzed in **Section 4.2.7, Fish and Wildlife**, and **Section 4.2.8, Special Status Species**, in Chapter 4 of the Final EIS.

Section 5.6 - Geology

Total Number of Comments: 5

Comment No.: 292_Soule_J_20150414_email-attach-4
Commenter: Joli Soule

Comment Excerpt Text:
• On p. 3-51: "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." Development of the Unit could lead to more rock-fall on Hwy 133, adding to the existing dangers. Landslides brought on by development could rupture pipelines and lead to spills into Paonia Reservoir, the North Fork of the Gunnison, the Gunnison, and the Colorado River. The possibilities are many, and have not been fully considered by the EIS. It is the responsibility of BLM to require SGI to post bond sufficient to remediate such catastrophic accidents that are likely to occur in the terrain of Bull Mountain.

Comment No.: 422_Kobrin_M_20150415_email-1
Commenter: Mike Korbin

Comment Excerpt Text:
The unstable slopes from the Raggeds down to the Muddy. Does anyone here remember 1986 when the massive slide dammed up the Muddy and CDOT had to keep track hoes digging day and night for weeks to keep the snowmelt running into Paonia reservoir and avoid potential catastrophe? Geologists came from all over the world to observe this earth slide. Now, if we are going to have injection wells up there, have you considered the seismic implications? Are you aware

of the seismic activity associated with waste water injection wells in Oklahoma?

Comment No.: 431_Leger_N_20150416_email-attach-4
Commenter: Natasha Leger

Comment Excerpt Text:
6. BLM did not consider or model the impact of earthquakes caused by hydraulic fracturing and the impact on the geological stability of the area. Current seismic activity is referenced on page 3-51, but does not consider the impact of the proposed development. BLM admits to inadequate study of earthquake impact on page 4-99.
Where are the 3D-geospatial scenario models of the proposed development and geological impact?

Comment No.: 503_WELC_King_L_20150416_email-attach-65
Organization: Western Environmental Law Center
Commenter: Laura King

Comment Excerpt Text:
The BLM's analysis of earthquake risk from injection wells is insufficient. The BLM recognizes that private drilling will increase the waste requiring disposal, requiring more fluid injection and potentially more injection wells, and that "the potential for inducing earthquakes would increase proportionally with the increase in disposal." See DEIS at 4-99. But the BLM fails to include the "background" level of private development in its analysis of seismicity under Alternatives B and C. See DEIS at 4-99. In its "cumulative" section within geologic resources, the DEIS acknowledges that increased fluid injection of wastes generated on private lands is expected to result in "an incremental cumulative increase in the potential impacts," but fails to provide the needed detail about the "incremental increase," merely noting that the significance of any increase would depend on the "tectonic stress field" and "hidden faults," which are not well known.

Comment No.: 503_WELC_King_L_20150416_email-attach-66
Organization: Western Environmental Law Center
Commenter: Laura King

Comment Excerpt Text:
In the DEIS, BLM gives cursory mention to the significant land movement event in the 1986 East Muddy Creek slide. See, e.g., DEIS at 4-93. However, BLM fails to analyze what a significant concern active land movements could cause along the transportation and access corridor to the Bull Mountain Unit of Highway 133. As the Colorado Geological Survey noted:
There are also other reasons to believe that the South Landslide poses a greater potential threat than the Central Landslide did in 1986. It appears almost inevitable that this large landslide will, in the near future, break out at the toe and rapidly disrupt Muddy Creek and CO Hwy 133. Any flood releases from a landslide dam could affect the operation and safety of Paonia Reservoir, because the potential height of a landslide dam here could be much greater than it was for the Central Landslide in 1986. In addition, the South Landslide is below the confluence with West Muddy Creek and would impound the combined floodwaters from East Muddy Creek and West Muddy Creek.Id at 17.

Summary

The Draft EIS does not describe the 1986 landslide around Muddy Creek. The unstable slopes in the area and wastewater injection wells may have impacts of landslides or earthquakes. The Draft EIS does not sufficiently analyze increased impacts due to wastewater injection wells on private land, which may have impacts on Muddy Creek or Panoia reservoir.

Response

The Draft EIS address the landslide risks and proposes mitigation measures as found in **Section 4.2.5**, Geology, under *Effects Common to All Alternatives*. Measures to address risks associated with landslides and earthquakes have been included in Alternative D, the Preferred Alternative (FEIS Section 2.2.9), and Appendix C (COA #53-56).

Section 5.7 - Vegetation

Total Number of Comments: 5

Comment No.: 407_GunnisonEnergy_Fyock_L_20150415_email-attach-3
Organization: Gunnison Energy LLC
Commenter: Lee Fyock

Comment Excerpt Text:
3. In the Vegetation section, Table 4-39/Alternative A shows effects on federal lands, which is an error if the No Action Alternative only affects private lands. If there are effects to federal lands, they become 'connected actions' and should be included in the Proposed Action. BLM should determine if there are federal lands affected by the No Action Alternative and revise the alternatives accordingly or remove effects to federal lands under the No Action Alternative in the Vegetation impact section.

Comment No.: 482_SGI_Gordy_S_20150416_email-attach-46
Organization: SG Interests I, Ltd.
Commenter: Shaun Gordy

Comment Excerpt Text:
BLM posits in the cumulative impact statement that vegetation disturbance would materialize from increased recreational OHV use. DEIS at 4-105. BLM should clarify that this impact occurs only on the 440 acres of the Bull Mountain Unit that are federal surface estate.

Comment No.: 482_SGI_Gordy_S_20150416_email-attach-81
Organization: SG Interests I, Ltd.
Commenter: Shaun Gordy

Comment Excerpt Text:
There is no support for the conclusion that impacts to land health are less under Alternative C as compared to Alternative B. DEIS at 4-104. As explained above, Alternative B is well-tailored to minimize environmental disturbance and carefully balances BLM's statutory mandate to ensure efficient production of the federal mineral estate with the agency's commitment to environmental values. As proposed, Alternative C contemplates a similar level of development as Alternative B while concomitantly limiting the operational flexibility that SG and BLM need -- and that Alternative B provides -- to minimize the operational footprint of oil and gas development.

Comment No.: 554_EPA_Strobel_P_20150415_hard-4
Organization: EPA
Commenter: Philip S. Strobel

Comment Excerpt Text:
Wetlandr; and Riparian Zones
In Section 3.2.6, Wetlands and Riparian Zones (p. 3-55), the text refers specifically to jurisdictional wetlands. Executive Order 11990 -Protection of Wetlands directs federal agencies to avoid to the extent possible long and short term adverse impacts to all wetlands. We recommend removing the reference to jurisdictional wetlands and discussing all wetlands present within the project area.

Summary

The Draft EIS should clarify its basis for saying Alternative C impacts on land health would be less than Alternative B. Impacts from recreational off-highway vehicles (OHVs) will be on BLM surface lands only. BLM should remove the reference to jurisdictional wetlands and discussing all wetlands present within the project area. Also, BLM should explain why impacts to Federal lands are noted in Table 4-39 although the text says Alternative A does not occur on Federal lands or mineral estate.

Response

While the same COAs would be applied under Alternatives B and C, and thus would reduce impacts similarly, the total acreage that would be disturbed would be greater under Alternative B. This is because there are more pads resulting in more disturbed acreage, and thus residual impacts would be greater.

Clarification has been added to the Final EIS, which was also revised to note that recreational OHVs would be on BLM-administered surface lands only, and BLM has removed the reference to jurisdictional wetlands.

Table 4-43 in the Final EIS indicates that lands overlying federal mineral estate would be impacted and is not an error. The acreage of disturbance is from roads that would be needed to access private wells. Chapter 2, Section 2.2.6, Alternative A, No Action Alternative has been revised to clarify this information.

Section 5.8 - Wildlife, Birds

Total Number of Comments: 18

Comment No.:
334_WElkScenicByway_Hoffmann_J_20150302_email-attach-9
Organization: West Elk Loop Scenic and Historic Byway
Commenter: John Hoffmann

Comment Excerpt Text:
It has not been noted in effects on FISH AND WILDLIFE (page 198) that the lights and roar of well operations continue 24-7 and each well can generate 1,000 heavy semi-truck trips which will negatively impact wildlife. Both factors need to be considered and mitigated by reducing the number of pads allowed and scheduling operations to be mindful of wildlife movement and needs.
The extremely winding and failure-prone section of Highway 133 along Paonia Reservoir must be addressed in light of the 146,000 possible semi-truck trips, given CDOT's limited funding. It seems unlikely the road was engineered for this level of use and this would be an expensive stretch of road to bring up to heavy use standards.

Comment No.:
407_GunnisonEnergy_Fyock_L_20150415_email-attach-4
Organization: Gunnison Energy LLC
Commenter: Lee Fyock

Comment Excerpt Text:
13. BLM should review and clarify for consistency (p. 4-119, 4-122, 4-127) all discussion of raptor and migratory bird surveys and timing restrictions for clearing and construction. On page C-7, number 62, it

states “From May 15 to July 15 no surface disturbing activities shall occur in order to protect breeding migratory birds.” It is generally accepted that as long as clearing occurs prior to May 15, construction can occur within the period of May 15 to July 15 and that clearing could occur between May 15 and July 15 as long as surveys are conducted and nothing is found. BLM should clarify this in the text. In the text in Chapter 4, surveys for migratory birds with the restriction for clearing from May 15 to July 15 should be clearly separated from any raptor surveys and subsequent timing restrictions for construction based on survey.

Comment No.: 482_SGI_Gordy_S_20150416_email-attach-18
Organization: SG Interests I, Ltd.
Commenter: Shaun Gordy

Comment Excerpt Text:
The DEIS states that fee surface/fee mineral estate lands are relatively evenly distributed across the unit. DEIS at 4-114. These lands are not evenly distributed.

Comment No.: 482_SGI_Gordy_S_20150416_email-attach-29
Organization: SG Interests I, Ltd.
Commenter: Shaun Gordy

Comment Excerpt Text:
Contrary to the representation in the DEIS, there could be trenching of pipeline crossings of roads and wetlands. DEIS at 4-109

Comment No.: 482_SGI_Gordy_S_20150416_email-attach-40
Organization: SG Interests I, Ltd.
Commenter: Shaun Gordy

Comment Excerpt Text:
The DEIS states that there is no issue with imposing a condition that no human encroachment would be allowed near active bird nests. DEIS at 4-128. This statement should be clarified to specify that it is limited to encroachment associated with project-related activity.

Comment No.: 482_SGI_Gordy_S_20150416_email-attach-43
Organization: SG Interests I, Ltd.
Commenter: Shaun Gordy

Comment Excerpt Text:
The DEIS discusses the presence of several varieties of raptors. DEIS at 4-125. The DEIS should include a discussion of data obtained from performing any surveys under the Bald and Golden Eagle Protection Act or other raptor surveys.

Comment No.: 482_SGI_Gordy_S_20150416_email-attach-51
Organization: SG Interests I, Ltd.
Commenter: Shaun Gordy

Comment Excerpt Text:
The DEIS states that there is long-term risk to wildlife from a pipeline rupture. DEIS at 4-109. BLM should clarify that the probability of such a rupture and any risk to wildlife from such a rupture is very low.

Comment No.: 482_SGI_Gordy_S_20150416_email-attach-75
Organization: SG Interests I, Ltd.
Commenter: Shaun Gordy

Comment Excerpt Text:
The DEIS also contains unsupported statements regarding the potential impacts of oil and gas development on wildlife. Among other provisions, the record lacks any discussion providing scientific and objective support for each of the following statements:

Construction, operation, and development of oil and gas resources are expected to have the greatest impacts on big game species. DEIS at 2-74, 4-108. Because big game species are highly mobile habitat generalists, they are unlikely to be the most impacted from resource development.

Development would potentially impact trout in Muddy Creek. DEIS at 3-59 – 61, 3-82.Based on surveys Kowolski of Colorado Parks & Wildlife conducted, and consistent with the discussion of trout elsewhere in the DEIS, there is no evidence populations of greenback cutthroat trout are present in the project area. See Appendix A.

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. DEIS at 3-64.

Mule deer are modifying their movement patterns as a result of oil and gas activity. DEIS at 3-62.

Statement that native vegetation communities would be lost. DEIS at 4-105. There is no basis to conclude, to the extent any native vegetation communities are disturbed, that those vegetation communities could not be successfully revegetated.

Power lines and poles provide perches for birds of prey, which may increase predation of unspecified species. DEIS at 4-117. There is also no supporting evidence that additional perches power lines and poles may create will increase predation above what existing perches -- in the form of trees, other natural structures, and existing power lines -- affords presently.

Surface disturbance would reduce habitat for raptors. DEIS at 4-125. There is no supporting evidence for the conclusion that surface disturbance reduces raptor habitat.

Timing limitations would provide added protection to wildlife. DEIS at 4-119, 4-121. The DEIS does not specify which species would benefit from these timing limitations nor cite any scientific data or analysis supporting this generalized observation.

Comment No.: 482_SGI_Gordy_S_20150416_email-attach-76
Organization: SG Interests I, Ltd.
Commenter: Shaun Gordy

Comment Excerpt Text:
The DEIS advances a number of operational assumptions that are unsupported or not explained in the record. Among other provisions, the record lacks any discussion providing scientific and objective support for each of the following statements:

Waterless fracturing is a viable technology for development of wells within the Bull Mountain Unit. DEIS at 4-84. Waterless fracturing has been unsuccessful in practice in many basins (SG has tried this method in the past) and the company that pioneered the technology has gone bankrupt.

Use of a centralized facility outside of Reduced Winter Activity Areas would reduce wildlife impacts. DEIS at 4-118. The DEIS does not include any discussion of which species would benefit from centralized production facilities or how such facilities would benefit those species. A centralized production facility, whose size and impacts are unspecified, could easily cause as many impacts as it is designed to reduce.

A closed loop system greatly reduces water use. DEIS at 4-86. An efficiently managed conventional drilling system can operate using similar quantities of water as a closed loop version.

Assumption that water for operations would be obtained between April and July. DEIS at 4-86. SG's ability to obtain water will be impacted by the provisions in the Augmentation Plan.

Injected fluids have the potential to migrate to shallow ground water. DEIS at 4-181. There is no peer-reviewed scientific support for concluding that injected fluids can migrate to shallow ground water.

Produced water injected into underground control wells will contain soil, grease, inorganic and organic additives. DEIS at 4-180. Produced water does not contain grease or inorganic and organic additives.

The severity of operational impacts would vary depending on surface ownership. DEIS at 4-167.

SG would focus on private development if BLM rejects the MDP, causing a greater development of private wells. DEIS at 4-160 to 162. As explained above, although adopting Alternative A will have little or no effect on the scope of mineral development that takes place, it will have important consequences for BLM's ability to ensure meaningful environmental review.

Comment No.:
503_WELC_King_L_20150416_email-attach-70
Organization: Western Environmental Law Center
Commenter: Laura King

Comment Excerpt Text:
the DEIS's analysis of wildlife impacts is inadequate for several reasons. First, it fails to consider the importance of the Bull Mountain Unit to wildlife populations of the greater North Fork area. Second, the DEIS fails to include sufficient information on the direct and indirect impacts of the proposed alternatives on wildlife, and makes general conclusions that are unsupported by documented facts. Third, the cumulative impacts analysis in the DEIS fails to acknowledge and analyze numerous active and planned energy developments in the interconnected landscape of the Upper North Fork.

Comment No.:
503_WELC_King_L_20150416_email-attach-73
Organization: Western Environmental Law Center
Commenter: Laura King

Comment Excerpt Text:
given the importance of the Unit and surrounding environs to wildlife vitality, we ask that a more robust and NEPA-compliant analysis be undertaken. To be sufficient, this must include the consideration and analysis of applicable research on direct and indirect impacts to wildlife. Until then, the current 'death by a thousand cuts' experience of wildlife in the Unit will continue, and will continue to be sanctioned by BLM analysis that fails to consider the relevant interconnected development proposals in the Upper North Fork.

Comment No.:
503_WELC_King_L_20150416_email-attach-74
Organization: Western Environmental Law Center
Commenter: Laura King

Comment Excerpt Text:
CDOW is concerned with the proposed density and extent of development in the Bull Mountain Unit as the area provides high quality habitat for a variety of species, and contains important wintering habitat for big game. As you are aware, the scale of the proposed development is unprecedented for this relatively pristine area. Impacts to wildlife, especially cumulative impacts, may be far reaching. We are concerned about the potential long-term displacement of big game from areas proposed for development, and how that might affect the overall carrying capacity of the adjacent habitat and long-term population trends for big game in the area. We are also concerned about the potential loss of remote and primitive hunting opportunities within and immediately adjacent to areas proposed for development. These issues should be thoroughly evaluated and disclosed in your NEPA document.(Letter from J. Wenum, Area Wildlife Manager, Colorado Parks & Wildlife, to Thane Stranathan, BLM, Bull Mountain Geographic Area Plan (Natural Gas Wells) Scoping Comments (Nov. 6, 2009) (emphasis added).)

Colorado Parks and Wildlife, conservation organizations, hunters, and the public acknowledge the fundamental importance of the Bull Mountain Unit, and the proposal's unprecedented scale of development. Yet the DEIS does not adequately respond to red flags raised by CPW and others, despite ample notice and opportunity to do so.

Comment No.:
503_WELC_King_L_20150416_email-attach-75
Organization: Western Environmental Law Center

Commenter: Laura King

Comment Excerpt Text:
DEIS fails to account for the direct, indirect, and cumulative impacts the proposal would have on elk and mule deer. For example, the DEIS states that: "The reduction in habitats...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." DEIS at 4-117. Although this statement acknowledges the probability of reduced density during the winter months, it entirely fails to acknowledge the likely year-round, long-term impacts of the proposal

Comment No.:
503_WELC_King_L_20150416_email-attach-76
Organization: Western Environmental Law Center
Commenter: Laura King

Comment Excerpt Text:
Although BLM focuses on route density as a means to characterize habitat quality and describe and assess impacts within the Unit, its analysis fails accurately account for the impacts the proposed densities would have. Notably, under Alternative B, 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, leading to a direct loss of habitat and habitat fragmentation. DEIS at 4-116. Road development under Alternative C would result in 15,370 acres where road densities are greater than 0.5 road mile per square mile. DEIS at 4-119. Under both Alternatives A and B over three-fourths of the Unit's landscape would be negatively impacted using a route density barometer of 0.5 road miles or greater per square mile. This has the potential to effectively render three quarters of the Unit as severely compromised and/or non-habitat.

Comment No.:
503_WELC_King_L_20150416_email-attach-77
Organization: Western Environmental Law Center
Commenter: Laura King

Comment Excerpt Text:
These studies [several studies cited in previous 3 paragraphs] indicate that the Unit's ability to remain elk habitat would be significantly compromised, yet the DEIS failed to take the necessary hard look to determine direct, indirect, and cumulative impacts to the local population.

Comment No.:
503_WELC_King_L_20150416_email-attach-78
Organization: Western Environmental Law Center
Commenter: Laura King

Comment Excerpt Text:
the DEIS underestimates the direct and indirect surface disturbance associated with well pad and infrastructure development. For example, the Wyoming Game and Fish Department (WGFD) calculated that there is a 29-acre area of reduced habitat effectiveness around each drill pad.(Id. at 17.) A single well pad typically disturbs 3 to 4 acres of habitat; but the direct and indirect footprint is much larger. Alternative B proposes 36 new well pads in the Unit, effectively reducing habitat effectiveness on 1,044 acres according to the study, just from well pads. This is substantially more than the total development footprint calculated by BLM (592 acres of shortterm disturbance and 214 acres of long-term disturbance). Alternative C proposes one less pad than Alternative B, for a similar loss of habitat. Roads, pads and infrastructure within and surrounding the Unit's elk winter range and winter concentration areas will severely impact the population of the Upper North Fork.

Comment No.:
503_WELC_King_L_20150416_email-attach-79
Organization: Western Environmental Law Center
Commenter: Laura King

Comment Excerpt Text:
At the very least, such impacts to wildlife populations elsewhere [Pinedale Anticline in WY, Atlantic Rim Mule Deer Study in WY] make it foreseeable that local populations will be similarly effected; underscoring the present insufficiency in BLM's analysis in this DEIS.

Comment No.:
503_WELC_King_L_20150416_email-attach-80
Organization: Western Environmental Law Center
Commenter: Laura King

Comment Excerpt Text:
The DEIS states: "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."DEIS at 4-112. But the document also acknowledges that mule deer are already "likely modifying movement patterns around some of the more active wells and roads to avoid human activities and traffic."DEIS at 3-62. Even with the relatively limited development current in the area, wildlife are being impacted. Development at the level anticipated in the DEIS, coupled with impacts from related energy projects in the Upper North Fork, could be overwhelming for mule deer, elk and other game species. The DEIS fails to take a hard look at such impacts to these wildlife populations, and fails to sufficiently describe or explain how mitigation measures are to avoid such impacts.

Summary

The BLM should clarify analysis for fish and wildlife, as follows:

- Discussion of all wildlife surveys required before implementing any existing survey data impacts from traffic and road density
- Impacts from pipelines
- Detailed analysis of oil and gas impacts
- Impacts on elk and elk habitat
- Cumulative impacts

Response

The BLM reviewed and clarified the wildlife and birds impact analysis in response to public comments (see **Sections 4.2.7** and **4.2.8** in the Final EIS). The MDP analysis is intended to provide sufficient detail to inform the decision-maker of the reasonable effects anticipated from planning for future development; the site-specific review for individual well pads, roads, or pipelines will be addressed at the APD stage, which will also include on-site visits and a discussion of the specific conditions of approval and best management practices needed to address potential impacts.

The Draft EIS includes a road density analysis (see pages 4-110 and 4-111); this information has been clarified in the Final EIS. Additionally, the Pinedale studies noted by commenters are in the Draft EIS analysis (see the effects described under each alternative in Section 4.2.7 of the Final EIS). The Draft EIS also includes a discussion of habitat fragmentation impacts from pipelines and roads and the impacts on elk wintering habitat (see the effects described under each alternative in Section 4.2.7 of the Final EIS). Measures to reduce impacts on these resources are also included in the analysis including multiple COAs and the Wildlife Habitat Plan measures that would be applied as design features under BLM's Preferred Alternative (Alternative D). Among other requirements, the wildlife design features described in the

WHP would include timing limitations to restrict oil and gas activities in critical elk and deer winter habitat (see specifics found in Appendix C, Wildlife Habitat Plan).

Section 5.9 - Special status species

Total Number of Comments: 10

Comment No.: 482_SGI_Gordy_S_20150416_email-attach-52
Organization: SG Interests I, Ltd.
Commenter: Shaun Gordy

Comment Excerpt Text:
The DEIS includes a discussion of sage-grouse habitat, but does not state whether it is relevant to an impacts analysis. DEIS at 4-13. BLM should clarify the basis for including this information and the expected applicability, if any, of sage-grouse conservation plans to the Bull Mountain Unit.

Comment No.: 503_WELC_King_L_20150416_email-attach-129
Organization: Western Environmental Law Center
Commenter: Laura King

Comment Excerpt Text:
BLM determines that increased traffic is not expected to impact lynx populations "due to a general lack of suitable habitat." DEIS at 4-135. But, as described above, while lynx habitat is negligible within the Bull Mountain Unit, the Unit is surrounded by a larger, connected landscape of suitable lynx habitat, Lynx Analysis Units ("LAUs") and Lynx Linkage Areas ("LLAs"). BLM may not discount the potential for the Unit to serve as a lynx movement corridor between more suitable surrounding habitats.

Comment No.: 503_WELC_King_L_20150416_email-attach-130
Organization: Western Environmental Law Center
Commenter: Laura King

Comment Excerpt Text:
The DEIS provides: "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." DEIS at 3-82. BLM relies on these distances to discount any impacts that may occur to these fish species, reasoning that "[c]apturing potential contaminants at Paonia Reservoir would minimize impacts on Colorado River fish as a result of hazardous spills or sediment releases . . . ." DEIS at 4-135. Elsewhere in the DEIS, however, BLM recognizes the threat of sedimentation, salinity, and contamination posed by the proposed action, as well as the hydrologic connectivity and, therefore, the connectivity of impacts, between waters in the Bull Mountain Unit and resources found in the Gunnison and Colorado Rivers. See Section B.7. This incongruence is left unexplained and unanalyzed.

Comment No.: 503_WELC_King_L_20150416_email-attach-81
Organization: Western Environmental Law Center
Commenter: Laura King

Comment Excerpt Text:
Thus, although BLM recognizes that highways pose a risk of direct mortality to lynx,(InterAgency Lynx Biology Team (attached above as Exhibit 122).) it does not acknowledge or account for the collective indirect and cumulative impacts that the Bull Mountain MDP may have on lynx. The DEIS states that "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.'" DEIS at 4-135. This dubious conclusion does not account for impacts to lynx that can occur outside of increased truck traffic. For example, the development of associated roads, power-lines, and pipelines to facilitate exploration and development could also result in impacts to lynx. As discussed earlier, the DEIS also fails to acknowledge the Unit's potential to facilitate lynx movement between more suitable blocks of habitat.

Comment No.:
503_WELC_King_L_20150416_email-attach-83
Organization: Western Environmental Law Center
Commenter: Laura King

Comment Excerpt Text:
the DEIS fails to contain any discussion or analysis of the Yellow-billed Cuckoo, its habitat, or the effects that the Bull Mountain Unit MDP and cumulative impacts could have on the species. Instead of the required NEPA analysis for this species, BLM unequivocally states that there is no potential for and/or occurrence of Yellow-billed Cuckoo in the Bull Mountain Unit despite documented breeding of this very rare bird immediately downstream from the Unit. DEIS at 3-78. The Rocky Mountain Bird Observatory notes: "Cuckoos were regularly detected as recently as the mid-1980s along the Uncompahgre and Gunnison Rivers near Delta."(Jason Beason, 2011 Yellow-billed Cuckoo Surveys in Western Colorado 1 (Jan. 2012) at 1 (attached as Exhibit 124).)

Comment No.:
503_WELC_King_L_20150416_email-attach-84
Organization: Western Environmental Law Center
Commenter: Laura King

Comment Excerpt Text:
Because there are nearby documented populations and suitable breeding habitat, the DEIS must take a "hard look" at the impacts to this species. This analysis needs to account for impacts such as disturbance, habitat degradation, pesticide use, and predators, as all can affect Cuckoos and are impacts that can be exacerbated by oil and gas development, such as that proposed for the Bull Mountain Unit.(See Bureau of Reclamation, Lower Colorado River Multi-Species Conservation Program, Species Accounts for the Lower Colorado River Multi-Species Conservation Program (Sept. 2008) (attached as Exhibit 126).)

Comment No.:
503_WELC_King_L_20150416_email-attach-85
Organization: Western Environmental Law Center
Commenter: Laura King

Comment Excerpt Text:
Increased pesticide use as part of this proposed action stands to further reduce habitat, compounding impacts on this bird. BLM's failure to consider this species and the direct, indirect, and cumulative impacts the proposal may have must be rectified in the DEIS

Comment No.:
503_WELC_King_L_20150416_email-attach-86
Organization: Western Environmental Law Center
Commenter: Laura King

Comment Excerpt Text:
Despite almost 3,000 acres of the Unit being mapped as winter forage and range area, the DEIS undertakes no analysis of impacts to this sensitive species. BLM makes the repetitive statement that developments "may affect, but are not likely to adversely affect" the birds. DEIS at 4-135; DEIS at 4-137. However, BLM has not proven that the generic stipulations requiring nesting surveys from April 15 to July 15 and avoiding surface disturbing activities near occupied nests would have any ameliorative effect on bald eagles.

Comment No.:
503_WELC_King_L_20150416_email-attach-87

Organization: Western Environmental Law Center
Commenter: Laura King

Comment Excerpt Text:
The DEIS dismisses impacts to the trout by stating that "there would be no activities within the Henderson or Roberts Creek drainages. As a result, oil and gas development in the Unit would have 'no effect' on the greenback cutthroat trout lineage fish." DEIS at 4-135. Yet, Alt B proposes roads directly adjacent to cutthroat trout habitat.(Rocky Mountain Wild, Proposed Bull Mountain Master Development Plan Bald Eagles/Cutthroat Trout/Canada Lynx/Wild Turkey Impacts (Apr. 9, 2015) (attached as Exhibit 127).) BLM's statement in the DEIS regarding cutthroat trout ignores other direct, indirect, and cumulative impacts from development.

Comment No.:
503_WELC_King_L_20150416_email-attach-88
Organization: Western Environmental Law Center
Commenter: Laura King

Comment Excerpt Text:
BLM's narrow-sighted look at impacts to greenback trout must be expanded to incorporate the real range of possible impacts associated with this proposal

Summary

The BLM should include additional analysis for the following:

- Rocky Mountain lynx (Canada lynx)
- Special status fish species
- Yellow-billed cuckoo
- Bald eagle
- Greater sage-grouse and its habitat
- Colorado pikeminnow
- Razorback sucker

Response

The BLM has reviewed the analysis and made the following conclusions:

- There is no proposed critical habitat for the yellow-billed cuckoo in the Unit. Current studies indicate the cuckoo does not nest as high as the Unit, and there is no indication that it is present in the Unit. Additionally, there are no abundant appropriate habitat types in the Unit; existing habitat is limited to along State Highway 133. New critical habitat has been proposed for the yellow-billed cuckoo and can be found on the Internet website, http://www.fws.gov/sacramento/outreach/Public-Advisories/WesternYellow-BilledCuckoo/WYBC_critical_habitat_maps.htm#CO.
- Sage-grouse habitat is approximately 50 miles beyond the Unit boundary, which is considered outside the area of cumulative analysis; therefore, it is not discussed.
- The BLM analyzed the foraging habitat for bald eagle on page 4-135 of the Draft EIS. The analysis noted that there may be some effect, but it found that bald eagles are not likely to be adversely affected (Draft EIS, page 4-136). There are no documented nesting sites in the Unit for bald eagle, and the cited timing stipulation is for elk and mule deer.
- Lynx was analyzed in the biological assessment, and the project will have no direct impacts on its habitat. The Unit does not support effective lynx habitat, though the Final EIS acknowledges that the Ragged Mountain Lynx Analysis Unit abuts the eastern boundary of the Unit. There is a

slightly increased potential for lynx to be killed by increased project-related traffic over McClure Pass, and this is analyzed in the Final EIS.

- Greenback trout: Map 3-11 has been clarified to better illustrate what streams are occupied and where greenback trout occupy the streams. Currently, populations of green lineage cutthroat trout occur in several tributaries of East Muddy Creek, northwest of the project area (outside the Unit boundary), and genetic testing has shown these populations to be 96 to 98 percent pure. The Final EIS analyzes the impacts of the alternatives on these populations, and the conservation populations of greenback trout has been addressed in the biological assessment. The BLM determined and the USFWS has concurred that the project will have no direct impacts on the habitat.
- Colorado River Cutthroat: This is a BLM special status species that occurs in Unit; however, the conservation population is outside the Unit, so it is not discussed in the EIS.
- Colorado pikeminnow and razorback sucker: As noted in Chapter 4, Section 4.2.9, Special Status Species, "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."

Section 5.10 - Cultural and Paleontological Resources

Total Number of Comments: 3

Comment No.:
503_WELC_King_L_20150416_email-attach-67
Organization: Western Environmental Law Center
Commenter: Laura King

Comment Excerpt Text:
The BLM fails to evaluate the effect of the project on the known cultural and paleontological resources in the Unit. Instead, the BLM provides general information about what amounts to damage to cultural and paleontological resources, discusses how surface-disturbing activity like that undertaken by the project could damage cultural and paleontological resources, and promises that any impacts from this project will be addressed at the APD stage.

Comment No.:
503_WELC_King_L_20150416_email-attach-68
Organization: Western Environmental Law Center
Commenter: Laura King

Comment Excerpt Text:
this EIS represents the last opportunity to assess effects of the project on areas that the BLM already knows to be high for cultural or paleontological sensitivity. The BLM also knows that this is an area that is rich with fossils. A map of the unit indicates that almost the entire unit is classified by the Potential Fossil Yield Classification System as "5": very high occurrence that consistently and predictably produce fossils. See DEIS at 3-99.

Comment No.:
503_WELC_King_L_20150416_email-attach-69
Organization: Western Environmental Law Center
Commenter: Laura King

Comment Excerpt Text:
That is, the agency knows where the high fossil-bearing formations are and where the significant ranch and road are. The agency also knows where pads are proposed to be constructed. The agency must evaluate impacts to the known or likely present resources based on this information. The BLM says that "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." DEIS at 4-147. But this statement does not square with the reality that the BLM has already identified areas of higher paleontological sensitivity (those with high PFYC ratings) and also knows the locations of proposed surface disturbance.

Summary

The BLM fails to evaluate the effect of the project on the known cultural and paleontological resources in the Unit; instead the BLM gives a general description of surface-disturbing activities and states that specific impacts would be addressed at the APD stage. Fossil-bearing formations are known through Probable Fossil Yield Classification (PFYC) data, and the surface-disturbing areas are also known. The Draft EIS statement "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" does not square with the known fossil and proposed surface-disturbing areas.

Response

As noted in Section 3.2.12, Cultural Resources, "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." Appendix C, Conditions of Approval 35 requires "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. The cultural resource survey and application of COA if needed would occur at the APD stage

The PFYC system is meant to provide baseline guidance for predicting, assessing, and mitigating paleontological resources. The BLM notes in Section 3.2.13, Paleontology (Draft EIS page 3-96), that while the area has PFYCs 3-5, "…there are few areas of exposed rock outcrops or strata and no known localities within the project area," indicating that there is a very low likelihood for discovery of paleontological resources. Additionally, as the locations in the alternatives are 40-acre analysis areas and are not site specific, potential impacts on paleontological resources under each alternative can only be generally estimated, which is directly correlated to the level of anticipated surface disturbance proposed under each alternative.

Section 5.11 - Visual resources

Total Number of Comments: 5

Comment No.: 482_SGI_Gordy_S_20150416_email-attach-65
Organization: SG Interests I, Ltd.
Commenter: Shaun Gordy

Comment Excerpt Text:
In distinguishing Alternative C from Alternative B, the DEIS represents that impacts to visual and paleontological resources would be less under Alternative C. DEIS at 4-174, 4-200. This is incorrect. As the attached exhibit demonstrates, development under Alternative B would not significantly impair scenic views from roadways in the area. See Appendix B.Nor is there evidence that development would have meaningful effect on paleontological resources. The discussion included in Appendix C explains that the surface geology of the Bull Mountain Unit will not yield significant fossils. See Appendix C.

Comment No.: 494_Thompson_G_20150415_email-attach-7
Commenter: Greg Thompson

Comment Excerpt Text:
Open pits and flared gas. This is relatively undeveloped, beautiful land. Open pits should not be allowed. Closed-loop systems should be mandated instead of allowing open pits. Flared gas should not be allowed due to air quality and climate change issues and because the road bisecting the project is a Colorado Scenic Byway. “Green” completion techniques should be mandated instead of allowing flared gas.

Comment No.:
503_WELC_King_L_20150416_email-attach-102
Organization: Western Environmental Law Center
Commenter: Laura King

Comment Excerpt Text:
The DEIS does not take a “hard look” at these myriad visual impacts from the project, which is especially imperative given the area’s high scenic value, the high public sensitivity to preserving the area’s scenic value, and the visibility of the project area. Especially concerning is the BLM’s arbitrary choice to consider the project area as Visual Resource Management (VRM) Class III, rather than the more sensitive (and appropriate) VRM Class II.

Comment No.:
503_WELC_King_L_20150416_email-attach-103
Organization: Western Environmental Law Center
Commenter: Laura King

Comment Excerpt Text:
in analyzing impacts, the BLM assumes a Class III rating for the project area. See DEIS at 4-153. This is inappropriate. The BLM should not blindly follow the rating provided by an outdated RMP. The BLM must evaluate impacts to visual resources based on the more protectively Class II standard that lands should retain their existing character, and the level of change to the landscape should be low.

Comment No.:
503_WELC_King_L_20150416_email-attach-104
Organization: Western Environmental Law Center
Commenter: Laura King

Comment Excerpt Text:
BLM declines to “accurately and comprehensively quantify impacts,” on the basis that “future site-specific plans need to be provided detailing the location of project features and the amount of cut-and-fill.” DEIS at 4-153. This is inappropriate. Again, the BLM may not avoid its obligation to analyze environmental consequences that foreseeably arise from the MDP merely by saying that the

consequences are unclear or will be analyzed later at the APD stage. See Kern, 284 F.3d at 1072. Enough is known about the project as proposed, including the number and approximate placement of wells, to allow the BLM to take a "hard look" at impacts to\ the visual resource

Summary

The BLM should review the visual impacts analysis and visual resource management (VRM) class rating for completeness and accuracy.

Response

The Unit's designation as VRM Class III is consistent with current management, and changing the VRM classification is outside the scope of this project. As stated in Chapter 3, the underlying visual resource inventory classification, which forms the basis for impact analysis, is based on a more recent 2009 survey. Quantifying impacts on visual resources, including the scenic quality rating, at the programmatic level is not possible for the reasons stated in Section 4.2.13. Site-specific plans would allow a more detailed analysis than what is possible at the programmatic level.

Section 5.12 - Traffic, Access

Total Number of Comments: 7

Comment No.:
334_WElkScenicByway_Hoffmann_J_20150302_email-attach-12
Organization: West Elk Loop Scenic and Historic Byway
Commenter: John Hoffmann

Comment Excerpt Text:
To conclude, since the majority of the Bull Mountain Master Development Plan Unit is private property, and because 11 pads and haul roads have already been built, and knowing that production will ensue anyway at some undesirable sites (page 61, Alternative A map), it is incumbent upon us to ensure that the extraction is as efficient as can be by utilizing the present pads, not approving additional pads, and not allowing any pads on what is known to be unstable grounds. Development and operational activities should be regulated to minimize traffic impacts on the West Elk Loop Scenic and Historic Byway (Highway 133).

Comment No.:
334_WElkScenicByway_Hoffmann_J_20150302_email-attach-9
Organization: West Elk Loop Scenic and Historic Byway
Commenter: John Hoffmann

Comment Excerpt Text:
It has not been noted in effects on FISH AND WILDLIFE (page 198) that the lights and roar of well operations continue 24-7 and each well can generate 1,000 heavy semi-truck trips which will negatively impact wildlife. Both factors need to be considered and mitigated by reducing the number of pads allowed and scheduling operations to be mindful of wildlife movement and needs.

The extremely winding and failure-prone section of Highway 133 along Paonia Reservoir must be addressed in light of the 146,000 possible semi-truck trips, given CDOT's limited funding. It seems unlikely the road was engineered for this level of use

and this would be an expensive stretch of road to bring up to heavy use standards.

Comment No.:
407_GunnisonEnergy_Fyock_L_20150415_email-attach-2
Organization: Gunnison Energy LLC
Commenter: Lee Fyock

Comment Excerpt Text:
7. Has a Transportation Plan been developed? If so, BLM should make the Transportation Plan available to the public.

Comment No.: 482_SGI_Gordy_S_20150416_email-attach-15
Organization: SG Interests I, Ltd.
Commenter: Shaun Gordy

Comment Excerpt Text:
In reality, the difference in the miles of roads constructed and utilized under Alternative B and Alternative C is less than the DEIS supposes, undermining the DEIS' overall impact analysis. See DEIS at 4-177. If BLM's intent was to cover all possible road upgrades for Alternative B, then the same logic should be applied to Alternative C [2: Dead-end roads should not be considered under either alternative.] The same is true for the DEIS' assumption that development under Alternative C would use less water than under Alternative B. See DEIS at 4-118. Because the same number of wells would be developed under either scenario, there is no basis for concluding that water use under Alternative C would be less than under Alternative B.

Comment No.: 482_SGI_Gordy_S_20150416_email-attach-4
Organization: SG Interests I, Ltd.
Commenter: Shaun Gordy

Comment Excerpt Text:
On page 4-167, for example, the DEIS represents that the impacts on private land resulting from development are "intrusive." Given that the private landowners have contracted for development on their property, such a description is unfair.

Comment No.:
504_WestSlopeConsCtr_Sauter_S_21050416_email-attach-7
Organization: Western Slope Conservation Center
Commenter: Sarah Sauter

Comment Excerpt Text:
The BLM failed to analyze the impacts of increased traffic along Highway 133 in Delta County. The BLM's traffic analysis is limited to impacts in Gunnison County, yet the two lane Highway 133, beginning in Hotckiss, is the likely access point to the project area. This stretch of highway, especially between Hotchkiss and Paonia has numerous entrances connecting to and exits from the highway with limited vision and short lines of sight creating hazards for vehicles accessing and leaving the roadway. There are no 3rd lane pull-overs or exit/entrance passing areas in this stretch of road. Increased vehicle traffic, especially truck traffic, increases the present risk of vehicle collisions beyond the many near misses that already occur. The EIS should include an examination of the impact of increased truck traffic and some coordination with CDOT to reduce accident risks in this area.

Comment No.: Form_CHC-6

Comment Excerpt Text:
The amount of traffic associated with this project, including an estimated 43,294 heavy truck trips, is unacceptable along Highway 133. This highway is a scenic byway, and it is the lifeblood of our local recreation and tourism-based economy. Nowhere has BLM adequately considered the potential impacts that this industrial traffic will have on local businesses and communities.

Summary

Commenters stated that the analysis for the following is incorrect or incomplete:

- Assumptions for road density under Alternatives B and C
- Impacts of increased traffic along State Highway 133

Response

Traffic counts have been analyzed in Section 4.3.5, Traffic and Transportation, including analysis after application of the measures from Appendix C and the alternatives. Traffic counts analyzed in the Draft EIS also take into consideration the number of new roadway miles, source and type of traffic (e.g., gravel trucks for well pad construction versus pickup trucks for operation).

The effects from increased traffic along State Highway 133 and other areas within the Unit are discussed in several sections of the FEIS including Section 4.2.7, Fish and Wildlife, Section 4.2.9, Special Status Species, Section 4.3.3, Recreation, Section 4.3.4, Lands and Realty, Section 4.3.5, Transportation and Access, and Section 4.4.2, Socioeconomics.

Section 5.13 - Hydraulic fracturing

Total Number of Comments: 4

Comment No.: 187_McGavin_R_20150414_email-attach-1
Organization: Certified Master Jeweler
Commenter: Rick McGavin

Comment Excerpt Text:
The fact is that the present RMP does not take into account the technological changes in drilling. The 1989 Resource Management Plan did not analyze the impacts of horizontal hydraulic fracturing because this technology did not exist when the Plan was written. As a result, BLM must analyze the impacts of horizontal hydraulic fracturing in this EA. Additionally, the BLM cannot put off analyzing the impacts of oil & gas development until some future date. All impacts must be analyzed before allowing the development of the oil and gas that depend on our roads , water and air to generate a profit for individuals and companies with no long term stake in this valley.

Comment No.: 482_SGI_Gordy_S_20150416_email-attach-27
Organization: SG Interests I, Ltd.
Commenter: Shaun Gordy

Comment Excerpt Text:
Contrary to the DEIS, water disposal wells are not always hydraulically fractured. DEIS at 4-180

Comment No.: 482_SGI_Gordy_S_20150416_email-attach-28
Organization: SG Interests I, Ltd.
Commenter: Shaun Gordy

Comment Excerpt Text:
The DEIS states that hydraulic fracturing is exempt from a significant list of laws. DEIS at 4-178. This is not true. Hydraulic fracturing is highly regulated under federal, state, and local law. Hydraulic fracturing is a technique used to stimulate oil and gas production in wells and is only one component -- a temporary and short-lived component -- of oil and

gas development. Neither hydraulic fracturing specifically, nor oil and gas development generally, is exempt from the provisions of the Clean Water Act, Clean Air Act, the Emergency Planning and Community Right-to-Know Act, the Resource Conservation and Recovery Act, CERCLA, or the Safe Drinking Water Act. To the contrary, oil and gas activity, like other commercial and private activity, is subject to all these laws.

Comment No.:
503_WELC_King_L_20150416_email-attach-32
Organization: Western Environmental Law Center
Commenter: Laura King

Comment Excerpt Text:

The UFO must also consider the use of new nitrogen fracking techniques. The use of nitrogen foam in the fracking process initially results in upwards of 60% nitrogen content in produced gas, which must be flared for an average of 60-90 days until the nitrogen content is reduced to 10% or less before the gas can enter a pipeline. As discussed below, the use of nitrogen creates a problematic tradeoff between water conservation and impacts to air quality and GHG emissions. Moreover, depending on the strength of measures required in BLM's impending methane rulemaking, the use of this technology might, in fact, be prohibited given the necessity for flaring. Regardless, the UFO must take a hard look at the impacts and tradeoffs implicit in methane fracking in the DEIS.

Summary

Commenters state that the hydraulic fracturing discussion should be clarified and corrected, including applicable laws and regulations and impacts from new fracking technologies.

Response

The Final EIS text has been edited to correct statements relating to applicable laws and possible impacts related to the new hydraulic fracturing technologies.

In 2015, the BLM released the new rule, Oil and Gas: Hydraulic Fracturing on Federal and Indian Lands (to be codified in 43 CFR, Part 3160). If and when the rule takes effect, it will apply to hydraulic fracturing operations on federal minerals. The requirements would not apply to actions conducted on exclusively private mineral estate.

Section 5.14 - Socioeconomic, Environmental Justice, Social Cost of Carbon

Total Number of Comments: 40

Comment No.:
007_DeltaChamberCommerce_Applegate_20150323_hard-1
Organization: Delta Area Chamber of Commerce
Commenter: Josh Applegate

Comment Excerpt Text:
Energy jobs pay 63 % higher than the average wage in Delta County; these higher wages have a stimulus effect on the wider local economy, as energy workers spend locally, creating jobs and raising incomes throughout the local economy. These jobs and incomes in turn spur even more economic activity. We believe that this effect has not been adequately analyzed and expressed in the EIS, and that the full economic impact of these jobs needs to be addressed.

Comment No.: 033_Bonine_M_20150401_hard-1
Commenter: Margaret Bonine

Comment Excerpt Text:
nowhere in the document is there any mention of the fact that each energy job will support many others in the local communities, as the people employed directly by the contractors and subcontractors for the development spend their higher incomes in local restaurants, hotels, car dealerships, grocery stores, electronics stores, and other small businesses. This is an oversight that I hope your Field Office will take into account as you determine which Alternative to select for your final EIS draft.

Comment No.: 096_Edson-Simmons_20150408_email-2
Commenter: Jan Simmons

Comment Excerpt Text:
The EIS should include the social cost of carbon (SCC). The Draft EIS quantifies the alleged economic benefits that this project would provide, but does not give equal consideration to the costs of such development, including costs to existing industries or analysis of SCC. Full analysis of SCC is essential to informed decision- making.

Comment No.: 106_Flenniken_K_20150323_hard-1
Organization: Grand Junction Economic Partnership
Commenter: Kelly Flenniken

Comment Excerpt Text:
Increased domestic energy production contributes directly to national energy security and an affordable domestic energy supply. This project will be an important and integral part of Western Slope natural gas production, which is now playing an important role in the discussion surrounding export opportunities for American natural gas. The BLM should include these bigger-picture national economic factors in your deliberations.

Comment No.: 118_GJChmbrComm_Schwenke_D_20150320_email-attach-1
Organization: Grand Junction Chamber of Commerce
Commenter: Diane Schwenke

Comment Excerpt Text:
This Master Development Plan submitted by SG Interests will, if implemented, bring numerous economic benefits to the Western Slope, many of which we feel have not been fully and adequately expressed in the EIS. The Western Slope, including the area in whichthe Bull Mountain development is being proposed, continues to experience a fragile economy, with unemployment and per capita income still behind many parts of the state, particularly on the Front Range. SG Interest's proposal will bring jobs to the region that pay higher-than-average wages, and these jobs will in turn stimulate economic activity, as those higher wages are spent in the community.

Comment No.: 130_Gwinn_M_20150404_hard-2
Commenter: Mike Gwynn

Comment Excerpt Text:
BLM failed to consider the social cost of carbon (SCC). BLM quantified the alleged economic benefits that this project would provide, but never gave equal consideration to the costs ofsuch development, including costs to existing industries or analysis of SCC. Full analysis of SCC is essential to informed decision-making.

Comment No.: 188_McGuire_E_20150415_email-7
Organization: Desert Weyr, LLC
Commenter: Eugenie McGuire

Comment Excerpt Text:
The draft EIS indicates that there will be some adverse impacts to local businesses and economy but fails to do the detailed analysis that is required of the BLM to document those costs. We have already

experienced a loss of sales due to the existing development and expect that if this proposal is allowed to move forward that it will only get worse. The BLM must provide a more accurate discussion of all the costs to the region and not just whitewash them by saying that there will be costs.

Comment No.: 189_Mcguire_K_20150415_email-4
Organization: Weyr Associates, LLC
Commenter: Kenyon McGuirer

Comment Excerpt Text:
The draft EIS indicates that there will be some adverse impacts to local businesses and economy but fails to do the detailed analysis that is required of the BLM to document those costs. We know that in other areas where extensive oil and gas development occurs that there is an increase in crime. In addition to the direct costs there is the added cost that our regular customers and tourists will no longer feel safe in our valley and will choose to go elsewhere. The BLM must provide a more accurate discussion of all the costs to the region and not just whitewash them by saying that there will be costs.

Comment No.: 219_Overton_L_20150410_hard-2
Commenter: Lee S. Overton

Comment Excerpt Text:
The BLM has identified the benefits anticipated from this oil and gas drilling project, but has not identified the costs to the North Fork community regarding its health affects from pollution, the damage to its infrastructure, the pressure on its economy, and the stress on the positive attitude of its population.

Comment No.: 220_Paladino_P_20150403_email-2
Commenter: Paul Paladino

Comment Excerpt Text:
BLM failed to and should consider the social cost of carbon (SCC). BLM quantified the alleged economic benefits that this project would provide, but never gave equal consideration to the costs of such development, including costs to existing industries or analysis of SCC. Full analysis of SCC is essential to informed decision-making.

Comment No.:
265_Schoonhoven_C_20150413_hard-1
Commenter: Carol Schoonhoven

Comment Excerpt Text:
The BLM EIS at 4-197 notes “there is some indication that
increased truck trafhc and visual impacts of drilling rigs may impact visitor experience”
and cites comments in support of these concerns fi’om local farmers and wineries as well
as comments from “local business owners involved in natural homes and alternative
energy” which have “already experienced a decrease in business related to uncertainly
about development and related impacts on the social setting’“ (EIS at 4’197). BLM
failed to give consideration to the costs to these existing businesses, only quantiffing the
alleged bãnefits that might accrue from this project. The BLM has an obligation to
examine both sides of this proposed development, especially because, as the EIS is now
written, it will displace an existing local economy which is promoted by the Colorado
Towism Office for agritourism, with an industry with ahistory of environmental
degradation and pollution.

Comment No.: 292_Soule_J_20150414_email-attach-1
Commenter: Joli Soule

Comment Excerpt Text:
• Commission an economic study that quantifies the economies that will be disrupted or lost because of developments like the Bull Mountain Unit. Paonia is no longer a desirable place to retire when it’s on the path to a gas patch.

• Commission an economic study that quantifies all the items that can be considered “social disruption”. Paonia does not have the capacity to house, feed, or provide police and medical services to the 284 people (Table 2-13 p. 2-77) and their families who would be migrating here from elsewhere. Require a mechanism of financial assurance from SGI that ensures the costs of servicing its workers will be paid by the company, not the town. Require SGI to house workers properly and not in impromptu camps.

Comment No.: 334_WElkScenicByway_Hoffmann_J_20150302_email-attach-11
Organization: West Elk Loop Scenic and Historic Byway
Commenter: John Hoffmann

Comment Excerpt Text:
During the discussion about the effects on REAL ESTATE VALUES (page 742), there is no discussion on the value of clean air, clean water, pristine, remote, high mountain valleys, etc, to present and future landowners. We believe real estate values would be decreased by much more than 75% due to health impacts of well development, including disruption of life by lights, noise, flaring, road dust, and gas venting. Since many of the homes are built on unstable slopes, earthquakes may cause damage not envisioned by the developers.

Comment No.: 386_Delaney_L_20150416_email-2
Commenter: Lisa Delaney

Comment Excerpt Text:
The plan also needs to take into account the social impacts of carbon, as was required of the local coal industry.

Comment No.: 387_DeltaCoComms_20150416_hard-4
Organization: Delta Board of County Commissioners
Commenter: Mark Roeber

Comment Excerpt Text:
Socio-economics and Cultural Resources:
While recognizing the socio-economic benefit of energy development to our Nation and communities, it is also understood that such development impacts other important economic sectors in communities, e.g. recreation and tourism, etc. All such impacts should be addressed.

Comment No.: 389_Deva_A_20150415_email-3
Commenter: Arlyn Alderdice

Comment Excerpt Text:
Commission an economic study that quantifies all the items that can be considered “social disruption”. Paonia does not have the capacity to house, feed, or provide police and medical services to the 284 people (Table 2-13 p. 2-77) and their families who would be migrating here from elsewhere. It would mitigate some of this disruption to require a mechanism of financial assurance from SGI that ensures the costs of servicing its workers will be paid by the company, not the town. Require SGI to house workers properly and not in impromptu camps. Also, take into consideration that much of the economic benefit does not stay in the area and leaves with the natural gas.

Comment No.: 406_Gulick_S_20150416_email-attach-3
Commenter: Stephen Gulick

Comment Excerpt Text:
5) Social Cost of Carbon. The judicial system has made clear in recent rulings on coal mining that the social cost of carbon has to be taken into consideration. For the same reasons, it should be considered in any gas development EIS too. The risks from greenhouse gases pose one of the greatest threats to human civilization. Yes, gases are invisible, but to ignore them at this point in our scientific understanding is inexcusable, and possibly criminal.

Comment No.: 413_Helleckson_B_20150416_email-4
Commenter: Brent Helleckson

Comment Excerpt Text:
Yet when analyzing the question of impact to the "character of rural towns," the DEIS states that level of impact is "difficult to determine at the MDP analysis level." Similar disparity is evident with regard to lodging tax impacts (DESI at 4195), and West Elk Scenic Byway visitor experience (DEIS at 4199). The latter is particularly inadequate. A 10% reduction in visitor use or spending along the Scenic Byway would likely result in a $20,500 decrease in revenue for my business, Stone Cottage Cellars, alone! The overall impression is that the benefits proposed by SG Interests are large and certain and the costs, where they are even identified, are small and unlikely. Such is almost surely not the case and the arbitrary treatment of the analyses is insufficient to defend any conclusion.

Comment No.: 431_Leger_N_20150416_email-attach-3
Commenter: Natasha Leger

Comment Excerpt Text:
5. The economic study is incomplete. Where is the economic study, and comparative economic and tax analysis for other economic development options? It is misleading to evaluate the economic pros and cons without any context to other economic development options. Especially, in light of the fact that on average these gas wells are productive for only 1.5 to 2 years, yet the communities are forever negatively impacted. The proposal will only lead to about 50 jobs from the valley (20% of the 246 new jobs required). Regarding the tax benefits to the state, what is the comparison of those benefits to other economic development options?

Comment No.: 482_SGI_Gordy_S_20150416_email-attach-1
Organization: SG Interests I, Ltd.
Commenter: Shaun Gordy

Comment Excerpt Text:
Yet in describing Alternative B, and its potential impacts, the DEIS does not fully describe the socioeconomic benefits and environmental protections associated with this alternative. The DEIS overstates the comparative impact of selecting Alternative B and understates the benefits of master comprehensive planning.

Comment No.: 482_SGI_Gordy_S_20150416_email-attach-37
Organization: SG Interests I, Ltd.
Commenter: Shaun Gordy

Comment Excerpt Text:
The charts in the DEIS listing economic benefits of oil and gas development are listed in a denomination (thousands of dollars) that makes the total difficult to discern. DEIS at 4-195 (Table 4-58), 4-200 (Table 4-61). The numbers should be reformatted so that the chart depicts revenues in millions of dollars.

Comment No.: 482_SGI_Gordy_S_20150416_email-attach-41
Organization: SG Interests I, Ltd.
Commenter: Shaun Gordy

Comment Excerpt Text:
The DEIS implies that public concern about water quality issues could have some socioeconomic impact on community and social conditions. DEIS at 4-197. BLM has not provided any explanation linking unsubstantiated concern to regional economics and refers to no data supporting this conclusion. BLM has not made any comparison between the economic benefits of regional development -- through employment, tax, and royalty revenue -- to the qualitative impact of this alleged concern.

Comment No.: 482_SGI_Gordy_S_20150416_email-attach-42
Organization: SG Interests I, Ltd.
Commenter: Shaun Gordy

Comment Excerpt Text:
The DEIS contains reference to a letter from the Paonia Chamber of Commerce regarding the leasing of North Fork parcels for oil and gas development. DEIS at 4-187 - 188. BLM should clarify that this area is 30 or more miles away and discuss what relevance, if any, it has to the Bull Mountain Unit.

Comment No.: 482_SGI_Gordy_S_20150416_email-attach-48
Organization: SG Interests I, Ltd.
Commenter: Shaun Gordy

Comment Excerpt Text:
In discussing federal mineral royalties, the DEIS states that in the absence of an MDP, a majority of drilling would occur on private land. DEIS at 4-195. BLM should clarify that federal minerals can still be developed in the absence of the MDP and that there is no basis to conclude that drilling would occur primarily on private land. BLM should also clarify whether “private land” means private mineral estate.

Comment No.: 482_SGI_Gordy_S_20150416_email-attach-49
Organization: SG Interests I, Ltd.
Commenter: Shaun Gordy

Comment Excerpt Text:
The DEIS indicates that there will be a loss of federal lands available for grazing. DEIS at 4-199. BLM should clarify the basis for this statement

Comment No.: 482_SGI_Gordy_S_20150416_email-attach-5
Organization: SG Interests I, Ltd.
Commenter: Shaun Gordy

Comment Excerpt Text:
The development of federal minerals as set forth in Alternative B would increase tax revenues and federal royalty payments. These socioeconomic benefits were omitted from the DEIS summary in Table 2-13 on page 2-77. Similarly, the DEIS omitted from its discussion of economic contributions on page 3-129, SG’s payment of wages, royalties and surface easement payments. The DEIS also omitted economic contributions from lodging and taxes associated with the development and operation of the Bull Mountain Unit.

Comment No.: 482_SGI_Gordy_S_20150416_email-attach-56
Organization: SG Interests I, Ltd.
Commenter: Shaun Gordy

Comment Excerpt Text:
The DEIS should clarify what weight it is providing to the North Fork Heart and Soul Project surveys. See DEIS at 4-189. The organization that conducted these surveys has a positional bias against oil and gas development in the area and the DEIS should acknowledge that such a bias may have affected the survey design and results.

Comment No.: 482_SGI_Gordy_S_20150416_email-attach-67
Organization: SG Interests I, Ltd.
Commenter: Shaun Gordy

Comment Excerpt Text:
Similarly, there is no explanation of how those with grazing rights will be economically impacted (DEIS at 4-186 to 187)

Comment No.: 482_SGI_Gordy_S_20150416_email-attach-70
Organization: SG Interests I, Ltd.
Commenter: Shaun Gordy

Comment Excerpt Text:

The DEIS also suggests that oil and gas operations have the potential to impact farmers with organic certification. DEIS at 4-194. Here, however, operations will be 30 or more miles from an organic farm. Organic certification is made through the farmer's record keeping of pesticide application. The DEIS failed to describe how such operations can cause the loss of an organic certification or how SG's operations in particular pose any risk to organic farmers. The discussion of the Terror Ditch company has no place in the environmental consequences section of the DEIS.

Comment No.: 482_SGI_Gordy_S_20150416_email-attach-72
Organization: SG Interests I, Ltd.
Commenter: Shaun Gordy

Comment Excerpt Text:
Statements in the DEIS concerning potential impacts to property and business are conclusory in nature and not supported. The DEIS contends that: drilling negatively impacts property values (DEIS at 4-202), the impact of development to non-market values is indefinite despite reclamation activities (DEIS at 4-202), operations cause a decrease in revenue for local businesses (DEIS at 4-197), hydraulic fracturing impacts the ability to obtain homeowners insurance or mortgages (DEIS at 4-190), and 37 of 44 residents are within 1 mile of proposed well pads (DEIS at 4-197). Rather than provide specific examples or reference reliable data, the DEIS relies upon generalized anecdotal statements that have not been verified. Before representing that these impacts are likely, the DEIS should verify that they are factually supported and provide the public with references supporting these statements.

Comment No.: 482_SGI_Gordy_S_20150416_email-attach-77
Organization: SG Interests I, Ltd.
Commenter: Shaun Gordy

Comment Excerpt Text:
There is no basis for concluding that the well pad distribution in Alternative C would produce a lower noise profile (DEIS at 4-66) or result in a reduced workforce (DEIS at 4-204). To the contrary, given the close proximity of well pads in Alternative C, development areas are likely to experience greater noise profiles than under Alternative B. And SG will require the same number of workers to develop and operate wells under Alternative C as under Alternative B. The DEIS should provide comparison data to support any conclusion to the contrary.

Comment No.: 494_Thompson_G_20150415_email-attach-6
Commenter: Greg Thompson

Comment Excerpt Text:
Traffic. Page 4-174. Hwy 133 is a very scenic, enjoyable 42 mile drive from Paonia to Redstone. I am certain many other people share this feeling. Bicyclists use it for this reason. In fact, the Colorado Pro Challenge came over McClure Pass in 2014. Other large bicycle tours (500 to 1000 riders each) have come over Hwy 133 from Carbondale to Paonia. These bicycle events bring economic benefit to the NFV. I would guess that these bicycle events would cease coming this way in the future due to heavy truck traffic related to this project. The impact will not be just for bicyclists. Tourists and recreationalists may decide to travel and spend their leisure dollars elsewhere so as to avoid the heavy, slow truck traffic headed into the NFV. All it takes is for one or two slow moving trucks to cause significant delays and the makings for a frustrating and unpleasant drive. Travelers experiencing this for the first time may never want to return. This likely loss of tourism will hurt the economy of the NFV. I also suspect that this truck traffic will cause more rock falls onto the highway due to heavy vibrations from large trucks and thus more closures of the highway. Closures negatively impact economic activity of the NFV. Have these negative impacts been factored into the socio-economic analysis for Bull Mountain?

Comment No.: 498_VanDusen_P_20150415_hard-5
Organization: Delta County Commissioners CHC
Commenter: Paul Van Dusen

Comment Excerpt Text:
The social costs contingent to development of drilling operations now has a predictability predicated on its' history in similar places and situations. BLM never mentions or factors these into the equation - only the possible economic benefits. For instance, the workers hired for the type of temporary jobs the industry produces are, for the most part, those who have experience in the field, notably from other places. Essentielly transient workers, these are skilled journeymen professionals who move about the country, as does the industry, in search of fluid hydrocarbons, not the local residents in the throes of career changes caused by the demise of coal dependency.

Comment No.:
503_WELC_King_L_20150416_email-attach-108
Organization: Western Environmental Law Center
Commenter: Laura King

Comment Excerpt Text:
BLM consistently defends oil and gas development on public lands, as here, by quantifying gas royalties and job creation, while avoiding quantification of the social cost of oil and gas development. See DEIS at 4-198, -200 (quantifying job creation and royalties benefits under Alternative B); 4-190 (declining to quantify non-market values under any alternative).

Comment No.:
503_WELC_King_L_20150416_email-attach-109
Organization: Western Environmental Law Center
Commenter: Laura King

Comment Excerpt Text:
However, the BLM downplays these concerns, including by asserting that local residents' health and quality of life related to air quality and water quality are not likely to be significantly affected, or that impacts will be sufficiently mitigated to reduce risk. See DEIS at 4-197. This conclusion is contradicted by the BLM's own analysis of impacts to water and air, as well as the supplemental information provided in these comments, including Appendix A addressing air quality. Moreover, the BLM ignores the fact that, for the most part, jobs from this project will go to those already employed by the oil and gas industry as contractors—not locals. The BLM does not appropriately weigh this marginal economic benefit to the risk to local air, water, and health

Comment No.:
503_WELC_King_L_20150416_email-attach-16
Organization: Western Environmental Law Center
Commenter: Laura King

Comment Excerpt Text:
The BLM's analysis [of the impacts to climate change from oil and gas development in Bull Mountain] is flawed in several respects. First, contrary to the BLM's assertion, there is a proven and sound methodology for quantifying GHG emissions: the social cost of carbon ("SCC"). As described in detail below, application of the SCC demonstrates that the GHG emissions from the Bull Mountain development will have significant negative impacts on the human environment.

Comment No.:
503_WELC_King_L_20150416_email-attach-22
Organization: Western Environmental Law Center
Commenter: Laura King

Comment Excerpt Text:
Calculating the SCC is all the more important here because, as noted, BLM compares the project's projected GHG emissions against the baseline of global GHG emissions—thereby marginalizing the project's contribution to our climate crisis while concluding the agency is powerless to avoid or mitigate such impacts. Applying the SCC, as provided above, takes abstract emissions and places them in concrete, economic terms. It also allows the

agency to easily perform the cost-benefit analysis mandated by EO 12866, as the policy of BLM.

Comment No.: 504_WestSlopeConsCtr_Sauter_S_21050416_email-attach-6
Organization: Western Slope Conservation Center
Commenter: Sarah Sauter

Comment Excerpt Text:
The BLM failed to consider the social costs of carbon. In September 2014, U.S. District Court Judge R. Brooks overturned Arch Coal's proposal to expand their coal mining operations under the Sunset Trail Roadless Area because the NEPA analysis failed to take a "hard look" at green house gas emissions and ignored the social costs of the project's potential contribution to climate change. The air quality review of the Bull Mountain Unit MDP DEIS provided in the comments submitted by Citizens for a Healthy Community et. al, indicate that the green house gas emissions from the Bull Mountain development will have significant negative impacts on the human environment. The BLM must provide a "hard look" at the social costs of carbon.

Comment No.: 575_Roberts_M_20150415_hard-1
Commenter: Mike Roberts

Comment Excerpt Text:
I feel that the EIS did not adequately illustrate all of the economic benefits, or show just how much of an economic driver this project will be. Each of the energy jobs that will be generated by the project will in turn generate others. This "multiplier effect" has been quantified by severalsfudies, including one from the University Of Colorado Leeds School Of Busrness in Boulder. I find it unfortunate that the EIS fals to adequately account for this economic impact in the socio-economic segment of the document, since that is a critically important consideration.

Comment No.: Form_CHC-4

Comment Excerpt Text:
A conservation alternative must consider the social cost of carbon. BLM quantified the alleged economic benefits that this project would provide, but it did not give equal consideration to the costs of this development (including the costs to existing industries). A full analysis of the social cost of carbon is essential to informed decision-making.

Summary

Commenters state that analysis in the Draft EIS was incomplete and suggested that additions include the following:

- Additional analysis of the impacts on the local economy from high wages in the energy industry, including the indirect support for other jobs
- Inclusion of an analysis of the social cost of carbon
- Detailed, quantified, analysis of non-market/social impacts, including analysis of the economic impact on existing agricultural, tourist and real estate industries from the project
- Discussion of the job locality (i.e., local versus non-local employees)

Commenters also requested clarification of the analysis and additional citations to support conclusions.

Response

The Draft EIS included an analysis of the higher wages and indirect jobs supported by the oil and gas industry. The IMPLAN modeling analysis takes into account average wages by industry in the area. As

explained in the Draft EIS (pages 4-184 and 4-185 and 4-191 to 4-193), impact estimates include both direct employment and indirect and induced employment. Detailed information on the IMPLAN method is included in Appendix K, Economic Impact Analysis Methodology—Technical Report.

The BLM recognizes that in some oil and gas leasing the social cost of carbon (SCC) calculation was analyzed. The Social Cost of Carbon (SCC) protocol was developed by the Office of Management and Budget using an interagency working group in response to Executive Order 12866, which requires federal agencies, to the extent permitted by law, "to assess both the costs and the benefits of the intended regulation and, recognizing that some costs and benefits are difficult to quantify, propose or adopt a regulation only upon a reasoned determination that the benefits of the intended regulation justify its costs." SCC estimates the monetary cost incurred by the emission of one additional metric ton of carbon dioxide (CO2), and is not applicable to nonCO2 GHG emissions, such as methane. It includes (but is not limited to) changes in net agricultural productivity, human health, property damages from increased flood risk, and the value of ecosystem services due to climate change. The SCC was developed to assist agencies in meeting Executive Order (EO) 12866's requirement to assess costs and benefits during the development of regulations, and to support agencies in responding to EO 13514; not for use in making land management decisions.

Executive Order 13514 required Federal agencies to submit a 2020 greenhouse gas pollution reduction target within 90 days, and to increase energy efficiency, reduce fleet petroleum consumption, conserve water, reduce waste, support sustainable communities, and leverage Federal purchasing power to promote environmentally-responsible products and technologies. This EO does not apply to land management decisions.

As a Federal District Court in Oregon recently held, in *League of Wilderness Defenders/Blue Mts. Biodiversity Project v. Connaughton* (2014 US Dist. LEXIS 170072 [D. Or. Dec. 9, 2014]), an SCC analysis is not a required part of a NEPA analysis where there is no clear way to quantify costs and benefits. Estimating SCC is challenging because it is intended to model effects on the welfare of future generations at a global scale caused by additional carbon emissions occurring in the present and does not account for the complexity of multiple stressors and indicators. Uncertainty of production rates, volumes, and end uses from the proposed action and alternatives would seriously limit the utility of the SCC protocol. The Agency does not know how quickly those resources would be developed; whether the fuel would be used in vehicles, power plants, or other consumptive use with varying emission rates; or what changes in technology or climate affecting end-uses may occur. It is BLM's determination that in this particular instance, calculating the SCC from CO2 emissions from the combustion of an unknown quantity of produced oil and gas would be highly speculative but likely would be negligible in relation to the impacts from oil and gas burned on a nationwide or global basis. BLM has provided reasonable estimates and discussion of impacts based on the information available to them at this time.

NEPA is an environmental full-disclosure law, which requires all federal agencies planning projects that would substantially affect the environment to consider the possible environmental effects. NEPA does not expressly require administrative agencies to undertake a cost-benefit analysis. Cost-benefit is not a primary consideration in the BLM's decision-making process, which places more emphasis on traditional resource areas, such as biological, water, air, and cultural resources.

The BLM recognizes that activities that result in resource development and use can impose costs on those users who prefer more pristine settings. Such effects were stated qualitatively. The BLM did not have available and was not required to prepare an analysis of non-market values to quantify these potential effects on the human experience of a relatively undeveloped environment. Analysis of such non-market

values and associated impacts is considerably more speculative than the analysis of "hard" benefits, such as those that would result from development and extractive activities. For these reasons, the disclosure of anticipated non-market costs is appropriately stated in qualitative terms. The level of information in the EIS is adequate for BLM decision-makers to make an informed decision.

Job locality information was based on estimates provided by SGI, based on industry standards and project experience. As stated in the Draft EIS (page 4-191), 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, and Farmington, New Mexico.

Where appropriate, the BLM has clarified the analysis in the Final EIS and added citations to support its conclusions.

Section 5.15 - GIS data and analysis

Total Number of Comments: 2

Comment No.: 482_SGI_Gordy_S_20150416_email-attach-44
Organization: SG Interests I, Ltd.
Commenter: Shaun Gordy

Comment Excerpt Text:
The map depicting pipelines on page 4-10 appears to be incomplete and displays unconnected pipeline. DEIS at 4-10. BLM should revise this map to include only the pipeline infrastructure that will be used to service development.

Comment No.: 482_SGI_Gordy_S_20150416_email-attach-66
Organization: SG Interests I, Ltd.
Commenter: Shaun Gordy

Comment Excerpt Text:
The DEIS indicates that oil and gas activity will impact land, stating that there will be a potential long-term loss of 14 acres (Alternative A), 23 acres (Alternative B), or 8 acres (Alternative C) of vegetation on BLM allotments. DEIS at 2-74. The basis for this calculation is not explained, however, and the discrepancy in numbers is not evident from the materials in the DEIS.

Summary

The map displays incomplete data for pipelines and displays unconnected pipelines. There are different acres for impacts on livestock grazing, and they are not adequately explained in the Draft EIS.

Response

All maps were updated and reflect revised information provided by SGI.

Differing amounts of proposed infrastructure overlap the BLM grazing allotments of Stock Driveway and Downing in different alternatives. This accounts for different acres impacted in each alternative, which has been explained in the Final EIS.

Section 5.16 – Hazardous Materials

Total Number of Comments: 7

Comment No.: 139_Hilberman_M_20150328_email-3
Commenter: Mark Hilberman

Comment Excerpt Text:
P 3-120 ff on Hazardous and Solid Waste has no data on the performance of SGI interests on their drilling operations in this region and elsewhere though there do not appear to have been significant ground or surface water contamination in the immediate area.

Comment No.: 431_Leger_N_20150416_email-attach-1
Commenter: Natasha Leger

Comment Excerpt Text:
1. A human health assessment was not conducted. References to human impact in Chapter 7 references are not specific to Bull Mountain or the surrounding North Fork Valley. BLM should conduct a human health impact assessment for the North Fork Valley, beyond the 10-mile radius of the proposed development.

Comment No.: 478_Schultz_K_20150416_email-attach-2
Organization: Endocrine Disruption Exchange
Commenter: Kim Schultz

Comment Excerpt Text:
Here we present analysis of the health and ecological effects of 1) hydraulic fracturing chemicals used in two wells in the Bull Mountain Unit; and 2) chemicals proposed to be used for further development of the Unit.

Health and ecological effects were identified using the TEDX Multistate Database (TEDX 2011) which identifies adverse health and ecological effects of chemicals based on research in government databases and peer-reviewed literature. Chemical identities are based on CAS numbers, which identify unique chemicals and are assigned by the American Chemistry Council to avoid errors than can come from relying on common names. Health effects are identified according to 11 categories based on main target organs or physiological systems. Ecological effects identify chemicals that can cause harm to the environment or wildlife.

Comment No.: 482_SGI_Gordy_S_20150416_email-attach-60
Organization: SG Interests I, Ltd.
Commenter: Shaun Gordy

Comment Excerpt Text:
There is a risk of seismic activity from disposal phases of oil and gas development. DEIS at 4-180. There is no evidence that produced water disposal has led to increased seismic activity in or around the Bull Mountain Unit.

Comment No.: 482_SGI_Gordy_S_20150416_email-attach-61
Organization: SG Interests I, Ltd.
Commenter: Shaun Gordy

Comment Excerpt Text:
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. DEIS at 4-184. The DEIS does not cite any evidence for the suggestion that drilling fluids contain endocrine disrupting chemicals nor provide any basis for the conclusion that development within the Bull Mountain Unit represents any risk to local water sources.

Comment No.: 482_SGI_Gordy_S_20150416_email-attach-62
Organization: SG Interests I, Ltd.
Commenter: Shaun Gordy

Comment Excerpt Text:
There is a risk to human health from emissions. DEIS at 4-182. The study that the DEIS cites for this conclusion, McKenzie 2012, observed certain health effects only on residents in very close proximity to well completion activities (less than one-half mile) and was completed before the implementation of EPA and Colorado emissions rules. The conclusion is also inconsistent with the risk analysis discussed earlier in the DEIS. (DEIS at 4-42).

Comment No.: 482_SGI_Gordy_S_20150416_email-attach-76
Organization: SG Interests I, Ltd.
Commenter: Shaun Gordy

Comment Excerpt Text:
The DEIS advances a number of operational assumptions that are unsupported or not explained in the record. Among other provisions, the record lacks any discussion providing scientific and objective support for each of the following statements:

Waterless fracturing is a viable technology for development of wells within the Bull Mountain Unit. DEIS at 4-84. Waterless fracturing has been unsuccessful in practice in many basins (SG has tried this method in the past) and the company that pioneered the technology has gone bankrupt.

Use of a centralized facility outside of Reduced Winter Activity Areas would reduce wildlife impacts. DEIS at 4-118. The DEIS does not include any discussion of which species would benefit from centralized production facilities or how such facilities would benefit those species. A centralized production facility, whose size and impacts are unspecified, could easily cause as many impacts as it is designed to reduce.

A closed loop system greatly reduces water use. DEIS at 4-86. An efficiently managed conventional drilling system can operate using similar quantities of water as a closed loop version.

Assumption that water for operations would be obtained between April and July. DEIS at 4-86. SG's ability to obtain water will be impacted by the provisions in the Augmentation Plan.

Injected fluids have the potential to migrate to shallow ground water. DEIS at 4-181. There is no peer-reviewed scientific support for concluding that injected fluids can migrate to shallow ground water.

Produced water injected into underground control wells will contain soil, grease, inorganic and organic additives. DEIS at 4-180. Produced water does not contain grease or inorganic and organic additives.

The severity of operational impacts would vary depending on surface ownership. DEIS at 4-167.

SG would focus on private development if BLM rejects the MDP, causing a greater development of private wells. DEIS at 4-160 to 162. As explained above, although adopting Alternative A will have little or no effect on the scope of mineral development that takes place, it will have important consequences for BLM's ability to ensure meaningful environmental review.

Summary

Commenters state that the BLM should review and provide support for analysis, including human health and safety.

Response

The BLM reviewed and updated the Final EIS to address the specific comments for clarifications and citations. The conditions of approval identified in Appendix C are included with Alternatives B and C and with Alternative D, the Preferred Alternative. Because the measures are included in the alternatives, the impact analysis was conducted to include their application to illustrate the impacts that would be mitigated with their application. For example, in Section 4.4.1, Hazardous and Solid Wastes, the BLM notes the nature and types of impacts typically seen from development and production activities, then further describes the individual impacts for each alternative. Based on these impacts, the BLM describes the specific measures that would be applied to address these impacts and goes on to explain how these measures would avoid, reduce, or eliminate the impacts. The BLM included citations and references to support the conclusions when they were available; otherwise, the statements represent professional experience and expertise.

Section 5.17 – Additional Impact Analysis Comments

Total Number of Comments: 5

Comment No.: 482_SGI_Gordy_S_20150416_email-attach-76
Organization: SG Interests I, Ltd.
Commenter: Shaun Gordy

Comment Excerpt Text:
The DEIS advances a number of operational assumptions that are unsupported or not explained in the record. Among other provisions, the record lacks any discussion providing scientific and objective support for each of the following statements:

Waterless fracturing is a viable technology for development of wells within the Bull Mountain Unit. DEIS at 4-84. Waterless fracturing has been unsuccessful in practice in many basins (SG has tried this method in the past) and the company that pioneered the technology has gone bankrupt.

Use of a centralized facility outside of Reduced Winter Activity Areas would reduce wildlife impacts. DEIS at 4-118. The DEIS does not include any discussion of which species would benefit from centralized production facilities or how such facilities would benefit those species. A centralized production facility, whose size and impacts are unspecified, could easily cause as many impacts as it is designed to reduce.

A closed loop system greatly reduces water use. DEIS at 4-86. An efficiently managed conventional drilling system can operate using similar quantities of water as a closed loop version.

Assumption that water for operations would be obtained between April and July. DEIS at 4-86. SG's ability to obtain water will be impacted by the provisions in the Augmentation Plan.

Injected fluids have the potential to migrate to shallow ground water. DEIS at 4-181. There is no peer-reviewed scientific support for concluding that injected fluids can migrate to shallow ground water.

Produced water injected into underground control wells will contain soil, grease, inorganic and organic additives. DEIS at 4-180. Produced water does not contain grease or inorganic and organic additives.

The severity of operational impacts would vary depending on surface ownership. DEIS at 4-167.

SG would focus on private development if BLM rejects the MDP, causing a greater development of private wells. DEIS at 4-160 to 162. As explained above, although adopting Alternative A will have little or no effect on the scope of mineral development that takes place, it will have important

consequences for BLM's ability to ensure meaningful environmental review.

Comment No.: 482_SGI_Gordy_S_20150416_email-attach-78
Organization: SG Interests I, Ltd.
Commenter: Shaun Gordy

Comment Excerpt Text:
There is no explanation for the significantly lower number of acreage impacts under Alternative C than under Alternative B. DEIS at 4-171. Because the scope of development is the same under all alternatives, and given the operational challenges that Alternative C would present, there is no evidence to support the conclusion that less acreage would be impacted under Alternative C.

Comment No.: 482_SGI_Gordy_S_20150416_email-attach-80
Organization: SG Interests I, Ltd.
Commenter: Shaun Gordy

Comment Excerpt Text:
There is no basis for concluding that Alternative B poses "the greatest possible increase, compared to Alternatives A and C, in land use authorizations from oil and gas development." DEIS at 4-171. To the contrary, because the scope of development is the same under all alternatives, the ability to implement comprehensive planning at an early stage of development that Alternative B affords is likely to minimize and streamline the need for land use authorizations associated with oil and gas development.

Comment No.: 548_BlackCanRegLandTrust_Puckett_J_20150415-4
Organization: Black Canyon Regional Land Trust
Commenter: Jeremy Puckett

Comment Excerpt Text:
BCRLT is specifically disappointed that the DEIS fails to acknowledge the purpose and importance of conserved private lands within the region or the need (whether legal or simply ethical) to consult with conservation easement holders as a course of doing business. In fact, the discussion and analysis of Lands and Realty (Sec. 3.3.4 & 4.3.4) says nothing regarding the existence and/or appropriate consideration of long-standing conservation easements within the project area

Comment No.: 548_BlackCanRegLandTrust_Puckett_J_20150415-6
Organization: Black Canyon Regional Land Trust
Commenter: Jeremy Puckett

Comment Excerpt Text:
to the extent that the DEIS contemplates "irreversible and irretrievable commitment of resources" (Sec. 4.5.1), the BLM should stipulate that any development on conserved private lands avoid such impacts, as conservation easements are specifically intended to protect conservation values in perpetuity

Summary

Commenters noted several concerns with assumptions made for impact analysis, as follows:

- There was no support for many operation assumptions made as part of the analysis of Alternative C: waterless fracturing as viable technology, use of centralized facilities creating less disturbance; closed loop results in less water use; when water would be obtained (depending on provisions in augmentation plan); injected fluids migrate to shallow aquifers (no literature to support); injected produced water contains contaminants (misstatement); operational impacts more severe, depending on surface ownership (unsupported); SGI would focus on private development if the BLM rejects the MDP (unsupported and not true).

- There was no support for statements that say Alternative B impacts are higher—the defined scope under Alternatives B and C are the same. Therefore, impacts should be noted as the same or similar.
- Conservation easements should be discussed in the affected environment impacts analysis, and a stipulation should be added that avoids impacts on conservation easements.

Response

Chapter 4 analytical assumptions were reviewed to ensure that all were appropriate for use. The assumption for waterless fracturing was revised to note that while "the use of waterless fracturing techniques could greatly reduce the quantity of water required for construction off wells, it is a technology that has not always been successful" (FEIS, Section 4.2.4). The other sections that discuss the effects of closed-loop systems and centralized facilities were reviewed for accuracy and found to be accurate; therefore, no change was made. The discussions regarding when water could migrate into aquifers was updated with references from the Geologic Society of America. The remaining statements that commenters suggested were unsupported were reviewed for accuracy and modified as necessary to ensure accuracy.

Regarding the finding that Alternative B impacts would be higher than Alternative C: While Alternatives B and C are similar in many ways, they differ in the number of pads, in additional wildlife mitigation measures and air quality measures, in requirements to collocate pipelines in roads, and in the requirements to bury electrical lines to the water disposal wells under Alternative C. When analysts calculated the amount of disturbed acreage, it was based on the number of pads and miles of roads and pipelines. These initial calculations were based on the information found in Table 2-2, Project Feature Assumed Short- and Long-term Disturbance Amounts, of the Draft EIS and the GIS data layers provided by SGI. The BLM recognizes that the numbers used to estimate disturbances are simply assumed averages and that actual pad size may differ, depending on the number of wells drilled per pad. However, as the exact number of wells per pad is not known at this time (it would be determined at the later APD stage), the BLM had to make a reasonable assumption.

Conservation easements are an agreement between a private landowner and the State of Colorado Parks and Wildlife Division; CPW will have the opportunity to comment on affected wildlife resources when BLM considers site-specific resource concerns associated with future APDs.

Section 5.18 – Visual Resources and Paleontological Resources

Total Number of Comments: 1

Comment No.: 482_SGI_Gordy_S_20150416_email-attach-65
Organization: SG Interests I, Ltd.
Commenter: Shaun Gordy

Comment Excerpt Text:
In distinguishing Alternative C from Alternative B, the DEIS represents that impacts to visual and paleontological resources would be less under Alternative C. DEIS at 4-174, 4-200. This is incorrect. As the attached exhibit demonstrates, development under Alternative B would not significantly impair scenic

views from roadways in the area. See Appendix B. Nor is there evidence that development would have meaningful effect on paleontological resources. The discussion included in Appendix C explains that the surface geology of the Bull Mountain Unit will not yield significant fossils. See Appendix C.

Summary

The Draft EIS incorrectly states the differences of impacts from Alterative B versus Alternative C for visual resources and fossils. Alternative B would not significantly impair scenic views from roadways. Bull Mountain Unit would not yield significant fossils.

Response

The PFYC system is meant to provide baseline guidance for predicting, assessing, and mitigating paleontological resources, and Section 3.2.13, Paleontology, of the Draft EIS notes that while the area has PFYCs 3 to 5, "…there are few areas of exposed rock outcrops or strata and no known localities within the project area" (Draft EIS, page 3-96). This indicates that there is a very low likelihood for discovery of paleontological resources. Additionally, as the locations in the alternatives are 40-acre analysis areas and are not site specific, potential impacts on paleontological resources under each alternative can be only generally estimated, which is directly correlated to the level of anticipated surface disturbance proposed under each alternative. The Final EIS has been updated and clarified to explain the low likelihood for paleontological discoveries.

The visual resources analysis was reviewed and updated to better describe the potential impacts from the potential activities.

Section 5.19 – Grazing and Rangelands

Total Number of Comments: 4

Comment No.: 482_SGI_Gordy_S_20150416_email-attach-49
Organization: SG Interests I, Ltd.
Commenter: Shaun Gordy

Comment Excerpt Text:
The DEIS indicates that there will be a loss of federal lands available for grazing. DEIS at 4-199. BLM should clarify the basis for this statement

Comment No.: 482_SGI_Gordy_S_20150416_email-attach-67
Organization: SG Interests I, Ltd.
Commenter: Shaun Gordy

Comment Excerpt Text:
Similarly, there is no explanation of how those with grazing rights will be economically impacted (DEIS at 4-186 to 187)

Comment No.: 482_SGI_Gordy_S_20150416_email-attach-68
Organization: SG Interests I, Ltd.
Commenter: Shaun Gordy

Comment Excerpt Text:
The DEIS also fails to note that removal of oak brush as part of development will allow for new grass and forb communities to be created, which may provide additional grazing land. See DEIS at 4-13.

Comment No.: 482_SGI_Gordy_S_20150416_email-attach-69
Organization: SG Interests I, Ltd.
Commenter: Shaun Gordy

Comment Excerpt Text:
The DEIS should clarify the basis for its conclusions on the impacts of each alternative on grazing allotments.

Summary

Commenters state that the BLM needs to clarify the statement that there would be a loss of federal lands available to grazing, as well as the conclusions for impact analysis on livestock grazing. In addition, a commenter states that the BLM needs to consider how vegetation changes from project activities may impact available grazing lands.

Response

The Final EIS has been revised to clarify that the acres of grazing allotments potentially impacted are related to federal allotments, not state or privately owned grazing lands. Table 4-52 in the Final EIS has been updated to include the acreage of disturbance under Alternative D and to remove estimates of acreage on private lands. In reviewing these numbers, the BLM decided that the assumptions for private grazing practices were too speculative and should be noted as such. Under the federal permits, there is a potential loss of a few acres on federal land but not enough to impact the permittee/allottee's ability to graze the remainder of the allotment. As the extent of acreage loss on federal grazing allotments is negligible, it would not show up in the broader socioeconomic analysis presented in Section 4.4.2 of the EIS. Additionally, as noted in Section 4.4.2, annual grazing decisions are made by individual ranchers and BLM does not have this information available resulting in the inability to make reasonable conclusions as to the extent of socioeconomic impacts on private ranching operations from the proposed development.

Section 6 - Cumulative Impacts

Total Number of Comments: 5

Comment No.:
407_GunnisonEnergy_Fyock_L_20150415_email-attach-1
Organization: Gunnison Energy LLC
Commenter: Lee Fyock

Comment Excerpt Text:
DEIS Section 4.1.3 states, "Spatial boundaries vary and are larger for resources that are mobile or migrate (e.g., deer populations) compared with stationary resource (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." BLM should provide a table by resource describing the various cumulative impact analysis areas. Again, if the boundaries differ, the No Action Alternative would be insufficient for baseline within the various boundaries.

Comment No.: 482_SGI_Gordy_S_20150416_email-attach-79
Organization: SG Interests I, Ltd.
Commenter: Shaun Gordy

Comment Excerpt Text:
The DEIS' assessment of the cumulative impacts under Alternative C is nonsensible. DEIS at 4-171. The DEIS states "[t]hat 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." Id. The DEIS does not explain which activities would affect BLM's ability to "authorize land use authorizations" or how any particular impact would affect the administration of the Bull Mountain Unit.

Comment No.:
503_WELC_King_L_20150416_email-attach-5
Organization: Western Environmental Law Center
Commenter: Laura King

Comment Excerpt Text:
Below is a list of a few of the past, present, and reasonably foreseeable projects and proposals that BLM must, yet has failed to consider, in its cumulative analysis section of the DEIS:

67 Active Gas Wells in Delta and Gunnison Counties: As of April 1, 2015, Gunnison and Delta Counties contain 67 active gas wells, the majority of which are located in the Upper North Fork and Muddy Creek areas. The DEIS does not discuss the impacts of these wells in conjunction with the Bull Mountain Unit proposal, despite connected infrastructure, access roads and ownership.

Petrox 50-Well Proposal at Pilot Knob:(See Dennis Webb, Roadless Dispute Clouds Drilling Proposal, THE DAILY SENTINEL, February 28, 2015, available at: http://www.gjsentinel.com/news/articles/roadless-dispute-clouds-drillingproposal.) Petrox is proposing up to 50 wells in a 6,400-acre project area that largely overlies the Pilot Knob Roadless Area north of Somerset.

Fram 108-Well Proposal:(See Dennis Webb, Fram Proposal: 108 New Oil Wells South of Palisade, THE DAILY SENTINEL, June 28, 2013, available at: http://www.gjsentinel.com/news/articles/fram-proposal-8232108-newoil-wells-8232south-of-p.) BLM approved a proposal for 108 oil wells from Norwegian company Fram, to be located downstream from the Bull Mountain Unit in the Whitewater Unit.

Gunnison Energy 60 to 600-Well Master Plan:(See Dennis Webb, North Fork Drilling Plans Remain

Small, THE DAILY SENTINEL, February 15, 2015, available at: http://www.gjsentinel.com/news/articles/north-fork-drilling-plans-remain-small.) Gunnison Energy is proposing large-scale development north of Somerset and west of the Bull Mountain Unit for up to potentially 600 wells. This alone could dwarf the Bull Mountain Unit, and given its proximity to the Unit, cannot be ignored.

Spadafora Waste Disposal Pits: The Spadafora Water Storage Facility was approved by the Gunnison County Planning Commission on March 6, 2015. Three water storage pits, each with a pump station and a volume of about 9,240,000 gallons, will sit on roughly 19 acres and will store and recycle produced water for drilling and gas well operations. (See Adam Broderick, Fracking Pits Approved for Development Near Paonia Reservoir, THE CRESTED BUTTE NEWS, March 11, 2015, available at: http://www.crestedbuttenews.com/index.php?option=com_content&task=view&id=6286&Itemid=40.) This facility is immediately west of the Bull Mountain Unit, yet is not discussed in the DEIS.

16-well development in the North Fork/Muddy Creek Planning Unit:(See Seth Mensing, Gas Developers Propose Three New Water Pits for North Fork, THE CRESTED BUTTE NEWS,May 4, 2015, available at: http://www.crestedbuttenews.com/index.php?option=com_content&task=view&id=3344&Itemid=40; In the Matter of the Promulgation and Establishment of Field Rules to Govern Operations in West Muddy Creek Field, Gunnison County, Colorado, Cause No. 1, Order No. 1-143, Colorado Oil and Gas Conservation Commission (March 30, 2009), available at: http://cogcc.state.co.us/orders/orders/1/143.html (attached as Exhibit 75).) In February, 2009 BLM approved a Master Surface Use Plan from Gunnison Energy for 16 wells just to the south of the Bull Mountain Unit. This is not analyzed in coordination with the Bull Mountain MDP analysis.

30,000-Acre Lease Sale:(See Uncompahgre Field Office, Oil and Gas Lease Sale February 2013, BUREAU OF LAND MANAGEMENT, available at: http://www.blm.gov/co/st/en/BLM_Information/nepa/ufo/august_lease_sale.html.) In December of 2011 BLM proposed leasing approximately 30,000 acres of public lands and minerals for oil and gas development in the North Fork Valley. While the lease sale has been deferred, there remains the possibility for future leasing. The impacts of this proposal are not included in the DEIS.

6 APDs from Gunnison and SG:(United States Department of the Interior, Scoping Notice for 31_60 (CO-S05) 201s-029EA, available at: http://www.blm.gov/style/medialib/blm/co/information/nepa/uncompahgre_field/fy2015_nepa_docs.Par.2447.File.dat/15-29%20EA%20Six%20APD%20Gunnison%20Energy%20SG%20Interests%20Scoping%20Notice%202015-0323.pdf (attached as Exhibit 85).) On March 23, 2015 BLM issued a scoping notice for a proposed action that includes six federal APDs submitted by two operators. The notice states that development associated with five of the APDs would require construction of five new multi-well pads, installation of new pipelines, and construction/reconstruction of access roads. “Roads used to access these five multi-well pads include CO State Highway 133 [and] Gunnison County Road (CR) 265...” (Id.) the same roads used to access the Bull Mountain Unit. Overall, the development of five new multi-well pads (15.5 acres of disturbance) and associated infrastructure would require an initial surface disturbance of approximately 31.6 acres within the project area. Additionally, SG has also submitted two Notices of Staking, which is a step that precedes submitting an APD.(BLM, Thompson Divide Drilling Proposal Information, http://www.blm.gov/co/st/en/fo/crvfo/thompson_divide_gas.html.) SG has also made clear in filings that it intends to put any gas produced from these wells into the Bull Mountain pipeline. This makes the proposal not only foreseeable, but also connected. Amazingly, this proposal is not noted or discussed in the DEIS,

despite the obvious connection and cumulative impacts. Indeed, BLM's failure to include these six wells in the DEIS undercuts NEPA's requirement that "Significance cannot be avoided by terming an action temporary or breaking it
down into small component parts." 40 C.F.R. § 1508.27(b)(7).

Huntsman Unit Proposal: (A categorical exclusion used for approval of a suspension of this lease is available: BLM, Categorical Exclusion DOI-BLM-CO-SO50-201-0035 CX, available at: http://www.blm.gov/pgdata/etc/medialib/blm/co/information/nepa/uncompahgre_field/ufo_nepa_documents0.Par.60636.File.dat/12-035CX%20SG%20USFS%20Lease%20Susp.pdf.) SG has proposed drilling in the Huntsman Unit (COC 74403X), which includes three SG leases (COC 63886, 63888, and 63889). SG has proposed one APD there for well 10-89-31 #1 inside lease COC 63886. That APD was filed in 2010. The unit and the leases are currently suspended pending Forest Service analysis. Nonetheless, with formal proposals on the table, the BLM must consider this a reasonably foreseeable proposal. Drilling the proposed well would require travel on the same roads, new road construction, additional cumulative impacts to wildlife habitat (including critical trout habitat), and additional cumulative impacts to regional air quality and other resources.

Pilots Knob APD:(See id.) SG has proposed an APD (12-89-30#1) in the Pilots Knob CRA on lease COC 64169. Development of that lease would involve the same potential impacts as others described above.

Coal: The DEIS states: "There are three active underground coal mines on federal mineral estate in the cumulative impacts analysis area." DEIS at 4-11. It should be noted that Oxbow's Elk Creek Mine closed in 2013. The DEIS then lists simple production data from the mines. But there is no discussion of impacts to wildlife, and the DEIS states that coal resources will not be discussed in detail. DEIS at 4-4. Recent proposals to expand the West Elk Coal Mine under 1,700 acres of the Sunset Roadless Area to access 10.1 million tons of coal are not mentioned. On April 6, the U.S. Forest Service issued a Notice of Intent to prepare a supplemental Environmental Impact Statement to propose reinstatement of the North Fork Coal Mining Area exception of the Colorado Roadless Rule. The exception would allow for temporary road construction for coal exploration and/or coal-related surface activities in a 19,100-acre area defined as the North Fork Coal Mining Area.(80 FED. REG. 18,598-02 (April 7, 2015) (U.S. Forest Service and USDA, Roadless Area Conservation; National Forest System Lands in Colorado).) Under the exception, Arch Coal plans to expand its underground West Elk mine, which includes bulldozing an extensive road network and scraping dozens of well pads in the Sunset Roadless Area. Also notable is the fact that coal mining in the North Fork Valley requires venting of methane, which releases significant amounts of VOCs that should be addressed in any cumulative impacts analysis.

Comment No.:
503_WELC_King_L_20150416_email-attach-97
Organization: Western Environmental Law Center
Commenter: Laura King

Comment Excerpt Text:
SG's Federal 11-90-9 APD, which is adjacent to the Bull Mountain Unit and should be considered cumulatively with the MDP

Comment No.:
504_WestSlopeConsCtr_Sauter_S_21050416_email-attach-2
Organization: Western Slope Conservation Center
Commenter: Sarah Sauter

Comment Excerpt Text:
The BLM has not adequately considered the cumulative impacts of this proposal in conjunction with historic, existing, or reasonably-foreseeable fluid mineral developments in the region.
Rivers, wildlife and air currents do not recognize

property boundaries, and this project should not be considered in a vacuum.
We respectfully ask the BLM to evaluate the Bull Mountain Unit MDP's impacts to air, water, wildlife, farmlands, and our
community in conjunction with the following projects: 1) the 76 active gas wells in Delta and Gunnison Counties, 2) the FRAM Whitewater Unit proposal for 108 wells in western Delta County, 3) the Petrox proposal for up to 50 wells at Pilot Knob, 4) Gunnison Energy's Master Plan for 60-600 wells north of Somerset, 5) the BLM-approved Master Surface Plan for Gunnison Energy's 16-well proposal in the North Fork/Muddy Creek planning Unit, 6) the Spadafora Waste Disposal Pits, 7) reasonably foreseeable development for the 30,000 acres in the lower North Fork Valley first nominated for the February 2011 lease sale, and 8) the six APD's identified in the BLM's March 23, 2015 scoping notice.

Summary

The BLM should review cumulative impacts, including the area of analysis by resource. In addition, the BLM should ensure cumulative analysis includes Federal 11-90-9 APD and 67 active oil and gas wells: Petrox 50, Fram 108 well development, Gunnison Energy 60-600 well Master Plan, Spadafora Wats Disposal Pits, 16-well development in the North Fork/Muddy Creek Planning Unit, 30,000 acre deferred lease sale, 6 APDs from Gunnison and SG, Huntsman Unit Proposal, Pilots Knob APD, and coal projects.

Response

The BLM has reviewed and revised the list of past, present, and reasonably foreseeable future actions with updated project information. While some of the projects noted above have been included in the list, a careful review of the projects showed that the remainder were speculative and therefore should not be included. The BLM considered a project as speculative if the reviewing agency has not received adequate proof that a company was intending to move forward with the development. For example, the Petrox 50 development, while having been discussed for several years, has not moved forward with any plans submitted to the Forest Service; nor is there any indication that Gunnison Energy intends to start the permitting process. Therefore, this project was not included in the updates to Table 4-3 of the Final EIS.

Section 6.1 - Air resources

Total Number of Comments: 3

Comment No.:
503_WELC_King_L_20150416_email-attach-15
Organization: Western Environmental Law Center
Commenter: Laura King

Comment Excerpt Text:
Therefore, even though climate change emissions from the Bull Mountain MDP may look minor when viewed on the scale of the global climate crisis we face, when considered cumulatively with all of the other GHG emissions from BLM-managed land, they become significant and cannot be ignored.

Comment No.:
503_WELC_King_L_20150416_email-attach-6
Organization: Western Environmental Law Center
Commenter: Laura King

Comment Excerpt Text:

Climate Change: BLM's analysis of the cumulative impact of climate change is limited to the observation that "[i]ncreased concern over greenhouse gas emissions and global warming issues may lead to future federal and state regulations limiting the emission of associated pollutants." DEIS at 4-15. BLM fails to consider the impact of the project in light of the additive impacts caused by global warming. For example, BLM acknowledges that erosion and sedimentation is a major issue in the project area. See DEIS at 3-51 ("The Unit is located in an area of active erosion and unstable slopes. These conditions present a continuing concern in the area..."). BLM also acknowledges that global climate change will exacerbate this problem. See id. ("Global climate changes may lead to more extreme ranges in rainfall and runoff.") But BLM fails to consider the impact of the project on erosion and sedimentation in light of the additive impacts caused by global warming. This should be done on a resource-by-resource basis.

Comment No.:
503_WELC_King_L_20150416_email-attach-7
Organization: Western Environmental Law Center
Commenter: Laura King

Comment Excerpt Text:
Most notably, the DEIS does not include a comprehensive regional inventory for use in determining reasonably foreseeable cumulative air quality impacts. See DEIS at 4-53. Instead, the MDP relies on the Colorado Air Resources Management Modeling Study (CARMMS) to evaluate cumulative air quality impacts. See id. However, the CARMMS is not exhaustive of the sources that BLM must consider. For example, it is not up-to-date and does not contain all State- and Federal-permitted sources that may impact the study area, including sources in other states. Additionally, the BLM's analysis must go beyond CARMMS, including by ensuring that direct and indirect (combustion) impacts of sources are considered.

Summary

The BLM's use of the CARMMS to evaluate cumulative air impacts is not enough to adequately show cumulative effects. It does not contain all state- and federal-permitted sources, including sources from adjacent states, and should include combustion impacts of sources. Additionally, the BLM's cumulative climate change analysis is limited and needs to be expanded to adequately account for GHGs and expected future climatic changes.

Response

The CARMMS project results are useful for disclosing potential cumulative impacts for the Bull Mountain project, as they include a conservative high oil and gas development scenario. The high oil and gas development scenario results are disclosed in the EIS. The oil and gas emissions included in this high development modeling scenario represent a maximum development level that would not likely occur. In addition CARMMS 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 Final EIS includes more recent information on climate change and GHG emissions (from the BLM's Air Resources Technical Report for Oil and Gas Development, New Mexico, Oklahoma, Texas, and Kansas), following proposed guidance from the CEQ (January 2014, Draft Guidance for Federal

Departments and Agencies on Consideration of Greenhouse Gas Emissions and the Effects of Climate Change in NEPA Reviews).

Section 6.2 - Soil

Total Number of Comments: 2

Comment No.:
496_TroutUnltd_Cross_S_20150416_email-attach-4
Organization: Trout Unlimited
Commenter: Shane Cross

Comment Excerpt Text:
First, it preserves the BLM's ability to mandate siting of oil and gas activities at a location that adequately protects riparian areas while maintaining flexibility to accommodate the operator. The condition of approval does not require siting of activities ¼ mile from the stream – it allows the BLM to increase the buffer distance up to ¼ mile from the stream. Due to soil types and slope steepness, there may be instances where ¼ mile is appropriate, and others where pushing the buffer past the riparian area could cause more damage to the stream and/or other resources. This condition of approval, as opposed to Best Management Practice 89, provides management flexibility and allows the BLM to require the best location in both circumstances.

Comment No.:
503_WELC_King_L_20150416_email-attach-9
Organization: Western Environmental Law Center
Commenter: Laura King

Comment Excerpt Text:
Despite these many impacts to soil resources, BLM concludes: "Implementation of BMPs in Appendix C would minimize cumulative impacts caused by Alternative B, and no additional mitigation measures are recommended." DEIS at 4-76. As is the case throughout the DEIS, here, the BLM's dismissive approach and empty reliance on industry-chosen BMPs is not enough to fulfill their burden under NEPA. Their discussion provides no assurance that BMPs will be adopted, nor any evidence that impacts can be avoided even if BMPs are adopted.

Summary

Due to soil types and slope, the BLM should consider a COA that allows the BLM to increase the buffer distance to up to a quarter-mile from a stream, which would be more flexible than BMP 89 ("Surface-disturbing activities shall avoid riparian/wetland habitat unless otherwise approved by the BLM. Any loose rock occurring in the vicinity will be scaled prior to construction if it presents a safety hazard").

Implementing BMPs to prevent the need for mitigation would not be satisfactory because BMPs might not be adopted or, even if BMPs are adopted, impacts might not be avoided.

Response

As noted in Section 2.3.1, Alternatives Considered and Eliminated during EA Development, of the Draft EIS, the BLM considered a 500-foot setback. This increased the extent of long-term surface disturbance and placed development higher on ridges and side-slopes, creating unacceptable soil and sedimentation impacts. In reviewing a 1,000-foot setback, the BLM found similar problems with increased acreage of

long-term surface disturbance and unacceptable locations on steep slopes and ridges. Therefore, the BLM eliminated this measure from consideration under Alternative D, the Preferred Alternative.

The following clarifies the definitions of condition of approval (COA) and best management practice (BMP):

- COAs are additional measures that are attached to an approved APD to ensure environmental protection, safety, and conservation of the mineral resource. As a condition of the APD's approval, they are required to be implements.
- BMP's are "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." BMPs tend to be general principles for resource protection and are not in themselves regulatory. The BLM's 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).

Federal Onshore Order 1 notes that "While the BLM encourages the use of Best Management Practices, they are voluntary unless after specific analysis during the APD processing, the BLM includes them as Conditions of Approval to mitigate impacts…If an operator proposes using Best Management Practices, they should be included in the Surface Use Plan of Operations" (Federal Onshore Order 1, page 10318).

Section 6.3 - Water

Total Number of Comments: 10

Comment No.: 067_Clark_R_20150414_hard-1
Commenter: Robert E. Clark

Comment Excerpt Text:
Also needing attention is the broader and cumulative impacts resulting from this proposal and from its combination with other proposed and possible developments within the upper North Fork Valley of the Gunnison River. Particular attention should be given to address the many combined consequences interactions, and considerations of other potential hydrofracturing (fracking) development and coal resource and coal gas development within the broad area and dowmstream. The area of focus should reach beyond the valley to examine consequences of pollutant flows upon water users far downstream. An example is the very recent spill of chemicals on Rabbit Ears Pass in Colorado of some fracking fluid concentrates. Such an event, depending on location and content, could significantly and adversely impact those utilizing water for organic farming mostly in Delta County down stream.

Comment No.:
387_DeltaCoComms_20150416_hard-1
Organization: Delta Board of County Commissioners
Commenter: Mark Roeber

Comment Excerpt Text:
- There have been produced water treatment and recycling facilities recently placed in the BMU area. The water recycling capability, direct piped water transport, and produced water recovery through pipelines and ponding infrastructures are just now beginning to make a reduction in truck traffic needed to drill and treat wells and recover their produced water.
o The water recycling collection and storage systems are just now making similar reductions to the related problems.

o Althought mentioned in the EIS, the reduction in necessary support traffic (and associated problems) by these developing water handling systems is not projected at the decreasing rate the Bull Mountain Unit area should experience

Comment No.: 406_Gulick_S_20150416_email-attach-4
Commenter: Stephen Gulick

Comment Excerpt Text:
7) Water. Where is the incredible amount of water required to develop these wells going to come from? Given that we are in the midst of a drought that is predicted by some to become the worst in the recorded history of this region, how can you justify the diversion of all this water from higher priority domestic and agricultural use, and especially just after California has declared a full-scale water emergency?

Comment No.: 494_Thompson_G_20150415_email-attach-9
Commenter: Greg Thompson

Comment Excerpt Text:
Sedimentation into Paonia Reservoir. Page 3-44, 1st and 3rd paragraphs. Since I am a farmer that relies on Paonia Reservoir to irrigate my orchard and vineyard I am especially sensitive to ground disturbance above the reservoir. I am grateful that BLM has identified this as an issue. Sedimentation of the reservoir has been happening and exacerbation of it would create a problem for the viability of agricultural productivity in the NFV.

Comment No.: 495_TownofHotchkiss_Koontz_W_20150414_hard-1
Organization: Town of Hotchkiss
Commenter: Wendell Koontz

Comment Excerpt Text:
1. Water and waste water from drilling activities. These waters should be, to the extent possible, be developed and disposed of either on or near the project site. The Town is uniquely situated on Highways 92 and 133 which will support much of the well development traffic. Minimizing transport thru our Town will minimize conflict and the potential for incidents. Development of process water on sight, waste water injection wells, and evaporation ponds all diminish the amount of water transported over the roads. Secondary containment for fuel, process water, waste water, and other chemicals will provide that potential for spills will be minimized.

Comment No.: 496_TroutUnltd_Cross_S_20150416_email-attach-3
Organization: Trout Unlimited
Commenter: Shane Cross

Comment Excerpt Text:
Trout Unlimited is concerned with adverse impacts to water quality in the Unit that are associated with oil and gas development. The BMDP area encompasses leases over federal mineral estate along Lee Creek, which contains a current population of Colorado River cutthroat trout (CRCT). The Unit also encompasses portions of East Muddy Creek and West Muddy Creek, which converge south of the Unit and flow directly into Paonia Reservoir and ultimately into the North Fork of the Gunnison River. In addition, lineage Greenback cutthroat trout, a threatened species, have been found in the upper reaches of the Muddy Creek watershed. These and other streams in the Unit contain valuable fisheries and are high quality water resources for Colorado.

Comment No.: 496_TroutUnltd_Cross_S_20150416_email-attach-5
Organization: Trout Unlimited
Commenter: Shane Cross

Comment Excerpt Text:

Due to the potential presence of Greenback cutthroat trout, the presence of CRCT, the location of wild trout fisheries, and the high elevation of the Unit, Trout Unlimited is concerned about the surface water quantity impacts of development. Accordingly, Trout Unlimited asks the BLM to consider and analyze all of its available options to work with the operator to encourage and ensure that water quantity resources will be protected in the BMDP area prior to approving the BMDP.

Comment No.: 497_Van-West_R_20150416_email-3
Commenter: Rein Van West

Comment Excerpt Text:
Another real impact is the large use of water that will be lost in an already arid area. Wouldn't it be possible for the BLM to require SG Interests to recycle its water or to use only recycled water for its operations? It is important to stay imaginative for the sake of our collective natural resources.

Comment No.: 497_Van-West_R_20150416_email-4
Commenter: Rein Van West

Comment Excerpt Text:
Actually, I do think the BLM would want to avoid the construction of these roads if it could. And conserve our precious water. And avoid wildlife disturbance. And avoid water contamination issues. And want to consider the carbon impacts as we all become more concerned with climate change impacts.

Comment No.:
503_WELC_King_L_20150416_email-attach-8
Organization: Western Environmental Law Center
Commenter: Laura King

Comment Excerpt Text:
The DEIS's cumulative effects analysis for water resources is confined to the cumulative effects of Alternatives A and B, with limited additional analysis of drilling activity within and outside the unit boundaries. Of particular note, the DEIS fails to acknowledge the cumulative effects on water quality or quantity posed by development (including effects from sedimentation, spills, and low stream flows) in combination with climate change and development-fueled growth.

Summary

Produced/recycled water should be used for the project, and such impacts as truck traffic should be correspondingly reduced. Wastewater should be disposed of on-site.

The project would have many cumulative effects on water, such as sedimentation in Paonia Reservoir, reduced water available for farming and other uses, and pollution of fish habitat, including greenback and Colorado River cutthroat trout. The cumulative effects of water are not sufficiently analyzed.

Response

Estimates for percentages of recycled water and freshwater used for development is the same across all alternatives, at 70 percent recycled and 30 percent freshwater. See Table 2-9 and each section titled *Water Use and Water Sources* under each alternative in the EIS.

The alternatives also note that wastewater is going to be disposed of on-site via injection wells; however, the text also notes that water could also be trucked elsewhere on-site for use if it is not available under SGI's water rights.

As noted by the commenter, any of these actions would have effects. The impacts are quantified under the *Water Use and Water Sources* section, and Section 4.2.4, Water Resources, of the EIS discusses in depth the potential impacts of water use. The COAs identified in Appendix C provide measures to reduce water impacts, and their application is described in the EIS for how they would reduce impacts. As noted in the biological assessment, fish habitat is upstream of the Unit and is not affected.

Section 6.4 - Wildlife, Birds

Total Number of Comments: 5

Comment No.:
503_WELC_King_L_20150416_email-attach-89
Organization: Western Environmental Law Center
Commenter: Laura King

Comment Excerpt Text:
BLM has completely failed to consider and analyze impacts to wildlife from nearby proposed energy development and mining operations, as discussed above. The Bull Mountain MDP must be considered within the context of energy development actions in the North Fork Valley. The Bull Mountain Unit is part of a landscape that is ripe with past, present and reasonably foreseeable future projects whose impacts on wildlife in conjunction with the MDP have not been analyzed by the agency. Many of the projects in the area will likely use shared infrastructure to deliver natural gas to local and national markets, including use of the Bull Mountain Pipeline and the Ragged Mountain Pipeline. It is also likely that other infrastructure, such as roads, power-lines and gathering systems, may be shared. Projects that must be considered in the agency's cumulative impacts analysis for wildlife species is discussed supra at I.B; see also 40 C.F.R. §§ 1508.25(a)(1), (2).

Cumulative impacts analysis should encompass, at a minimum, the following:

• Bull Mountain MDP;
• 67 active oil and gas wells in Gunnison and Delta Counties;
• Petrox's 50-well proposal at Pilot Knob;
• Fram's 108-well proposal;
• Spadafora Waste Disposal Pits;
• 16-well development in the North Fork/Muddy Creek Planning Unit (CO-150-2008-35-EA);
• August 2012 Oil and Gas Lease Sale (DOI-BLM-CO-S050-2012-0009 EA);
• Six APDs from GE and SG (3160 (CO-S05) 2015-029EA);
• Three active underground coal mines and proposed coal mine expansion into the Sunset Roadless Area;
• All other past, present, and foreseeable actions, including oil and gas development in the area. This must be analyzed regardless of agency (Federal or non-Federal) or person undertaking such action(s).

Comment No.:
503_WELC_King_L_20150416_email-attach-90
Organization: Western Environmental Law Center
Commenter: Laura King

Comment Excerpt Text:
This truncated discussion of cumulative impacts in the DEIS offers no analysis of the effect that these impacts will have on wildlife, fails to even acknowledge major projects, and ultimately fails to draw any conclusion about the significance of these impacts. Such unsupported assumptions do not satisfy NEPA's mandate that the agency undertake the required analysis and provide the needed evidentiary support for its decisions

Comment No.:
503_WELC_King_L_20150416_email-attach-91
Organization: Western Environmental Law Center
Commenter: Laura King

Comment Excerpt Text:
BLM needs to revisit the DEIS and take a hard look at the cumulative impacts of other projects in the area, all of which are likely to impact local wildlife. BLM must also take a hard look at the MDP is a connected, similar, and cumulative action to other past, present, and reasonably foreseeable actions within this geographic area.

Comment No.:
503_WELC_King_L_20150416_email-attach-92
Organization: Western Environmental Law Center
Commenter: Laura King

Comment Excerpt Text:
The analysis of cumulative wildlife effects is devoid of information that a decision-maker might reasonably use to understand how little or great the impact may be. The DEIS's language does not constitute analysis, but consists instead of general statements based on an incomplete record. BLM must make substantial improvements to this portion of the EIS

Comment No.:
504_WestSlopeConsCtr_Sauter_S_21050416_email-attach-3
Organization: Western Slope Conservation Center
Commenter: Sarah Sauter

Comment Excerpt Text:
The BLM has not sufficiently analyzed cumulative impacts to wildlife. As stated in our past comment letters on the Bull Mountain Unit Master Development Plan, the BLM should develop a wildlife mitigation plan (WMP) in consultation with Colorado Parks and Wildlife. The DEIS offers mitigations, but only a cursory discussion on impacts that recognizes that the proposed action would reduce the availability of habitat and forage as well as increase habitat fragmentation.

Summary

The BLM should include an additional cumulative impacts analysis for wildlife, including impacts from North Fork Valley oil and gas leasing and the following projects proposed next to the project area:

- 67 active oil and gas wells in Gunnison and Delta Counties
- Petrox's 50-well proposal at Pilot Knob
- Fram's 108-well proposal
- Spadafora Waste Disposal Pits
- 16-well developments in the North Fork/Muddy Creek Planning Unit (CO-150-2008-35-EA)
- August 2012 Oil and Gas Lease Sale (DOI-BLM-CO-S050-2012-0009 EA)
- Six APDs from GE and SG (3160 (CO-S05) 2015-029EA)
- Three active underground coal mines and proposed coal mine expansion into the Sunset Roadless Area
- All other past, present, and foreseeable actions, including oil and gas development in the area

Commenters also suggested that the BLM should include a wildlife mitigation plan as part of the alternatives.

Response

As noted in Section 6, Cumulative Impacts, the BLM has determined that the above-noted projects and North Fork Valley leasing actions are either speculative or beyond the defined area of analysis for the wildlife and bird species found in the project area.

Additionally, SGI proposed a wildlife habitat plan in an amendment to its Proposed Action (Alternative B) and included in the Preferred Alternative (Alternative D). The BLM has taken this into consideration and revised the impact analysis accordingly to reflect the additional specific measures SGI has put forth.

The BLM revised the cumulative analysis further to reflect a refined discussion of the effects anticipated from past, present, and future actions resulting from this project and the others identified within the defined cumulative analysis area and time frame.

Section 6.5 - Traffic, Access

Total Number of Comments: 3

Comment No.:
387_DeltaCoComms_20150416_hard-3
Organization: Delta Board of County Commissioners
Commenter: Mark Roeber

Comment Excerpt Text:
Traffic and Road Use:
The support routes within the proposal do not involve County roads; however the County's maintenance of Forest Service road 265 under an agreement with the Forest Service would be affected by the proposed plan. The County would like for any decision on the (EA) to consider the County's involvement in this support road. It is likely that Stevens Gulch Road (similarly maintained) may also be used at times and would also be of concern for the County. The County requests the EA specifically address the impact of the project phasing schedule on traffic and road use.

Comment No.: 431_Leger_N_20150416_email-attach-7
Commenter: Natasha Leger

Comment Excerpt Text:
14. The heavy truck traffic from this project will impact the entire North Fork Valley. There are only two access points to the area - over McClure Pass or Highways 92 and 133. All told, the project could result in 43,294 heavy truck trips for drilling, fracking, and production over the life of the project. This type truck traffic will radically change the scenic and agricultural quality of the valley, which will negatively impact tourism and the economy.

Comment No.:
495_TownofHotchkiss_Koontz_W_20150414_hard-4
Organization: Town of Hotchkiss
Commenter: Wendell Koontz

Comment Excerpt Text:
4. Traffic thru Town. The Town requests notification of oversized equipment, hazardous waste shipments, or large convoys of equipment that may be transported thru Town affecting events such as the Sheepdog Trials, Delta County Fair, parades, or other events. Scheduling equipment convoys at night or on off-peak commuting hours and when events are planned will minimize conflict. The contact can be made thru Marshall D. Miller at the Hotchkiss Town Hall either by phone or by our website www.townofhotchkiss.com

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Summary

The BLM should consider traffic impacts beyond the planning area, including County involvement in road maintenance.

Response

The Draft EIS cumulative effects analysis provided quantitative analysis for roadways within the Unit regarding the number of trips anticipated under each alternative. The Draft EIS also presented a qualitative analysis regarding potential traffic-related impacts beyond the Unit boundary but did not provide trip data for roadway segments outside the Unit. As noted in the Draft EIS, traffic volumes are generally increasing throughout west-central Colorado due to expanding urban and resort areas, with the potential cumulative impacts being longer travel times, road surface quality degradation, and more frequent road construction. The Draft EIS notes that the most noticeable impacts would likely occur along State Highway 133, especially between Hotchkiss and the Unit.

Section 7 – Water Quantity Required for the Project

Total Number of Comments: 2

Comment No.: 389_Deva_A_20150415_email-1
Commenter: Arlyn Alderdice

Comment Excerpt Text:
One of my biggest concerns is the water needed for the project. We have had several droughts in the recent past and I do not believe that the area can spare the 353.6 million gallons of fresh water the BLM estimates it will use over the life of the project.

Comment No.: 494_Thompson_G_20150415_email-attach-5
Commenter: Greg Thompson

Comment Excerpt Text:
Water is such a precious resource at this time of drought. As an agricultural water user of the watershed being impacted I would like to see more restrictions placed on well location setbacks (to include 1,000 foot setbacks for new well locations from water bodies).

Summary

The water used for this project is too much for a project in a drought-prone location. New well locations should have a 1,000-foot setback from water bodies.

Response

As noted in Section 2.3.1, Alternatives Considered and Eliminated during EA Development, of the Draft EIS, the BLM considered a 500-foot setback that would increase the extent of long-term surface disturbance and would place development higher on ridges and side-slopes, creating unacceptable soil and sedimentation impacts. In reviewing a 1,000-foot setback, the BLM found similar problems with increased acreages of long-term surface disturbance and unacceptable locations on steep slopes and ridges. Therefore, the BLM eliminated this measure from consideration under Alternative D, the Preferred Alternative.

Water use is based on water rights held by SGI and its availability under those water rights. Any additional water would be obtained from willing sellers (see Section 4.2.4, Water Resources, of the Final EIS)

Section 8 - Mitigation Measures

Total Number of Comments: 13

Comment No.: 482_SGI_Gordy_S_20150416_email-attach-2
Organization: SG Interests I, Ltd.
Commenter: Shaun Gordy

Comment Excerpt Text:
In distinguishing between Alternatives B and C, the DEIS appears to suggest that mitigation measures applicable to Alternative C would not likewise apply under Alternative B. But nothing about the contemplated mitigation measures is unique to Alternative C. Among other measures, operational

conditions to reduce the risk of seismic events (DEIS at 4-96), timing limitations to protect wildlife (DEIS at 4-118), and nitrogen oxide (NOx) limitations are equally applicable irrespective which alternative BLM selects (DEIS at 2-63).

Comment No.: 482_SGI_Gordy_S_20150416_email-attach-73
Organization: SG Interests I, Ltd.
Commenter: Shaun Gordy

Comment Excerpt Text:
In Alternative C, the DEIS proposes mitigation measures that appear to carry environmental consequences with the potential to outweigh the purported benefits. The DEIS indicates that under Alternative C power lines would be buried (DEIS at 2-70, 4-141) and set backs would be imposed (DEIS at 4-80) to reduce the risk of harm to wildlife and the environment. But there is no net benefit associated with burying power lines. Burying lines creates a greater amount of ground disturbance than overhead lines, and with increased disturbance comes an increased risk of week establishment and potential for wildfire. The DEIS also fails to cite any technical or scientific basis for concluding that a setback can reduce the risk of stream contamination. The agency should provide explanations for these statements.

Comment No.: 482_SGI_Gordy_S_20150416_email-attach-85
Organization: SG Interests I, Ltd.
Commenter: Shaun Gordy

Comment Excerpt Text:
the following mitigation measures are not limited to Alternative C:

The listed mitigation measures in Table 2-13. DEIS at 2-63. In fact, SG negotiated these very same measures for Alternative B with BLM.

Reclamation requirements. DEIS at 4-74.

Use of fencing around all cuttings pits. DEIS at 4-112, 4-113.

Compliance with the Bald and Golden Eagle Protection Act. DEIS at 4-133.

The “added measures to protect wildlife and reduce surface disturbance” and construction of roads on an as-needed basis. DEIS at 4-176.

New roads would be designed considering impacts to big game. DEIS at 4-116.

Compliance with 40 C.F.R. part 60 subpart OOOO and all other applicable air quality regulations.

Compliance with COGCC’s green completion requirements as described in Rule 805.

Comment No.: 494_Thompson_G_20150415_email-attach-8
Commenter: Greg Thompson

Comment Excerpt Text:
Water and air monitoring. Fracking is an industrial process that jeopardizes air and water quality. For this reason BLM needs to require; 1) mandatory baseline surface water sampling and ongoing monitoring; 2) collection of baseline air samples prior to development; and 3) ongoing air monitoring to test for chemicals related to drilling and fracking operations, such as methane, volatile organic compounds and polycyclic aromatic hydrocarbons.

Comment No.:
503_WELC_King_L_20150416_email-attach-100
Organization: Western Environmental Law Center
Commenter: Laura King

Comment Excerpt Text:
For the mitigation measures that BLM did consider in the DEIS, the agency failed to analyze the effectiveness of each measure. This must be rectified

Comment No.:
503_WELC_King_L_20150416_email-attach-101
Organization: Western Environmental Law Center
Commenter: Laura King

Comment Excerpt Text:
there is no analysis of how effective the mitigation measures will be. Simply listing the mitigation measures, and asserting that they will be completely successful in eliminating or substantially reducing the Project's adverse impacts, with no scientific evidence or analysis to support those claims, is the definition of an arbitrary and capricious decision.

Comment No.:
503_WELC_King_L_20150416_email-attach-119
Organization: Western Environmental Law Center
Commenter: Laura King

Comment Excerpt Text:
Each individual resource contains hundreds of additional BMPs aimed at developing oil and gas reserves in a manner that protects the many human and environmental resources at stake. BLM should evaluate these BMPs thoroughly, including their efficacy, in light of a hard look at impacts and include stipulations mandating use of these BMPs in its alternatives analysis.

Comment No.:
503_WELC_King_L_20150416_email-attach-53
Organization: Western Environmental Law Center
Commenter: Laura King

Comment Excerpt Text:
First, while the application of mitigation measures is better than unconstrained development, reliance on mitigation measures is inappropriate if the measures are merely discretionary and undefined. BLM mentions the possible use of spill containment structures, the possible use of setbacks, and the possible use of (undefined) BMPs. Thus, the BLM relies on mitigation measures that are uncertain and apparently discretionary with the industry.

Comment No.:
503_WELC_King_L_20150416_email-attach-62
Organization: Western Environmental Law Center
Commenter: Laura King

Comment Excerpt Text:
the mere mention of mitigation measures does not satisfy the BLM's "hard look" requirement. Rather than providing empty reassurances in the form of possible measures that might be implemented, the DEIS must clearly set out the alternatives as they exist, and analyze the impacts posed by each of those alternatives. In this way, the decisionmaker may determine the need for mitigation, and evaluate alternatives based on their inclusion of mitigation. BLM must require—not just suggest or contemplate—meaningful mitigation measures, including closed-loop drilling, the use of only recycled water for drilling and fracking.

Comment No.:
503_WELC_King_L_20150416_email-attach-72
Organization: Western Environmental Law Center
Commenter: Laura King

Comment Excerpt Text:
The EIS must analyze actual impacts and specific mitigation measures before the Bull Mountain MDP can be approved. This DEIS does not adequately accomplish either requirement.

Comment No.:
503_WELC_King_L_20150416_email-attach-95
Organization: Western Environmental Law Center
Commenter: Laura King

Comment Excerpt Text:
Appendix C is no more than a generic list of BMPs and COAs that have not been analyzed for effectiveness by BLM

Comment No.:
503_WELC_King_L_20150416_email-attach-96
Organization: Western Environmental Law Center
Commenter: Laura King

Comment Excerpt Text:
The proposed timing limitations and other measures are not supported by evidence, and do nothing to placate public concern over the detrimental effects of this project. BLM's unsupported reliance on these measures is faulty; while BMPs and COAs help minimize impacts to wildlife, waters and other resources, it is clear that BMPs "reduce, but do not eliminate, the indirect impacts associated" with oil and gas development.(BP America Production Company, San Juan Basin Colorado Wildlife Mitigation Plan (Mar. 2011) at 7 (attached as Exhibit 134).) The DEIS should include a thorough description and analysis of the likely effectiveness of any proposed mitigation measures and mitigating impacts, and not rely on blanket conclusions of their worth

Comment No.:
503_WELC_King_L_20150416_email-attach-99
Organization: Western Environmental Law Center
Commenter: Laura King

Comment Excerpt Text:
BLM cannot simply discuss mitigation measures. It must determine, based on sound evidence, that each measure would actually be effective. See id. This is especially true here, as BLM's listed mitigation measures to purportedly protect big game have been specifically criticized as inadequate by USFWS and CPW staff. An agency's failure to respond to scientific criticism of its mitigation measures violates NEPA

Summary

The BLM should review the discussion of mitigation measures to clarify which mitigation measures are applicable under each alternative and the effectiveness of each mitigation measure.

Response

The COAs identified in Appendix C are included in Alternatives B and C and Alternative D, the Preferred Alternative. Because of this, the impact analysis was conducted to include the impacts of applying the COAs to illustrate the impacts that would be mitigated. For example, Section 4.2.6, Vegetation and Invasive, Nonnative Species, of the Draft EIS notes the nature and types of impacts typically seen from development and production, then further describes the individual impacts under each alternative. Based on these impacts, the analysis describes the specific measures that would be applied to address these impacts. It goes on to explain how these measures would avoid, reduce, or eliminate the impacts. Citations and references are included to support the conclusions when they were available; otherwise, the statements represent professional experience and expertise.

SGI submitted a wildlife habitat plan amendment to its Proposed Action (Alternative B), resulting in changes to the anticipated impacts for this alternative. The Final EIS presents a revised analysis that includes application of this plan. In addition to the plan's application, the measures in Appendix C would still apply.

Section 8.1 - Air resources

Total Number of Comments: 9

Comment No.: 071_Coleman_F_21050407_email-2
Commenter: Frank M. Coleman

Comment Excerpt Text:
It is also important that the directive of the Secretary of Interior, Secretarial Order 3226, be followed with respect to monitoring of emissions from natural gas and oil wells.

Comment No.: 071_Coleman_F_21050407_email-3
Commenter: Frank M. Coleman

Comment Excerpt Text:
If it is found that air quality in the wilderness areas bordering the project fails to meet standards set by the CAA, then appropriate measures must be taken. This includes cessation of activities. The CAA requires prevention of significant deterioration (PSD) of air quality in wilderness areas in comparison with standards applying to other areas.

Comment No.: 293_Soule_M_20150413_hard-1
Commenter: Michael Soule

Comment Excerpt Text:
Accomplish new and review past baseline environmental studies and surveys to document past and present conditions of all potentially affected habitats and environments, surface and sub-surface. Notably, please plan for preventing and mitigating the potential atmospheric impacts of the MDP that could or should be mitigated, particularly those development related impacts that would exacerbate emissions of greenhouse gases such as carbon dioxide and methane

Comment No.:
400_GMUGNF_Armentrout_20150416_email-attach-3
Organization: USDA United States Department of Agriculture
Commenter: Scott Armentrout

Comment Excerpt Text:
• Even with the use of Tier 2 drill rigs there are some levels of acceptable change
(deciviews and acid deposition) that will be exceeded at sensitive Forest Service areas. Is there a way to further mitigate this impact? Because these sensitive areas are within wildernesses in the cumulative effects area, are other wilderness character or characteristics affected by these projected changes that require additional discussion?

Comment No.:
503_WELC_King_L_20150416_email-attach-13
Organization: Western Environmental Law Center
Commenter: Laura King

Comment Excerpt Text:
BLM should require mandatory collection of baseline air samples prior to development and ongoing air monitoring to test for chemicals related to drilling and fracking operations, like methane, volatile organic compounds (“VOCs”), and polycyclic aromatic hydrocarbons (“PAHs”).

Comment No.:
503_WELC_King_L_20150416_email-attach-136
Organization: Western Environmental Law Center
Commenter: Laura King

Comment Excerpt Text:
The BLM must propose a detailed and enforceable mitigation plan and consider that plan in detail as an alternative in the MDP DEIS, using any and all means, prior to issuance of the final EIS, that will ensure no violations of Clean Air Act standards and, further, adherence to thresholds established by best

available science regarding protection of public health and the environment. If the BLM authorizes the proposed action, its actions will not ensure air quality protection. The BLM must improve upon its air quality analysis and then must develop an alternative that ensures no violations of Clean Air Act standards.

Comment No.:
503_WELC_King_L_20150416_email-attach-28
Organization: Western Environmental Law Center
Commenter: Laura King

Comment Excerpt Text:
Moreover, Colorado's CARPP, is a tool that can provide an important state-of-the-art resource to guide the agency's analysis of GHG mitigation measures applicable to the Bull Mountain MDP. In particular, Table V-I identifies Best Management Practices and Air Emission Reduction Strategies for Oil and Gas Development, which displays some emission reduction measures, their potential environmental benefits and liabilities, and feasibility. As detailed above, the UFO's failure to consider and include the CARPP in its analysis is a significant omission, which could otherwise benefit the agency's consideration of mitigation measures, as here

Comment No.:
503_WELC_King_L_20150416_email-attach-40
Organization: Western Environmental Law Center
Commenter: Laura King

Comment Excerpt Text:
The UFO must require emission reduction strategies to satisfy the requirements of NEPA, SO 3226, FLPMA, and the MLA

Comment No.:
554_EPA_Strobel_P_20150415_hard-2
Organization: EPA
Commenter: Philip S. Strobel

Comment Excerpt Text:
Hazardous Air Pollutants
The Draft EIS includes modeling to estimate the risk of cancer due to the project's HAP emissions for both the Most Likely Exposed (MLE) and Maximally Exposed Individual (MEl). The Draft EIS projects cancer risk exceeding the one-in-one million threshold for both the MLE population and the MEl, ranging from approximately 5-in-one million to 37-in-one million, respectively. In order to avoid exposures to HAP emissions, we recommend the BLM identify and require a buffer distance from residences sufficient to reduce the risk of cancer to the MEl to below one-in-one million

Summary

The BLM needs to consider appropriate air resources measures and monitoring to ensure that impacts on air quality are mitigated, which include mandatory collection of baseline air samples before develop begins, an air mitigation plan, and additional measures outlined in the CARPP. These measure need to prevent adverse air resources impacts, such as significant deterioration of air quality in wilderness areas, and must demonstrate compliance with the Clean Air Act. The monitoring measures should comply with Secretarial Order 3226.

Response

The air resources COAs for development alternatives effectively reduce adverse impacts on air quality and air quality-related values. The analysis indicated that there would be no violations of any NAAQS and that deposition and visibility impacts would be below applicable threshold values in the Class I and sensitive Class II areas.

BLM considered including an air monitoring station in the preferred alternative; however, there are several other operators and sources that influence the air quality of the region through complex operations (e.g., oil, gas, and coal mining). BLM therefore concluded that a project-specific air modeling station would not be effective in this instance. BLM may, in the future, construct and operate an air monitoring station in the North Fork area, if appropriate.

Section 8.2 - Water

Total Number of Comments: 5

Comment No.: 482_SGI_Gordy_S_20150416_email-attach-73
Organization: SG Interests I, Ltd.
Commenter: Shaun Gordy

Comment Excerpt Text:
In Alternative C, the DEIS proposes mitigation measures that appear to carry environmental consequences with the potential to outweigh the purported benefits. The DEIS indicates that under Alternative C power lines would be buried (DEIS at 2-70, 4-141) and set backs would be imposed (DEIS at 4-80) to reduce the risk of harm to wildlife and the environment. But there is no net benefit associated with burying power lines. Burying lines creates a greater amount of ground disturbance than overhead lines, and with increased disturbance comes an increased risk of week establishment and potential for wildfire. The DEIS also fails to cite any technical or scientific basis for concluding that a setback can reduce the risk of stream contamination. The agency should provide explanations for these statements.

Comment No.: 495_TownofHotchkiss_Koontz_W_20150414_hard-3
Organization: Town of Hotchkiss
Commenter: Wendell Koontz

Comment Excerpt Text:
3. Reclamation and reseeding should likewise follow Best Management Practices to ensure long-term success of the reclamation. The Bull Mountain area is in the headwaters of the North Fork of the Gunnison which flows thru Hotchkiss. Sedimentation, spills, or other issues are a concern for our citizens. Likewise, construction of pipelines and other infrastructure, if needed, should follow the same protocol of developing in the Best Management Practices.

Comment No.: 496_TroutUnltd_Cross_S_20150416_email-attach-1
Organization: Trout Unlimited
Commenter: Shane Cross

Comment Excerpt Text:
1. The BLM should analyze and include a best management practice/condition of approval requiring surface disturbing activities to be located up to ¼ mile from perennial surface waters, if necessary, depending on type and use of water source, soil type, and slope steepness.

Comment No.: 503_WELC_King_L_20150416_email-attach-54
Organization: Western Environmental Law Center
Commenter: Laura King

Comment Excerpt Text:
Second, even assuming that all of the measures BLM mentions are implemented, the BLM fails to identify the amount of remaining risk, whether that risk is significant, and what impacts it will have on stream health and public health

Comment No.:
503_WELC_King_L_20150416_email-attach-60
Organization: Western Environmental Law Center
Commenter: Laura King

Comment Excerpt Text:

The EIS provides the feeble reassurances that "pits would be lined to prevent releases" and "drilling wastes would be properly disposed." Id. The BLM must do more to address the potential momentous impacts to groundwater caused by leaks or spills of frack fluid or produced water.

Summary

The Draft EIS should provide evidence that setbacks reduce the risk of stream contamination. The Draft EIS should analyze a BMP of a ¼-mile setback from perennial surface waters. Construction and infrastructure should follow BMPs to reduce sedimentation risk, as the area is within the North Fork of the Gunnison River. The Draft EIS needs to analyze the risk to water/streams, assuming all BMPs are implemented.

Response

As noted in Section 2.3.1, Alternatives Considered and Eliminated during EA Development, of the Draft EIS, the BLM considered a 500-foot setback that increased the extent of long-term surface disturbance and placed development higher on ridges and side-slopes. This created unacceptable soil and sedimentation impacts. In reviewing a 1,000-foot setback, the BLM found similar problems with increased acreages of long-term surface disturbance and unacceptable locations on steep slopes and ridges. Therefore, the BLM eliminated this measure from consideration under Alternative D, the Preferred Alternative.

There have not been many studies to show what specific buffer distances are appropriate or work the best for all applications; nevertheless, there are several studies that show how including buffer areas help protect stream corridors. This is because the buffers allow for space and time to soak up spills. However, finding the perfect distance would not eliminate the potential spill risks associated with development. The BLM revised and updated the COAs and the resultant analysis to provide clarification in the Final EIS.

Section 8.3 - Vegetation

Total Number of Comments: 1

Comment No.: 548_BlackCanRegLandTrust_Puckett_J_20150415-3
Organization: Black Canyon Regional Land Trust
Commenter: Jeremy Puckett

Comment Excerpt Text:
regarding the long-term disturbance or conversion of important sage brush habitat, BCRLT would like to suggest that the operator be required to perform off-site sage brush habitat mitigation projects or contribute funds to facilitate permanent conservation of lands of similar habitat value

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Summary

The operator should be required to perform off-site sagebrush habitat mitigation or contribute funds to conserve lands of similar habitat value.

Response

Appendix B, Construction, Drilling, Completion, and Reclamation, describes revegetation of well pads and other surface disturbances. The analysis provides information on reclamation requirements that will be sufficient to mitigate noted impacts described in Chapter 4, Environmental Consequences.

Section 8.4 - Wildlife, Birds

Total Number of Comments: 7

Comment No.: 431_Leger_N_20150416_email-attach-6
Commenter: Natasha Leger

Comment Excerpt Text:
13. BLM should require additional mitigation measures to prevent harm to big game animals—which would also harm the local hunting economy—such as timing limitation stipulations during certain seasons on operations and maintenance activities and big game monitoring throughout the life of the project.

Comment No.: 482_SGI_Gordy_S_20150416_email-attach-74
Organization: SG Interests I, Ltd.
Commenter: Shaun Gordy

Comment Excerpt Text:
Other proposed mitigation measures appear to have little reasoning behind them. Limiting traffic to areas between the hours of 9am to 3pm, for example, produces no environmentally beneficial result. See DEIS at 2-49. To the contrary, concentrating traffic during early mornings and late evenings is likely to maximize traffic during period when wildlife are most likely to be active and when equipment, services, and operational support is least likely to be available

Comment No.: 503_WELC_King_L_20150416_email-attach-71
Organization: Western Environmental Law Center
Commenter: Laura King

Comment Excerpt Text:
the DEIS fails to adequately consider mitigation as a way of reducing the severity of adverse impacts to wildlife, and must require additional mitigation measures. These flaws necessitate a more robust analysis that gives an accurate picture of the numerous, sustained impacts that development of this magnitude will have on wildlife populations.

Comment No.: 503_WELC_King_L_20150416_email-attach-80
Organization: Western Environmental Law Center
Commenter: Laura King

Comment Excerpt Text:
The DEIS states: “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.”DEIS at 4-112. But the document also acknowledges that mule deer are already “likely

modifying movement patterns around some of the more active wells and roads to avoid human activities and traffic."DEIS at 3-62. Even with the relatively limited development current in the area, wildlife are being impacted. Development at the level anticipated in the DEIS, coupled with impacts from related energy projects in the Upper North Fork, could be overwhelming for mule deer, elk and other game species. The DEIS fails to take a hard look at such impacts to these wildlife populations, and fails to sufficiently describe or explain how mitigation measures are to avoid such impacts.

Comment No.:
503_WELC_King_L_20150416_email-attach-93
Organization: Western Environmental Law Center
Commenter: Laura King

Comment Excerpt Text:
The DEIS repeats the faulty pattern prevalent in the previous EA by failing to adequately consider mitigation as a way of reducing the severity of impacts to wildlife. Instead, BLM relies once again on a list of unanalyzed and overwhelming voluntary conditions in Appendix C.

Comment No.:
503_WELC_King_L_20150416_email-attach-94
Organization: Western Environmental Law Center
Commenter: Laura King

Comment Excerpt Text:
While relying on these BMPs and COAs, the DEIS provides no analysis concerning how they would reduce impacts to wildlife. The DEIS states that under this alternative "[a]dherence to design features, required plans and BMPs from Appendix C...would minimize the potential for impacts on wildlife. DEIS at 4-118. But there is no discussion in the document to support this conclusion. BLM proffers a foregone conclusion that implementation of COAs and BMPs would reduce impacts on wildlife and sensitive species:

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.

Comment No.:
503_WELC_King_L_20150416_email-attach-98
Organization: Western Environmental Law Center
Commenter: Laura King

Comment Excerpt Text:
BLM fails to analyze the effectiveness of the measures that the DEIS asserts would protect wildlife and sensitive species.

Summary

The Final EIS should include a detailed analysis of the effectiveness of proposed mitigation measures for wildlife.

Response

The wildlife measures provided for in Appendix C and the amended Alternative B, including SGI's proposed wildlife habitat plan, are considered design features including reduced traffic measures such as remote telemetry and timing limitations on development; as such, the impacts were analyzed with the inclusion of these measures. Timing limitations will mitigate impacts where applied on the federal surface or split estate; however, because BLM does not make decisions for private mineral estate, there may be a compounding effect should development become concentrated on private land. The effects would likely

continue through production (e.g., workovers and maintenance). Based on the wildlife habitat plan amendment to Alternative B, and in response to public comments, the Final EIS was updated and revised to better convey the anticipated results of wildlife design features included in Alternative B and now in Alternative D, the Preferred Alternative.

Section 8.5 - Special status species

Total Number of Comments: 2

Comment No.:
503_WELC_King_L_20150416_email-attach-132
Organization: Western Environmental Law Center
Commenter: Laura King

Comment Excerpt Text:
Despite recognizing the immediate presence of this species, as well as their vulnerability to impacts, the DEIS concludes that "may affect, and are not likely to adversely affect" greenback cutthroat trout, despite a pipeline crossing of Roberts Creek, given the use of Best Management Practices and applicant-committed mitigation." DEIS at 4-132. There is, of course, no analysis or explanation of how those BMPs and industry mitigation would protect species impacts.

Comment No.:
503_WELC_King_L_20150416_email-attach-82
Organization: Western Environmental Law Center
Commenter: Laura King

Comment Excerpt Text:
One way to cure this insufficient analysis is for BLM to comply with the recommendations made in the Lynx Conservation Assessment and Strategy ("LCAS"). The LCAS recommends Federal land management agencies to take certain actions at the programmatic planning stage to ensure the viability of lynx. These include:

• Map oil and gas production and transmission facilities, mining activities and facilities, dams, and agricultural lands on public lands and adjacent private lands, in order to assess cumulative effects;
• Develop and implement a plan to protect key linkage areas on federal lands from activities that would create barriers to movement;
• Barriers could result from an accumulation of incremental projects, as opposed to any one project; and
• Evaluate the potential importance of shrub-steppe habitats in providing landscape connectivity between blocks of lynx habitat."(Ruediger et al. at 88 (emphasis added) (attached above as Exhibit 121).

Summary

The Final EIS should explain the "may affect, and are not likely to adversely affect" status for greenback cutthroat trout, due to BMPs or mitigation, and it should consider including mitigation measures recommended in the Lynx Conservation Assessment and Strategy (LCAS).

Response

The BLM provided a biological assessment and to the USFWS as part of the formal ESA consultation. The BLM submitted the Biological Assessment to the USFWS for review on September 22, 2015. For each listed species, the BLM determined if the implementation of the Preferred Alternative may affect the species that was the subject of the consultation. The USFWS responded on October 20, 2015 with a

memorandum concurring with the BLM's analysis that project "may affect, is not likely to adversely affect" the threatened Greenback cutthroat trout and threatened Canada lynx and "may affect, is likely to adversely affect" the four endangered Colorado River fishes. The finding on the Colorado River fishes falls under BLM Colorado's Programmatic Biological Assessment (PBA) for water depleting activities associated with BLM's fluid minerals program in the Colorado River Basin in Colorado. U.S. Fish and Wildlife Service (FWS) issued a Programmatic Biological Opinion (PBO) (ES/GJ-6-C0-08-F-0006) on December 19, 2008, which concurred with BLM's determination that water depletions are "Likely to Adversely Affect" the Colorado pikeminnow, Humpback chub, Bonytail, and Razorback sucker.

Section 8.6 – Application of Stipulations and COAs on Private Property

Total Number of Comments: 6

Comment No.: 006_Antal_J_20150408-1
Commenter: Jessica Antal

Comment Excerpt Text:
In other words, your agency simply does not have the right to tell these property owners what kinds of lease stipulations they can or cannot apply to their own property. Seen in this light, I am sure you can agree that the additional timing limitations and well placement restrictions included in Alt. C are singularly inappropriate.

Comment No.: 007_DeltaChamberCommerce_Applegate_20150323_hard-2
Organization: Delta Area Chamber of Commerce
Commenter: Josh Applegate

Comment Excerpt Text:
We do not believe that the BLM has the right or authority to impose restrictions or measures that will in any way violate those agreements. Unfortunately, Alternative C includes many such measures.

Comment No.: 011_Astin_S_20150413_hard-1
Commenter: Steve Astin

Comment Excerpt Text:
Should the BLM pick Alternative C, it would violate these agreements by imposing further regulations on private land.

Comment No.: 017_Ayers_B_20150413_hard-1
Commenter: Brian Ayers

Comment Excerpt Text:
By adding limits to what can and can't be done on the surface of these lands, the BLM is inappropriately infringing on the rights of property owners to make their own decisions as to how to utilize their property. By imposing these new and expanded measures, the BLM seems to me to be exceeding their authority.

Comment No.: 084_Cross_S_20150410_hard-1
Commenter: Sarah Cross

Comment Excerpt Text:
Alternative C lists a number of stipulations that exceed those agreed to by the landowners. This is a blatant infringement on property rights, and is something that no government agency has a right to do.

Comment No.: 413_Helleckson_B_20150416_email-1
Commenter: Brent Helleckson

Comment Excerpt Text:
Regardless of the process by which exploration and development proceeds, the BLM in adherence to its perceived responsibilities under FLPMA and various energy related directives, is proposing to preside over the industrialization of previously agricultural and/or sylvan landscapes and communities. Granted, most of the proposed development occurs on private land and, should the effects of such development be contained within the landholders property boundaries, there would be no reason for discussion. The impacts do not and there is ample reason for discussion. I oppose such industrialization because of its impacts to my quality of life, and my means of making a living. As such, I am here advocating for a DEIS that examines methods of minimizing or eliminating those effects.

Summary

Commenters state that stipulations imposed on private surface, particularly measures proposed under Alternative C, infringe on private property rights. The BLM also needs to analyze the effects of applying protection and mitigation measures for how they reduce impacts to areas beyond the Unit's boundary.

Response

As noted in Section 2, Jurisdiction and Authority, of this Responses to Comments, the BLM is required to consider the effects and mitigation measures on split-estate lands in essentially the same manner as a lease overlain by federal surface. While a private landowner's wishes should be considered in decisions, they do not overrule requirements of these statutes and their implementing regulations. Further the BLM has analyzed the results of applying mitigation measures and design features that are intended to reduce impacts to resources within the Unit as well as resources that extend beyond the Unit boundary. The Chapter 4, Environmental Consequences, notes the direct and indirect effects of actions with mitigation measures applied, and the Cumulative Effects subsection under each resources discusses the effects that extend geographically beyond the Unit boundary.

Section 8.7 – Mitigation Measures to Control Methane Emissions

Total Number of Comments: 5

Comment No.:
503_WELC_King_L_20150416_email-attach-116
Organization: Western Environmental Law Center
Commenter: Laura King

Comment Excerpt Text:
BLM should include in its analysis an alternative that applies a stipulation which mandates the use of best available methane reduction technologies to all development within the Bull Mountain Unit. Recent research has demonstrated that the use of ten technically proven and commercially available methane emissions reduction technologies can together capture more than 80 percent of the methane currently going to waste in the oil and gas sector's operations. See Harvey Report (attached above as Exhibit 47). These technologies include:

1. Green Completions to capture oil and gas well emissions;
2. Plunger Lift Systems or other well deliquification methods to mitigate gas well emissions;
3. Tri-Ethylene Glycol (TEG) Dehydrator Emission Controls to capture emissions from dehydrators;
4. Desiccant Dehydrators to capture emissions from dehydrators;

5. Dry Seal Systems to reduce emissions from centrifugal compressor seals;
6. Improved Compressor Maintenance to reduce emissions from reciprocating compressors;
7. Low-Bleed or No-Bleed Pneumatic Controllers used to reduce emissions from control devices;
8. Pipeline Maintenance and Repair to reduce emissions from pipelines;
9. Vapor Recovery Units used to reduce emissions from storage tanks; and
10. Leak Monitoring and Repair to control fugitive emissions from valves, flanges, seals, connections and other equipment.

Comment No.:
503_WELC_King_L_20150416_email-attach-27
Organization: Western Environmental Law Center
Commenter: Laura King

Comment Excerpt Text:
There are several widely recognized best management practices ("BMPs") for mitigating methane emissions that, as discussed above, must be considered by BLM in its analysis of the proposed action. We believe that most, if not all of these measures should be considered and adopted, both because they can reduce methane emissions from significant emissions sources and because they have also been shown to have very quick paybacks from the sale of captured methane, even at today's low gas prices. The most important of these measures include:

• Centralized Liquid Gathering Systems and Liquid Transport Pipelines
• Reduced Emission Completions/Recompletions (green completions)
• Low-Bleed/No-Bleed Pneumatic Devices on all New Wells
• Dehydrator Emissions Controls
• Replace High-bleed Pneumatics with Low-Bleed/No-Bleed or Air-Driven Pneumatic Devices on all Existing Wells; and
• Electric Compression
• Liquids Unloading (using plunger lifts or other deliquification technologies)
• Improved Compressor Wet Seal Maintenance/Replacement with Dry Seals
• Vapor Recovery Units on Storage Vessels
• Pipeline Best Management Practices; and
• Leak Detection and Repair

Comment No.:
503_WELC_King_L_20150416_email-attach-29
Organization: Western Environmental Law Center
Commenter: Laura King

Comment Excerpt Text:
Another area of concern is the effectiveness of the mitigation measures adopted to ensure that the methane captured is able to make it to market for sale and the realization of rapid payback. Such considerations must be included in the agency's NEPA analysis. This includes, inter alia, how the agency will require operators on private and public lands to coordinate development to ensure that centralized liquids gathering and treatment investments are made prior to the appraisal and field development phase when production increases dramatically. The UFO should identify and describe the mechanisms they plan to employ to achieve this desirable outcome.

Comment No.:
503_WELC_King_L_20150416_email-attach-30
Organization: Western Environmental Law Center
Commenter: Laura King

Comment Excerpt Text:
The second issue is how gas (as opposed to liquids) captured by implementation of the mitigation measures will enter sales gas lines and make it to market, as opposed to simply being flared and wasted. We believe that the UFO should spell-out whether all of the gas captured by the mitigation measures adopted is expected to have similar access to a sales line, or whether some or all of it will be sent to flares and wasted. If the latter, we believe that additional mitigation measures should be instituted,

comparable to the measure adopted for liquids, requiring planning and timely development of gas gathering and treatment infrastructure to ensure that GHG emissions are reduced, that revenues from gas sales are maximized for the realization of paybacks for operators, royalty payments for the federal and state governments, and that waste of this important resource is minimized.

Comment No.:
503_WELC_King_L_20150416_email-attach-31

Organization: Western Environmental Law Center
Commenter: Laura King

Comment Excerpt Text:
The DEIS currently contains no mitigation measures for methane waste and emissions. As the UFO conducts its analysis for the Bull Mountain MDP, we urge the agency to consider the full range of methane waste and emissions mitigation technologies and practices described above, and to adopt the widest possible set of measures tailored to the future levels of development described in the MDP.

Summary

The Final EIS should include additional stipulations related to controlling methane emissions and should fully evaluate the effectiveness of these mitigation measures.

Response

The project is subject to the EPA's Standards of Performance for Crude Oil and Natural Gas Production, Transmission, and Distribution regulation (found in 40 CFR, Part 60, Subpart OOOO) and CDPHE's Regulations Number 6 and Number 7, which all focus on reducing VOC emissions. By reducing VOC emissions, methane emissions are also reduced.

Section 9 - Consultation, coordination

Total Number of Comments: 2

Comment No.: 026_Bishop_S_20150330_email-1
Commenter: Sara Bishop

Comment Excerpt Text:
The list of agencies and organizations BLM consulted with in developing the Draft EIS does not include the Colorado Department of Transportation. I find this a serious lack, as the enormous increase in traffic resulting from any alternative that allows for new well development will have a substantial impact on the state highway 133 road bed. BLM should consult with CDOT about truck traffic impact on this highway, whether that traffic comes from the east or west end of highway 133

Comment No.: 548_BlackCanRegLandTrust_Puckett_J_20150415-5
Organization: Black Canyon Regional Land Trust
Commenter: Jeremy Puckett

Comment Excerpt Text:
Whether consultation or coordination with land trusts is legally required or not, the BLM should clearly document and disclose the roles and responsibilities of such parties as part of the EIS process

Summary

Colorado Department of Transportation should be consulted since there would be many impacts on transportation and roads. The BLM should document and describe the roles and responsibilities of land trusts as part of the EIS.

Response

The BLM invited the Colorado Department of Transportation to participate in the EIS process, but it declined to become a cooperating agency. Despite CDOT not joining as a cooperating agency, the BLM has coordinated with it and included information regarding traffic and roads in the Draft and Final EISs (see Section 4.3.5, Transportation and Access, of the Draft and Final EISs). Land trusts are beyond the scope of this document as they are specific agreements developed between landowners and the Colorado Parks and Wildlife Department.

Section 10 - Other Laws, Policy, Regulations

Total Number of Comments: 2

Comment No.: 482_SGI_Gordy_S_20150416_email-attach-83
Organization: SG Interests I, Ltd.
Commenter: Shaun Gordy

Comment Excerpt Text:
The implementation of Alternative A will prevent the government and the public from realizing the benefits of master planning. BLM has consistently recognized that, unlike piecemeal development, master planning "facilitates the consideration of cumulative effects early in the process and enables broad application of identified mitigation measures, and minimizes the overall timeframe for approval." Onshore Oil & Gas Order No. 1, 72 Fed. Reg. 10,308, 10,310 (Mar. 7, 2007). Master planning provides early notice to the public of where operations are being contemplated, and of the scale or intensity of the development. Frontloaded analysis also provides BLM with the tools necessary to perform a more comprehensive and streamlined review of development proposals, ensuring an accurate analysis of cumulative effects and preserving agency resources. "Because the process allows for better planning of field development, adverse environmental impacts are minimized." Id.

Comment No.: 482_SGI_Gordy_S_20150416_email-attach-84
Organization: SG Interests I, Ltd.
Commenter: Shaun Gordy

Comment Excerpt Text:
By foregoing approval of the MDP and deciding to authorize well development on a permit-by-permit basis, BLM will contravene the statutory requirements "[t]o ensure timely action on oil and gas leases and applications for permits to drill" and "expeditious compliance with . . . the National Environmental Policy Act . . . and any other applicable environmental and cultural resources laws." 42 U.S.C. § 15921(a)(1). The approval of a programmatic development approach will allow the BLM to tier to previous analysis and avoid unnecessary duplicative environmental analysis in considering APDs. In the absence of MDP approval, BLM will be required to prepare separate NEPA analyses for each APD submitted, resulting in unnecessary and duplicative environmental evaluation. This approach wastes agency resources. It would also increase the amount of time required to review the APDs, which can have negative impacts on tax revenues, employment, and result in an adverse climate for economic development.

Summary

A commenter states that failure to approve a master development plan, as under Alternative A, would prevent the government and the public from realizing the benefits of master planning and would not facilitate compliance with regulations included in Onshore Oil and Gas Order 1, 72 *Federal Register* 10,308 and 10,310 and 42 USC, Section 15921(a)(1).

Response

The commenter's assertion is correct and is noted in the Draft and Final EISs as part of the Purpose and Need statement in Chapter 1.

Section 10.1 - New hydraulic fracturing rule

Total Number of Comments: 1

Comment No.: 067_Clark_R_20150414_hard-3
Commenter: Robert E. Clark

Comment Excerpt Text:
The Bureau of Land Management's new requirements for Oil and Gas; Hydraulic Fracturing on Federal and Indian Lands (43 CFR Part 3160) should be made applicable to fracking activities in the upper North Fork Valley. Particular attention should given to road improvement, water use, water quality monitoring, new road construction, road strengthening, casing performance monitoring, storage of produced water, and timely public accessibility to information on operating records and regarding accidents.

Summary

The commenter states that area hydraulic fracturing should meet requirements specified in the BLM's new regulations specified under Oil and Gas: Hydraulic Fracturing on Federal and Indian Lands (43 CFR, Part 3160).

Response

In 2015, the BLM released the new rule, Oil and Gas: Hydraulic Fracturing on Federal and Indian Lands (to be codified in 43 CFR, Part 3160). If and when the rule takes effect, it will apply to hydraulic fracturing operations on federal minerals. The requirements would not apply to actions conducted on exclusively private mineral estate.

Section 10.2 - Revised RMP

Total Number of Comments: 6

Comment No.: 386_Delaney_L_20150416_email-1
Commenter: Lisa Delaney

Comment Excerpt Text:
In particular, we urge BLM to hold off on the Bull Mountain MDP until the UFO's RMP and EIS are completed. As the existing UFO RMP is out of date and not applicable to today's environment in the North Fork Valley, moving forward with oil and gas development would prejudice the development of the RMP EIS. Please consult with CDOT before moving forward with actions that will increase heavy truck traffic on Highway 133. The situation is already perilous, with the very large trucks that barrel downvalley on this narrow road as it passes by Paonia, and around Hotchkiss, with numerous roads and driveways. Hotchkiss faces a different issue, with its small town feel threatened by a greatly increased flow of heavy truck traffic. We are concerned about both safety and road degradation from the addition of numerous heavy trucks on a daily basis.

Comment No.:
503_WELC_King_L_20150416_email-attach-1
Organization: Western Environmental Law Center

Commenter: Laura King

Comment Excerpt Text:
As identified in Citizen Groups' earlier comments to BLM, a moratorium on all oil and gas development within the UFO is required, pending revision to the Resource Management Plan ("RMP") and environmental impact statement ("EIS"). Proceeding with oil and gas development while the RMP revision is pending would prejudice the development of the RMP EIS. Moreover, the existing UFO RMP is completely out-of-date and can no longer serve as the foundation for decisions on oil and gas development within the UFO. See Scoping Comments at 11-14; EA Comments at 2-4.

Comment No.:
503_WELC_King_L_20150416_email-attach-2
Organization: Western Environmental Law Center
Commenter: Laura King

Comment Excerpt Text:
The current 1989 RMP, accompanying EIS, and technical report for oil and gas did not analyze the site-specific impacts of gas development using today's modern extraction techniques – specifically the use of hydraulic fracturing, or fracking – and failed to anticipate the pace of development now facing the Uncompahgre area and, thus, was incapable of incorporating land use designations that encompass BLM's multiple use mandate.

Comment No.:
503_WELC_King_L_20150416_email-attach-3
Organization: Western Environmental Law Center
Commenter: Laura King

Comment Excerpt Text:
Moreover, there is no updated, current analysis that identifies what overall level of development – and the nature of that development – is reasonably foreseeable. Without this analysis, there is considerable uncertainty and controversy regarding the size, nature, and impacts of further oil and gas development, in particular relative to cumulative impacts.

Comment No.:
503_WELC_King_L_20150416_email-attach-4
Organization: Western Environmental Law Center
Commenter: Laura King

Comment Excerpt Text:
Given the significant challenges and management issues that must be addressed in the still pending UFO RMP revision, it would be impossible for BLM to proceed in allowing such a major oil and gas development without prejudicing the ultimate mineral management decisions to be made, and the alternatives considered, in the revised RMP.

Comment No.:
504_WestSlopeConsCtr_Sauter_S_21050416_email-attach-1
Organization: Western Slope Conservation Center
Commenter: Sarah Sauter

Comment Excerpt Text:
The BLM must issue a moratorium on all oil and gas development in the Uncompahgre area for as long as the UFO RMP remains uncompleted. As stated in our past comment letters on the Bull Mountain Unit Master Development Plan, the BLM should not proceed with new oil and gas activities until the UFO Resource Management Plan has been completed. The 1989 UFO RMP is out-dated and can no longer serve as the foundation for decisions on oil and gas development within the UFO. We ask the BLM to wait until the Record of Decision on the new RMP has been finalized. We understand the draft RMP will be made available for public comment some time this year.

Summary

Commenters state that the BLM should issue a moratorium on oil and gas leasing until the Record of Decision on the Uncompahgre RMP revision is finalized. They state the current 1989 RMP is outdated, does not include an analysis of modern extraction techniques—specifically the use of hydraulic fracturing, and does not include a current reasonably foreseeable development scenario. In addition, commenters state that proceeding with decisions for the Bull Mountain MDP would be prejudicing mineral management decisions and alternatives considered in the revised RMP

Response

All alternatives in the Bull Mountain MDP Draft EIS are in conformance with the 1989 Uncompahgre RMP and Onshore Oil and Gas Order 1, as revised in 2007. Additionally, the MDP incorporated by reference the Uncompahgre Reasonably Foreseeable Development Scenario to update the analysis with more recent data. Although the BLM is revising the 1989 RMP, the existing land use plan decisions remain in effect until the revision is completed and approved.

Section 10.3 – Methane Emission Regulations and Onshore Order #9

Total Number of Comments: 2

Comment No.:
503_WELC_King_L_20150416_email-attach-25
Organization: Western Environmental Law Center
Commenter: Laura King

Comment Excerpt Text:
A draft of BLM rulemaking on Order No. 9 is anticipated to be made public by the end of summer 2015. Accordingly, new standards to limit the waste of vented and flared gas will soon be in place, and it is foreseeable that these standards will apply to the oil and gas development proposed in the Bull Mountain MDP. Accordingly, it is imperative that the BLM take a "hard look" at the implications of Order No. 9 on the project.

Comment No.:
503_WELC_King_L_20150416_email-attach-26
Organization: Western Environmental Law Center
Commenter: Laura King

Comment Excerpt Text:
BLM's failure to consider the Colorado Air Quality Control Commission's ("AQCC") new regulations on methane emissions.(See Colorado Department of Public Health and the Environment, Revisions to Colorado Air Quality Control Commission's Regulation Numbers 3, 6, and 7: Fact Sheet, available at:
https://www.colorado.gov/pacific/sites/default/files/003_030614-729AM-R3-6-7-fact-sheet-003_1.pdf (attached as Exhibit 100).) An important focus of the regulations is limiting emissions from venting, flaring, and leaks from oil and gas development, including (1) by requiring controls on compressors, wells, dehydrators, and storage tanks, and (2) by requiring leak detection and repair (LDAR) at compressor stations and well production facilities.(See id.) The BLM makes no mention of this important rulemaking that is designed specifically to minimize ozone impacts from natural gas fracking operations. This is a major omission that must be remedied in the FEIS.

Summary

The BLM failed to discuss regulations for methane emissions in the EIS, including the Colorado Air Quality Control Commission's (AQCC) new regulations on methane emissions focused on limiting venting, flaring, and leaks from storage tanks and the BLM's Onshore Oil and Gas Order 9 (Waste Prevention and Beneficial Use of Oil and Gas).

Response

The Final EIS has been updated to list the CDPHE AQCC's Regulations 3, 6, and 7, which apply to oil and gas development.

Section 10.4 – Endangered Species Act

Total Number of Comments: 5

Comment No.:
503_WELC_King_L_20150416_email-attach-127
Organization: Western Environmental Law Center
Commenter: Laura King

Comment Excerpt Text:
Notably, the BLM fails to discuss the Gunnison sage grouse, the Yellow-billed cuckoo, and the Mexican spotted owl, even though the project area contains habitat or range for each of these species. BLM's failure to discuss these and other listed and candidate species is troubling, and fails to meet the requirements of the ESA.

Comment No.:
503_WELC_King_L_20150416_email-attach-128
Organization: Western Environmental Law Center
Commenter: Laura King

Comment Excerpt Text:
BLM relies on a 2,000-vehicle-per-day threshold – at which point lynx are believed to be impeded from moving across the highway – to conclude that the Proposed Action "may affect but not likely to adversely affect" lynx. DEIS at 4-135. This determination was made after looking only at impacts from traffic, and not at any other factor. The relatively low threshold for triggering the ESA is whether a listed species "may be present" in the area of action. See 50 C.F.R. § 402.01. By looking only at traffic impacts on SH 133, and not at any other possible impacts, the EIS fails to sufficiently analyze the effect that the proposed development may have on lynx, and thus fails to meet the requirements of both the ESA and NEPA.

Comment No.:
503_WELC_King_L_20150416_email-attach-131
Organization: Western Environmental Law Center
Commenter: Laura King

Comment Excerpt Text:
BLM determined that the "Proposed Action 'may affect, and is likely to adversely affect' the Colorado pikeminnow, razorback sucker, humpback chub, and bonytail chub." Id. Nevertheless, and despite a determination that triggers ESA requirements to prepare a biological opinion and formally consult with FWS, BLM concludes: "the impacts of additional water depletions could be mitigated by SG and the BLM, which would therefore make their activities compliant with the 1999 Programmatic BO and Recovery Agreement and ensure continued recovery of these listed species." EIS at 4-131 (emphasis added). It is remarkable that BLM, in their DEIS, is explicitly ignoring the requirements of the

ESA by relying on unspecified mitigation that could protect these species, without so much as even informal consultation with FWS. BLM does so in the face of a FWS determination that considers any water depletion to be significant to these species, thus signaling the need to perform a biological opinion. BLM's unrepentant disregard for these endangered fish species is plainly in direct violation of ESA section 7, and cannot be sustained.

Comment No.:
503_WELC_King_L_20150416_email-attach-133
Organization: Western Environmental Law Center
Commenter: Laura King

Comment Excerpt Text:
BLM's cursory approach fails to satisfy even this initial threshold requirement of the ESA. Moreover, formal consultation and a biological opinion ("BiOp") are required where, as here, an acting agency determines that any action it takes "may affect listed species or critical habitat." 50 C.F.R. § 402.14(a); see also, Colorado Environmental Coalition v. Office of Legacy Management, 819 F.Supp.2d 1193, 1222 (D. Colo. 2011) (holding the agency "acted arbitrarily and capriciously by failing to consult with FWS prior to or immediately following the issuance of the EA, in violation of the ESA."). BLM has chosen to ignore these compulsory ESA requirements and, instead, has chosen to rely on "[a]dherence to applicable BMPs listed in Appendix C [which] would minimize the potential for impacts to Threatened, Endangered, and Candidate species." EA at 66. Not only are these mitigation measures insufficient under NEPA – as tirelessly stated throughout these comments – but also, as explained above, fail to meet the standards of the ESA.

Comment No.:
503_WELC_King_L_20150416_email-attach-134
Organization: Western Environmental Law Center
Commenter: Laura King

Comment Excerpt Text:
Indeed, these mitigation measures – aimed to protect listed species and habitat – amount to nothing more than a general requirement for ESA compliance, as well as a requirement that the operator notify FWS and BLM if ESA listed species are discovered. Appendix C-2, C-9. Such measures are horrifyingly insufficient in meeting the requirements of section 7 of the ESA, and do not "identify the means to avoid or minimize effects on listed species or habitat and, therefore, provides no assurances that those resources will be protected." FWS Comments at 5. BLM must conduct a BiOp and engage in formal consultation with FWS before the Bull Mountain MDP can proceed.

Summary

Comments note that the determinations for threatened and endangered species in the planning area need to be supported by a formal consultation from the USFWS and that a biological opinion needs to be issued to meet the requirements of Section 7 of the Endangered Species Act. In addition, the EIS should discuss the Gunnison sage-grouse, yellow-billed cuckoo, and the Mexican spotted owl because the project area contains habitat or range for these threatened or endangered species. Finally, in looking only at traffic impacts on State Highway 133 and not at any other possible impacts, the EIS fails to sufficiently analyze the effect that the proposed development may have on lynx and thus fails to meet the requirements of both the ESA and NEPA.

Response

The BLM submitted a Biological Assessment to the USFWS for review on September 22, 2015. For each listed species, the BLM determined if the implementation of the Preferred Alternative may affect the

species that was the subject of the consultation. The USFWS responded on October 20, 2015 with a memorandum concurring with the BLM's analysis that project "may affect, is not likely to adversely affect" the threatened Greenback cutthroat trout and threatened Canada lynx and "may affect, is likely to adversely affect" the four endangered Colorado River fishes. The finding on the Colorado River fishes falls under BLM Colorado's Programmatic Biological Assessment (PBA) for water depleting activities associated with BLM's fluid minerals program in the Colorado River Basin in Colorado. U.S. Fish and Wildlife Service (FWS) issued a Programmatic Biological Opinion (PBO) (ES/GJ-6-C0-08-F-0006) on December 19, 2008, which concurred with BLM's determination that water depletions are "Likely to Adversely Affect" the Colorado pikeminnow, Humpback chub, Bonytail, and Razorback sucker. This information is summarized in Chapter 5, Consultation and Coordination.

Section 10.5 – Unnecessary or Undue Degradation

Total Number of Comments: 2

Comment No.:
503_WELC_King_L_20150416_email-attach-124
Organization: Western Environmental Law Center
Commenter: Laura King

Comment Excerpt Text:
Therefore, drilling activities may only go forward as long as unnecessary and undue environmental degradation does not occur. This is a substantive requirement, and one that BLM must define and apply in the context of oil and gas development in the North Fork Valley generally, and within the Bull Mountain Unit specifically. In other words, BLM must define and apply the substantive UUD requirements in the context of the specific resource values at stake – an application that can be found nowhere in the DEIS, but which is required before development pursuant to the Bull Mountain MDP can proceed.

Further, these UUD requirements are distinct from requirements under NEPA. "A finding that there will not be significant impact [under NEPA] does not mean either that the project has been reviewed for unnecessary and undue degradation or that unnecessary or undue degradation will not occur." Ctr. for Biological Diversity, 623 F.3d at 645 (quoting Kendall's Concerned Area Residents, 129 I.B.L.A. 130, 140 (1994)). In the instant case, BLM's failure to specifically account for UUD in its EA – which is distinct from its compliance under NEPA – is also actionable on procedural grounds and must occur before the Bull Mountain MPD can be approved.

Comment No.:
503_WELC_King_L_20150416_email-attach-126
Organization: Western Environmental Law Center
Commenter: Laura King

Comment Excerpt Text:
BLM's analysis of the Bull Mountain MDP must consider, on equal footing, the value of protecting and preserving other important resource values in the planning area, along with SG Interest's intent to develop the Unit for oil and gas development. BLM must evaluate these competing resources and give suitable weight to FLPMA's mandate to, where appropriate, preserve and protect public lands in their natural condition. See 43 U.S.C. § 1701(a)(8). Unfortunately, here, the agency has failed to utilize this opportunity

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Summary

Commenters question whether BLM had taken sufficient measures to prevent substantive unnecessary or undue degradation (UUD) as required under the Federal Land Policy and Management Act and that this analysis does not occur in the Bull Mountain MDP.

Response

All of the leases in the Bull Mountain Unit are held by production; As a lessee and unit operator, SGI has the right to develop and extract the federal mineral resources, as long as unnecessary and undue environmental degradation does not result. The MDP alternatives provide an opportunity to plan full-field development and ensure that direct, indirect, and cumulative impacts are fully analyzed, including any and all design features and mitigation measures needed to reduce or avoid adverse impacts. The alternatives present numerous design features and the analysis provide additional mitigation measure to reduce impacts from potential future development of the wells and pads, while allowing for environmentally responsible development. The lease stipulations and alternative design features are measures that would be required to be included with future APDs, plus additional measures could be added as conditions of approval to respond to site-specific conditions. They have been analyzed as part of the alternatives in the effects analysis and will be required as applicable to the SUPOs for these locations. BLM has analyzed design features and mitigation measures in the EIS. BLM is "not required to assess compliance with the FLPMA requirement to prevent unnecessary or undue degradation in an EIS prepared to consider the potential environmental impacts of oil and gas development." Wyoming Outdoor Council, 176 IBLA 15, 46 (2008). However, BLM is cognizant of its obligation to prevent unnecessary or undue degradation of the lands. Wyoming Outdoor Council, 176 IBLA at 46; see also Biodiversity Conservation Alliance, 174 IBLA 1, 6-7 (2008). BLM's analysis indicates that the measures incorporated in Alternative D, the Preferred Alternative, would minimize adverse impacts and prevent unnecessary or undue degradation of the lands.

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Appendix O

12-89-7-1 APD Package

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Form 3160-3
(August 2007)

FORM APPROVED
OMB No. 1004-0136
Expires July 31, 2010

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

APPLICATION FOR PERMIT TO DRILL OR REENTER

5. Lease Serial No.
COC66704

6. If Indian, Allottee or Tribe Name

1a. Type of Work: ☒ DRILL ☐ REENTER

7. If Unit or CA Agreement, Name and No.

1b. Type of Well: ☐ Oil Well ☒ Gas Well ☐ Other ☐ Single Zone ☒ Multiple Zone

8. Lease Name and Well No.
FEDERAL 12-89-7 1

2. Name of Operator
SG INTERESTS I LTD
Contact: CATHERINE DICKERT
E-Mail: cdickert@sginterests.com

9. API Well No.

3a. Address
PO BOX 26
MONTROSE, CO 81402

3b. Phone No. (include area code)
Ph: 970-209-6464

10. Field and Pool, or Exploratory
EXPLORATORY

4. Location of Well *(Report location clearly and in accordance with any State requirements.*)*

At surface 1431FSL 730FEL 39.025470 N Lat, 107.341720 W Lon

At proposed prod. zone 1431FSL 730FEL 39.025470 N Lat, 107.341720 W Lon

11. Sec., T., R., M., or Blk. and Survey or Area
Sec 7 T12S R89W Mer 6PM

14. Distance in miles and direction from nearest town or post office*
20 MILES NORTH OF PAONIA, CO

12. County or Parish
GUNNISON

13. State
CO

15. Distance from proposed location to nearest property or lease line, ft. (Also to nearest drig. unit line, if any)
730' TO LEASE/PROPERTY LINE, 1475' TO UNIT LINE

16. No. of Acres in Lease
2100.70

17. Spacing Unit dedicated to this well

18. Distance from proposed location to nearest well, drilling, completed, applied for, on this lease, ft.
NA NO OTHER WELL ON THIS LEASE

19. Proposed Depth
4500 MD

20. BLM/BIA Bond No. on file
B03278

21. Elevations (Show whether DF, KB, RT, GL, etc.
7378 GL

22. Approximate date work will start
07/15/2012

23. Estimated duration
3 WEEKS

24. Attachments

The following, completed in accordance with the requirements of Onshore Oil and Gas Order No. 1, shall be attached to this form:

1. Well plat certified by a registered surveyor.
2. A Drilling Plan.
3. A Surface Use Plan (if the location is on National Forest System Lands, the SUPO shall be filed with the appropriate Forest Service Office).
4. Bond to cover the operations unless covered by an existing bond on file (see Item 20 above).
5. Operator certification
6. Such other site specific information and/or plans as may be required by the authorized officer.

25. Signature
(Electronic Submission)

Name (Printed/Typed)
CATHERINE DICKERT Ph: 970-209-6464

Date
05/01/2012

Title
MANAGER

Approved by (Signature)

Name (Printed/Typed)

Date

Title

Office

Application approval does not warrant or certify the applicant holds legal or equitable title to those rights in the subject lease which would entitle the applicant to conduct operations thereon.
Conditions of approval, if any, are attached.

Title 18 U.S.C. Section 1001 and Title 43 U.S.C. Section 1212, make it a crime for any person knowingly and willfully to make to any department or agency of the United States any false, fictitious or fraudulent statements or representations as to any matter within its jurisdiction.

Additional Operator Remarks (see next page)

Electronic Submission #136837 verified by the BLM Well Information System
For SG INTERESTS I LTD, sent to the Durango

**** OPERATOR-SUBMITTED ** OPERATOR-SUBMITTED ** OPERATOR-SUBMITTED ****

Additional Operator Remarks:

BLM onsite for this well was held in May 2011.

SG Interests I, Ltd.
922 East Second Ave
Durango, CO 81301

Federal 12-89-7 #1 Gas Well
Federal Lease #: COC 066704, Bull Mountain Unit, COC 67120X
Surface Location: 1431' FSL 730' FEL Sec 7 T12S R89W (vertical well)
Gunnison County, CO

SURFACE USE PLAN OF OPERATIONS

1. Existing Roads

From Paonia, CO, travel north on State Highway 133 approximately 25 miles to its intersection with County Road 265. Turn NW on CR 265 and travel approximately 1 ¼ miles. Turn left onto a private road and continue straight ahead for about 1 mile. Keep to the left and stay on the main road for approximately 6 more miles. At Gunnison Energy Corporation's Hotchkiss 12-90 #1-34 well, continue on the main road for 1 ½ miles south to the location.

There is an existing access road to the proposed well location that does not require upgrades. A portion of the access road is on lease COC 66704 and a portion of the road is off this lease.

Table 1. Existing road (not upgraded) lengths and disturbances.

	Off Lease COC 66704 (Estimates)	**On Lease COC 66704 (Estimates)**
Length of existing access road (not upgraded or otherwise changed)	27,635 feet (5 1/4 miles) Begin at CR 265 and end at Hotchkiss Sheep Camp. Inc. segment from GEC Hotchkiss 1-34 well to COC 66704 lease line.	6,410 feet (1 ¼ miles) Begin at COC 66704 lease line and end where realignment begins.
Total distance of access road	38,370 feet (7 ¼ miles) Total distance of road off lease COC 66704 (inc upgraded portion).	6,410 feet (1 ¼ miles) Total distance of road on lease COC 66704.
Total area disturbed when building existing, unchanged access road	19 acres	4 ½ acres

The portion of the existing road that is on lease COC 66704 (6,410 feet beginning at the lease line and continuing to the segment of road that will be realigned, see Figure 1) has been recently upgraded by Gunnison Energy Corporation to access their Hotchkiss 12-90 #1-34 well. This existing access road has a surface that has been designed to support gas drilling traffic. It has been rocked with 3" road base. Nine culverts to move drainage under the road surface have been appropriately located along the road. These culverts are 12" diameter corrugated metal pipe. The roadside ditches along this segment of road are approximately one foot deep and approximately two feet wide. Rock check dams have been constructed in these ditches to slow water flow and these dams have been adequately spaced according to road grade. The turning radius around the road corners will allow larger vehicles to safely travel this portion of the road. There are vehicle pull-offs located along the road segment as needed to allow

vehicles to pass one another safely as needed per line of sight distance. The road crown will be maintained at 2˚ from center.

All roads used in conjunction with this project will be maintained in as good or better condition as they were pre-project. The private access road was in existence at the time of project construction and will not be reclaimed at the end of the project unless agreed upon by the surface landowner and SG Interests. This road, both on lease and off lease, will continue to be used for ranching operations during and after the project. The road is gated at the property line and is not open to the general public. The cattle guards along the existing road to the north would be cleaned and maintained as agreed upon with the surface owner. There are three cattle guards along the existing access road. All three cattle guards are 8' by 16' in size and all are located on the portion of the road that is off lease COC66704. One guard is located just past the Rock Creek Ranch and Nick Hughes property line on Rock Creek Ranch property, approximately 850 feet southwest of the intersection of the existing access road with Gunnison CR 265. The second is at the Rock Creek Ranch and Aspen Leaf Ranch property line, approximately 1 2/5 miles south of the intersection of the existing access road with Gunnison CR 265. The third is located at the Aspen Leaf Ranch and Nick Hughes property line, approximately 2.6 miles south of the intersection of the existing access road with Gunnison CR 265. Use of the existing access road will minimize the impact to the environment because a new access road in addition to the existing ranch road is not required for the project. This access road will be used for access to additional sites in the Bull Mountain Unit.

The access road would be maintained so that its integrity is not compromised by the additional truck traffic. This maintenance would not include any additional construction activities; instead more frequent road maintenance is required as traffic volume increases. Fresh water would be applied to the road more frequently as traffic volumes increase (and according to weather patterns) to keep dust down. Approximately 5,000 – 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 – 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). Estimated fresh water usage for dust control on the existing road is 13,000 gallons per day to 52,000 gallons per day (10,500 gallons per day to 42,000 gallons per day off lease and 2,500 gallons per day to 10,000 gallons per day on lease). Roadside ditches would be maintained to control and direct runoff.

Average Daily Traffic estimates are as follows:

Table 2. Estimated daily traffic on the access road (entire road) by activity.

Activity	Round Trips	Duration of Activity
Well Pad Construction	8 pick-ups per day, 2 4,000 gallon water trucks per day, 4 dump trucks per day, one grader and one dozer brought in by semi 1 round trip each	10 days
Drilling	one drill rig once, 45 trips by rig up trucks total, 10 per day by water trucks, 4 per day by pick-ups	14 days
Completion	8 by haul trucks total, 4 pick-ups per day	14 days
Production	2 per day by pick-ups	365 days, for life of well

Gravel sources will be checked for possible weed issues and treated as necessary. Graveling of these roads will occur as necessary to maintain the post-construction surface quality. The current gravel

source is United's Tri County Pit in Hotchkiss, Colorado. Gravel may be staged on the Federal 11-90-35 #1 for use in graveling this road. If this area is needed for gravel storage SG will permit this use of the well pad accordingly. The speed limit on the access road will be 20 mph.

The right-of-way width of existing roads will be maintained as they presently exist unless authority to widen is given by the surface land owner in writing. The existing access road is approximately 16 feet wide (driving surface). Width of cut and fill slopes of existing access road are dependent on topography. Any damage to county or private roads, resulting from SG's use will be repaired immediately. The operator will use fresh water for dust control on all private roads.

Any required road use permits for CR 265 will be obtained from Gunnison County Public Works. Gunnison County will grade and apply magnesium chloride to County Road 265 annually as per the terms of the agreement between SG Interests I, Gunnison Energy Corporation, and Gunnison County (LI # 10-241).

Operations will cease, excepting emergencies, during periods when mud and silt cannot be contained within the road prism, or when construction specification cannot be achieved because of wet or frozen ground conditions. Vehicles will not be towed through the mud.

The operator will schedule heavy traffic periods, such as moving the rig in or out (see Table 2: Drilling for estimated heavy traffic), to take place during the week on public roads if possible and not on weekends or holidays. All construction signage will be in compliance with the Manual of Uniform Traffic Control Devices. The operator will post warning signs on CR 265 to alert the public of heavy truck traffic. The operator will use flagmen as necessary during drilling and related equipment moves on and off the drill site when utilizing public roads. Figure 2 shows existing access roads and route to the Federal 12-89-7 #1 well.

2. New or Reconstructed Access

A portion of the existing road (shown on Figure 2) was upgraded to accommodate traffic to another of SG Interests' well sites (Eck 12-90-1 #1 well), per agreement with the surface owner. These road upgrades were entirely off lease COC 66704. This road was widened at the corners to allow larger vehicles such as drill rigs to make the turns. The turning radius is now approximately 70 feet or greater. The driving surface on this portion of road is approximately 16 feet wide and has been surfaced with 6" of 3" fractured road base. Along this portion of road, drainage features were established including drainage ditches and rip/rapping and armoring of culverts. Culverts were placed or upgraded at low spots where needed. Four culverts were added to this section of road and an additional 15 culverts were cleaned and fixed for use. Culverts were 12" diameter corrugated metal pipe. The road has a 2-4% inslope to the ditch for drainage off the road surface. Catchment basins with rock armored outfalls as appropriate were constructed at the culvert ends. Seeding of areas disturbed for this upgrade but not needed for road use is scheduled to take place in the fall of 2012. Seed mixes are per landowner direction and are weed free. Stormwater control BMPs were set as needed during construction and prior to stabilization of these areas in compliance with the Colorado Department of Public Health and Environment permit. Silt fence was installed downslope of disturbed areas to contain any sediment mobilized by rain events. Drainage control features were adjusted in the field as needed to correct flows and prevent sediment mobilization.

Table 3. Reconstructed and Realigned Access Road Lengths and Disturbances

	Off Lease COC 66704 (Estimates)	**On Lease COC 66704 (Estimates)**
Length of upgraded access road	10,740 feet (2 miles) Begin at Hotchkiss Sheep Camp and end at GEC Hotchkiss 1-34 well.	None Existing access road was not upgraded on lease COC 66704.

Table 3 Continued.	**Off Lease COC 66704 (Estimates)**	**On Lease COC 66704 (Estimates)**
Length of realigned access road	None Road alignment is entirely on lease.	810 feet (0.15 miles) Begins approximately 6,410 feet from the lease line along existing road and ends after exiting new well pad.
Total distance of road	38,370 feet (7 ¼ miles) Total distance of road off lease COC 66704 (inc. existing section).	6,410 feet (1 ¼ miles) Total distance of road on lease COC 66704.
Total area disturbed when upgrading existing access road	7.4 acres	0 acres
Total area disturbed when realigning existing access road	0 acres	1/2 acre

The existing access road that passes through the planned well pad area will be routed around the pad on its western edge (see Figure 1). The rerouted section is entirely on lease. SG would notify the surface landowner before beginning this construction. This will result in approximately 810' of rerouted roadway. The area of the planned realignment would be cleared of vegetation to create a 30' wide construction zone (to accommodate the drivable road surface and drainage ditches). Cuts along the realigned road section range from 10.4' to 1.7'. The road continues to the south of the pad at level grade with existing topography. The realigned road will be surfaced with 3" fractured road base. Oak removed from the construction zone would be broken up and used in reclamation. No tree branches would be left extending over the roadway. If cuts associated with construction of the road result in fragmented rock, this rock material would be buried in fill areas resulting from construction of the well pad. Construction of the road will not take place when the ground and road-building materials are frozen or too wet to achieve the correct compaction. No fence cuts or cattle guards are needed on the realigned portion of the road. The road width will be maintained through the reroute (approximately 16' drivable surface and approximately 30' total disturbed area width). The road realignment will be constructed using standard crown-and-ditch specifications. The existing road has a drainage ditch on both sides of it and the ditch has rock check dams installed in it to control flow velocity. This ditch and the rock check dams would be replaced along the realigned section of road. These ditches will conform to the slope, grade and shape of the road cross-section and will not have roots, stumps, rocks or other material sticking out into them. The ditch will be constructed at least one foot below the driving surface of the road. Two drainage turn outs will be constructed along the realigned segment of the road. No culverts or bridges are needed for this rerouted section. Topsoil removed from the rerouted road area will be separated and stored with the topsoil that was salvaged from the well pad area (location shown on Figure 7). The cut and fill areas resulting from creation of a level driving surface will be reclaimed as quickly as possible by returning topsoil to these areas and seeding them. Where practicable, SG would scatter woody vegetation over disturbed surfaces during reclamation to serve as mulch and to stabilize the surface.

Average daily traffic estimates for the upgraded and realigned sections of road are the same as those listed in the Existing Roads section of this document (Section 1, Table 2).

3. Locations of Existing Wells

Figure 3 shows the known gas/oil/water injection, disposal, drilling wells within a one-mile radius of the proposed Federal 12-89-7 #1.

4. Location of Existing and/or Proposed Production Facilities

The approximately 300 foot long pipeline route runs from the proposed well to the existing Narrows Gathering Pipeline to the west of the proposed well pad location. The approximately 300 foot long Federal 12-89-7 #1 tie-in pipeline system is a 6” diameter gas pipeline and a 4” diameter water pipeline buried within the same trench. From here the Narrows Gathering Pipelines will transport produced water and natural gas north to their final destinations (injection well and sales respectively). This Narrows Gathering Pipeline system gas line is 12”-16” diameter (varies along route) and the water pipeline is 8” diameter. The southern terminus of the Narrows Gathering Pipeline includes gas and water future connections for future wells. A 12” gas line and 8” water line are planned to connect a drilled fee minerals well (Volk 12-89-21 #1) and other future wells to the gathering system, but a construction schedule for this pipeline has not been determined. The Narrows Gathering Pipeline did not have any wetland crossings that were subject to pre-construction notification to the US Army Corps of Engineers. Waters of the US were crossed according to the conditions of Nationwide Permit 12. The Narrows Gathering Pipeline was constructed in a 50’ right-of-way over private property. Stormwater BMPs were installed along the route to control stormwater and prevent erosion and sedimentation (Figure 8a). Reclamation of the pipeline route includes returning the work area to near pre-construction contours, returning topsoil to the surface of the right-of-way, scattering any woody debris over the surface and seeding with landowner approved seed mix. Seed mixes are weed free. The Narrows Gathering Pipeline connects future southern pipelines to the Hotchkiss Lateral Pipeline to the north. The Hotchkiss Lateral Pipeline connects to the Bull Mountain Pipeline, the main trunkline in the area.

Table 4. Lengths and Area of Disturbances for Pipelines Associated with this Project

	Off Lease	**On Lease**
Narrows Pipeline	16.8 acres (12,075’)	5 ¾ acres (6,275’ length)
Federal 12-89-7 #1 Pipeline	0	.34 acres (300’ length)

Other aboveground facilities on site include the piping and valves at the well head. There will be an enclosed gas/water separator for each well on the pad that will include gas and water meters, heaters and a fuel gas pot. Dimensions of the separator are approximately 11’ wide x 20 ft long x 10 ft high. Four 400-BBL tanks will be located on the well pad. These measure approximately 12’ wide and 20’ high. Tanks have heaters that are used during cold weather conditions. Artificial lift may be needed on one or more of the wells on this location during the life of the well. Examples of lift include a 40 hp walking beam or other pumping unit may be used. Beam lifts are approximately 7 ½’ wide x 29’ long x 20’ high and are located approximately four feet away from the well head. A compressor may be needed on a well during its lifetime. Compressor skids are approximately 14’ wide x 20’ long x 9’ high. Compressor horsepower is decided based on specific well conditions. Compressor engines will be permitted as appropriate through the Air Quality Control Division of the Colorado Department of Public Health and Environment. Possible water transfer pump would be a 20 horsepower natural gas motor with piping and meter enclosed in a shed 6' wide by 12' long by 8' high.

5. Location and Type of Water Supply

Fresh Water to be used during drilling operations will be delivered to the location by water truck. Recycled water to be used in completion operations will be piped to the well site via either an existing buried water pipeline or a temporary surface poly pipeline (HDPE pipe). It is possible that some water may be delivered to the location via water truck, but this is expected to result in few additional truck trips. This water will be stored in the McIntyre Flowback Pits located in T11S R90W Sections 23, 24, and 26 until needed. Flowback water from the well will be piped back to the pits for storage and reuse until it is disposed of in an injection well. Currently, SG Interests has in operation one deep water injection well, the Federal 24-2 WDW (T11S R90W Section 24).

Approximately 5,000 BBL of recycled water from the McIntyre Flowback Pits will be needed for each well completion stage for this sandstone/coalbed methane well. The well may be completed in multiple zones or stages, depending on well log information acquired during the drilling of each well. If the well log information from the sandstone formation is favorable, only one completion stage will occur. If the well logs are not favorable for the sandstone formation, the well will be completed in the coal formation and an additional 5,000 BBL of recycled water from the McIntyre Flowback Pits will be required.

Flowback and stimulation fluids will be sent to separators and tanks before the fluids are transferred off location. An estimated eleven flowback tanks will be located on the well pad for approximately one month during completion. The entire level well pad will be surrounded by a berm with a drainage ditch constructed interior to that berm in order to contain any potential release on the well pad. The berm will be approximately 4 feet in height around the pad except at the access road entrance where a culvert will be located and on the west side where the realigned road will be located (reference Figure 7). Any fluid in the interior drainage ditch will be contained in the ditch and culvert until clean up. During fracturing operations, the site will be manned 24-hours per day so that any leak or spill can be quickly identified and dealt with. Tanks will be set on compacted earth to decrease the permeability of the soil in the event of a release. The berm will create a containment capacity greater than 150% of the largest single container on the location.

Water may be drawn from free-flowing fresh water sources and augmented from Bainard Reservoir No. 1 according to the terms of SG's approved Augmentation Plan. SG was granted a Water Augmentation Plan in District Court, Water Division No. 4, Case No. 09CW16. This Water Augmentation Plan is monitored and implemented by Steve Tuck, Colorado Division of Water Resources Water Commissioner, District 40. Water used through SG's augmentation plan is replaced from the Bainard Reservoir No. 1 when required under the terms of the plan. The surface and water rights related to Bainard Reservoir No. 1 are owned by Rock Creek Ranch I, Ltd. Rock Creek Ranch is an entity owned by the principal and general partner of SG Interests I, Ltd. Bainard Reservoir No. 1 itself is not a water source for this project. Fresh water sources could include East and West Muddy Creek, Aspen Leaf Reservoir, Ault Reservoir/Ault Creek (as shown in Figure 5). Water used for dust control will be fresh water only. It is also possible that water for drilling and/or completions may be purchased from a permitted commercial supplier. Commercial water used in SG's operations is trucked from the closest source, which is in Paonia. This water is fresh water, but is non-potable.

6. Construction Materials

The well pad will be constructed from soils on site. The disturbed area during construction will be approximately 3.4 acres. Topsoil will be salvaged and stored adjacent to the well pad. The top six inches of this soil will be salvaged for use over the reclaimed areas. The rest of the soil that is manipulated for this project will be considered subsoil and if stored on site, it will be stored separately from topsoil. Some topsoil will be used to reclaim areas around the level pad disturbed during construction, but not needed for long-term operations. The area of the level well pad will be approximately 2.9 acres following interim reclamation. The level well pad will be graveled with 3" fractured road base from United's Tri County Pit in Hotchkiss, Colorado (3569 J 75 Drive, Hotchkiss CO), or some similar provider depending on availability.

7. Methods of Handling Waste Materials

The location and access roads will be kept orderly and as clean as practicable at all times. All garbage and trash will be put in a trash container. The container will be periodically emptied at an approved disposal site. A portable latrine will be provided for human wastes, and wastes will be pumped from portable toilets and hauled to an approved sanitation facility. Sewage will not be buried on location.

No unapproved chemicals will be used during drilling or completion operations. Any petroleum product or other spills will be cleaned up immediately and the material will be hauled to an approved facility.

The operator will prevent gasoline, diesel fuel, oil, grease, or any other petroleum products and drilling fluids from migrating off the location or from entering any live stream or riparian area. A spill kit will be

available at the locations shown in SG Interests' SPCC Plan. Fuels and lubricants will be transported by fuels distributors and will be stored in facilities specifically designed for that purpose.

A cuttings bin will be used rather than a cuttings pit. This cuttings bin is typically a lined trailer container that holds cuttings aboveground until the trailer is hauled to an approved cuttings disposal area. Cuttings will not be stored on location past the active drilling phase. No extra space is required to store the cuttings bins. Eight cuttings bins may be located on the well pad at any time during drilling. These will be located on the southeast side of the well pad. Cuttings will be tested in accordance with the requirements of the disposal destination and taken to that facility as soon as possible. Alternatively, cuttings may be buried on location according to state and federal rules and regulations. Currently, cuttings are transported to Adobe Buttes Landfill located at 12211 Trap Club Road, Eckert, Colorado or to Industrial Ecosystems Incorporated located at 49 CR 3150, Aztec, NM. Vehicle trips to haul off cuttings are estimated to be 1 roundtrip per every 1,000' drilled.

Flowback water contained in tanks on location will be transferred to the McIntyre Flowback Pits via temporary surface poly pipelines for storage and reuse or injected into the Federal 24-2 WDW for disposal. If feasible this water may be transferred to the water disposal well via existing buried steel pipeline. Drilling mud fluids are stored in 500 BBL tanks and trucked to an approved disposal site (currently Envirotech, 5796 U.S. 64, Farmington, NM or Industrial Ecosystems Incorporated located at 49 CR 3150, Aztec, NM.) Unusable and/or excess flowback fluids, along with any solid wastes, will be trucked to an approved industrial disposal facility (Alanco Energy Services, Deer Creek Facility, 5180 Hwy 50, Whitewater, CO 81527).

Gas (if present) will be handled according to applicable regulations at the time of completion activities.

8. Ancillary Facilities

No camps, airstrips, or additional staging areas are planned at this time. If gravel is stored on the Federal 11-90-35 #1 well pad (Figure 6), no additional surface disturbance would be required at that location.

9. Well Site Layout

The initial construction area of the well pad is approximately 3.4 acres. The area of the level pad or working surface will be approximately 2.9 acres after interim reclamation. The shape of the well pad following interim reclamation is shown on the well site layout drawing (Figure 7). 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 and completion operations. Since a closed loop system is employed, cuttings bins will be used rather than a reserve pit or cuttings pit. See Section 7 above for additional details.

SG plans to drill up to five gas wells on the well pad. The estimated lifespan of each gas well is approximately 30 to 40 years. There may be one or two coalbed methane wells; one or two sandstone wells; and/or one to three shale wells on the well pad for a total of up to five wells. Of these wells, at most one would produce a combination of fee and federal minerals and up to five wells would produce federal minerals. These combinations are determined based on the target formation and the proximity of federal and fee leases from the surface location. The Bull Mountain Unit Agreement allows for the drilling and production of gas across lease lines.

10. Plans for Reclamation of the Surface

Following pipeline construction, the disturbed ground (.34 acres) will be contoured to near original topography. A slight mound may be left over the pipeline trench to accommodate any settling. The pipeline will not be constructed during frozen conditions and frozen soil will not be used to backfill the trench. The entire area disturbed during pipeline construction will be covered with salvaged topsoil prior to seeding. The preferred seeding method is drilling, but if this is not feasible on part or the whole route, seed will be broadcast at twice the rate per acre as drilled seed. Any woody debris that was removed from the route and salvaged will be returned to the disturbed area in order to provide surface roughening.

Weed-free seed will be used in all reclamation activities. Disturbed areas on lease would be seeded with a BLM-approved weed free seed mix that has also been approved of by the surface landowner. No other plantings are planned at this site.

Areas of the well pad and areas along the realigned road section that were disturbed during construction, but that are not needed for long-term operations, will be reclaimed (approximately 3/4 acre). This reclamation will consist of returning topsoil to these areas, seeding with weed-free seed, and using any salvaged woody debris for surface roughening.

All areas that are disturbed during construction of this project will be covered under SG Interests' field-wide stormwater management plan and discharge permit. SG's plan to control stormwater runoff includes perimeter ditches, silt fence/straw wattles, outfall protection devices, and road side ditches. Figure 8a and Figure 8b depict these controls as currently planned for this project.

When the well is no longer productive, it will undergo final reclamation. The well pad area will be returned to near-original contour and the realigned access road will either be recontoured and reclaimed (if no longer needed by the surface landowner) or replaced to its original alignment. Topsoil will be spread over the disturbed area. The area will be seeded.

SG 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, BLM, and the state of Colorado (Colorado Weed Management Act CRS Title 35, Article 5.5 as amended) will be controlled (see list in Attachment 3). The purpose of this weed 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.

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 treated. 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.
- 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.

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 and subject to fee-landowner approval in consultation with the BLM authorized officer. All herbicides will be applied in accordance with all applicable laws and regulations on BLM 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 5. Noxious weeds and appropriate controls

Weed Name	Herbicide Used?	Herbicide details	Mechanical measures used?	Type of mechan. 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
Dalmation toadflax	Yes (ex. Tordon K)	Herbicide w/surfacet-ant 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
Hounds-tongue	Yes	Spray prebud or rosette state	Yes	Hand pull after bolting stage, if flowers bag heads	Yes	Seeding w/desirable species

Table 5 continued						
Weed Name	**Herbicide Used?**	**Herbicide details**	**Mechanical measures used?**	**Type of mechan. control**	**Cultural Control Used?**	**Type of cultural control**
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
Mediterran-ean sage	No	NA	Yes	Cut flowering plants and bag heads	Yes	Seeding w/desirable species
Musk thistle	Yes (ex. Tordon 22K)	Spray rosettes and early bolting stages	Yes	Hand pull, sever tap root, bag heads, mow large infest. at bolt - 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 infest. at bolt - early flower stage	Yes	Seeding w/desirable species
Poison hemlock	Yes (ex. phenoxy herbicides or glypho.)	Spray young plants	No	NA	Yes	Seeding w/desirable species
Puncturevine	Yes (ex. chlorsulfur -on and 2, 4-D)	Chlorsulfur-on 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 glypho-sate)	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

Table 5 continued						
Weed Name	**Herbicide Used?**	**Herbicide details**	**Mechanical measures used?**	**Type of mechan. control**	**Cultural Control Used?**	**Type of cultural control**
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
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.

SG 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, SG 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 and its control.

11. Surface Ownership

The well pad, 6,410 feet of existing access road, and the realigned access road will be located on lease COC 66704 on surface owned by Hotchkiss Ranches, PO Box 479, Hotchkiss, CO 81479; phone: 970-872-4213.

The existing road to the pad crosses private property owned by Hotchkiss Ranches, Nick Hughes, Aspen Leaf Ranch, and Rock Creek Ranch I, LLC (off lease distance of 27,635 feet). These landowners have granted SG Interests access through their lands on this existing road in order to reach project locations.

The pipeline route crosses land on lease COC 66704 that is owned by Hotchkiss Ranches. SG has in place a surface use agreement with Hotchkiss Ranches that covers pipeline construction and operation (Attachment 1).

The existing Narrows Gathering Pipeline crosses property owned by Hotchkiss Ranches Inc., Nick Hughes, and Gunnison Hunting Properties, LLC. The Nick Hughes and Gunnison Hunting Properties portions, along with the off-lease portion of the route on Hotchkiss Ranches (2,365 feet), is 12,075 in length. The on-lease portion of the Narrows Gathering System Pipeline is 6,275 feet in length.

12. Other Information

Firearms and dogs are not allowed on the access road or location during any phase of this project. The drilling crew will have sufficient fire equipment on hand during fire season for suppressing fires on the well pad, access road, and pipeline route.

Certification

I hereby certify that I, or someone under my direct supervision, have inspected the drill site and access route proposed herein; that I am familiar with the conditions which currently exist; that I have full knowledge of state and federal laws applicable to this operation; that the statements made in this APD package are, to the best of my knowledge, true and correct; and that the work associated with the operations proposed herein will be performed in conformity with this APD package and the terms and conditions under which it is approved. I also certify that I, or the company I represent, am responsible for the operations conducted under this application. These statements are subject to the provisions of 18 USC 1001 for the filing of false statements.

Catherine Dickert

Executed this 29 day of October, 2015.

Catherine Dickert, Environmental and Permitting Manager,
922 East Second Ave, Durango, CO 81301, Phone: 970-385-0696,
Email: cdickert@sginterests.com

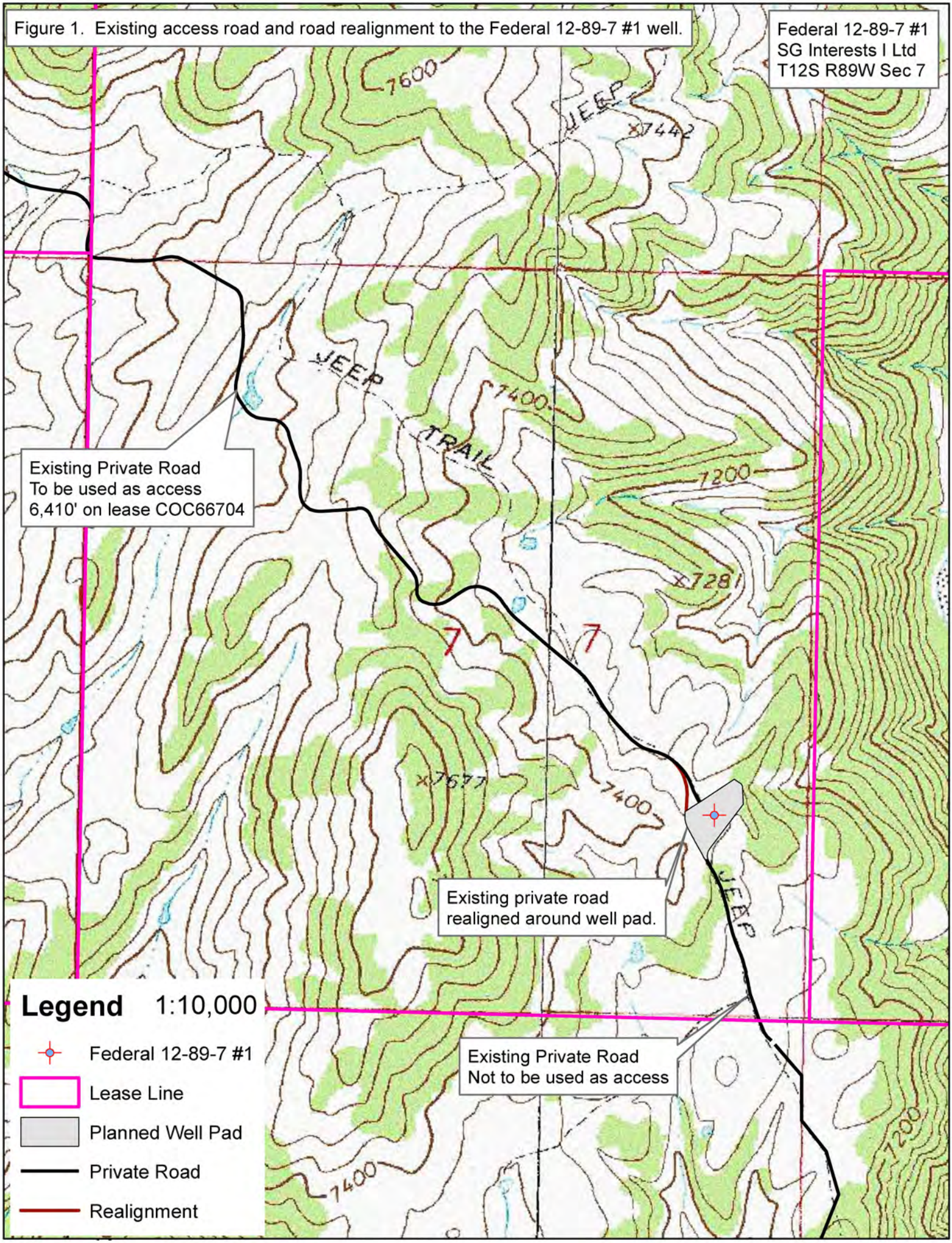
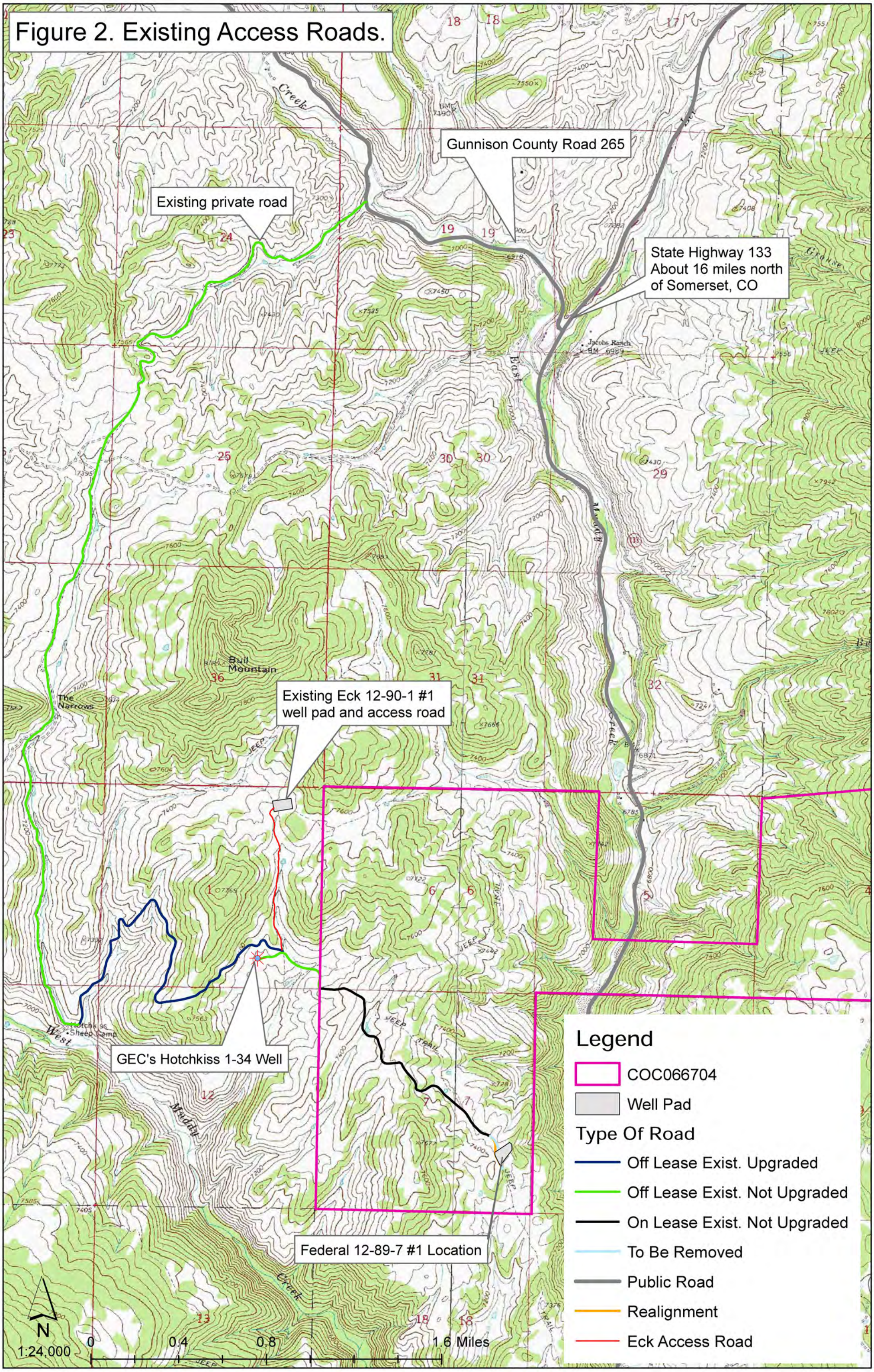


Figure 1. Existing access road and road realignment to the Federal 12-89-7 #1 well.
Federal 12-89-7 #1
SG Interests I Ltd
T12S R89W Sec 7
7600
JEEP
7442
JEEP
TRAIL
7400
7200
7281
7677
7400
7400
7200
Existing Private Road
To be used as access
6,410' on lease COC66704
Existing private road
realigned around well pad.
Existing Private Road
Not to be used as access
Legend 1:10,000
Federal 12-89-7 #1
Lease Line
Planned Well Pad
Private Road
Realignment

Figure 2. Existing Access Roads.



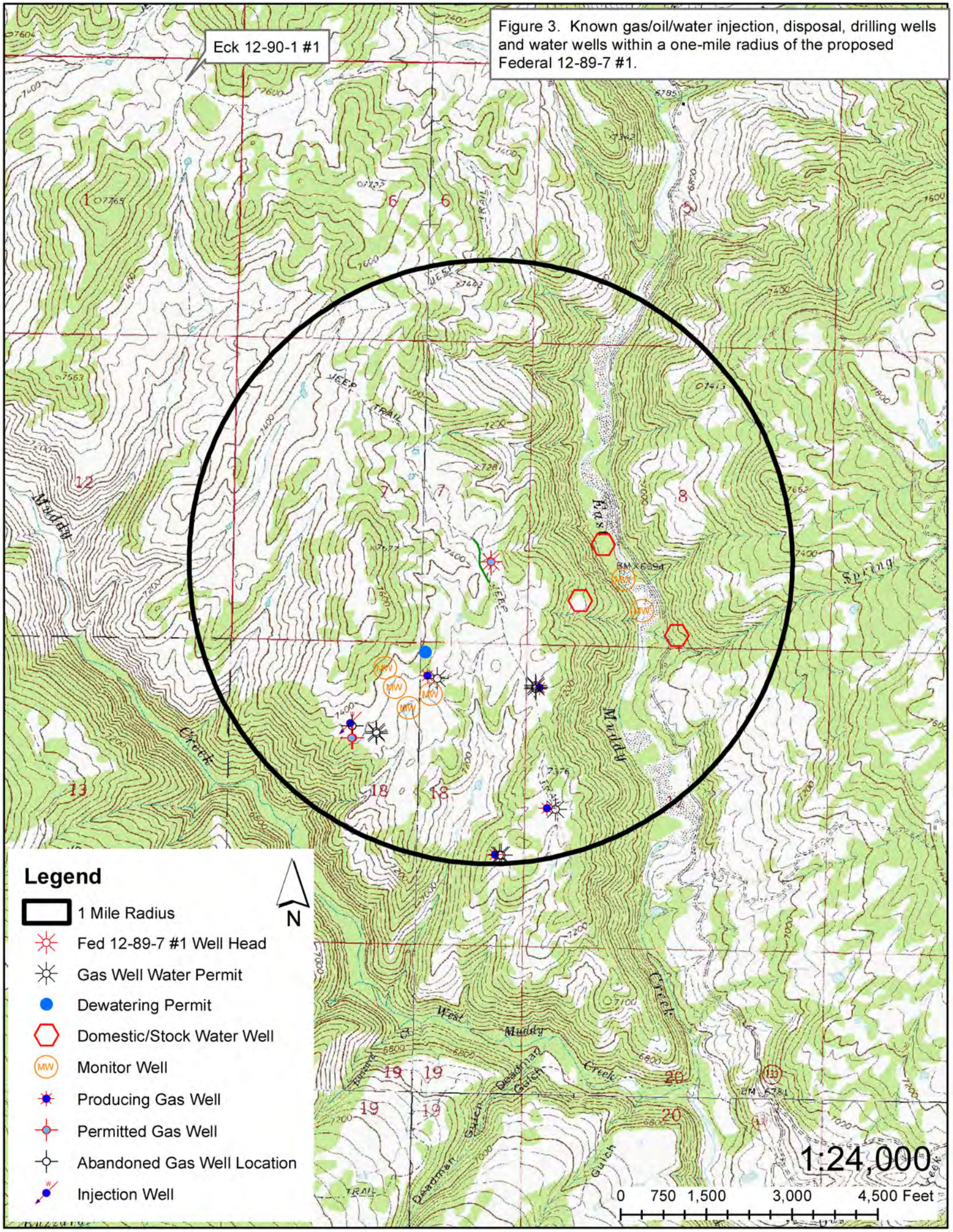


Figure 3. Known gas/oil/water injection, disposal, drilling wells and water wells within a one-mile radius of the proposed Federal 12-89-7 #1.

Figure 4 . Location of Proposed and Existing Production Facilities - Pipelines

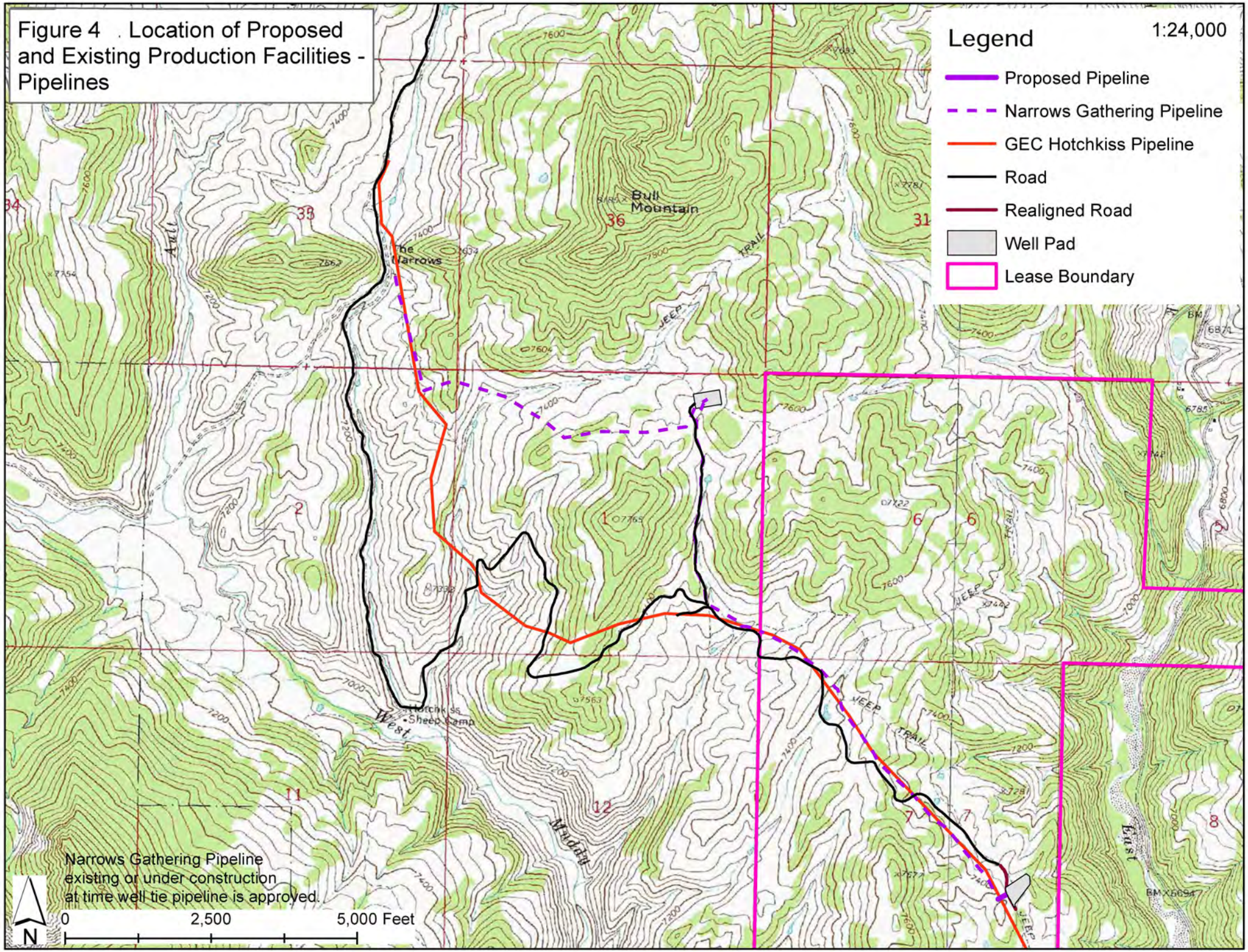
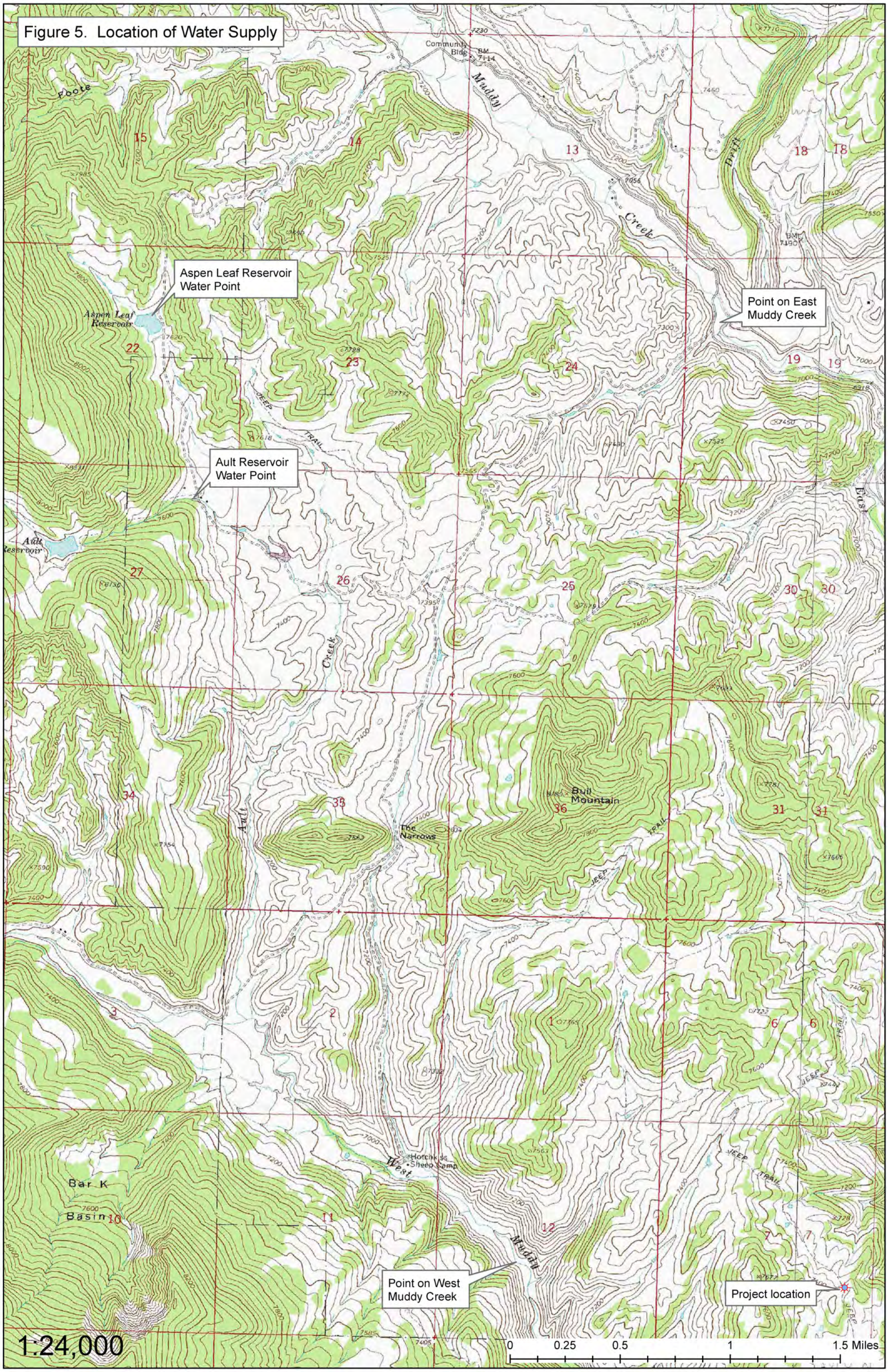


Figure 5. Location of Water Supply



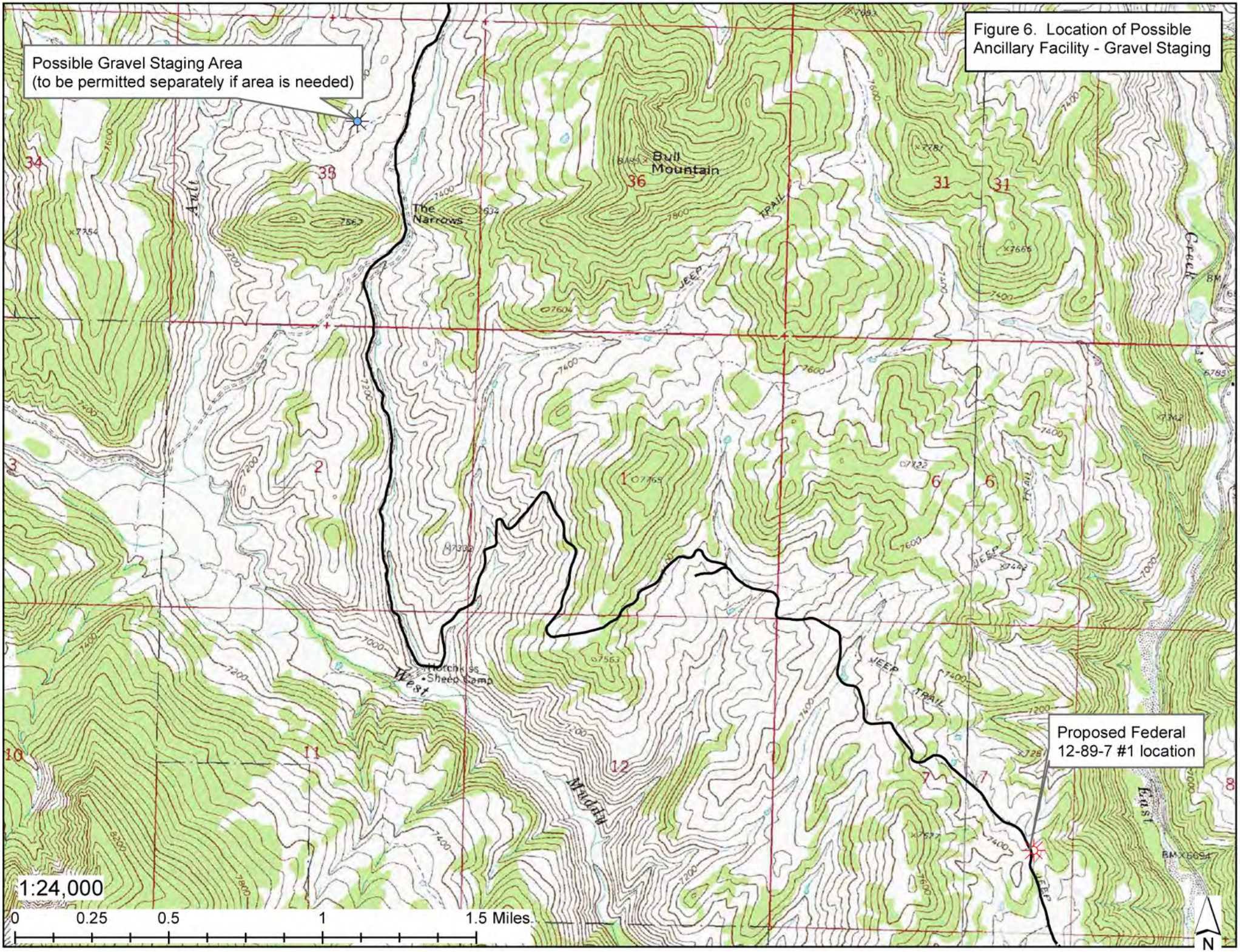
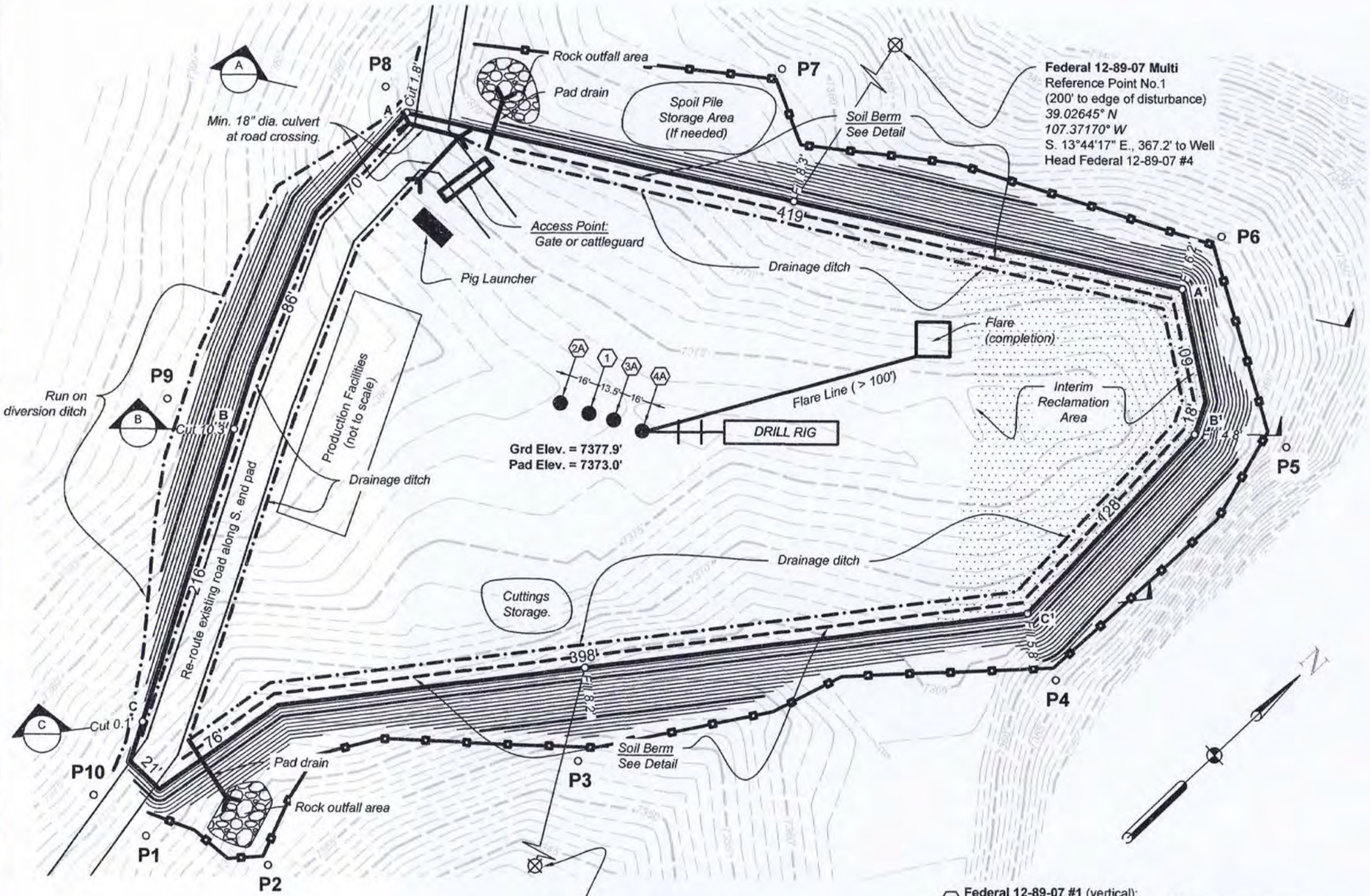


Figure 6. Location of Possible Ancillary Facility - Gravel Staging
Possible Gravel Staging Area
(to be permitted separately if area is needed)
Proposed Federal
12-89-7 #1 location
Bull Mountain
The Narrows
Ault
Muddy
West
Fork
Creek
JEEP TRAIL
1:24,000
0
0.25
0.5
1
1.5 Miles
N

Figure 7

Well Site Layout

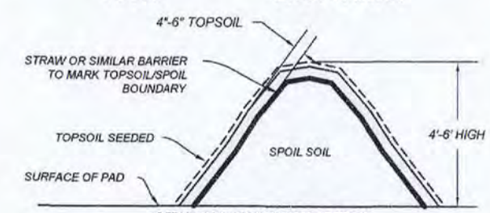
AECOM



Pad Report: (irregular size)

Top of pad elevation: 7373.0'
Cut Slope: 2.00:1
Fill Slope: 2.00:1

Total cut :	11,081.04 C.Y.
Total fill:	8,690.98 C.Y.
Balance Export:	2,390.06 C.Y.
Area:	3.406 ± acres
Post Interim Reclamation Area:	2.987 ± acres



DETAIL: SOIL BERM TYPICAL SECTION
N.T.S.

Note: See page 2 for cross sections.

LEGEND:

- ~Pre-Construction Contour
- ~Pre-Construction Index Contour
- ~Post Construction Contour
- ~Post Construction Index Contour
- ~Centerline Ditch (proposed)
- ~Centerline Soil Berm (proposed)
- ~BMP's (proposed)
- ~Interim Reclamation Area

0' 60' 120' 180'

Scale: 1" = **60** U.S. Survey feet
Contour Interval = 1 foot

(1) **Federal 12-89-07 #1** (vertical):
Surface Location
39.02543° N 1416 FSL
107.37148° W 757 FEL

(2A) **Federal 12-89-07 #2:**
Surface Location
39.02541° N 1408 FSL
107.37153° W 770 FEL

(3A) **Federal 12-89-07 #3:**
Surface Location
39.02545° N 1423 FSL
107.37144° W 745 FEL

(4A) **Federal 12-89-07 #4:**
Surface Location
39.02547° N 1430 FSL
107.37139° W 731 FEL

COLORADO REGISTERED DAVID G. NICEWICZ 24963 10/8/15 PROFESSIONAL LAND SURVEYOR

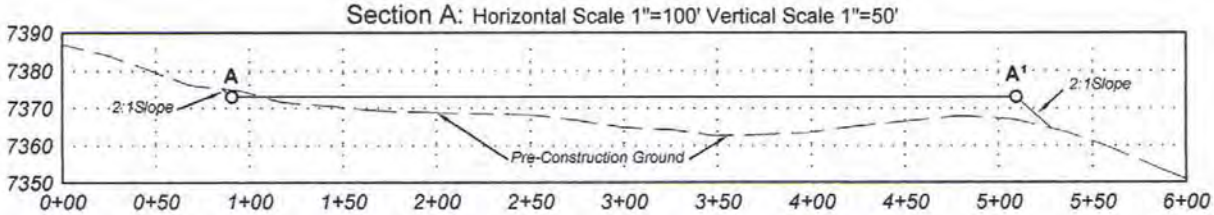
GAS WELL LAYOUT

FEDERAL 12-89-07 #1
Located in the SE 1/4 Section 7,
Township 12 South, Range 89 West, 6th P.M.,
Gunnison County, Colorado

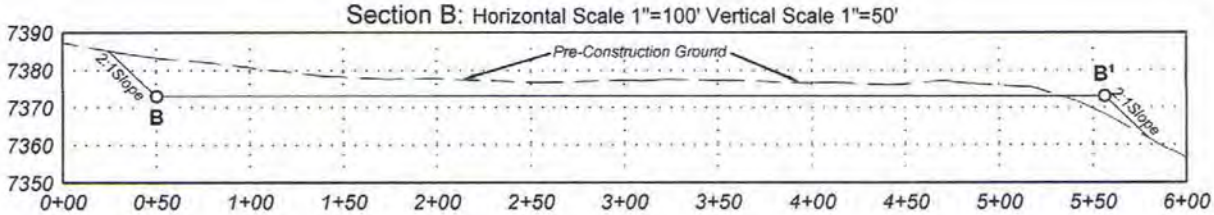
SURVEYED BY: DGN	DWG DATE: 10/07/15	AECOM David G. Nicewicz, PLS 804 Colorado Ave, Suite 201 Glenwood Springs Co 81610 cell: (720) 456-1104 email: david.nicewicz@aecom.com
DRAFTED BY: MLD	SCALE: 1" = 60'	
JOB NO.: 22244264.70300		SHEET NO. 1 of 2

AECOM

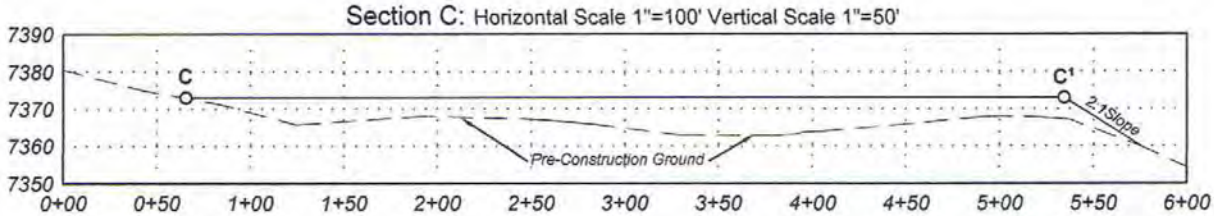
Section A: Horizontal Scale 1"=100' Vertical Scale 1"=50'



Section B: Horizontal Scale 1"=100' Vertical Scale 1"=50'



Section C: Horizontal Scale 1"=100' Vertical Scale 1"=50'



Scale: 1" = **100** U.S. Survey feet

COLORADO REGISTERED PROFESSIONAL LAND SURVEYOR DAVID G. NICEWICZ 24963 9/28/15

GAS WELL LAYOUT CROSS SECTIONS

FEDERAL 12-89-07 #1
Located in the SE 1/4 Section 7,
Township 12 South, Range 89 West, 6th P.M.,
Gunnison County, Colorado

SURVEYED BY: DGN	DWG DATE: 09/27/2015	AECOM David G. Nicewicz, PLS 804 Colorado Ave, Suite 201 Glenwood Springs Co 81610 cell: (720) 456-1104 email: david.nicewicz@aecom.com
DRAFTED BY: MLD	SCALE: 1" = 100'	
JOB NO.: 22244264.70300		SHEET NO. 2 of 2

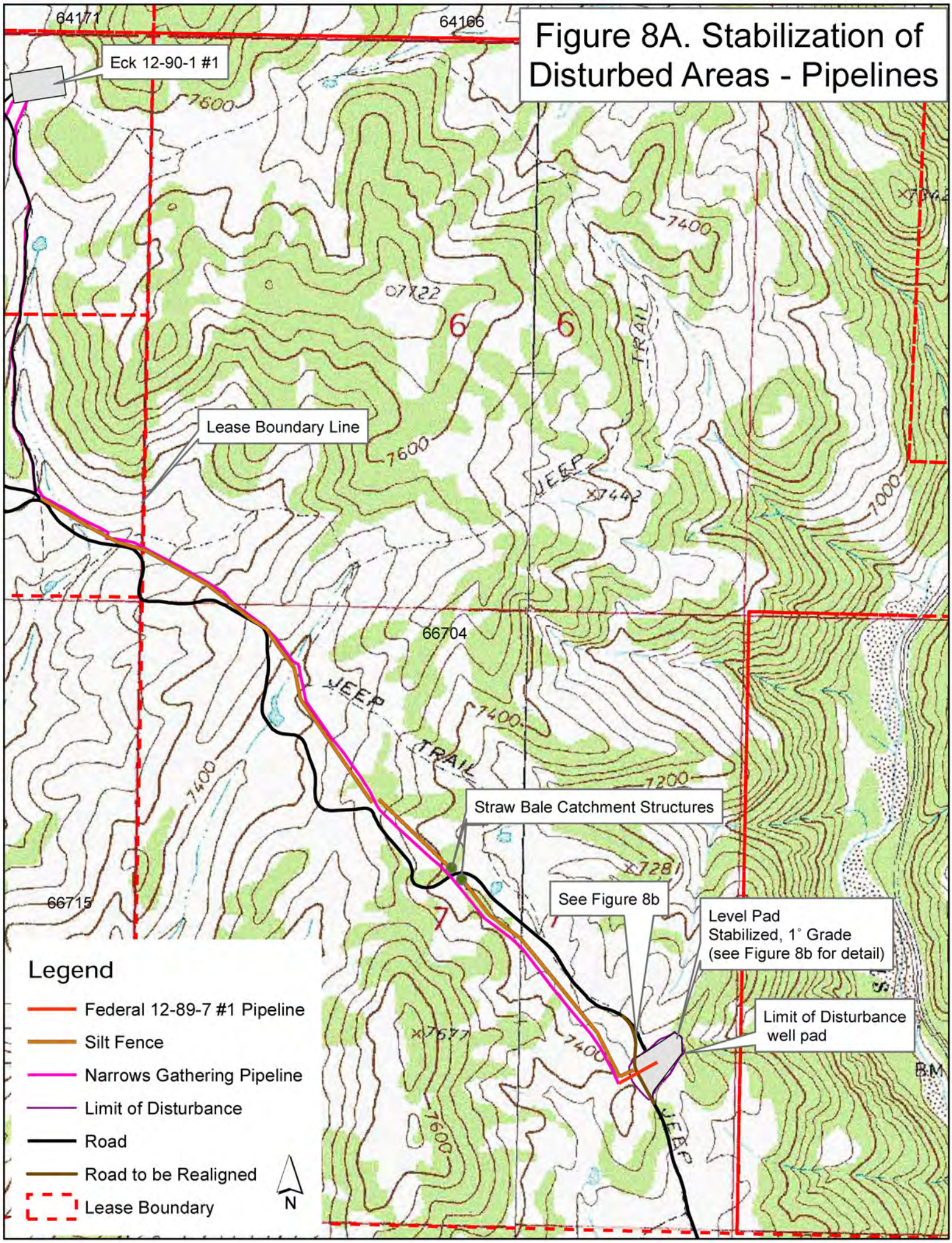


Figure 8A. Stabilization of Disturbed Areas - Pipelines
64171
64166
Eck 12-90-1 #1
7600
7400
7722
6
6
TRAIL
Lease Boundary Line
7600
JEEP
7442
7000
66704
JEEP
7400
TRAIL
7400
7200
Straw Bale Catchment Structures
7281
See Figure 8b
Level Pad
Stabilized, 1° Grade
(see Figure 8b for detail)
66715
7
7
Limit of Disturbance
well pad
7677
7400
7600
JEEP
B.M.
Legend
Federal 12-89-7 #1 Pipeline
Silt Fence
Narrows Gathering Pipeline
Limit of Disturbance
Road
Road to be Realigned
Lease Boundary
N

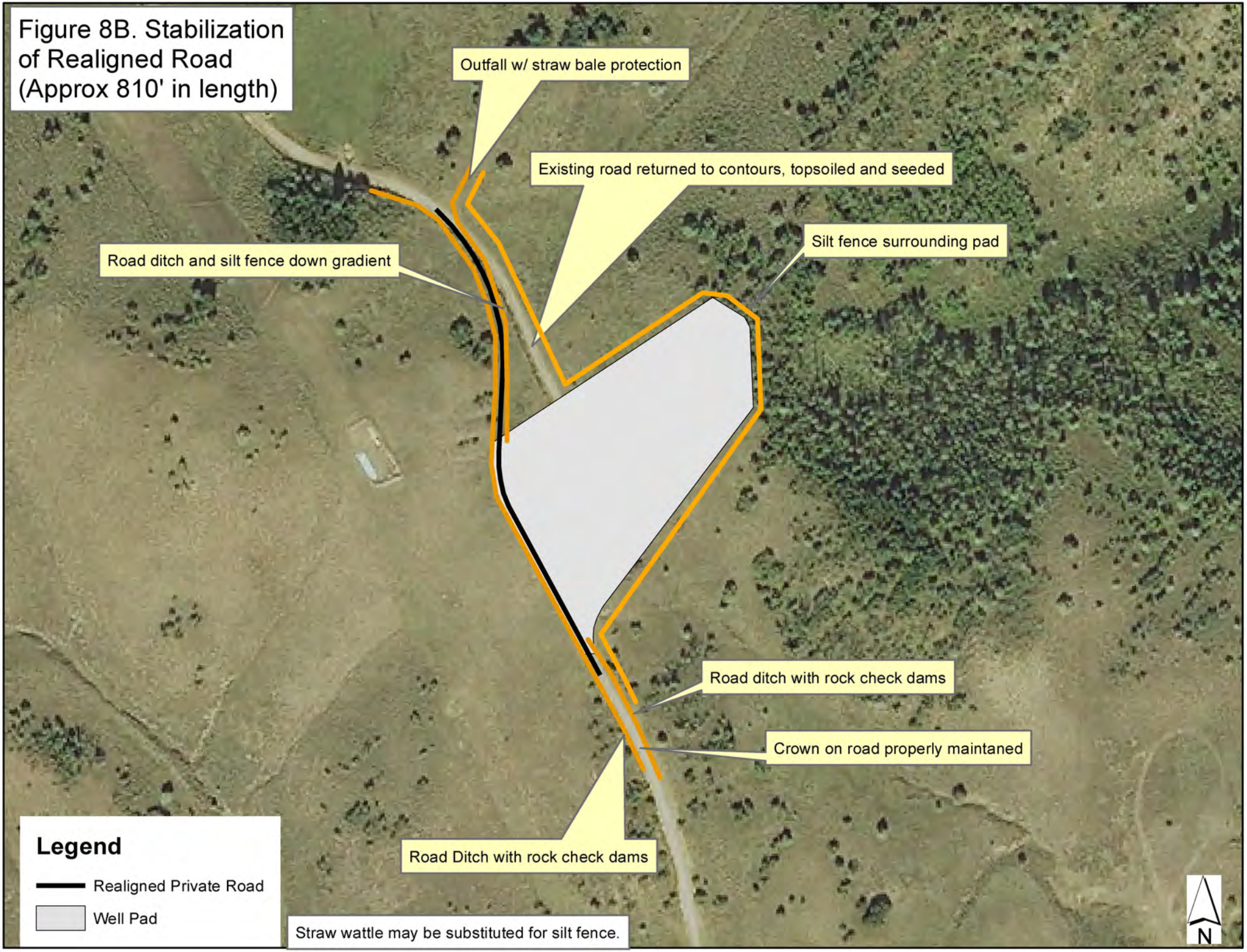


Figure 8B. Stabilization of Realigned Road (Approx 810' in length)
Outfall w/ straw bale protection
Existing road returned to contours, topsoiled and seeded
Silt fence surrounding pad
Road ditch and silt fence down gradient
Road ditch with rock check dams
Crown on road properly maintaned
Road Ditch with rock check dams
Legend
Realigned Private Road
Well Pad
Straw wattle may be substituted for silt fence.
N

Attachment 1

Recorded Surface Use Agreement

Stella Dominguez, Gunnison County, CO
Rec Fee: $21.00 Doc Fee: $0.00 eRecorded

NOTICE OF ADDENDUM TO SURFACE USE AND DAMAGE AGREEMENT

Notice is hereby given that Hotchkiss Ranches, Inc., Owner, has entered into a written ADDENDUM TO SURFACE USE AND DAMAGE AGREEMENT (hereinafter called "AGREEMENT") dated 2/22/12, that is now valid and subsisting with SG Interests VII, Ltd.. Said ADDENDUM TO SURFACE USE AND DAMAGE AGREEMENT is applicable to the following described lands in Gunnison County, Colorado.

Township 12 South, Range 89 West, 6th P.M.

Section 6: All
Section 7: All

Township 12 South, Range 90 West, 6th P.M.

Section 1: SW/4
Section 2: E/2SE/4. SW/4SE/4
Section 11: SE/4, SE/4NE/4, W/2NW/4
Section 12: All,

Gunnison County, Colorado,

also described in a Notice of Surface Use and Damage Agreement recorded in the Clerk and Recorder's Office, Gunnison County, Colorado, at Reception No. 546004.

This Addendum shall supercede and replace that Surface Use and Damage Agreement executed between these same parties on July 14, 2004 and acknowledged by Notice of Surface Use and Damage Agreement

recorded at Reception No. 546004 in the Clerk and Recorder's Office in Gunnison County, Colorado.

Any party needing further information concerning this Addendum shall contact one of the parties to this Addendum. Addresses are as follows:

SG Interests VII, Ltd.
100 Waugh Drive, Suite 400
Houston, TX 77007

Hotchkiss Ranches Inc., a Colorado Corporation
P.O. Box 479
Hotchkiss, CO 81419

This Notice is given this 22nd day of Feb, 2012.

Hotchkiss Ranches, Inc., a Colorado Corporation

By: _____

Brian K. Farmer, President

SG Interests VII, Ltd., a Texas limited partnership

By: Gordy Oil Company, General Partner

By: _____

Robert H. Guinn, II, Vice-President-Land

ACKNOWLEDGMENT

STATE OF COLORADO)

)ss.

COUNTY OF DELTA)

The foregoing instrument was acknowledged before me this 2nd day of Feb., 2012, by Brian K. Farmer, President of Hotchkiss Ranches, Inc., a Colorado Corporation,

Witness my hand and official seal.

My Commission Expires:
5-24-2015

Lee Ann Slaughter

Notary Public

LEE ANN SLAUGHTER
NOTARY PUBLIC
STATE OF COLORADO
My Commission Expires 05/24/2015

STATE OF TEXAS)

)ss.

COUNTY OF HARRIS)

The foregoing instrument was acknowledged before me this 28th day of February 2012, by Robert H. Guinn, II, Vice President Gordy Oil Company, General Partner of SG Interests VII, Ltd.

Witness my hand and official seal.

My Commission Expires:
4-18-14

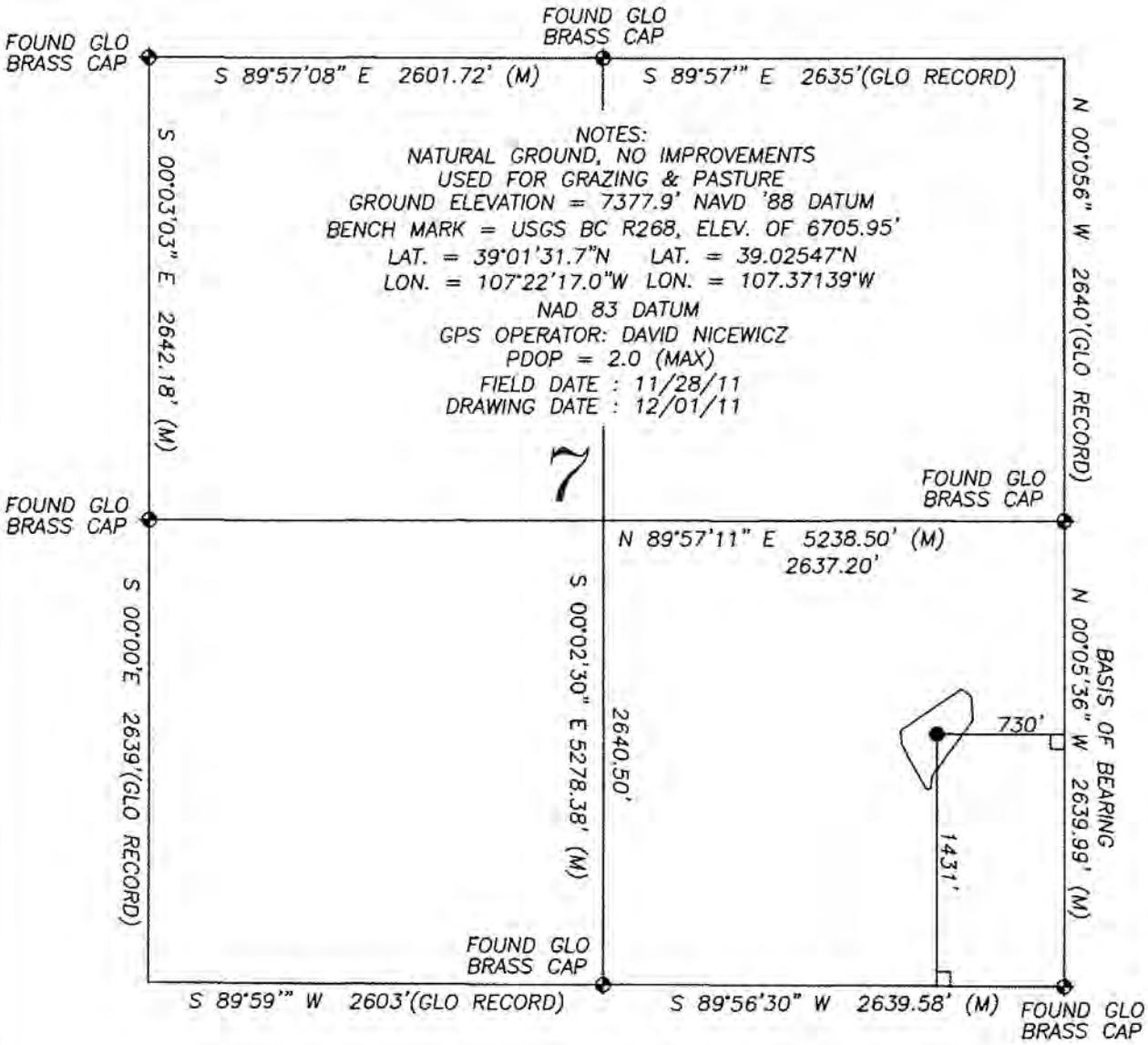
JONI BYRD
Notary Public, State of Texas
My Commission Expires
April 18, 2014

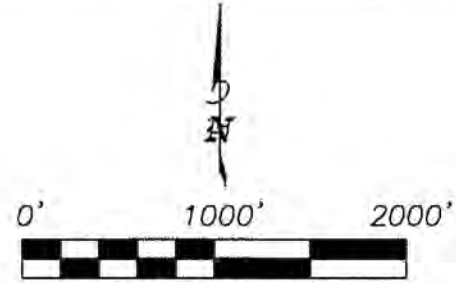
Joni Byrd

Notary Public

Attachment 2

Well Plat and Electronic Geospatial Data *(previously provided)*





GRAPHIC SCALE
1" = 1000 U.S. SURVEY FEET

LEGEND

- FOUND GLO BRASS CAP ON STEEL POST
- WELL HEAD
- (M) MEASURED IN FIELD
- ∟ 90° SYMBOL

BASIS OF BEARING:
THE LINE FROM THE SE CORNER TO THE E 1/4 CORNER OF SECTION 7, TOWNSHIP 12 SOUTH, RANGE 89 WEST, 6TH P.M., WAS ASSUMED TO BEAR N 00°05'36" W AS MONUMENTED AND SHOWN HEREON.

CERTIFICATE OF SURVEY:
I, DAVID G. NICEWICZ, A REGISTERED PROFESSIONAL LAND SURVEYOR IN THE STATE OF COLORADO, DO HEREBY CERTIFY THAT THE SURVEY REPRESENTED BY THIS PLAT WAS MADE UNDER MY DIRECTION AND SUPERVISION AND THAT THIS PLAT ACCURATELY REPRESENTS THIS SURVEY.

12/7/11

DAVID G. NICEWICZ, P.L.S. NO. 24963

COLORADO REGISTERED DAVID G. NICEWICZ 24963 PROFESSIONAL LAND SURVEYOR

E. SCHAAF AND ASSOC., INC. OF DELTA, COLORADO, has in accordance with a request from ERIC SANFORD, for SG INTERESTS I, LTD, determined the location of FEDERAL 12-89-7 #1 to be 1431' FSL & 730' FEL Section 7, Township 12 South, Range 89 West, of the Sixth Principal Meridian, Gunnison County, Colorado.

GAS WELL LOCATION

FEDERAL 12-89-7 #1
LOCATED IN S. 7, T. 12 S., R. 89 W., 6th P.M.
GUNNISON COUNTY, COLORADO

SURVEYED BY	DATE	E. SCHAAF AND ASSOC., INC.	
DGN	12/01/11	340 PALMER ST., DELTA, CO. 81416	
DRAWN BY	SCALE	ACCT. NO.	
FRM	1"=1000'	WE11155SG	SG INT

Attachment 3
Listed weeds.

The following noxious weeds are listed noxious weeds by the state of Colorado, included in the Gunnison Basin Weed District Management Plan, or listed by the BLM. 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. The state also maintains a Watch List for weeds that pose a threat to agriculture and the environment of Colorado. The goal for weeds on the Watch List is to further understanding of their distribution in order to determine if they should receive official listing.

Weed Name	**Scientific Name**	**County Listed**	**Colorado (A, B, C Listed or W for Watch List)**	**BLM Listed**
Velvetleaf	*Abutilon theophrasti*		C	
Russian knapweed	*Acroptilon repens*		B	
Jointed goatgrass	*Aegilops cylindrica*		B	√
Camelthorn	*Alhagi pseudalhagi*		A	√
European beachgrass	*Ammophila arenaria*			√
Spurred anoda	*Anoda cristata*		B	
Scentless chamomile	*Anthemis arvensis*		B	√
Mayweed chamomile	*Anthemis cotula*		B	√
Burdock	*Arctium minus*		C	√
Absinth wormwood	*Artemisia absinthium*	√	B	
Giant reed	*Arundo donax*		A	√
Fivehorn smotherweed	*Bassia hyssopifolia*			√
Black mustard	*Brassica nigra*			√
Wild turnip	*Brassica tournefortii*		W	√
Ripgut brome	*Bromus diandrus*			√
Japanese brome	*Bromus japonicas*			√
Red brome	*Bromus rubens*			√
Downy brome	*Bromus tectorum*		C	√
Mexican bird-of-paradise	*Caesalpinia gilliesii*			√
Lens-podded whitetop	*Cardaria chalepensis*			√
Hoary cress	*Cardaria draba*	√	B	√
Plumeless thistle	*Carduus acanthoides*	√	B	√
Musk thistle	*Carduus nutans*	√	B	√
Italian thistle	*Carduus pycnocephalus*			√
Slender-flowered thistle	*Carduus teniflora*			√
Sea iceplant	*Carpobrotus chilensis*			√
Hottentot fig	*Carpobrotus edulis*			√
Distaff thistle	*Carthamus lantus*			√
Common caraway	*Carum carvi*		B	√
Longspur sandbur	*Cenchrus longispinus*			√
Purple starthistle	*Centaurea calcitrapa*			√
Cornflower	*Centaurea cyanus*			√
Diffuse knapweed	*Centaurea diffusa*	√	B	√
Iberian starthistle	*Centaurea iberica*			√

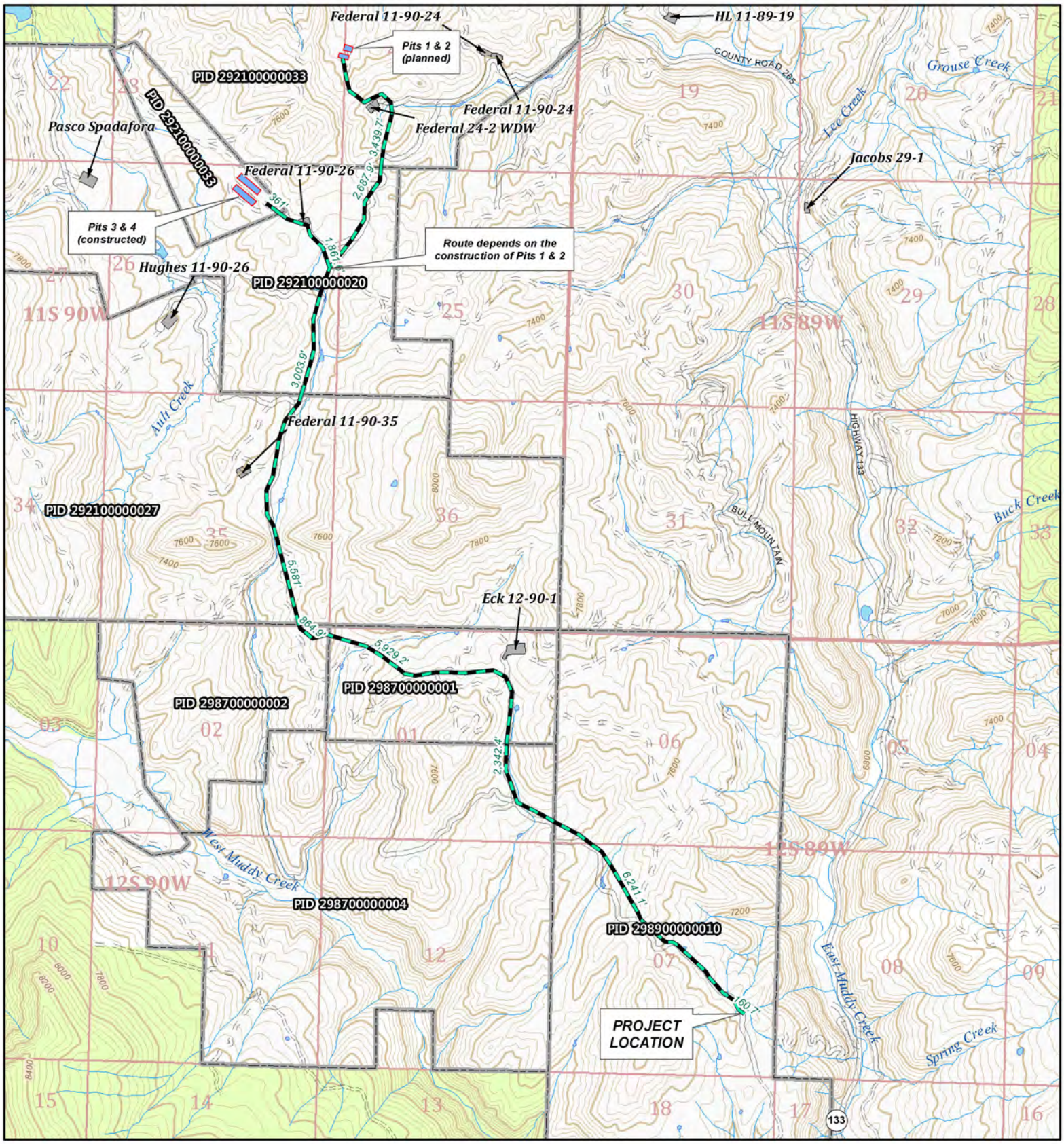
Weed List Cont.				
Weed Name	**Scientific Name**	**County Listed**	**Colorado (A, B, C Listed or W for Watch List)**	**BLM Listed**
Brown knapweed	*Centaurea jacea*			√
Bighead knapweed	*Centaurea macrocephala*			√
Spotted knapweed	*Centaurea maculosa*	√	B	√
Malta starthistle	*Centaurea melitenisis*			√
Mountain cornflower	*Centaurea montana*			√
Black knapweed	*Centaurea nigra*			√
Vochin knapweed	*Centaurea nigrescens*			√
Meadow knapweed	*Centaurea pratensis*		A	√
Russian knapweed	*Centaurea repens*	√	B	√
Yellow starthistle	*Centaurea solstitialis*		A	√
Feather-headed knapweed	*Centaurea trichocephal*			√
Squarrose knapweed	*Centaurea virgata*		A	√
Chicory	*Chichorium intybus*		C	√
Rush skeletonweed	*Chondrilla juncea*		A	√
Oxeye Daisy	*Chrysanthemum leucanthemum*	√	B	√
Canada thistle	*Cirsium arvense*		B	√
Bull thistle	*Cirsium vulgare*		B	√
Chinese clematis	*Clematis orientalis*		B	√
Poison hemlock	*Conium maculatum*		C	√
Field bindweed	*Convolvulus arvensis*	√	C	√
Andean pampas grass	*Cortaderia jubata*		W	√
Pampas grass	*Cortaderia selloana*			√
Bristly hawkweed	*Crepis setosa*			√
Common crupina	*Crupina vulgaris*		A	√
Artichoke thistle	*Cynara cardunculus*			√
Bermudagrass	*Cynodon dactylon*			√
Houndstongue	*Cynoglossum officinale*		B	√
Spanish broom	*Cytisus junceum*			√
French broom	*Cytisus monspessula*			√
Scotch broom	*Cytisus scoparius*		W	√
Portugese broom	*Cytisus striatus*			√
Foxglove	*Digitalis purpurea*			√
Common teasel	*Dipsacus fullonum*		B	√
Blueweed	*Echium vulgare*			√
Brazilian waterweed	*Egeria densa*			√
Veldt grass	*Ehrharta calycina*			√
Water hyacinth	*Eichhornia crassipes*		W	√
Russian olive	*Elaeagnus angustifolia*		B	√
Quackgrass	*Elytrigia repens*		B	√
Lehmann lovegrass	*Eragrostis lehmanniana*			√
Australian fireweed	*Erechtites glomerata*			√
Redstem filaree	*Erodium cicutarium*		C	
Cypress spurge	*Euphorbia cyparissias*		A	√
Leafy spurge	*Euphorbia esula*	√	B	√

Weed List Cont.				
Weed Name	**Scientific Name**	**County Listed**	**Colorado (A, B, C Listed or W for Watch List)**	**BLM Listed**
Myrtle spurge	*Euphorbia myrsinites*		A	√
Edible fig	*Ficus carica*			√
Fennel	*Foeniculum vulgare*			√
Goat's rue	*Galega officinalis*			√
Baby's breath	*Gypsophila paniculata*		W	√
Halogeton	*Halogeton glomeratus*		C	√
Dame's rocket	*Hesperis matronalis*	√	B	√
Venice mallow	*Hibiscus trionum*		B	
Orange hawkweed	*Hieracium aurantiacum*	√	A	√
Mouseear hawkweed	*Hieracium pilosella*			√
Yellow hawkweed	*Hieracium pretense*			√
Hydrilla	*Hydrilla verticillata*		A	√
Black henbane	*Hyoscyamus niger*	√	B	√
Common St. Johnswort	*Hypericum perforatum*		C	√
Dyer's Woad	*Isatis tinctoria*		A	√
Blue buttons	*Knautia arvensis*			√
Everlasting peavine	*Lathyrus latifolius*			√
Perennial pepperweed	*Lepidium latifolium*		B	√
Himalayan bush clover	*Lespedeza cuneata*		W	√
Dalmation toadflax	*Linaria dalmatica*	√	B	√
Yellow toadflax	*Linaria vulgaris*	√	B	√
Garden loosestrife	*Lysimachia vulgaris*			√
Purple loosestrife	*Lythrum salicaria*	√	A	√
Wand loosestrife	*Lythrum virgatum*			√
Chilean tarweed	*Madia sativa*			√
Eurasian milfoil	*Myriophyllum spicatum*		B	√
Matgrass	*Nardus stricta*			√
Scotch thistle	*Onopordum acanthium, O. taricum*	√	B	√
Wild proso millet	*Panicum miliaceum*		C	√
African rue	*Peganum harmala*		A	√
Crimson fountain grass	*Pennisetum setaceum*			√
Bulbous bluegrass	*Poa bulbosa*		C	
Japanese knotweed	*Polygonum cuspidatum*		A	
Giant knotweed	*Polygonum sachalinense*		A	
Bohemian knotweed	*Polygonum x bohemicum*			
Sulphur cinquefoil	*Potentilla recta*		B	√
Bridal veil broom	*Retama monosperma*			√
Himalayan blackberry	*Rubus discolor*		W	√
Mediterranean sage	*Salvia aethopis*		A	√
Giant salvinia	*Salvinia molesta*		A	
Bouncing bet	*Saponaria officinalis*		B	√
Brazilian pepper	*Schinus terebrinthifolius*			√
Schismus	*Schismus arabicus*			√
Tansy ragwort	*Senecio jacobaea*		A	√
German ivy	*Senecio mikanoides*			√

Weed List Cont.				
Weed Name	**Scientific Name**	**County Listed**	**Colorado (A, B, C Listed or W for Watch List)**	**BLM Listed**
Bitter nightshade	*Solanum dulcamara*			√
Perennial sowthistle	*Sonchus arvensis*		C	√
Johnsongrass	*Sorghum halepense*		C	√
Medusahead	*Taeniatherum caputmedusae*		A	√
Tamarisk	*Tamarix parviflora, T. ramosissima, T gallica, T. chinensis, T. pentanda, T. aphylla*	√	B	√
Common tansy	*Tanacetum vulgare*		B	√
Puncturevine	*Tribulus terrestris*		C	
Gorse	*Ulex europaeus*			√
Siberian elm	*Ulmus pumila*			√
Moth mullein	*Verbascum blattaria*		B	
Common mullein	*Verbascum thapsus*		C	

Attachment 4

Poly Pipeline Route



Temp. Poly Pipeline (above ground)

Flowback pit

Parcel Boundary (crossed by pipeline)

Existing pad/facility

Existing Road

Improved road

Unimproved road

Temp. Poly Pipeline Option: Pits 1 and 2

Parcel Number	Owner	Pipe segment length (ft)
292100000033	Rock Creek Ranch	3,439.7
292100000020	Aspen Leaf Ranch Inc.	5,691.73
292100000027	Nick R. Hughes	5,581.0
298700000002	Nick R. Hughes	864.9
298700000001	Gunnison Hunting Properties, LLC	5,929.2
298700000004	Hotchkiss Ranches Inc.	2,342.4
298900000010	Hotchkiss Ranches Inc.	6,401.8
Total		**30,250.6**

Temp. Poly Pipeline Option: Pits 3 and 4

Parcel Number	Owner	Pipe segment length (ft)
292100000033	Rock Creek Ranch	361
292100000020	Aspen Leaf Ranch Inc.	4865.4
292100000027	Nick R. Hughes	5581
298700000002	Nick R. Hughes	864.9
298700000001	Gunnison Hunting Properties, LLC	5929.2
298700000004	Hotchkiss Ranches Inc.	2342.4
298900000010	Hotchkiss Ranches Inc.	6,401.8
Total		**26,345.7**

SG Interests I Ltd.
Federal 12-89-7 #1

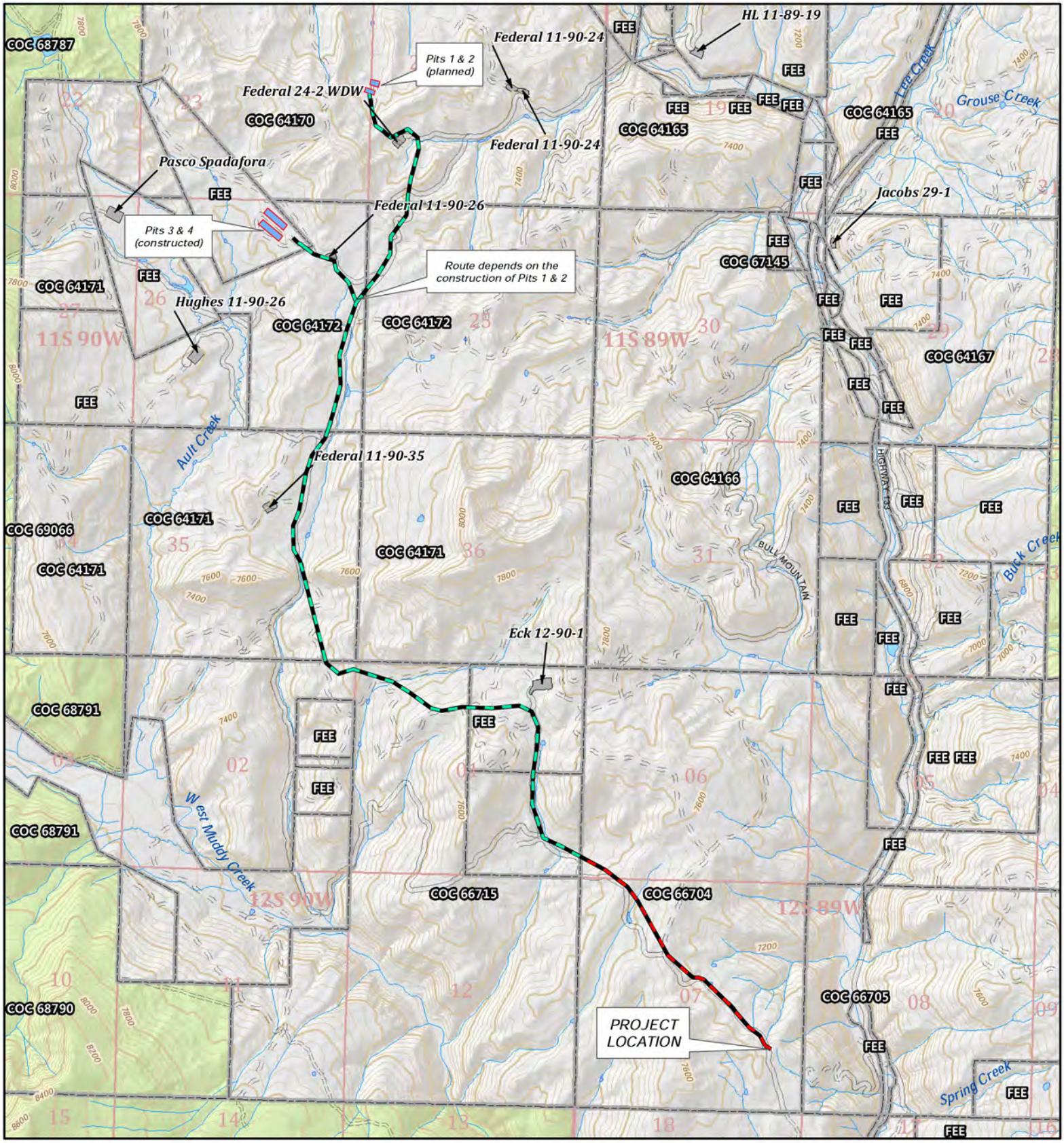
Temporary Poly Pipeline Route

0 0.5 1 Miles

1 in = 3,000 feet

Disclaimer: This product is for informational purposes and may not have been prepared for, or be suitable for legal, engineering, or surveying purposes. Users of this information should review or consult the primary data and information sources to ascertain the usability of the information.

Prepared for SG Interests I Ltd. by TerraCognito GIS, Inc. September 2015



Pits 1 & 2: Temporary Poly Pipeline
- On-lease segment (6,401.8')
- Off-lease segment (23,848.9')

Pits 3 & 4: Temporary Poly Pipeline
- On-lease segment (6401.8')
- Off-lease segment (19,943.9')

- Flowback pit
- Lease Boundary (crossed by pipeline)
- Existing pad/facility

Existing Road
- Improved road
- Unimproved road

SG Interests I Ltd.
Federal 12-89-7 #1

Temporary Poly Pipeline Route

0 0.5 1 Miles
1 in = 3,000 feet

Disclaimer: This product is for informational purposes and may not have been prepared for, or be suitable for legal, engineering, or surveying purposes. Users of this information should review or consult the primary data and information sources to ascertain the usability of the information.

Prepared for SG Interests I Ltd. by TerraCognito GIS, Inc. September 2015

SG Interests I, Ltd.
1485 Florida Road, Suite C202
Durango, Colorado 81301

Federal 12-89-7 #1
Lease Number: COC66704
Bull Mountain Unit: COC67120X
1431' FSL, 730' FEL Sec. 7 T12S R89W
Gunnison County, CO

EIGHT POINT DRILLING PROGRAM

The proposed Federal 12-89-7 #1 well is a vertical well to complete in the [redacted]. It is proposed to set and cement 16" conductor pipe to +/-80', drill a 12-1/4" surface hole to ± 970' MD, run and cement with cement returns to surface 9-5/8" surface casing, drill 8-1/2" production hole to [redacted], run and cement 5-1/2" production casing with cement returns to surface. Log offsets for this well are Hotchkiss Federal 18-31, Hotchkiss Federal 17-11, and Hotchkiss Federal 1-34.

1. Estimated formation tops:

Federal 12-89-7 - 1 (VERTICAL)		
Datum = Ground Level True Vertical Measured Depth in Feet		
Formation/Group	**Depth of Top (feet, TVD)**	**Thickness (feet)**
Wasatch	Surface	950
Ohio Creek	950	350
Williams Fork (top of the Mesaverde)	1,300	1,800
Rollins Sandstone	3,100	950
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]

2. Estimated depth and thickness of formations:

Federal 12-89-7 - 1 (VERTICAL)				
Datum = Ground Level True Vertical Measured Depth in Feet				
Type	Name	Depth (feet)	Thickness (feet)	Lithology
None	Wasatch	0	950	Sand-Shale
None	Ohio Creek	950	350	Sand-Shale
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

3. Minimum Specifications for Pressure Control Equipment:

BOP equipment and accessories will meet or exceed BLM requirements outlined in 43 CFR Part 3160. A 3,000 or a 5,000 psig double ram hydraulic BOP will be used (see attached diagram) for the production portion of the well (970' – [redacted]). Maximum anticipated formation pressure is 2,000 – 2,200 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% 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 1,500 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" adjustable and 3" positive chokes, and pressure gauge.

4. Casing and Cementing Program:

Casing	MD
16” conductor pipe	80’
9 5/8” surface casing	970’
5 ½” production casing	[redacted]

String	Size of Hole	Size of Casing	Weight Per Foot (lbs)	Grade	Setting Depth (MD)	Sacks Cement	Cement Bottom	Cement Top
Conductor	24”	16”	65	J-55	80’	185	80’	Surface (0’)
Surface	12 1/4”	9 5/8”	40	J-55	970’	370	970’	Surface (0’)
Production	8.5”	5 1/2”	17	P-110	[redacted]	[redacted]	[redacted],	Surface (0’)

Procedure:

Drill 8-1/2” Production hole to [redacted] utilizing Water Base Mud.

1. POOH.
2. Run 5-1/2” Production Casing to TD and cement same to surface.
3. Rig down and release rig.

5. Mud Program:

A native water based spud mud system (FW) will be used for the surface hole (970' of 12-1/4" hole, set 9-5/8" casing). Primary product used will be gel for viscosity control.

A low-solids, non-dispersed gel system (LSND) will be used throughout the production hole [redacted]. Products used may include but not be limited to Barite for weighting material, gel for viscosity control, lime for alkalinity control, 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. Holes 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.

Depth	Type	Wt (ppg)	Vis (sec)	Wtr loss	Solids
0-970’	FW	± 8.5-8.7	30-40	NC	<7%
970’[redacted]	LSND	± 8.7-9.5	40-70	6-8 cc	<7%

6. Testing, Coring and Logging Program:

Openhole logs will include GR, Induction, Caliper, and Density logs from intermediate casing to surface casing and GR-MWD log from TD to intermediate casing. Mud logging services will be placed on the well from immediately below surface casing (970 ft.) to TD. The Mud logging services include gas detection and monitoring, drilling sample collection and examination for lithology every 30 ft.

Open hole testing such as Drill Stem Testing or Repeat Formation Tester is not planned. No coring of any type is planned. If a decision is made to complete the well, casing will be run and the well will be tested through perforations. Cased hole logs (CBL) will be used to evaluate cement behind pipe in both the surface casing and production intervals.

7. Anticipated Drilling Conditions: Pressures, Temperatures, Lost Circulation, H2S, etc.:

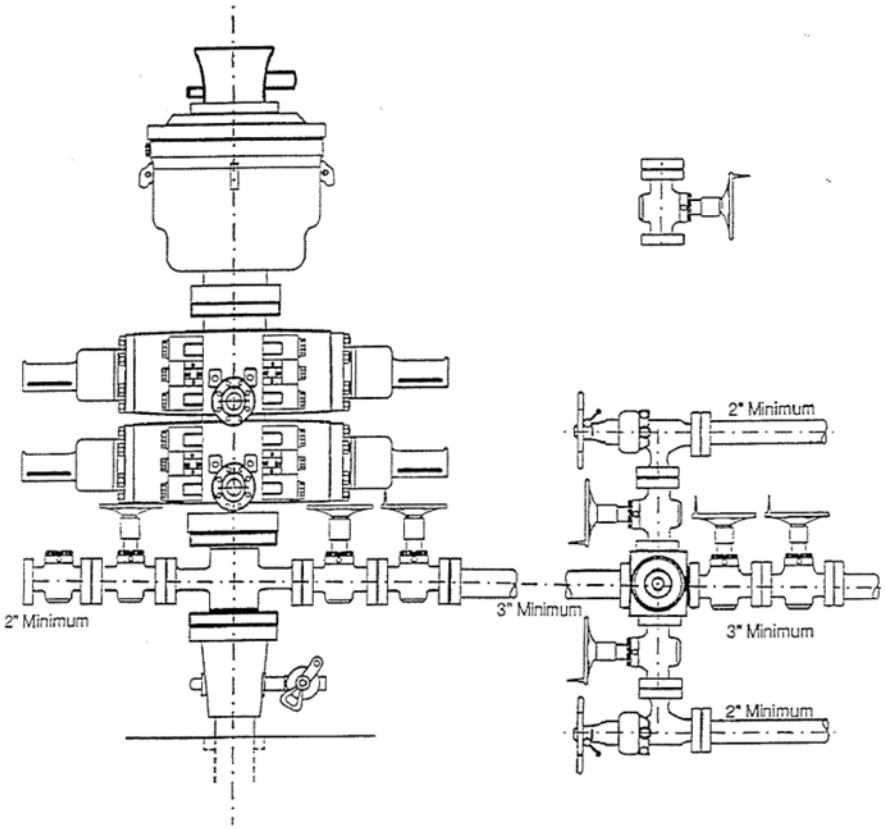
No abnormal pressures or temperatures are expected in this well. Maximum anticipated reservoir pressure at TD is 2,000 – 2,200 psig with a normal temperature gradient. Lost circulation is possible. Lost circulation material will be maintained on location. Both the surfaces and production strings will be cemented to surface. No H2S is expected nor has H2S been encountered in the drilling of any previous wells.

8. Operations:

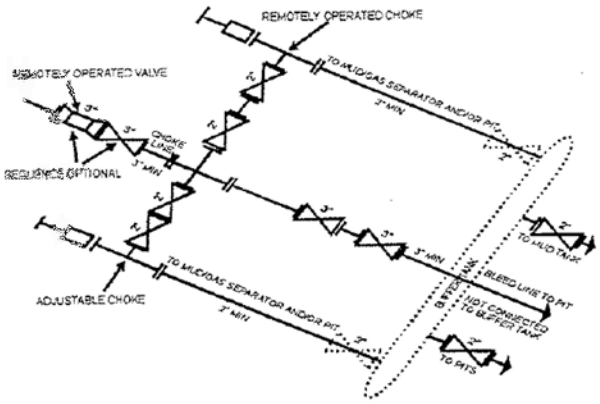
Anticipated spud date is July 15, 2014 or as soon as permits are received and work can be scheduled. Estimated drilling time is 10-15 days. The well will be completed as a cased hole completion, perforated and hydraulically fracture stimulated. Completion operations are expected to take 7-14 days and will commence as soon after completion of drilling operations and scheduling allow.

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. When 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]